زبان تخصصی

مجموعهٔ شیمی

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Contents

Summary of abbreviations and symbols

n.	noun
v.	verb
adj.	adjective
adv.	adverb
prep.	preposition
pl.	word only used in the plural
s.o.	someone
sth.	something
e.g.	for example
i.e.	that is to say; in other words
etc.	and so on
(U)	uncountable word
(C)	countable word
≠	opposite
[not I lost the bus]	indicates that a word or an expression is wrong

Lesson 1

Spectroscopy

"All words are pegs to hang ideas on"
Henry ward Beecher

distribute *v.* allocate, circulate, disperse, scatter, spread
antonyms: collection, gathering
orbit *n.* circle, compass, path, range, scope, sweep, trajectory
orbital *n.* an electron cloud with an energy state characterized by given values of *n,l,m*
vibrate *v.* judder, oscillate, pulsate, shake, swing, tremble, undulate
rotation *n.* cycle, gyration, orbit, revolution, spin, spinning, succession, turn, turning
adjacent *adj.* abutting, adjoining, along side, beside, bordering, juxtaposed, near, neighboring, next, touching
antonyms: distant, remote
excite *v.* affect, agitate, animate, arouse, awaken, disturb, elate, engender, evoke, fire, foment, ignite, impress, induce, instigate, touch, turn on, upset, waken, quell
antonyms: apathetic, composed
photon *n.* individual quantum of radiant energy of wavelength.
wavelength *n.* the distance between two similar points an a wave of energy such as light or sound.
pattern *n.* 1. method, order, plan, system 2. decoration, design, figure, motif, ornamentation 3. guide model, prototype, stencil, template
absorb *v.* assimilate, consume, devour, digest, drink in, engross, immerse, monopolise, suck up, take in
antonyms: dissipate, exude
emission *n.* diffusion, ejection, emanation, exhalation, radiation, release, vent
antonyms: absorption
spectroscopy *n.* the study of methods of producing and analyzing spectra.
dissociate *v.* break off, detach, disband, disconnect, disrupt, distance, divorce, isolate, segregate
antonyms: associate, attach, share, unite
trigger *v.* activate, cause, elicit, generate, initiate, produce, prompt, provoke, set off, spark off, start
arrangement *n.* array, design, layout, line-up, marshalling, method, order, organisation, planning, schedule, tabulation

The internal energy of molecule is ***distributed*** in several ways: in the arrangement of electrons in the **orbitals** of the molecule, and in the ***vibrations*** and ***rotations*** of the chemical bonds.According to quantum mechanics – the theory that explains the behaviour of objects the size of atoms and smaller – these energies can have only certain values. This gives rise to series of electronic, vibrational and rotational energy levels. The difference between ***adjacent*** energy levels is equevelent to a quantum of electromagnetic energy. The energy, ***E***, of this quantum is linked to its frequency, υ, by the relationship $E = h\upsilon$, where ***h*** is Planck's constant, 6.6×10^{-34} Js.

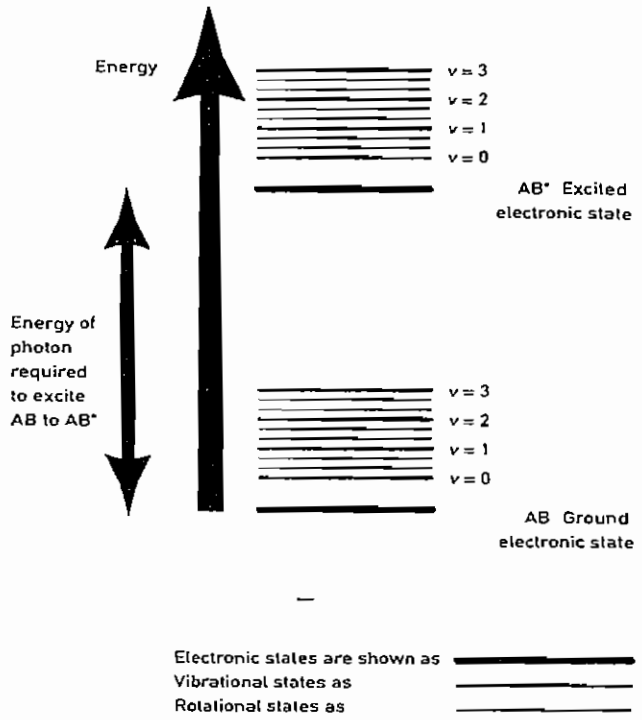


Figure 1. Energy levels in the ground state of a diatomic molecule and the excited state.

Each electronic level has a series of vibrational and rotational levels associated with it, Figure 1. Usually a molecule (AB) exists in its lowest energy level, or ground state but can be ***'excited'*** to a higher level (AB^*) by absorbing a **photon** of electromagnetic ***radiation*** with the appropriate frequency (or **wavelength**). Ultraviolet and visible wavelengths are needed to excite electronic levels, while vibrational and rotational levels absorb the lower-energy (longer-wavelength) infrared and microwave radiation. Once the molecule is in an excited state it may drop back to a lower energy level or the ground state, emitting radiation in the process.

The ***pattern*** of energy levels in a molecule is unique to that molecule. This means that the ***absorption*** spectrum of a molecule (the pattern of wavelengths it absorbs) and the ***emission*** spectrum (the pattern of wavelengths given out by an excited molecule) provide a way of identifying it. They can also help to solve its chemical structure or to measure its concentration.

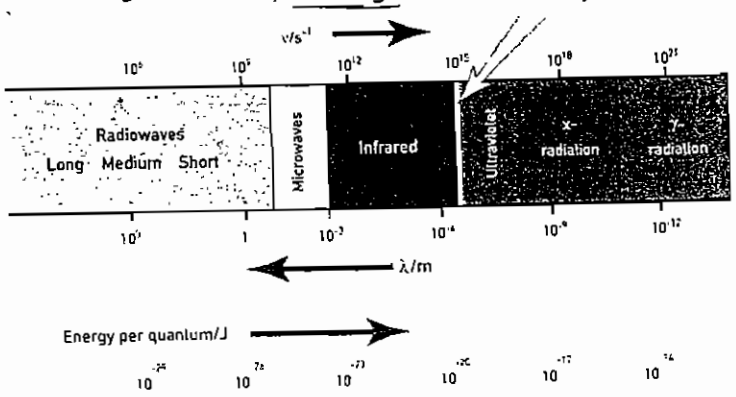


Figure 2. The electromagnetic spectrum.

Indeed modern **spectroscopy** is a key analytical in following chemical reactions.

The energy, frequency and wavelength of different types of electromagnetic radiation are linked by the expressions $E = h\upsilon$, and $c = \upsilon\lambda$ where λ is the wavelength and c the speed of electromagnetic radiation ('the speed of light', 3×10^8 m s^{-1}) as shown in Figure 2.

To undergo a reaction the molecule has to absorb enough energy not only to excite it to a higher energy level but also to cause it to break up, or ***dissociate***, So, many reactions can be ***triggered*** by light. The resulting transfer of electrons brings about a ***rearrangement*** of bonding and thus the formation of new molecules.

1. The energy of a covalent bond is 400 kJ ol . This is the energy of a mole of bonds. What is the energy of just one bond? What frequency of electromagnetic radiation does this correspond to? What is the equivalent wavelength? What region of the electromagnetic spectrum does it fall into?

Spectroscopy can be used to ***idnetify*** the short-lived molecules which exist during the steps of this process. If carried out over a number of time intervals, it can also monitor the changing concentrations of these chemical species, thus probing how fast the reaction goes – in other words, the rate of reaction, often called the reaction kinetics.

A. General Vocabulary Practice

Directions: put the number of the definition in column B beside the correct word in column A.

A	B
....1.... a. absorb	1. allocate
..... b. adjacent	√2. start
..... c. dissociate	√3. instigate
..... d. distribute	4. detach
..... e. emission	√5. spinning
....1... f. excite	√6. radiation
...√.... g. pattern	√7. take in
....1.... h. rotation	√8. motif
...√.... i. trigger	√9. oscillate
..8..... j. vibrate	√10. juxtaposed

B. Directions: select a word in column B which is opposite in meaning to a word in column A.

A	B
	1. include
..... a. airy	2. stimulate
..... b. defrost	√3. uncomfortable
..... c. expand	4. perhaps
..... d. convenient	√5. airless
..... e. complimentary	6. not free
..... f. eliminate	√7. limit
..... g. wide-ranging	8. tasteful
..... h. well-being	9. limited in scope
..... i. addition	10. lack of health and happiness
..... j. undoubtedly	11. subtraction
	√ 12. freeze

C. Read the following passage and choice the best answer to each question

Diamonds, an occasional component of rare igneous rocks called lamproites and kimberlites, have never been dated satisfactorily. However, some diamonds contain minute inclusions of silicate minerals, commonly olivine, pyroxene, and garnet. These minerals can be dated by radioactive decay thechniques because of the very small quantities of radioactive trace elements they, in trun, contain. Usually, it is possible to conclude that the inclusions are older than their diamond hosts, but with little indication of the time interval involved. Sometimes, however, the crystal form of the silicate inclusions is observed to resemble more closely the internal structure of diamond than that of other silicate minerals. It is not known how rare this resemblance is, or whether it is most often seen in inclusions of silicates such as garnet, whose crystallography is generally somewhat similar to that of diamond; but when present, the resemblance is regarded as compelling evidence that the diamonds and inclusions are truly cogenetic.

1. The author implies that silicate inclusions were most often formed.

1) with small diamonds inside of them.
2) with trace elements derived from their host minerals.
3) by the radioactive decay of rare igneous rocks.
4) at an earlier period than were their host minerals.
5) from the crystallization of rare igneous material.

2. According to the passage, the age of silicate minerals included in diamonds can be determined due to a feature of the..... .

1) trace elements in the diamond hosts.
2) trace elements in the rock surrounding the diamonds.
3) trace elements in the silicate minerals.
4) silicate minerals' crystal structure.
5) host diamonds' crystal structure.

3. The author states that which of the following generally has a crystal structure similar to that of diamond?

1) Lamproite 2) Kimberlite 3) Olivine 4) Pyroxene
5) Garnet

4. The main purpose of the passage is to .....

1) explain why it has not been possible to determine the age of diamonds.
2) explain how it might be possible to date some diamonds.
3) compare two alternative approaches to determining the age of diamonds.
4) compare a method of dating diamonds with a method used to date certain silicate minerals.
5) compare the age of diamonds with that of certain silicate minerals contained within them.

LESSON 2

Catalysts

The catalytic cycle

"Good words anoint a man, ill words kill a man"

John Florio, First Fruites

bond *n.* 1. affiliation, attachment, connection, link 2. agreement, obligation

wide *adj.* broad, expanded

antonyms: limited, restricted

variety *n.* diversity, difference, multiplicity

antonyms: monotony, uniformity, similitude

spectator *n.* viewer, watcher

tune *n.* concert, harmony

tune *v.* adjust, adopt

modify *v.* improve, redesign, reorganise

react *v.* acknowledge, act, behave, function, operate, respond, work

link *n.* association, comtuent, bond, joint, liaison, part, piece, tie, tie-up, union

antonyms: separate, unfasten

subtle *adj.* delicate, faint, fine drawn, nice

antonyms: crude, obvious, unsophisticated

alter *v.* adapt, adjust, amend, change, convert, diversify, emend, recast, reform shift, transform, transmute, transpose, turn, vary

antonym: fix

shift, transform, transmute, transpose, turn, vary

antonym fix

claw *n.* gripper, nail, nipper, pincer, pounce, talon, tentacle, unguis

substrate *n.* the substance that is affected by the action of a catalyst.

profound *adj.* 1. extensive, extreme 2. serious

infinite *adj.* boundless, countless, enormous, immeasurable, inestimable, limitless

antonym: finite

selective *adj.* careful, discerning, discriminating, electric, particular

antonyms: indiscriminate, unselective

scope *n.* ambit, area, compass, range, latitude, confines

detach *v.* cutoff, disconnect, disjoin, dissociate, isolate, remove, segregate, separate

antonym: attach

gap *n.* blank, breach, break, chink, cleft, crack, crevice, divergence, divide, hole, interlude, interruption, interval, lull, rift, space, void

precise *adj.* absolute, accurate, actual, authentic, careful, correct, definite, exact, meticulous, strict, succinct, unequivocal

precision *n.* accuracy, care, correctness, detail, meticulousness, neatness, rigour

antonyms: imprecision, inaccuracy

surface *n.* covering, exterior, plan

antonyms: interior, inside

intermediate *adj.* halfway, in-between, intermediary, intervening, mean, median, mid, middle, midway, transitional

antonym: extreme

production *n.* assembly, construction, creation, fabrication, facture, making, manufacture, preparation, producing, staging

antonym: consumption

insertion *n.* addition, entry, implant, inclusion, inset, intrusion, supplement

surrounding *adj.* adjacent, adjoining, bordering, encircling enclosing, nearby, neighbouring

surroundings *n.* ambience, background, environment, locale, vicinity

accelerate *v.* advance, expedite, forward, hasten, hurry, pick up speed, promote, quicken, speed, speed up, step up

antonyms: decelerate, delay, slow down

Versatile transition metal complexes

Transition metal complexes are very effective catalysts because the central metal atoms can bond to a ***wide variety*** of molecules or ions called lignads. Although they may remain bound throughout the catalytic process without being consumed or directly involved, these spectator ligands are of key importance because they can be carefully chosen to ***tune*** the ***reactivity*** of the metal so as to ***modify*** its catalytic properties. Potential ligands come in all shapes and sizes. They can be simple ions such as chloride $\left(Cl^-\right)$, small neutral molecules like water $\left(H_2O\right)$, ***ammonia*** $\left(NH_3\right)$ or carbon monoxide (CO), or larger more complicated structures.

Q 1. What feature of electronic structure must all ligands have to allow them to form a bond with a transition metal atom or ion?

One class of ligands frequently used in catalysts is the phosphines. They are rather like **tertiary amines** and consist of hydrocarbon units ***linked*** to a phosphorus atom which then ***binds*** to the metal. Figure1, Chemists have synthesized many different phosphines by ***subtly altering*** the hydrocarbon groups to tailor the ligand for the job in hand. Sometimes two phosphorus atoms are linked together by a bridging unit to form a ***'claw'***, Figure 2, which binds even more strongly to metal.

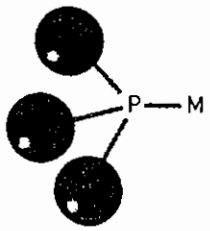


Figure 1. phosphine ligand

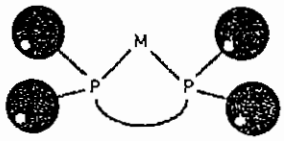


Figure 2. A diphosphine ligand

To bring about a catalytic reaction, the metal must also be able to bind to the ***substrate***(s). This happens at an active site whose geometry, as for enzymes, is ***profoundly*** influenced by the size and shape of the ligands. Since the choice of ligands is almost ***infinite***, chemists have great ***scope*** for designing catalysts with the required activity and ***selectivity***. Sometimes an active site must be generated by ***detaching*** one or more ligands from the metal catalyst, providing a ***gap*** where the substrate can bind. Altering the metal at the heart of the complex can also lead to dramatic changes in catalytic behaviour, as can more subtle tinkering, such as changing its oxidation state.

The ***precise pathway***, or mechanism, by which a homogeneous catalyst works is generally easier to study than that for a heterogeneous catalyst. This is because the individual molecules involved in homogeneous catalysis can often be defined precisely using modern analytical techniques such as nuclear magnetic resonance (NMR), infrared (IR), and ultraviolet (UV) spectroscopy, and X-ray ***diffraction***. Such studies are much more difficult for a heterogeneous catalyst where the reaction occurs only on the ***surface***. The above techniques cannot distinguish surface atoms from atoms in the bulk material (which outnumber them by a factor of 10^8).

For many homogeneous processes, the catalytic cycle linking reactants to products through a series of reactions is thus easier to define. In many cases the ***intermediates*** can be studied individually. Figure 3 illustrates the principle of a catalytic cycle. You can think of it as a factory ***production*** line with individual parts being added at different stages of the assembler. The cycle shown represents a type of reaction called an ***insertion***. The overall effect is to insert an atom or molecule (represented by the pink ball, B) between two parts of a substrate (the red and green balls in A)..

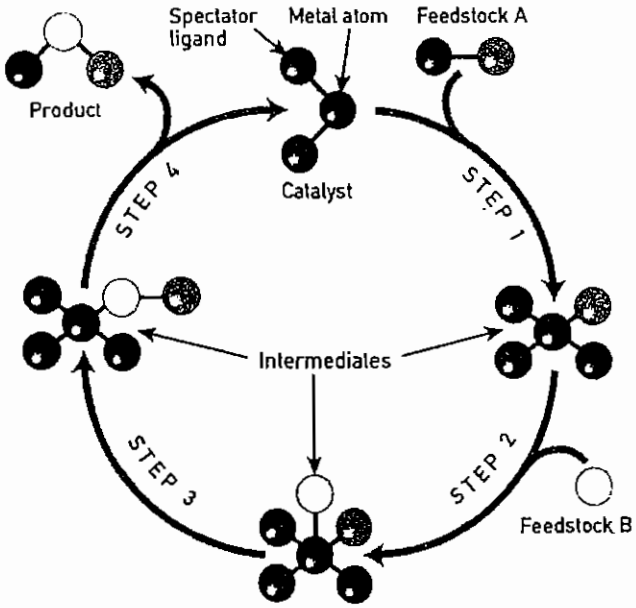


Figure 3. A catalytic cycle. The overall effect to "insert" a molecule of feedstock B into a molecule of feedstock A.

This overall process is achieved by a series of reactions which form a loop. In each step, chemical bonds are either broken or made. The catalyst itself, made up of a metal ion and its ***surrounding*** ligands, continuously travels around this loop, producing one molecule of product on each lap. The overall speed of the catalytic process is governed by the slowest reaction in the cycle, often referred to as the ***rate determining step***. If a more active catalyst is to be designed, a way must be found to ***accelerate*** this step

A whole branch of chemistry – **organometallic chemistry** – has grown up around the need to understand reactions of metal compounds with organic molecules. This area received a huge impetus with the discovery of the 'sandwich' structure of ferrocene in 1954. Sir Geoffrey Wilkinson shared the Nobel prize in 1973 with Ernst Otto Fischer, for their independent pioneering work in this field. The chemistry of the so-

called 'sandwich compounds' is still an area of huge importance, and has led to the development of a new generation of polymers efficient catalysts for the manufacture of polymers like poly(ethene).

A. Directions: Select a word in column B which is synonym in meaning to word in column A.

A	B
..... a. accelerate	1. delicate
..... b. insertion	2. range
..... c. wide	3. dissociate
..... d. subtle	4. operate
..... e. link	5. speed up
..... f. detach	6. joint
..... g. gap	7. expanded
..... h. react	8. in between
..... k. intermediate	9. entry
..... l. scope	10. break

B. Directions: select a word in column B which is opposite in meaning to word in column A.

A	B
	1. expert
..... a. specialist	2. damage
..... b. conceptual	3. a person not trained in a particular subject
..... c. secure	4. physical
..... d. enliven	5. fluid
..... e. inelastic	6. sadden
..... f. maintain	7. huge
..... g. praise	8. flexible
..... h. unify	9. scold
..... i. primitive	10. modern
..... j. tiny	11. separate
	12. not safe

C. choose the word which best completes each blank.

infinite – bind – scope – detach – gap – diffraction – surface – intermediate – production – surrounding – accelerate – selectivity – alter – insertion - subtly

1. When an electric discharge is passed through a sample of dihydrogen, the H_2 molecules ..... into atoms.
2. Electron ..... techniques used to determine structures of chemical compounds.
3. The only restriction that we place on the total energy E is that it must be positive and cannot be .....

4. The ratio of hydrogen to carbon monoxide in water gas can be ..... with the water – gas shift reaction.
5. Carbene ..... into a metal – hydrogen bond gives a methyl group.
6. The cyanide ion could ..... tightly to hemoglobin.
7. The coordination number specifies the closest ..... atoms.
8. A similar set of transformation may occur on catalystic metal .....
9. Hydrocarbons are the most common ..... in reductive elimination reactions.
10. Catalysts ..... reactions without alteration in reagents' energy.
11. Catalysts apply their ..... in different ways.

D. Read the following passage and choice the best answer to each question.

Eight percent of the Earth's crust is aluminum, and there are hundreds of aluminum – bearing minerals and vast quantities of the rocks that contain them. The best aluminum ore is bauxite, defined as aggregates of aluminous minerals, more or less impure, in which aluminum is present as hydrated oxides. Bauxite is the richest of all those aluminous rocks that occur in large quantities, and it yields alumina, the intermediate product required for the production of aluminum. Alumina also occurs naturally as the mineral corundum, but corundum is not found in large deposits of high purity, and therefore it is an impractical source for making aluminum. Most of the many abundant nonbauxite aluminous minerals are silicates, and, like all silicate minerals, they are refractory, resistant to analysis, and extremely difficult to process. The aluminum silicates are therefore generally unsuitable alternatives to bauxite because considerably more energy is required to extract alumina from them.

1. The author implies that a mineral must eighte be or readily supply which of the following in order to be classified as an aluminum ore?

1) An aggregate
2) Bauxite
3) Alumina
4) Corundum
5) An aluminum silicate

2. The passage supplies information for answering all of the following questions regarding aluminous minerals EXCEPT:

1) What percentage of the aluminum in the Earth's crust is in the form of bauxite?
2) Are aluminum – bearing nonbauxite minerals plentiful?
3) Do the aluminous minerals found in bauxite contain hydrated oxides?
4) Are aluminous hydrated oxides found in rocks?
5) Do large quantities of bauxite exist?

3. The author implies that corundum would be used to produce aluminum if .....

1) corundum could be found that is not contaminated by silicates.
2) the production of alumina could be eliminated as an intermediate step in manufacturing aluminum.
3) many large deposits of very hight quality corundum – were to be discovered.
4) new technologies were to make it possible to convert corundum to a silicate.
5) manufacturers were to realize that the word's supply of bauxite is not unlimited.

Lesson 3

Mass spectrometry and Microwave spectroscopy

"Good words are worth much and cost little"

George Herbert, gacula prudentum

regular *adj.* 1. common, correct, daily, normal, ordinary, routine 2. balanced, steady, uniform, unvarying
antonyms: 1. unusual 2. irregular, occasional
vapor *n.* breath, damp, exhalation, fog, fumes, haze, mist, smoke, steam
vaporize *v.* change into vapor.
Fragment *n.* bit, chip, fraction, part, particle, piece
Antonyms: joint, hold together
fragment *v.* break, come to piece.
detect *v.* find out, discover
ratio *n.* balance, correlation, proportion, relation, relationship
decomposition *n.* breakdown, corruption, decay, disintegration, dissolution, division, putrefaction, rot
needle *n.* something long, thin and sharp
fog *n.* 1. blanket, cloud, gloom, haze, mist, murkiness, smog 2. bewilderment, confusion, daze, obscurity, perplexity, puzzlement, trance, vagueness
foggy *adj.* cloudy, dark, dim, grey, hazy, misty, murky, shadowy, smoggy
antonym: abet.
drop *n.* 1. bead, bubble, dab, dash, globule, pinch, sip, spot, trickle 2. decline, decrease, deterioration, fall, plunge, reduction, slump 3. abyss, chasm, descent, precipice, slope
destroy *v.* annihilate, break, crush, demolish, dismantle, dispatch, eliminate, eradicate, extinguish, gut, kill, level, nullify, ravage, ruin, sabotage, smash, torpedo, undermine, un shape, waste, wreck
tumble *v.* disorder, drop, fall, flop, jumble, overthrow, pitch, plummet, roll, stumble, topple, toss, trip up
tumble *n.* collapse, drop, fall, flop, plunge, roll, stumble, toss, trip
asymmetry *n.* disproportion, imbalance, inequality, irregularity, misproportion, unevenness
antonym: symmetry.
asymmetrical *adj.* asymmetric, awry, crooked, disproportionate, irregular, unbalanced, unequal, uneven, unsymmetrical
antonym: symmetrical.
rotate *v.* gyrate, pivot, revolve, spell, spin, swivel, turn
rotation *n.* cycle, gyration, orbit, spinning, turning
separate *v.* departmentalise, detach, disaffiliate, diverge, estrange, isolate, remove, secede, segregate, split(up), uncouple, withdraw
antonyms: combine, join, unite

separate *adj.* alone, apart, autonomous, detached, discrete, disjointed, divorced, isolated, solitary, sundry, unattached, unconnected

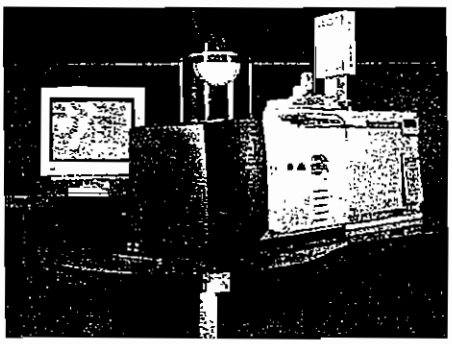
antonyms: attached, together

distribute *v.* allocate, circulate, convey, deal, deliver, diffuse, dish out, dispense, disperse, dispose, divide, group, hand out, scatter, share, spread, supply

antonyms: collect, gather in

Mass spectrometry

Another technique that is ***regularly*** used by organic chemists is mass spectrometry. In one form of mass spectrometer, the molecules in the sample are first ***vaporized*** and broken into charged ***fragments*** (ions) using an electric and magnetic fields before reaching a suitable detector. The ***ratio*** of the charge to the mass of the fragments is then recorded. This allows the mass of the molecule to be accurately determined as well as the nature of the atoms in the fragments. The pattern of fragmentation also depends on the most energetically favourable routes for ***decomposition*** and also helps analysts to work out the structure of the molecule.



A GC-MS instrument.
Courtesy of Micromass UK Ltd.

Mass spectrometry is a technique that is rapidly growing in popularity because of improved methods of vaporizing molecules. Until recently, it could not be applied to large molecules such as proteins because they would decompose, losing their identity completely. Now, however, there are two new methods for getting proteins into a sort of 'gaseous state' one, called electrospray, involves spraying a solution of the protein into the instrument through a syring equipped with a ***needle*** at high electric potential. The electric field breaks up the liquid into a ***fog*** of charged ***droplets*** which then eject protein molecules carrying many charges. The resulting 'protein ions' can then be analysed in the mass spectrometer. In the other method, laser ***desorption***, the sample protein is mixed with a matrix of smaller molecules such as urea. Then a laser pulse is fired with the ***right energy*** and wavelength to vaporize the matrix material without ***destroying*** the protein. The matrix and protein, which picks up charge from the matrix, are then propelled towards the detector. The mass of the charged protein is obtained from an accurate measurement of the time required for the protein to travel to the detector – heavier proteins will take longer. Once the mass of the protein has been measured, it can be broken into fragments in a controlled way and its mass spectrum measured.

Microwave spectroscopy

As well as vibrating, molecules also rotate-especially in liquids and gases where the molecules can readily ***tumble*** around (although molecules can rotate in solids as well). This leads to energy levels associated with rotation. These occur in the **microwave** part of the spectrum. The technique of microwave spectroscopy is most useful in gases where the levels are well-defined and separated by energies that depend on the moment of inertia of the molecule-a property which measures how the mass of a molecule is distributed. The molecule must have an overall **dipole moment** to give a microwave spectrum, which means an

asymmetrical distribution of electric charge is needed. Methane, for example, has no microwave spectrcum. Although each bond has a dipole, the dipoles cancel out because of the tetrahedral shape of the molecule.

However, where there is a dipole moment, microwave spectra can provide very accurate values for moments of inertia, bond lengths and, therefore, structure.

Q 1. (a) Which of the following molecules have a dipole moment?

i) water, H_2O;

ii) oxygen, O_2;

iii) carbon monoxide, CO;

iv) ammonia, NH_3.

(b) Explain why sulfur dioxide (SO_2) has a dipole moment while carbon dioxide (CO_2) does not.

A. General Vocabulary practice

Directions: put the number of the definition in column B beside the correct word in column A.

A	B
..... a. asymmetry	1. disintegration
..... b. distribute	2. spin
..... c. detect	3. gloom
..... d. decomposition	4. imbalance
..... e. fog	5. ordinary
..... f. fragment	6. quantity
..... g. magnitude	7. allocate
..... h. regular	8. bit
..... i. rotate	9. detached
..... j. separate	10.find out

B. choose the word which best completes each blank.

1. Jain had a ..... for experimental inorganic chemistry.

a. procedure b. speed c. talent d. quality

2. An active ..... may explode at any time.

a. mountain range b. volcano c. earthquake d. material

3. He attends evening classes to ..... his ability at work.

a. improve b. attempt c. perform d. deliver

4. She ..... the rope and pulled herself up.

a. broke b. grasped c. followed d. based

5. She placed a hand over her mouth to ..... a shriek of laughter.

a. capture b. expand c. insert d. prevent

6. The course ..... elements of chemistry, physics, and engineering.

a. embraces b. devises c. transmits d. imitates

7. The icy conditions made road travel dangerous so ..... going by car we took the subway.

a. therefore b. as well as c. instead of d. in spite of

8. ..... the extraordinary good results, it was decided to try the same approach next year.

a. In spite of b. In view of c. However d. Despite

9. The prices of its good suddenly dropped in the market and the company ..... collapsed in 1990.

a. eventually b. relatively c. considerably d. merely

10. Every employee is required to follow the ..... of the company closely.

a. alternatives b. distinctions c. guidelines d. variations

C. Read The following passage and choice the best answer te each question.

We can distinguish three different realms of matter, three levels on the quantum ladder. The first is the atomic realm, which includes the world of atoms, their interactions, and the structures that are formed by them, such as molecules, liquids and solids, and gases and plasmas. This realm includes all the phenomena of atomic physics, chemistry, and, in a certain sense, biology. The energy exchanges taking place in this realm are of a relatively low order. If these exchanges are below one electorn volt, such as in the collisions between molecules of the air in a room, then atoms and molecules can be regarded as elementary particles. That is, they have "conditional elementarily" because they keep their identity and do not changes. If one goes to higher enery exchanges, say 10^4 electron volts, then atoms and molecules will decompose into nuclei and electrons; at this level, the latter particles must be considered as elementary. We find examples of structures and processes of this first rung. Of the quantum examples of structures and pfocesses of this first rung of the quantum ladder on Earth, on planets, and on the surfaces of stars.

The next rung is the nuclear realm. Here the energy exchanges are much higher, on the order of millions of electron volts. As long as we are dealing with phenomena in the atomic realsm, such amounts of energy are unavailable, and most nuclei are inert: they do not change. However, if one applies energies of millions of electron volts, nuclear reactions, fission and fusion, and the process of radioactivity occur; our elementary particles then are protons, neutrons, and electrons. In addition, nuclear processes produce neutrinous, particles that have no detectable mass or charge. In the universe, energies at this level are available in the centers of stars and in star explosions. Indeed, the energy radiated by the stars in produced by nuclear reactions. The natural radioactivity we find on Earth I is the long – lived remnant of the time when now – earthly matter was expelled into space by a major stellar explosion.

The third rung of the quantum ladder is the subnuclear realm. Here we are dealing with energy exchanges of many billions of electron volts. We encounter excited nucleons, new types of particles such as mesons, heavy electons, quarks, and gluons, and also antimatter in large quantities. The gluons are the quanta, or smallest units, of the force (the strong force) thyat keeps the quarks together. As long as we are dealing with the atomic or nuclear realm, these new types of particled do not occur and the nucleons remain inert. But as subnuclear energy levels, the nucleons and mesons appear to be composed of quarks, so that the quarks and gluons figure as elementary particles.

1 - The primary topic of the passage is which of the following?

1) The interaction of the realms on the quantum ladder
2) Atomic structures found on Earth, on other planets, and on the surfaces of stars
3) Levels of energy that are released in nuclear reactions on Earth and in stars
4) Particles and processes found in the atomic, nuclear, and subnuclear realms
5) New types of particles occurring in the atomic realm

2 - According to the passage, radioactivity that occurs naturally on Earth is the result of

1) the production of particles that have no detectable mass or electric charge
2) high energy exchanges on the nuclear level that occurred in an ancient explosion in a star
3) processes that occur in the center of the Sun, which emits radiation to the Earth
4) phenomena in the atomic realm that cause atoms and molecules to decompose into nuclei and electrons
5) high-voltage discharges of electicity that took place in the atmosphere of the Earth shortly after the Earch was formed

3 - The author organizes the passage by,

1) making distinctions between two groups of particles, those that are elementary and those that are composite
2) explaining three methods of transferring energy to atoms and to the smaller particles that constitute atoms
3) describing several levels of processes, increasing in energy, and corresponding sets of particles, generally decreasing in size
4) putting forth an argument concerning energy levels and then conceding that several qualifications of that argument are necessary
5) making several successive refinements of a definition of elementarily on the basis of several groups of experimental results

4 - According to the passage, which of the following can be found in the atomic realm?

1) More than one level of energy exchange
2) Exactly one elementary particle
3) Exactly three kinds of atomic structures
4) Three levels on the quantum ladder
5) No particles smaller than atoms

5 - According to the author, gluons are <u>not</u>

1) considercd to be detcetable
2) produced in nuclead e" r reactions
3) encountered in subnuclear energy exchanges
4) related to the strong force
5) found to be conditionally elementary

6 - At a higher energy level than the subnuclear level described, if such a higher level exists, it can be expected on the basis of the information in the passage that there would probably be

1) excited nucleons
2) elementary mesons
3) a kind of particle without detectable mass or charge
4) exchanges of energy on the order of millions of electron volts.
5) another set of elementary particles

7 - The passage speaks of particles as having conditional elementarily if they

1) remain unchanged at a given level of energy exchange
2) cannot be decomposed into smaller constituents
3) are mathematically simpler than some other set of particles
4) release energy at a low level in collisions
5) belong to the nuclear level on the quantum ladder

Lesson 4

Block copolymers on their way to nanodevices

"Better one living word than a hundred dead"

W.G. Benham, Quotations

cosmetic *adj.* non-essential, superficial, surface

antonym: essential

cosmetics *n.* grease paint, make-up

adhesive *adj.* adherent, adhering, attaching, clinging, cohesive, gluey, gummy, holding, sticking, sticky, tacky

adhesive *n.* cement, glue, gum, paste, tape

interior *adj.* central, inner, inside, inward, mental, private, remote, spiritual

antonyms: exterior, outside

segregate *v.* cut off, discriminate against, isolate, quarantine, separate, set apart

antonyms: join, unite

aggregate *n.* accumulation, amount, collection, combination, entirety, generality, sum, total, totality, whole

aggregate *adj.* accumulated, added, collected, collective, combined, complete, composite, cumulative, mixed, total, united

aggregate *v.* accumulate, add up, amount to, assemble, cluster, collect, combine, conglomerate, heap, mix, total

stretch *n.* area, distance, exaggeration, expanse, reach, run, space, stint, strain, sweep, tract

stretch *v.* cover, elongate, expand, inflate, pull, rack, swell, tauten, tighten, unfold, unroll

antonyms: relax, squeeze

variation *n.* alteration, change, departure, deviation, discrepancy, diversification, diversity, elaboration, inflection, innovation, modification, modulation, variety

antonyms: monotony, uniformity

spherical *adj.* globe-shaped, rotund, round

seminal *adj.* containing, producing, influencing future development in a new way.

unique *adj.* exceptional, incomparable, inimitable, matchless, single, sole, unrivalled

antonym: common

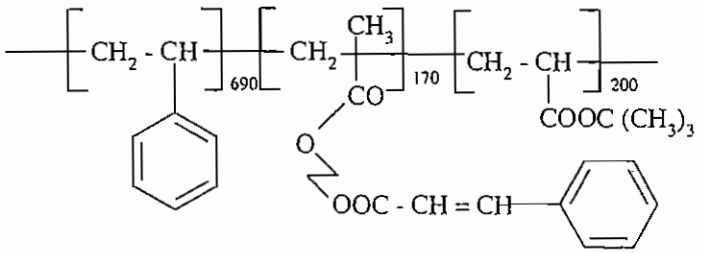
Block copolymers are made by joining covalently polymer chains of different types. The simplest block copolymer is a diblock $A_n B_m$ consisting of n consecutive A and m consecutive B units joined in a head-to-tail fashion.

Block copolymers are all around us and found in ***cosmetic*** products, upholstery foam, and ***adhesive*** tape, etc. Over the past decade, much progress has been made by Canadian researchers in using them to make nano-structures including nanofibres, nanotubes, hollow nanospheres, and nanospheres with patterned interior and / or surface, etc. More recently, these different nanocomponents are coupled chemically to yield more complex structures, paving the way for the construction of solvent-***dispersible*** nanodevices.

Block copolymer self-assembly

Nanostructure fabrication from block copolymers is possible mainly due to the fascinating self-assembling properties of the polymers. In a block copolymer solid, the different blocks of a block copolymer ***segregate*** to yield equilibrium block segregation patterns that are highly regular and ordered with periodicity ranging from tens of nanometers to several hundred nanometers. This self-assembly phenomenon of block copolymers has been extensively reviewed. Those who are interested are referred to an excellent introduction article for a more detailed account of the subject. What I will describe in some detail below is the self-assembly of block copolymer in block-selective solvent, an area where Canadian researchers have made pioneering contributions. A block-selective solvent solubilizes only some and not all blocks of a block copolymer. In a block-selective solvent, the insoluble block of different chains of a diblock ***aggregates*** and segregates from the solvent phase to form a polymer-rich phase that is stabilized by chains of the soluble block. The need to minimize the interfacial energy between this insoluble phase and the solvent favours the formation of large aggregates. The need to minimize the ***stretching*** of chains of the soluble and insoluble blocks favours small aggregates. A compromise between the opposing forces leads to the formation of micelles of a particular shape with an optimal size. Adi Eisenberg, FCIC, a professor at McGill university, and his graduate student Ligeng Zhang, ACIC, were the first to discover the multiple morphologies of block copolymer micelles and to establish the trend of their morphological ***variation*** with polymer composition. If the soluble block is long, the insoluble block of a diblock copolymer aggregates to produce spherical micelles. As the length of the soluble block is decreased relative to the insoluble block, cylindrical, ***vesicular***, and then composite micelles and micelles of many other shapes are formed. A composite micelle consists of many aggregated small ***spherical*** micelles.

Figure 1 shows transmission electron microscopy (TEM) images of micelles formed in water from polystyrene-block-poly (acrylic acid), PS-PAA, with different compositions.



In the seminal work of Eisenberg and Zhang, the micelles were prepared in water. Water is *unique* medium in which there exists an intricate interplay of ***hydrophobic*** and electrostatic interactions.

A. General Vocabulary practice

Directions: put the number of the word in column B beside the correct word in column A.

A	B
..... a. adhesive	1. gluey
..... b. aggregate	2. accumulation
..... c. cosmetics	3. grease paint
..... d. interior	4. alteration
..... e. makeshift	5. inner
..... f. segregate	6. sole
..... g. seminal	7. round
..... h. spherical	8. discriminate
..... i. unique	9. temporary
..... j. variation	10. producing

B. choose the word which best completes each blank.

1. In steel making, desulphurization is the ..... of sulfur from molten iron.
a. inserting b. removal c. building up d. accumulating

2. ..... means decomposing by corrosion.
a. Decay b. Falling c. To Fading d. Worsened

3. The application of a thin film of metal to the surface of a material is called ..... .
a. plating b. blasting c. roasting d. soldering

4. Corrosion is a natural process that tries to ..... the chemical action of the refining process.
a. endorse b. reverse c. forwarding d. promotional

5. Segregation of carbon, manganese and other chemical elements occurs in the ..... , and the ..... of the steel in these segregated portions will differ from that in the remainder of the ingot.
a. ingot-harden b. melted-hardenability c. shapes-wears d. shapes-breaking

6. Metals are familiar objects with a characteristic ..... they are ..... of changing their shape permanently.
a. appearance-capable b. properties-ready c. rigidity-unabie d. colour-interested

7. A composite micelle consists of many ..... small spherical micelles.
a. separate b. segregated c. aggregated d. expanded

8. ..... means to only a small extent.
a. Essentially b. Rationally c. Periodically d. Marginally

9. To ..... an object, a substance, or a noise, you produce something that looks, feels, or sounds like it.
a. stimulate b. simulate c. translate d. systematize

10. If something ....., it becomes larger and rounder than normal.
a. swells b. spills c. sweeps d. strikes

C. Read the following passage and choice the best answer to each question.

It is a popular misconception that nuclear fusion power is free of radioactivity; in fact, the deuteriumtritum reaction that nuclear scientists are currently exploring with such zeal produces both alpha particles and neutrons. (The neutrons are used to produce tritium from a lithium blanket surrounding the reactor). Another common misconception is that nuclear fusion power is a virtually unlimited source of energy because of the enormous quantity of deuterium in the sea. Actually, its limits are set by the amount of available lithium, which is about as plentiful as uranium in the Earth's crust. Reasearch should certainly continue on controlled nuclear fusion, but no energy program should be premised on its existence until it has proven practical. For the immediate future, we must continue to use hydroelectric power, nuclear fission, and fossil fuels to meet our energy needs. The energy sources already in major use for good reason.

1. The primary purpose of the passage is to

1) criticize scientist who believe that the deuterium – tritium fusion reaction can be made feasible as an energy source.
2) admonish scientists who have failed to correctly calculate the amount of lithium available for use in nuclear fusion reactors.
3) defend the continued short- term use of fossibl fuels as a major enegy source.
4) caution against uncritical embrace of nuclear fusion power as a major energy source.
5) correct the misconception that nuclear fusion power is entirely free of radioactivity.

2. It can be inferred from the passage that the author believes which of the following about the current state of public awareness concerning nuclear fusion power?

1) The public has been deliberately misinformed about the advantages and disadvantages of nuclear fusion power.
2) The public is unaware of the principal advantage of nuclear fusion over nuclear fission as an energy source.
3) The publics awareness of the scientific facts concerning nuclear fusion power is somewhat distorted and incomplete.
4) The public is not interested in increasing its awareness of the advantages and disadvantages of nuclear fusion power.
5) The public is aware of the disadvantages of nuclear fusion power but not of its advantages.

3. The passage provides information that would answer which of the following questions?

1) What is likely to be the principal source of deuterium for nuclear fusion power?
2) How much incidental radiation is produced in the deuterium – tritium fusion reaction?
3) Why are scientists exploring the deuteriumtritium fusion reaction with such zeal?
4) Why must the tritium for nuclear fusion be synthesized from lithium?
5) Why does the deuterium – tritium reaction yield both alpha particles and neutrons?

4. Which of the following statements concerning nuclear scientists is most directly suggested in the passage?

1) Nuclear scientists are not themselves aware of all of the facts surrounding the deuterium – tritium fusion reaction.
2) Nuclear scientists exploring the deuterium – tritium reaction have overlooked key facts in their eagerness to prove nuclear fusion practical.
3) Nuclear scientists may have overestimated the amount of lithium actually available in the Earth's crust.
4) Nuclear scientists have not been entirely dispassionate in their investigation of the deuterium – tritium reaction.
5) Nuclear scientists have insufficiently investigated the lithium to tritium reaction in nuclear fusion.

Lesson 5

SWIMMING POOL CHEMISTRY

"A word to the wise is sufficient"

Plautus, Persa

dirt *n.* clay, dust, earth, excrement, filth, grime, indecency, mire, muck, mud, slime, smudge, soil, stain, tarnish, yuck

dirty *adj.* clouded, dark, grimy, muddy

antonyms: clean, cleanse

treat *n.* banquet, celebration, fun, gift, surprise, thrill

antonyms: drag.

treat *v.* 1. consider, deal with, discuss, handle, use, manage 2. attend to, care for, heal, nurse 3. entertain, feast, give, provide, regale, stand

release *v.* absolve, break, circulate, discharge, free, issue, loose, unfasten

antonyms: check, detain, imprison

release *n.* absolution, acquittal, announcement, discharge, exemption, freedom, publication, relief

antonyms: detention, imprisonment

ingredient *n.* component, constituent, element, factor, part

bleach *v.* blanch, decolorize, fade, lighten, pale, whiten

disinfect *v.* clean, cleanse, decontaminate, deodorize, fumigate, purge, purify, sanitise, sterilize

antonyms: contaminate, infect

participate *v.* be involved, co-operate, engage, enter, join in, partake, perform, share, take part

participation *n.* a piece of the action, assistance, contribution, co-opration, involvement, partnership, sharing

swing *n.* fluctuation, motion, oscillation, rhythm, swaying, sweep, vibration, waving

contaminate *v.* adulterate, corrupt, debase, defile, infect, pollute, soil, stain, sully, taint, tarnish

antonym: purify

accelerate *v.* advance, expedite, facilitate, forward, hurry, pick up speed, promote, stimulate

exposure *n.* 1. airing, contact, disclosure, discovery, exhibition, showing, uncovering, unveiling

protect *v.* care for, cover, defend, escort, guard, harbour, preserve, save, shelter, shield, support

influence *n.* agency, authority, bias, control, effect, reach, rule, strength

influence *v.* affect, alter, arouse, dispose, impel, incline, instigate, manipulate, modify, motivate, predispose, prompt, sway, train, weigh with

extreme *adj.* acute, dire, drastic, exceptional, extravagant, final, greatest, harsh, intense, red-hot, rigid, terminal, ultimate, utter, worst, zealous

antonyms: mild, moderate

extreme *n.* boundary, climax, consummation, depth, edge, end, excess, height, pinnacle, pale, top, outmost

precipitate *v.* accelerate, bring on, expedite, hasten, trigger

precipitate *adj.* abrupt, breakneck, brief, frantic, hasty, impatient, impetuous, impulsive, rapid, sudden, swift, unexpected, violent

antonyms: careful, cautious

corrosive *adj.* abrasive, acrid, caustic, consuming, corroding, cutting, wasting, wearing

adjust *v.* acclimatise, accommodate, accustom, adopt, arrange, balance, change, convert, harmonise, jiggle, settle, temper, tune

bit *n.* atom, chip, crumb, fragment, grain, instant, iota, jot, scrap, segment, slice, speck, whit

odor *n.* air, aroma, atmosphere, aura, bouquet, breath, fragrance, perfume, scent, smell

irritation *n.* aggravation, anger, annoyance, fury, irritant, pain, provocation, resentment, snappiness, testiness, vexation

antonyms: delight, pleasure, satisfaction

attribute *v.* accredit, apply, ascribe, assign, blame, charge, impute, refer

attribute *n.* affection, aspect, character, facet, property, quality, sign, trait, virtue

dive *v.* descend, dip, drop, fall, jump, leap, plunge, submerge, swoop

dive *n.* dash, header, lunge, spring

sparkle *v.* beam, bubble, fizz, fizzle, gleam, glint, shimmer, shine, spark, twinkle

disturb *v.* 1. disrupt, distract, interrupt 2. agitate, disorganise, upset

simultaneous *adj.* accompanying, coinciding, concurrent, parallel, synchronic, synchronous

antonym: asynchronous, separate

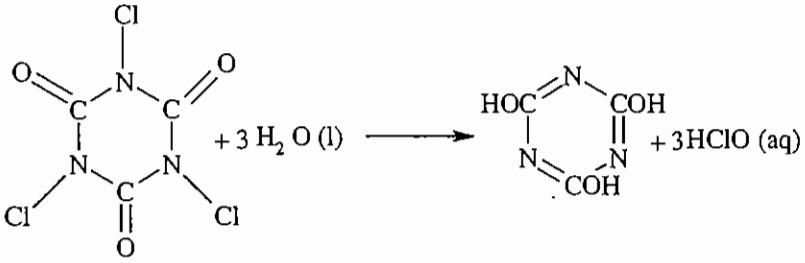
A freshly filled swimming pool is an aqueous equilibrium system open to the atmosphere and (if it is outdoors) to sunlight. When swimmers enter the pool, bacterial, ***dirt***, and organic by–products are mixed into the system. To maintain a healthy and beautifully clear swimming pool requires careful balancing of the pool chemistry.

The majority of pools are ***treated*** with chemicals that ***release*** hypochlorous acid (Equation 1). As this acid is the active ***ingredient*** for oxidizing odorcausing organic chemicals, ***bleaching***, and ***disinfecting***, it is desirable to keep the concentration of the acid high. Because hypochlorous acid (and hypochlorite ion) ***participates*** in several equilibria in aqueous solution, its concentration is clearly pH dependent.

The pool pH is, in turn, dependent upon the natural "alkalinity" of the water-the concentration of hydrogen carbonates, carbonates, and hydroxides dissolved in the water. Hydrogen carbonates can provide a buffering action that helps to maintain a constant pH. In a pool with low alkalinity, very small additions of acid or base can cause undesirably wide ***swings*** in pH, and in such cases sodium hydrogen carbonate must be added to the pool to correct this condition. A pH range of 7.2-7.6 is ideal, for in this range hypochlorous acid has its maximum bactericidal effect.

Each pool has its own "chlorine demand" based on the amount of ***contaminants*** brought into it, the temperature, the alkalinity, and the amount of sunlight it receives, for sunlight ***accelerates*** the decomposition of hypochlorous acid. In regions where sunlight ***exposure*** is high, pools can be "chlorinated" and ***protected*** from sunlight by the same chemical. For example, trichloroisocyanuric acid yields hypochlorous acid and cyanuric acid upon hydrolysis.

The cyanuric acid absorbs ultraviolet radiation (note the double bonds alternating with single bonds), thereby screening the hypochlorous acid in a swimming pool from the sun.



tcichloroisocyanuric acid cyanuric acid

An additional factor that ***influences*** swimming pool chemistry is the hardness of the water. A bad balance among alkalinity, temperature, pH, and water hardness can lead at one ***extreme*** to ***precipitation*** of calcium carbonate on the pool walls and filtering system, or at the other extreme, to ***corrosion*** of metal equipment exposed to the pool water. These conditions are corrected by adding hydrochloric acid or sodium hydrogen carbonate to ***adjust*** the pH and the alkalinity as needed.

One more interesting ***bit*** of swimming pool chemistry-an unpleasant ***odor*** and eye ***irritation*** are often ***attributed*** to too much chlorine in a pool. The cause of this condition is actually too little "chlorine" in the pool. The irritating chemicals are chloramines (compounds with nitrogen-chlorine bonds), which are formed by the reaction of hypochlorous acid with amines and, urea (from sweat and urine), for example.

$$NH_3\,(aq) + HClO(aq) \rightarrow NH_2Cl(aq) + H_2O(l) \qquad (Eq.2)$$

In the presence of additional hypolorous acid, the chloramines are destroyed by oxidation to nitrogen, for example:

$$2NH_2Cl(aq) + HClO(aq) \rightarrow N_2(g) + H_2O(l) + 3HCl(aq) \qquad (Eq.3)$$

The next time you ***dive*** into a ***sparkling*** swimming pool, you might remember that you are about to ***disturb*** a number of ***simultaneous*** aqueous equilibria.

A. General Vocabulary practice

Directions: put the number of the word in column B beside the correct word in column A.

A	B
..... a. accelerate	1. decolorise
..... b. adjust	2. fumigate
..... c. bleach	3. annoy
..... d. disinfect	4. accomodate
..... e. dirt	5. component
..... f. ingredient	6. speed up
..... g. irritation	7. exactness
..... h. precision	8. impurity
..... i. simultaneous	9. synchronous
..... j. swing	10. oscillate

antonyms: genuine, natural, real, true

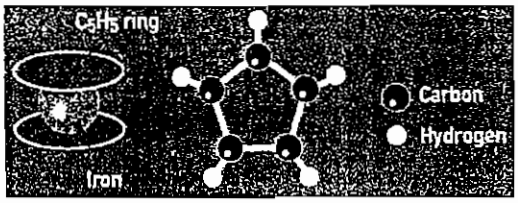
sweeten *v.* cushion, honey, improve, mellow, soften, soothe, sugar, sugar-coat, temper

antonyms: aggravate, embitter

inflammatory *adj.* explosive, fiery, provocative, rabble-rousing, riotous, seditious

antonyms: claming, pacific

The first sandwich compound to be discovered was ferrocene, $Fe(C_5H_5)_2$, which forms orange crystals. It contains an iron atom sandwiched between two flat rings which consist of five carbon atoms, each bonded to a hydrogen atom. These C_5H_5 ***rings*** are represented by blue discs in the diagrams below.

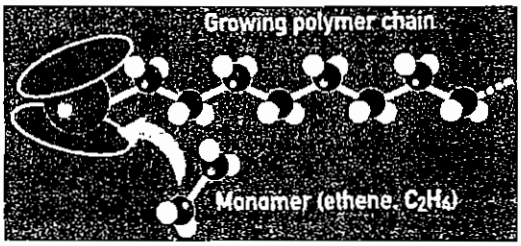


The structure of ferrocene. An iron atom is sandwiched between two C_5H_5 hydrocarbon rings, represented by the gray discs.

The chemical ***reactivity*** of the rings is similar to that of benzene (C_6H_6) because they have delocalized electrons.

We now know of a whole class of sandwich compounds which contain various transition metals as the 'filling'. The 'bread' of the sandwich can also come in various 'flavours' where the hydrogen atoms of the C_5H_5 rings are replaced by more complex chemical structures. Chemists have recently become very interested in these so-called metallocenes, ***primarily*** because of the discovery that they can be used as catalysts for making valuable polymers such as poly(ethene) and poly (propene) which are manufactured on a huge scale worldwide. Polymers of this type have long been made using heterogeneous catalysts based on titanium and aluminium.

These were discovered by Karl Ziegler and Glulio Natta, who were awarded the Noble Prize in 1963.



The mechanism for polymerization of ethene by a metallocene catalyst. The polymer chain grows by incorporating ethene molecules one at a time.

Metallocene polymerization catalysts. Chemists can change the shape of the active site by altering the structures of the organic rings sandwiching the metal atom.

In the late 1970s Walter Kaminsky's research group at the University of Hamburg found that metlallocenes containing the metals titanium, zirconium or hafnium were extremely good polymerisation catalysts when they added certain aluminium compounds to the reaction mixture as ***promoters***. Later work notably by Hans Brintzinger at the University of Costance has helped us to understand how these catalysts work.

In metallocene polymerization catalysts, the rings ***tilt*** to give a bent sandwich. This creates an active site on the metal atom where a polymer chain can grow by incorporating monomer units, one by one. In the example shown, the monomer is ethene, C_2H_4, and the resulting polymer is poly(ethene) (polythene). A range of other polymers can be made using similar catalysts. For exmple, in poly (propene), one of the red hydrogens on each monomer unit is replaced by a methyl (CH_3) group. The way these side groups are positioned along the polymer chain affects the physical properties of the resulting plastic. If all the methyl

B. choose the word which best completes each blank.

1 - complete or total means, ...

1) false 2) utter 3) real 4) true

2 - A ..... of things is a group of different kinds or examples of the same thing.

1) variety 2) variation 3) species 4) stream

3 - A ..... on something is the same thing presented in a slightly different form.

1) score 2) dressing 3) variation 4) cover

4 - If a number of things are described as ....., they are very different from one another.

1) variety 2) variation 3) various 4) variously

5 - If you ..... something, you break it into many pieces by hitting, throwing, or dropping it.

1) smash 2) destroy 3) defeat 4) differ

6 - The ..... is an imaginary line round the middle of the earth, halfway between the north and south poles.

1) Tropics 2) Altitude 3) Circle 4) Equator

7 - Something that is ..... is extremely important absolutely necessary to a particular subject, situation, or activity.

1) essential 2) extra 3) stressful 4) disturbing

8 - ..... to something dangerous means being in a situation where you are affected by it.

1) Extension 2) Exposure 3) External 4) Extraction

9 - ..... means covering many details, ideas, or items.

1) External 2) Internal 3) Extensive 4) International

10 - A/An ..... state or situation is not natural and exists because people have created it.

1) real 2) creative 3) artificial 4) true

C. Read the following passage and choice the best answer to each question.

Convective flow should be familiar to anyone who has noted the boiling of a heated liquid. The most elementary type of convection can be explained by the fact that heat rises. In the simplest cases, convective flow begins when a fluid is heated from below. As the bottom layer of the fluid is heated, it expands and thus becomes less dense than the layers above. The warmer and lighter bottom layer then tends to rise and the cooler layer tends to sink in a continuous cycle. The same mechanism of convective flow is responsible for the great ocean currents and for the global circulation of the atmosphere. In an ocean, the water is warmed by the Sun to a depth of perhaps thirty meters, and evaporation near the water's surface is responsible for the cooling effect.

1 - The main purpose of this passage is to .....

1) explain the basic principle of convection.
2) describe regular changes in the Earth's atmosphere.
3) explain the boiling temperatures of liquids.
4) state the principles of ocean currents.

2 - According to the passage, what happens as a fluid is warmed?

1) The bottom layer sinks.
2) The circulation stops.
3) It becomes very sensitive to light.
4) It becomes less dense.

3 - What does the passage say about ocean currents?

1) They circulate locally as well as globally.
2) They usually cause a rise in air temperature.
3) They interfere with atmospheric circulation.
4) They are caused by circular flow.

4 - Acoording to the passage, which of the following is the result of convective flow?

1) The electric currents in the atmosphere.
2) The power of oceangoing vessels.
3) The movement of air around the Earth.
4) The daily rotation of the globle.

5 - A simple exmpale of convection could be seen in

1) a cake baking.
2) a pot of soup heating.
3) sunlight being absorbed by a plant.
4) water dripping from a faucet.

Lesson 6

Sandwich Compounds

"By words the mind is excited and the spirit elated"

Aristophanes The Birds

ring *n.* 1. arena, band, circle, circuit, circus, enclosure, hoop, loop, rink 2. association, cartel, cell, clique, coterie, crew, group, organisation, syndicate

ring *v.* circumscribe, encircle, enclose, encompass, gird, surround

reaction *n.* acknowledgement, answer, compensation, conservatism, counteraction, feedback, recoil, reply, response

primarily *adv.* At first, basically, chiefly, especially, essentially, fundamentally, mainly, mostly, originally, principally

antonym: secondarily

promote *v.* 1. advertise, advocate, aid, assist, boost, develop, encourage nurture, plug, support, urge 2. advance, elevate, exalt, honour, upgrade

antonyms: 1. hinder, obstruct 2. demote

tilt *v.* incline, lean, list, pitch, slant, slope, tip

tilt *n.* angle, inclination, incline, list

back bone *n.* 1. basis, core, foundation, mainstay, spine, vertebral, column 2. grit, mettle, nerve, pluck, power, resolve, stamina, steadfastness, strength, support, tenacity, toughness

instrumental *adj.* active, auxiliary, conductive, influential, subsidiary

antonyms: obstructive, unhelpful

operate *v.* act, function, go, handle, manage, manoeurvre, perform, run, serve, use, utilise, work

create *v.* appoint, beget cause, coin, compose, design, devise, engender, establish, formulate, found, generate, hatch, initiate, install, invent, invest, make, occasion, originate, produce, set up

treatment *n.* 1. care, cure, healing, medication, medicine, remedy, surgery 2. conduct, dealing, discussion, handling, management, process, reaction, usage, use

disease *n.* affliction, ailment, blight, cancer, canker, complaint condition, contamination, disorder, epidemic, ill-health, illness, infection, infirmity, sickness, upset, virus

antonym: health

vital *adj.* 1. basic, critical, crucial, essential, imperative key, requisite, urgent 2. alive, dynamic, energetic, spirited, vibrant vigorcus

antonyms: 1. inessential, peripheral, unimportant

mirror *n.* glass, looking-glass, reflection, reflector

mirror *v.* copy, depict, echo, imitate, mimic, reflect, represent, show

image *n.* 1. appearance, concept, conception, idea, notion, perecption 2. effigy, figure, icon, idol, likeness, picture, portrait, reflection, replica, representation, statue

artificial *adj.* affected, assumed, bogus, contrived, fake, false, man-made, mannered, manufactured, non-natural, pseudo, sham, simulated, spurious, synthetic, unnatural

antonyms: genuine, natural, real, true

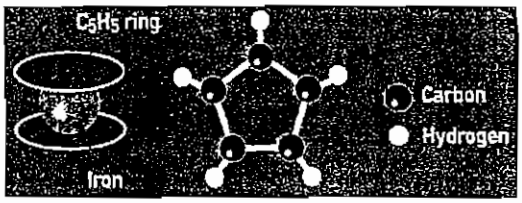
sweeten *v.* cushion, honey, improve, mellow, soften, soothe, sugar, sugar-coat, temper

antonyms: aggravate, embitter

inflammatory *adj.* explosive, fiery, provocative, rabble-rousing, riotous, seditious

antonyms: claming, pacific

The first sandwich compound to be discovered was ferrocene, $Fe(C_5H_5)_2$, which forms orange crystals. It contains an iron atom sandwiched between two flat rings which consist of five carbon atoms, each bonded to a hydrogen atom. These C_5H_5 ***rings*** are represented by blue discs in the diagrams below.

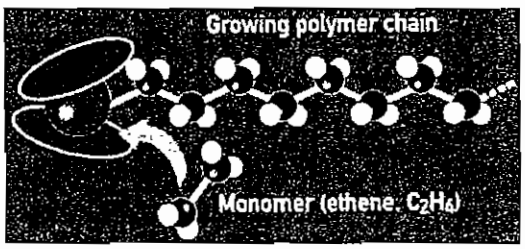


The structure of ferrocene. An iron atom is sandwiched between two C_5H_5 hydrocarbon rings, represented by the gray discs.

The chemical ***reactivity*** of the rings is similar to that of benzene (C_6H_6) because they have delocalized electrons.

We now know of a whole class of sandwich compounds which contain various transition metals as the 'filling'. The 'bread' of the sandwich can also come in various 'flavours' where the hydrogen atoms of the C_5H_5 rings are replaced by more complex chemical structures. Chemists have recently become very interested in these so-called metallocenes, ***primarily*** because of the discovery that they can be used as catalysts for making valuable polymers such as poly(ethene) and poly (propene) which are manufactured on a huge scale worldwide. Polymers of this type have long been made using heterogeneous catalysts based on titanium and aluminium.

These were discovered by Karl Ziegler and Glulio Natta, who were awarded the Noble Prize in 1963.



The mechanism for polymerization of ethene by a metallocene catalyst. The polymer chain grows by incorporating ethene molecules one at a time.

Metallocene polymerization catalysts. Chemists can change the shape of the active site by altering the structures of the organic rings sandwiching the metal atom.

In the late 1970s Walter Kaminsky's research group at the University of Hamburg found that metlallocenes containing the metals titanium, zirconium or hafnium were extremely good polymerisation catalysts when they added certain aluminium compounds to the reaction mixture as ***promoters***. Later work notably by Hans Brintzinger at the University of Costance has helped us to understand how these catalysts work.

In metallocene polymerization catalysts, the rings ***tilt*** to give a bent sandwich. This creates an active site on the metal atom where a polymer chain can grow by incorporating monomer units, one by one. In the example shown, the monomer is ethene, C_2H_4, and the resulting polymer is poly(ethene) (polythene). A range of other polymers can be made using similar catalysts. For exmple, in poly (propene), one of the red hydrogens on each monomer unit is replaced by a methyl (CH_3) group. The way these side groups are positioned along the polymer chain affects the physical properties of the resulting plastic. If all the methyl

groups are attached to one side of the polymer ***backbone***, the plastic is more rigid, whereas an alternate up-down arrangement gives a more transparent material.

The age of plastics. Which form is produced can be controlled by maked subtle changes to the rings attached to the metal, which influences the size and shape of the active site. The metallocene catalysts shown here each produce a polymer with different properties. Such control is less easily achieved for heterogeneous catalysts in which the active sites are less well defined.

These homogeneous metallocene catalysts have been marketed by number of companies and are beginning to compete with the estabilished Ziegler-Natta catalysts in certain areas of the plastics market.

As well as the discovery of sandwich compounds, Sir Geoffrey Wilkinson was also ***instrumental*** in designing other transition metal catalysts. One of these is now known universally as Wilkinson's catalyst, and is used to catalyse the reactions of hydrogen with organic molecules containing carbon-carbon double bonds (C = C). Wilkinson's catalyst contains the precious metal rhodium surrounded by three phosphine ligands and a chloride ligand. The catalytic cycle which ***operates*** is shown in Figure 1. It is thought that for Wilkinsons' catalyst to become active, one of the phosphine ligands must first detach from the rhodium (step 1). This ***creates*** an active site whre a molecule of hydrogen can react with the central rhodium atom (step 2) The alkene then binds to the complex (step 3) and each of the hydrogens can hop in turn on to the alkene to give the product alkane (steps 4 and 5). The whole cycle can then repeat.

A whole range of catalysts, many also containing rhodium, have been developed to catalyse these kinds of reactions. A commercially important example is the hydrogenation of vegetable oils to make butter substitutes. Another application is in the manufacture of pharmaceuticals such as L-DOPA, a drug used in the ***treatment*** of Parkinson's ***disease***. (It is said that the production of L-DOPA ceased in 1986 because the catalytic synthesis was so efficient that it led to stockpiles of the drug that could meet demand for several years!) The drug can exist in two chiral, or mirror-image forms, only one of which is active for the treatment. It is therefore ***vital*** to find a way of making the drug which gives the correct ***mirror image***. The US company, Monsanto, developed a rhodium catalyst containing ligands designed to create an active site with just the right shape to produce the desired version of the drug.

So-called asymmetric catalytic hydrogenation is also used in the synthesis of the ***artificial sweetener***, aspartame (trade name Nutrasweet, Figure 2) whose mirror image molecule tastes bitter. Another example is S-Naproxe, an anti-***inflammatory*** drug, whose mirror-image molecule, R-Naproxen, is a liver toxin, showing just how important it is to obtain the drug in the correct form.

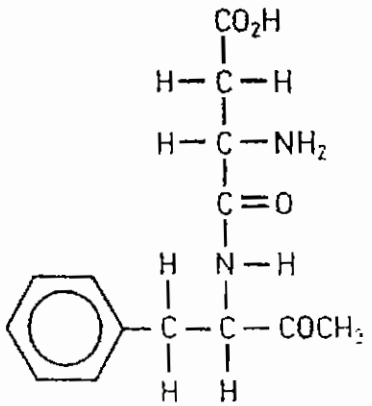


Figure 2. The articficial sweetener aspartame

A. General Vocabulary practice

Directions: put the number of the word in column B beside the correct word in column A.

A	B
..... a. artificial	1. figure
..... b. backbone	2. perform
..... c. create	3. man-made
..... d. image	4. explosive
..... e. inflammatory	5. at first
..... f. mirror	6. develop
..... g. operate	7. slope
..... h. primarily	8. reflection
..... i. promote	9. spine
..... j. tilt	10. engender

B. select a word in column B which is opposite in meaning to word in column A.

A	B
..... a. artificial	1. modern
..... b. disease	2. damage
..... c. inelastic	3. health
..... d. maintain	4. flexible
..... e. primitive	5. natural
..... f. promote	6. huge
..... g. sweeten	7. inessential
..... h. tiny	8. hinder
..... i. unify	9. separate
..... j. vital	10. aggravate

C. Read the following passages and choose the best answer to each question.

Passage One :

A useful definition of an air pollutant is a compound added directly or indirectly by humans to the atmosphere -in such quantities as to affect humans, animals vegetations, or materials adversely. Air pollution requires a very flexible definition that permits continuous change. When the first air pollution laws were established in England in the fourteenth century, air pollutants were limited to compounds that could be seen or smelled-a far cry from the extensive list of harmful substances known today. As technology has developed and knowledge of the health aspects of various chemicals has increased, the list of air pollutants has lengthened. In the future, even water vapor might be considered an air pollutant under certain conditions.

Many of the more important air pollutants, such as sulfur oxides, carbon monoxide, and nitrogen oxides, are found in nature. As the Earth developed, the concentrations of these pollutants were altered by various chemical reactions; they became components in biogeochemical cycle. These serve as an air purification scheme by allowing the compounds to move from the air to the water or soil on a global basis, .nature's output of these compounds dwarfs that resulting from human activities. However, human production usually occurs in a localized area, such as a city.

1 - The passage is mainly concerned with.....

1) dangers posed by air pollutants.
2) change in current viewpoint towards air pollutants.
'3) what constitutes an air pollutant.
4) ways to combat air pollutants.

2 - The word "adversely" in line 3 is closest in meaning to ..... .

1) unfavorably 2) artificially 3) drastically 4) eventually

3 - Paragraph 1 implies that..... .

1) most air pollutants can be seen or smelled today.
2) water vapor is detrimental to human health.
3) laws to prevent air pollution is a novel experience.
4) the definition of air pollutants is subject to change.

4 - All of the following are listed as natural air pollutants EXCEPT ..... .

1) nitrogen oxides 2) sulfur oxides
3) carbon monoxide 4) water vapor

5 - Natural pollutants can play an important role in controlling air pollution for which of the following reasons?

1)They occur in greater quantities than other pollutants.
2)They function as part of a purification process.
3) They have existed since the Earth developed.
4) They are less harmful to living beings than are other pollutants.

6 - The word "biogeochemical "as used in line 13 is directly related to the study of all of the following Except..... .

1) earth 2) life 3) solar radiation 4) chemical elements

7 - The author's attitude towards the subject of the passage could best be described as.....

1) cynical 2) objective 3) sarcastic 4) emotional

Passage Two

To some people, a perfect or utopian system for waste disposal would be a technology that is capable of accepting an unlimited amount of waste and safely containing it forever outside the sphere of human life. Although such a waste disposal scheme might some day be possible, it is not likely to be a reality in the near future. On the other hand, to many environmentally conscious people, this situation would not be ideal

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Lesson 7

The world of liquid crystals

"with words we govern men"
B. Disraeli, C. Fleming

sensitive *adj.* 1. impressionable, irritable, perceptive, responsive, susceptible, temperamental, touchy 2. delicate, fine, precise
antonyms: 1. hard, insensitive, thick-skinned 2. approximate, imprecise
membrane *n.* diaphragm, film, skin, tissue, veil
spin *v.* 1. gyrate, pirouette, reel, revolve, rotate, swirl, turn, twirl, twist, wheel, whirl 2. concoct, develop, invent, narrate, recount, relate, tell, un fold
spin *n.* 1. gyration 2. agitation, flap, panic, tizzy 3. drive, ride, run
immemorial *adj.* age-old, ancient, archaic, fixed, traditional
antonym: recent.
arrange *v.* 1. adjust, align, categorise, methodise, set out, settle, sift tidy 2. adapt, orchestrate, score, set
antonyms: 1. disorganise, muddle, untidy
odd *adj.* 1.abnormal, atypical, bizarre, curious, eccentric, extraordinary, queer, unusual 2. irregular, occasional, random 3. left-over, miscellaneous, spare, unpaired
antonyms: 1. normal, usual 2. regular
melt *v.* dissolve, fuse, liquefy, thaw
antonyms: freeze, harden, solidify
cloudy *adj.* blurred, blurry, dark, dim, dull, hazy, indistinct, leaden, muddy, murky, nebulous, obscure, opaque, overcast, somber, sullen
antonyms: bright, clear, sunny
pair *n.* brace, combination, couple, twins, twosome
cross *adj.* 1. angry, annoyed, bad tempered, grumpy, snappy, sullen 2. crosswise, hybrid, interchanged, oblique, opposite, reciprocal, transverse
antonyms: 1. calm, placid, pleasant
origin *n.* ancestry, base, basis, dawning, derivation, extraction, fountain, heritage, lineage, parentage, pedigree, roots, source, spring, start, stock, wellspring
antonyms: end, termination
pack *n.* 1. back-pack, bundle, haversack, kit, kitbag 2. band, collection, company, flock, gang, troop
pack *v.* batch, bundle, charge, compact, cram, crowd, ram, stow, stuff, throng, wedge
direction *n.* 1. administration, control, guidance, supervision 2. line, path, road, route, way
slight *adj.* 1. feeble, ignore, inconsiderable, insignificant, minor, modest, negligible, trivial, unimportant 2. delicate, slender, slim
antonyms: 1. considerable, major, noticeable, significant 2. large, muscular
narrow *adj.* 1. close, confined, cramped, fine, limited, marginal, slender, slim, tapering, thin, tight 2. biased, bigoted, dogmatic, exclusive narrow-minded, restricted

antonyms: 1. broad, wide 2. broad-minded, tolerant
narrow *v.* constrict, diminish, limit, reduce, simplify, tighten
antonyms: broaden, increase, loosen, widen
aromatic *adj.* balmy, fragrant, perfumed, pungent, redolent, savoury, spicy, sweet-smelling
antonym acrid

If you have looked at a calculator or mobile phone display, used a laptop computer or a digital watch, you have made use of liquid crystals. As we will see, they also have applications in the materials used for bullet proof vests, temperature ***sensors*** and computer information storage devices and are being developed to produce things such as erasable electronic newspapers. Liquid crystals are also found in living cell ***membranes***, and even the slime in your soap dish contains them.

Mankind has known about liquid crystals for just over a hundred years, yet spiders have been ***spinning*** webs containing these molecular curiosities since time ***immemorial***.

What are liquid crystals?

When we think of a liquid, we picture its molecules as being ***arranged*** at random, while the molecules in a crystal are in a highly ordered arrangement. So, it seems ***odd*** to talk about a liquid crystal. However, it turns out that many substances with ***rod-shaped*** molecules have a state, called a mesophase, between liquid and crystal where the molecules have lost their regular arrangement but still tend to point in the same direction, Figure 1. This is the basis of the liquid crystal state-the molecules have lost their positional order (they can move about), but they still have directional order (they all point in essentially the same direction).

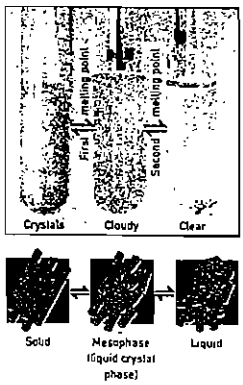
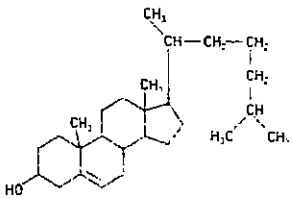


Figure 1. In the liquid crystal state, rod-shpaed molecules can move about but still point in the same general direction.

The phenomenon of liquid crystallinity was first discovered by an Austrain botanist, Friedrich Reinitzer in 1888. He was trying to measure the ***melting*** point of a compound he had just made, cholesteryl benzoate, and found that it seemed to have two melting points. At $145.5^{\circ}C$ $(418.5K)$ the crystals formed a ***cloudy*** liquid and at $178.5^{\circ}C$ $(451.5K)$ the liquid became clear.



A colleague of Reinitzer's, Otto Lehmann, examined the liquid 'in-between' phase of cholesteryl benzoate with a polarized light microscope in which the sample being examined is sandwiched between a pair of crossed polaroids, Figure 2. He was surprised to find that it had different ***refractive indices*** in different directions – a property called birefringence. This is a property normally associated with ordered crystalline solids, where a direction can be specified in terms of the layers of atoms, molecules or ions in the crystal, and so Lehmann was astounded to find it shown by a liquid. The observation implied that the molecules in the liquid were arranged in an orderly fashion. This was the origin of the term 'liquid crystal'.

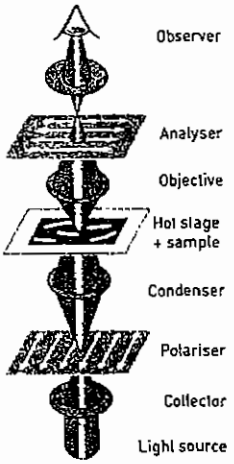


Figure 2. A polarized light microscope

The fourth state of matter.

We can now explain Reinitzer and Lehmann's observations. Cholesteryl benzoate molecules are rod-shaped overall, rather like pencils, Figure 3. In the solid state, they line up like pencils ***packed*** tightly into a pencil box which is just the right size to hold them. When heated up past the first melting point, the molecules are able to move around but they all still point in the same ***direction***. This is the liquid crystal state. It is rather like pencils in a slightly bigger box – the pencils can move from place to place, but the box is too ***narrow*** for them to turn around, so they all have to point in the same ***direction***. At the second melting point (the clearing temperature of the cloudy liquid), the 'pencil box' is large enough to enable the molecules to turn around as well as move from place to place, Figure 4.

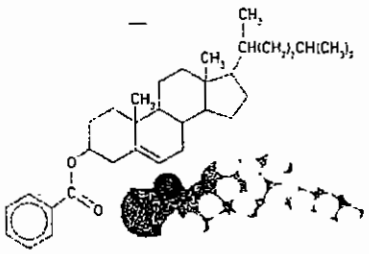


Figure 3. The rod-like molecular structure of cholesteryl benzoate.

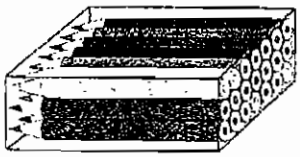
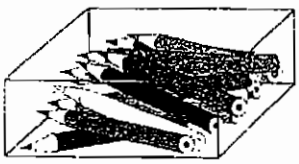


Figure 4. Tightly packed pencils are not free to move (solid).



More loosely packed pencils can move around in the box but all point in the same general direction (liquid crystal).

If the box is larger than the pencils, all order is lost (liquid).

Other liquid crystal

The structures of liquid crystal molecules are quite varied, but they some features in common. The molecules are usually rod shaped, Figure 5, and they have an uneven distribution of electrons. This leads to **intermolecular forces** which, over a certain range of temperatures, are strong enough to cause the molecules to line up in the same overall direction but not strong enough to hold them firmly in one place.

In the early years of this century, the German chemist Daniel Vorilander established that the rod-shpaed molecules which formed the liquid crystalline state had flat, rigid sections consisting of a planar, electron-rich **aromatic** ring or rings joined by short linkages usually containing double bonds. These cores have attached to them one or two carbon chains, Figure 5.

Vorlander also showed that the clearing temperature, when all order is lost, is linked to the shape of the molecule. Rod-like molecules which can pack closely together have high clearing temperatures while molecules with side chains on the rods have lower clearing temperatures.

Q 1. Suggest why molecule (C) in Figure 5 would be expected to have a flat core?

Q 2. What types of intermolecular force are caused by an uneven distribution of electrons?

There are two main types of liquid crystal phase. The one described above for cholesteryl benzoate, where the molecules tend to point in the same ***direction***, is called ***nematic***, and the direction in which they point is called the director. The second main type of liquid crystal is called ***smectic***. Here the molecules are arranged in layers.

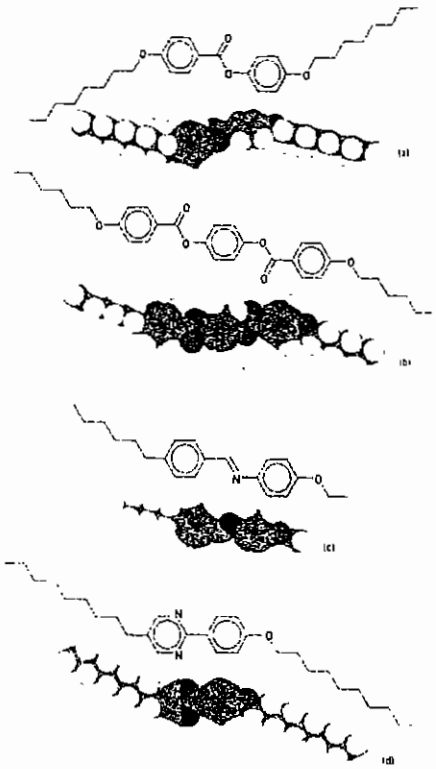


Figure 5. Some examples of rod-shaped liquid crystal molecules showing the cores which hae linked aromatic rings. The rod shapes are seen most clearly from the space filling models.

A. General Vocabulary practice

Directions: put the number of the definition in column B beside the correct word in column A.

A	B
..... a. aromatic	1. organise
..... b. arrange	2. interchange
..... c. cloudy	3. ancient
..... d. cross	4. pungent
..... e. direction	5. opaque
..... f. immemorial	6. path
..... g. melt	7. fuse
..... h. pack	8. couple
..... i. pair	9. bundle
..... j. spin	10. gyrate

B. select a word in column B which is opposite in meaning to word in column A.

A	B
..... a. ascend	1. final
..... b. chronic	2. temporary
..... c. contract	3. go down
..... d. decline	4. expand
..... e. ignore	5. darken
..... f. illuminate	6. horizental
..... g. initial	7. notice
..... h. overwhelming	8. absolute
..... i. relative	9. rise
..... j. vertical	10. negligible

C. Read the following passages and answer the questions by choosing the choice

Plants need large amounts of nitrogen, potassium , and phosphorus to grow in abundance. Chemical fertilizers can help provide these nutrients to crops, which in turn provide us with a bountiful and balanced diet. Fertilizers are especially important in certain regions of Asia and Africa where food can sometimes be scarce.

Advances in biotechnology also offer the potential to further increase worldwide food production. Finally, chemical enigineers are at the forefront of food processing where they help create better tasting and most nutritious foods.

1 - According to the above passage, choose the correct sentence:

1) N, P and K are produced by many plants.
2) Crop plants are sources of bountiful and balanced diet.
3) To develop more chemical plants, a lot of N, P, and K are needed.
4) Without chemical fertilizer, food shortages would have happened.

2 - According to the text, complete the following sentence: "Chemical engineers are at the forefront of food processing" means..... .

1) chemical engineers are keen to process food.
2) chemical engineers have the most important role in the processing of food.
3) chemical engineers are the most responsible persons to increase food production.
4) chemical engineers are capable of producing chemical fertilizer for food industries.

Passage II:

Chemical engineers have been able to take small amounts of antibiotics developed by people such as Sir Arthur Fleming (who discovered pencillin in 1929) and increase their yields several thousand times through mutation and special brewing techniques. Today's low price, high volume, drugs owe their existence to the work of chemical engineers. This ability to bring once scare materials to all members of society through industrial creativity is a defining characteristic of chemical engineering.

3 - According to the text above, choose the correct sentence:

1) Sir A. Flaming discovered antibiotics mutation.
2) All members of the society have benefited from low price drugs.
3) chemical engineers are capable to reduce the price by mass production.
4} chemical engineers are capable of producing all kind of chemicals and drugs

Passage III:

Molasses is diluted to a 10-15% sugar concentration and adjusted to a PH of 4-S to support Yeast growth which furnishes invertase and zymase catalytic enzymes. Nutrients such as ammonium and magnesium sulfate or phosphate is added when lacking in the molasses. This diluted mixture tailed mash is run into large wooden or steel fermentation tanks.

Yeast solution, grown by inoculating sterile mash, is added and fermentation ensues with evolution of heat which is removed via cooling sails, The temperature is kept at 20 - 30°C over a 30-70 hr period, rising near the end, to 35°C. Carbon dioxide may be utilized as a by-product by water scrubbing and ,.compressing; otherwise it is vented after water scrubbing.

Separation of the 8-10% alcohol in the fermented liquor called beer is accomplished by a series of distillations. In the beer still, alcohol (50-60% conc.) and undesirable valatiles such as aldehydes are taken off the tap and fed to the aldehyde still. Alcohol is palled off as a side-stream ˙split to the rectifying column

4 - In the fermentation process , ammonium sulphate is added as:

1) Food 2) Additive 3) Catalyst 4) Preservative

5 - In the fermentation process, aldehyde vapours are collected as voulatiles which are :

1) by products 2) unnecessary 3) non – essential 4) unwanted

6 - Highly concentrated ethanol is obtained from :

1) mash solution 2) beer distillation 3) rectifying column 4) fermentation liquor

7 - In the fermentation process, the control of pH is necessary for :

1) enzymatic reactions 2) supporting enzyme growth
3) control of side reactions 4) suppressing yeast growth

Lesson 8

Nd^{3+} Doped TiO_2 Nanoparticles

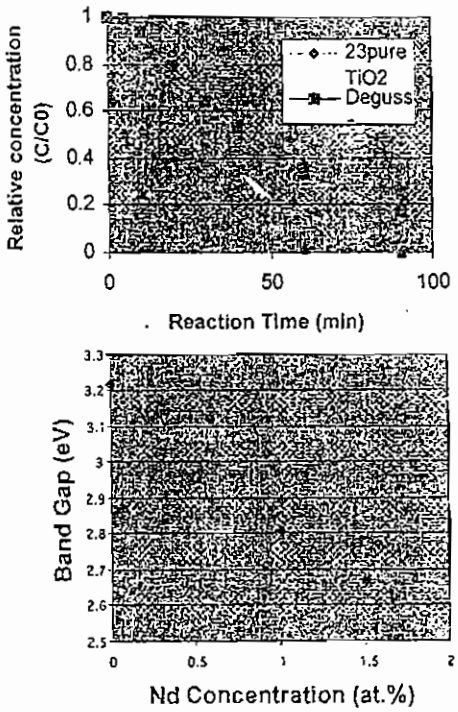
"Clearness is the most important matter in the use of words"
Quintillian

remedy *n.* answer, antidote, corrective, countermeasure, cure, medicine, panacea, therapy, treatment
remedy *v.* correct, counteract, cure, fix, heal, mitigate, put right, rectify, redress, reform, repair, restore, solve, soothe, treat
bulk *n.* amplitude, bigness, body, dimensions, extensity, extent, generality, immensity, magnitude, plurality
bulky *adj.* big, chunky, colossal, cumbersome, enormous, heavy, hefty, huge, hulking, immense, large, massive, substantial, unwieldy, weighty
antonyms: handy, insubstantial, small
combine *v.* amalgamate, associate, bind, blend, bond, compound, connect, cooperate, fuse, incorporate, integrate, join, link, marry, merge, mix, pool, synthesise, unify, unite
antonyms: **detach**, divide, separate
probability *n.* assumption, chance, chances, expectation, likelihood, odds, prospect
antonym: improbability
pollution *n.* adulteration, contamination, corruption, defilement, desecration, foulness, impurity, infection, profanation, stain, taint, violation, vitiation
antonyms: cleanness, purification, purity
area *n.* arena, canvas, field, zone
gap *n.* blank, breach, break, cleft, crevice, divergence, divide, hole, interclude, interval, recess, rift, space, void
increment *n.* addition, advancement, extension, gain, increase, step up, supplement
antonym: decrease
efficiency *n.* ability, capability, competence, mastery, productivity, proficiency, readiness, skillfulness, skill
critical *adj.* 1. all-important, crucial, essential, grave, serious, urgent, vital 2. dangerous, perilous, precarious, risky
dope *n.* 1. drugs, hallucinogen, narcotic, opiate 2. blockhead, clot, dimwit, dunce, fool, half-wit, idiot, simpleton
dope *v.* anaesthetise, doctor, drug, inject, load, medicate, sedate
incorporate *v.* absorb, assimilate, blend, coalesce, combine, consolidate, contain, embody, fuse, include, integrate, merge, mix, subsume, unite
antonyms: separate, split off
beg *v.* beseech, crave, desire, pray, scrounge, supplicate
lattice *n.* arrangement, channels, grid, grill, maze, mesh, net, network, structure
distribute *v.* allocate, circulate, convey, deal, scatter, share, spread, supply
antonyms: collect, gather in

vacancy *n.* accommodation, job, opening, opportunity, place, position, post, room, situation, space
trap *n.* ambush, artifice, danger, deception, hazard, net, noose, pitfall, ruse, snare, spring, subterfuge, trap-door, trick, wile
trap *v.* ambush, beguile, catch, corner, dupe, enmesh, ensnare, entrap, snare, trick

TiO_2 is a promising photocatalyst for environmental ***remediation*** processes. TiO_2 nanoparticles offer additional advantages if the size can be optimized.In ***bulk*** or large particles more than 90% of the photo-generated carriers ***recombine***.

Therefore, decreasing the total volume of the particle decrease the recombination ***probability*** making available more carriers for the oxidation or reduction of a surface adsorbed ***pollutant***. However, there is an optimal size. Small particles have large total surface ***area*** where the surface recombination can occur. A size optimization is, therefore, required.



The large band gap of TiO_2 nanoparticles has to be tailored in order to provide additional ***increment*** in the photocatalytic ***efficiency***. Nanoparticles,with their increased surface area, provide surface states within the band gap to effectively reduce the band gap. However, as discussed above, the particle size cannot be decreased below a ***critical*** limit. Another way of decreasing the effective band gap is by doping with appropriate ***dopant***. In our work, dopants such as Pt, Pd, Fe and Nd have been tried Nd was found to be most effective in increasing the catalytic efficiency of TiO_2 of 2-chlorophenol decomposiotion. The enhancement is related to the relative size of the dopant and the Ti ions. When ***incorporated*** subsitutionally, Nd ion being the ***beggest*** of all the dopants tested, induces stresse in the ***lattice*** which causes local charge ***redistribution***. This, in combination with the higher electonegativity of Nd, causes oxygen ***vacancy*** formation which serves as electron ***traps*** and effectively enhance the holes lifetime. Increased hole lifetime helps in oxidative degradation of ***pollutants***. This effect has been measured by the photocatalytic degradation of 2-chlorophenol (2-CP). 1 in which the ***degradation*** of 2-CP for various TiO_2 particles are plotted. Included in the plot is the 2-CP degradation performance of Degussa P-25 (diameter ~ 50nm), undopted TiO_2 nanoparticles, and Nd doped TiO_2 nanoparticles. The optical band gap of the particle is plotted in Fig.2 measured by optical absorption. This measurement has been confirmed

experimentally by Near Edge X-ray Absorption Fine Structure Spectroscopy (NEXAFS) and theoretically by Linearized Augmented Plane Wave Model (LAPW).

A. General Vocabulary practice

Directions: put the number of the definition in column B beside the correct word in column A.

A	B
..... a. collaboration	1. emanate
..... b. emit	2. avaricious
..... c. extreme	3. muddy
..... d. greedy	4. spoken
..... e. illuminate	5. co-operation
..... f. make shift	6. temporary
..... g. opaque	7. extraordinary
..... h. oral	8. rotate
..... i. transmit	9. light up
..... j. twirl	10. broadcast

B. select a word in column B which is opposite in meaning to word in column A.

A	B
..... a. bulky	1. gather in
..... b. commence	2. small
..... c. distribute	3. shrink
..... d. expand	4. finish
..... e. harsh	5. decrease
..... f. incorporate	6. split off
..... g. increment	7. smooth
..... h. migrate	8. purification
..... i. pollution	9. stay at home
..... j. probability	10. improbability

C. Read the following passages and answer the questions by choosing the best choice

The first synthetic plastic was a thermosetting resin called ebonite, patented in 1843. Plastics are divided into two broad categories, thermosets and thermoplastics. The thermosets are materials that, once heated, take on a permanent form that cannot be changed by rehearing, while thermoplastics repeatedly soften on heating and harden on cooling.

Much of the early work on plastics was on thermosets, and it may have been this limitation that prevented them from becoming highly acceptable materials. Another reason is that they were looked upon as substitutes for existing materials, rather than as new materials requiring new ideas in design and usage.

Part of this "substitute" outlook still survives, with people disparaging plastics as second-rate materials. However, with the major advances in formulation and use of plastics since the Second World War, this attitude is now passing out of fashion.

1 - What does the passage mainly discuss?

1) The importance of plastics in the Second World War
2) Various uses for plastics
3) The early history of synthetic plastics
4) People's attitudes toward new materials

2 - According to the passage, materials which can repeatedly be softened and hardened are called

1) thermoplastics 2) ebonites 3) thermosets 4) substitutes

3 - According to the passage, why may plastics not have been widely accepted at first?

1) Initial research was on plastics with limited utility.
2) A world war caused plastics to be in short supply.
3) Existing plastics were not sufficiently heat-resistant.
4) Some researchers felt that plastics were dangerous.

4 - Which of the following would he LEAST useful if it were made from a thermoplastic?

1) A vase for flowers 2) A doorknob 3) A table 4) A coffee cup

5 - The paragraph following the passage most probably discusses:

1) the characteristics of plastics made in the early 1800's
2) the greater acceptance of plastics since the Second World War
3) the reasons some people consider plastics inferior to other materials
4) the absence of plastics from the world of fashion

Lesson 9

Computational chemicstry and the virtual Laboratory

"we tie knots and bind up words in double meanings, and then try to unite them"

Seneca

immerse *v.* bathe, dip, douse, duck, plunge, sink, submerge, submerse

variety *n.* 1. array, assortment, collection, difference, diversity, intermixture, medley, miscellany, mixture, multiplicity, potpourri, range 2. brand, breed, category, class, kind, make, sort, species, strain, type

antonyms: monotony, similitude, uniformity

procedure *n.* action, conduct, course, custom, form, formula, method, move, operation, performance, plan of action, process, strategy, transaction

assemble *v.* 1. accumulate, amass, collect, congregate, convene, flock, gather, mobilize, summon 2. build, compose, construct, fabricate, make, manufacture, piece together, put together

extreme *adj.* acute, dire, drastic, exceptional, excessive, extraordinary, greatest, harsh, high, immoderate, intense, strict, supreme, ultimate, worst, zealous

attraction *n.* allure, amenity, appeal, bait, charm, fascination, inducement, lure, pull, seduction, show, temptation

repulse *v.* beat off, check, defeat, drive back, refuse, reject, repel, snub, spurn

evaluate *v.* assess, calculate, compute, estimate, gauge

distribute *v.* allocate, circulate, convey, diffuse, hand out, scatter, share, spread, supply

antonyms: collect, supply

approximate *adj.* close, estimated, guessed, inexact, near, relative, rough, similar, verging on

antonym: exact

approximate *v.* approach, be tantamount to, border on, resemble, verge on

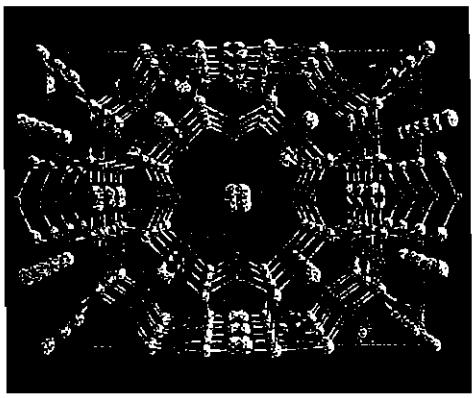
ab-initio method: A method of calculating from the first principles of quantum mechanics, without using quantities.

derived: from experiment as parameters.

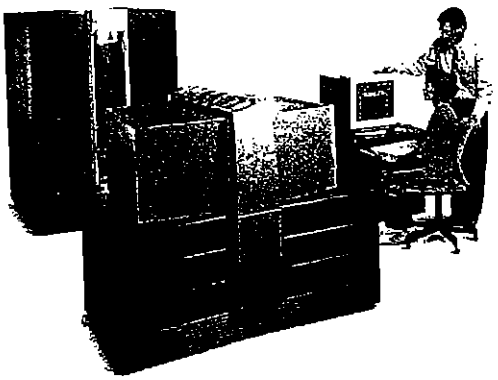
restrict *v.* bound, confine, constrain, contain, cramp, demarcate, hamper, handicap, impede, inhibit, limit, regulate, restrain, tie

antonyms: broaden, encourage, free

How does computer modeling work?



Modellers study systems ranging from single isolated molecules to proteins containing thousands of atoms ***immersed*** in a sea of solvent molecules. Computational chemists have at their disposal a ***variety*** of methods but at the heart of all programmes is some ***procedure*** for calculating the energy after each change. The programmes then make small changes to the system and recalculate the energy after each change. They then use the principle that a chemical system tends to adopt the lowest energy which it can attain to select the most likely configuration of the system.



Energies can be calculated using two basic methods- quantum mechanics or molecular mechanics. Deciding which is the appropriate method to use depends upon the kind of questions we want to ask and on the available computing power. Quantum mechanics offers the most fundamental approach and is mostly used on simple atoms and molecules. Molecular mechanics is particularly useful for modeling large molecules and ***assemblies*** of molecules.

Quantum mechanical methods

A quantum mechanical calculation starts with the Schrodinger equation, Which fully describes any atom or molecule in terms of its wavelike quantum nature. The problem is to solve the equation the thus calculate the energy levels of the system. However, this equation can only be solved exactly for ***extremely*** simple systems, such as the hydrogen atom, which consists of just one proton and one electron. No exact solution is possible even for the helium atom!

When written out in full, the Schrodinger equation consists of a very large number of terms which take account of the ***attractions*** and ***repulsions*** between all possible pairings of particles of the atoms in the molecule, and also their kinetic energies. ***Evaluating*** these terms is out of the question without computers, and progress to bigger molecules has been possible only because advances in computing power have allowed the methods described below to be used. These calculations can tell us how the energy of the molecule varies with the molecule's properties such as dipole moments (the ***distribution*** of electronic charge in the atom or molecule represented by δ^- and δ^+).

Since the Schrodinger equation cannot be solved exactly, theorists need to think up ingenious ways of finding ***approximate*** solutions. A key component of most of these approaches is the variation principle, which states that the 'better' the solution the lower the energy.

The general idea is to solve the Schrodinger equation approximately make small changes to the starting conditions and solve it again, make more changes and solve it yet again and so on.

Eventually a solution of minimum energy will be found-this is the 'best' solution. William Hartree did tedious calculations like these at Cambridge in the 1930s and 40s on mechanical calculators aided by his family!

Quantum mechanical methods can be divided in two types-***ab initio*** methods and semi-empirical ones. Ab initio means 'from the beginning'; the calculations work from first principle, using as inputs only physical constants such as the, charge on the electron. Semi-empirical methods use data derived from experiment, such as ionization energies, to help out the calculations which are therefore much quicker to do and require less computing power.

Despite this and other advances, quantum mechanical calculations are ***restricted*** to single molecules containing a few tens of heavy atoms.

A. General Vocabulary practice

Directions: put the number of the definition in column B beside the correct word in column A.

A	B
..... a. absorb	1. mix together
..... b. abundant	2. submerge
..... c. assemble	3. suck up
..... d. blend	4. confine
..... e. evaluat	5. very plentiful
..... f. immerse	6. repel
..... g. procedure	7. construct
..... h. repulse	8. necessary to life
..... i. restrict	9. estimate
..... j. vital	10. method

B. In column A are ten words. Match them correctly with their opposite meaning in column B.

A	B
..... a. approximate	1. shortage
..... b. attraction	2. slow
..... c. elevate	3. lower
..... d. hasty	4. make smaller
..... e. magnify	5. neat
..... f. oral	6. variety
..... g. similitude	7. split-up
..... h. surplus	8. exact
..... i. unify	9. written
..... j. untidy	10. repulsion

C. Read the following passages and answer the questions by choosing the best choice.

Magnesium is another mineral we now obtain by collecting huge volumes of ocean water and treating it with chemicals, although originally it was derived only from brines or from the treatment of such magnesium-containing rocks as dolomite, of which whole mountain ranges are composed. In a cubic mile of seawater there are about four million tons of magnesium. Since the direct extraction method was developed about 1941, production has increased enormously. It was magnesium from the sea that made possible the wartime growth of the aviation industry, for every airplane made in the United States (and in most other countries as well) contains about half a ton of magnesium metal. And it has innumerable uses in other industries where a lightweight metal is desired, besides its longstanding utility as an insulating material, and its use in printing inks, medicines, and toothpastes

1 - What is the main topic of this passage?

1) Uses of seawater
2) Treatment of seawater
3) Chemical properties of magnesium
4) Derivation and uses of magnesium

2 - According to the passage, magnesium was first obtained from..... .

1) rocks found on land
2) great amounts of ocean water
3) the sea floor
4) major industrial sites

3 - According to the passage, which of the following was a direct consequence of the new method of obtaining magnesium?

1) The development of insulation materials
2) Increased airplane production
3) Improved medical facilities
4)The development of cheap inks for printing

4 - According to the passage, why is magnesium important to industry?

1) It is strong.
2) It conducts heat well.
3) It weighs little.
4) It is inexpensive to produce.

5 - It can inferred from the passage that during the past fifty years. the demand for magnesium has ..... .

1) declined greatly
2) remained stable
3) increased slightly
4) risen dramatically

Lesson 10

C_{60} - the most symmetrical cluster

"words, like fine flowers, have their colors, too"

Ernest Rhys

identify *v.* catalogue, classify, detect, diagnose, distinguish, pick out, pinpoint, recognize, single out, specify, tag

allotrope *n.*

tremendous *adj.* amazing, colossal, enormous, extra ordinary, fabulous huge, marvelous, stupendous, terrific, vast, wonderful

antonyms: appalling, dreadful, tiny

explore *v.* analyse, examine, inspect, investigate, probe, prospect, reconnoiter, research, scout, scrutinize, survey, travel

bond *v.* bind, connect, fasten, fuse, glue, gum, paste, seal, unite

roll up *v.* arrive, assemble, cluster, congregate, convene, gather

antonyms: leave, scatter

detect *v.* ascertain, catch, discern, disclose, discover, distinguish, expose, find, identify, observe, perceive, recognize, reveal, sight, spot, spy, track down, unmask

rotate *v.* gyrate, pivot, revolve, spell, spin, swivel, turn

beam *n.* 1. gleam, glint, glow, ray, shaft 2. bar, board, boom, grider, joist, plank, rafter, spar, timber

beam *v.* broadcast, emit, glare, grin, radiate, shine, smile, transmit

condence *v.* abbreviate, abridge, coagulate, concentrate, summarised

antonyms: diluted, expanded

cluster *n.* assemblage, batch, bunch, clump, collection, gathering, group, knot, mass

cluster *v.* bunch, flock

apparatus *n.* appliance, bureaucracy, device, equipment, framework, gadget, machine, system, tools, utensils

shed *v.* afford, diffuse, discard, give, moult, radiate, scatter, slough, spill

shed *n.* barn, hut, lean-to, lock up, out house, shack

create *v.* appoint, beget, cause, coin, design, develop, make

magic *n.* black art, conjuring, hocus-pocus, illusion, occultism, spell, trickery, voodoo

magic *adj.* bewitching, charming, fascinating, marvelous, spellbinding, wizard, wonder-worker

speculate *v.* conjecture, consider, contemplate, gamble, guess, surmise, venture, wonder

frustrate *v.* baffle, black, block, foil, forestall, inhibit nullify, spike

antonyms: fulfil, further, promote

evaporate *v.* dematerialise, disappear, dispel, distil, dry, exhale, fade, vanish, vaporize

rod *n.* pole, bar

contaminate *v.* adulterate, corrupt, debase, defile, deprave, infect, pollute, soil, stain, sully, taint, tarnish

antonym: purify

hump *n.* bulge, bump, knob, lump, mound, projection, prominence, protuberance, swelling

spherical *adj.* globe-shaped, rotund, round

cage *v.* confine, coop up, encage, fence in, impound, imprision, incarcerate, lock up, restrain, shut up

antonyms: free, let out, release

cage *n.* aviary, coop, corral, enclosure, pen, pound

condensation *n.* abridgement, compression, concentration, consolidation, contraction, crystallization, curtailment, digest distillation, liquefaction, precipitation, précis, reduction, synopsis

intense *adj.* acute, close, concentrated, deep, eager, earnest, energetic, fervent, fervid, fierce, forceful, forcible, great, harsh, intensive, keen, passionate, powerful, profound, severe, strained, strong, vehement

antonyms: mild, moderate, weak

beam *n.* 1. gleam, ray, shaft 2. bar board, boom, spar, timber,

beam *v.* broadcast, emit, glare, radiate, shine

insulate *v.* cocoon, cushion, cut off, isolate, protect, sēparate off, shelter, shield

conduct *n.* 1. actions, attitude, manners, ways 2. control, direction, leadership, operation

conduct *v.* accompany, acquit, act, administer, carry, convey, escort, lead, regulate, steer, usher

Perhaps the most famous nanocluster of all is the football-shaped carbon molecule, C_{60}, Figure 1. This was ***identified*** for the frist time by a team of UK and US scientists in 1985, and it represents a third ***allotrope*** of carbon; the two best known are graphite and diamond Figure 2 and 3 Since its discovery, C_{60} has caused ***tremendous*** excitement among scientists. It has opened the door into a new world of related cage-and tube-shaped carbon molecules, called fullerenes, with new chemistry (and physics) to ***explore***. Like other clusters, C_{60} and its relations have not only provided insights into our understanding of chemical ***bonding*** and structure but also offer the promise of new applications in electronics, materials science and even medicine.

Although C_{60} became a subject of serious study only in the mid-1980s, people had speculated earlier on what would happen if you ***rolled up*** the hexagonl 'chicken-wire' structure of graphite into a ball. In the 1970s, theorists had suggested that C_{60} should be a stable molecule, and had predicted its properties-although few people seem to have noticed these studies.

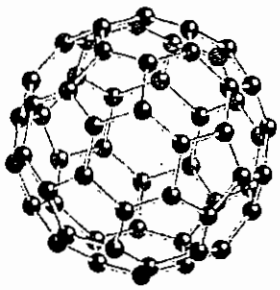


Figure 1. Buckminsterfullerene.

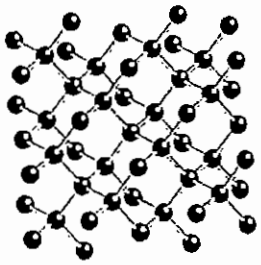


Figure 2. Diamond

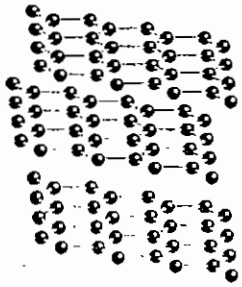


Figure 3 . Graphite

The story of a discovery

The full story of the discovery of C_{60} is long and exciting and there is room for only the highlights here. It is well told in the book Perfect Symmetry by Jim Baggott (OUP), Fig.4.

The story starts with Harry Kroto (now Sir Harry), a spectroscopist at the University of Sussex. He and his colleagues were interested in very long chain carbon molecules called cyanopolyynes that might form in the atmospheres of carbon-rich stars. The molecules can be ***detected***, even across the wide reaches of space, by microwave spectroscopy. This technique analyses the electromagnetic radiation absorbed and emitted by these molecules as they ***rotate*** and allows information such as bond lengths to be determined.

Q 1. What information does the name 'cyanopolyyne' give about the structure of the molecule?

In 1984 another spectroscopist, Robert Curl at Rice University in Houston, Texas, suggested that Kroto visit the laboratory of his colleague, Richard Smalley, Smalley was using a laser to vaporize atoms from a solid target disc.

The ***beam*** of atoms was then allowed to cool and ***condense*** into ***clusters*** in the vapour phase which could be studied by mass spectrometry (rather like the sodium clusters mentioned earlier) When Kroto saw Smallery's ***apparatus***, he realised that it might ***shed*** light on his idea an the creation of carbon chaines in the atmospheres of certain stars.(Fig.5 and Fig.6)

Figure 4. The C_{60} Cowrtesy of sir Harry Kroto.

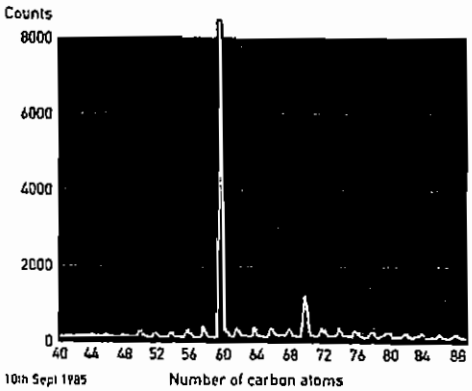


Figure 5. The mass spectrum obtained by vaporizing carbon with a laser and allowing the atoms to condense. The peaks for C_{60} can be clearly seen.

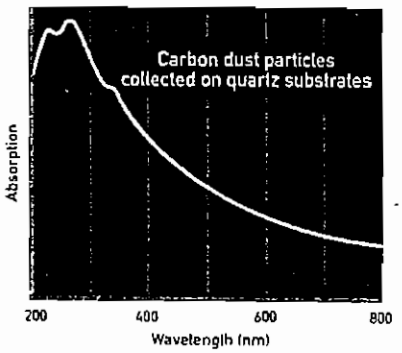


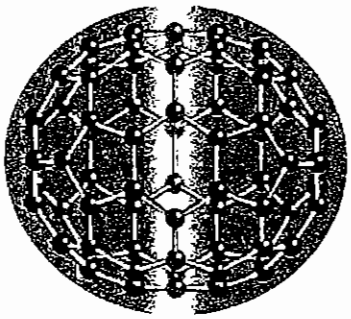
Figure 6. The UV spectrum of Huffman and Kratschmer's samples of 'soot' showed two camel-like humps which are due to C_{60}

In September 1985, Kroto, Smalley and Curl, together with postgraduated Jim Heath, Sean O'Brien and Yuan Liu set to work using a graphite disc to ***create*** carbon clusters. They alredy knew that clusters with certain '***magic numbers***' or carbon atoms were favoured but were surprised to find that one number, 60, dominated the spectrum. Another peak that stood out was that for C_{70}. Figure 7.

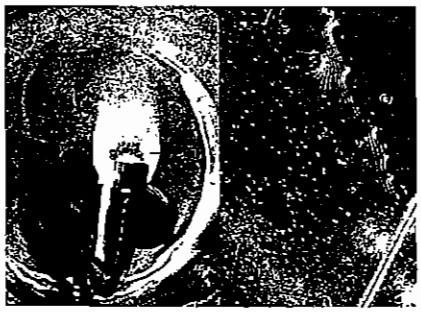
The researchers had not then heard of the earlier ***speculations*** on C_{60}, but clearly there was something unusual about the structure of C_{60} which made it so stable. They came to the conclusion that C_{60} was a closed spherical cage of carbon atoms similar in shape to the ***geodesic domes*** (see photo) designed by the American architect Richard Buckminster Fuller. C_{60} consisted of a hollow spherically-shaped polyhedron composed of 20 hexagones and 12 pentagons with carbon atoms sitting at the 60 ***vertices***. When Smalley asked the head of Rice's mathematics department what this shape was called, the answer was: I could explain this to you in a number of ways, but what you've got there is a soccer ball! C_{70}, which is more elongated (in the shape of a rugby ball), has 25 hexagons.

C_{60} was dubbed buckminsterfullerene-later shortened to 'buckyballs' in the popular press-after the architect, while the new class of molecules was given the family name of fullerenes.

The evidence was still circumstantial, although well supported by further experiments and theoretical calculations. The problem was that the researchers could ***produce*** only a few tens of thousands of molecules, which was not enough to determine their structures.



Carbon forms a range of closed cage-like structures-the fullerenes. C_{70} is shown here.



Carbon dust particles floating upwards in the current of helium gas, looking like a cloud of cigratte smoke.

Richard Smalley. Robert Curl. Sir Harry Kroto.

Donald dout. In 1996 the discovery of a new form of carbon was regonised through the award of a Nobel prize to the senior members of the original team kroto, Smalley and curl.

A breakthrough at last

Kroto's team at Sussex spent five ***frustrating*** years looking for a way to make larger amounts of C_{60} so that they could analyse it. Here is where another strand of the story links in, also starting in space. Two physicists, Donald Huffman at the University of Arizona and Wolfgang Kratschmer at the Max Planck Institute for Nuclear Physics in Heidelberg, were interested in interstellar dust which they thought was probably mainly soot-like particles of carbon.

In the early 1980s, they started experiments to model the formation of soot in space by ***evaporating*** a graphite ***rod*** in a bell-jar of low-pressure helium. They collected the soot and measured its ultraviolet absorption spectrum. They noted that there were two strange camel-like humps in the spectrum which they thought must be due to ***contamination***. However, when Kroto and his colleagues announced their supposed C_{60} molecule, Huffman and Kratschmer decided to have another look at the artificially-produced soot, speculating that the '***camel humps***' in its spectrum might be due to C_{60}, Figure 4. The Kratschmer-Huffman research teams measured the mass, ultraviolet and infrared spectra. They found that the results fitted the theoretical predictions for C_{60}.

By 1990 the physicists could make quantities of a few milligrams of what they now believed was C_{60}. The soot sample dissolved in benzene to form a red solution, which when evaporated left behind red crystals-a mixture of 75% C_{60} and 23% C_{70} and a few per cent of higher fullerenes, Kratschmer and Huffman called the mixture 'fullerite'. They then want on to measure the crystal structure of fullerite using X-ray and electron diffraction, confirming that the structure of C_{60} was indeed that of a ***spherical cage.***

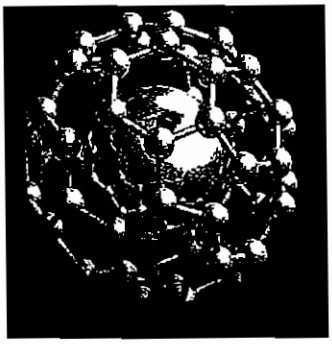


Figure 8. Metal ions can be trapped inside a C_{60}

Figure 9. A C_{60} polymer.

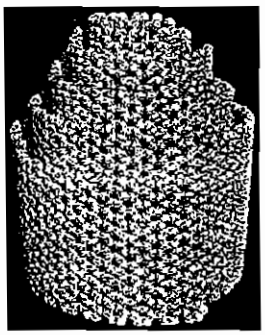
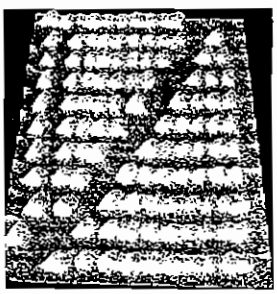
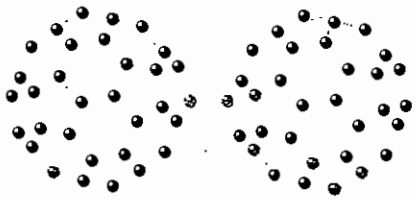


Figure 10. An individual carbon nanotube closed at one end by a fullerene cap sontaiing both carbon pentagons and hexagons. The main cylindrical body consists solely of carbon hexagons.



A molecular graphic of a nanotube.



Fullerenes as 'cages'

Early on, during the search to find the structure of buckminsterfullerene, some informative experiments were carried out. The Rice-Sussex team managed to enclose metal atom in the C_{60} cage by soakig graphite sheets in solutions of metal salts and repeating the laser vaporisation-***condensation*** experiments. Mass spectrometry results revealed that the C_{60} molecules had metal ions attached which could not be removed by irradiating them with on ***intense*** laser ***beam***. This result reinforced the idea that the metal atoms were trapped inside the C_{60} structure, Figure 8.

Q. In a mass spectrometry experiment, what mass would you expect for the molecular ion (parent ion) formed from C_{60}? What molecular ion would you expect for a C_{60} molecule with a potassium atom trapped inside?

What is more, further laser-blasting of the C_{60}-metal compounds ruptured the carbon cage and released two carbon atoms before closing up again. The team found that they could gradually reduce the size of the carbon cage so as to 'shrink-wrap' the metal ions, the final cage dimensions depending on the ionic ***radii*** of the enclosed ***species***.

By the early 1990s it was possible to make C_{60} in reasonable amounts and research groups around the world set about exploring its chemistry. Because of its unusual structure, C_{60} was expected to have some fascinating electronic properties. The electron density across its surface is uneven, being somewhat higher in the six-membered carbon rings and lower in the five membered rings. In the solid state, C_{60} molecules pack together in a face-centred-cubic lattice, Figure 10, but are free to rotate at random about their centres, even at low temperatures.

The electrical conduction of fullerenes

In 1991, researchers at AT&T Bell Laboratories in New Jersey showed that when crystalline C_{60} is 'doped' with metals such as potassium, which can donate electrons, C_{60} forms negative ions and the compound $\left[3K^{+}\ {C_{60}}^{3-}\right]$ is electrically conducting. The highest conductivity is achieved with three potassium ions for every C_{60} molecule. However, the addition of further metal ions turns C_{60} into an ***insulator***. The Bell Labs team further discovered that K_3C_{60} becomes a ***superconductor*** below about 18 K.This was improved on by researchers at the NEC Fundamental Research Laboratories in Japan, who substituted potassium with rubidium and caesium to obtain a material with a T_c of 33 K – the highest T_c for a molecular material.

A. General Vocabulary practice

Directions: put the number of the definition in column B beside the correct word in column A.

A	B
..... a. align	1. enduring
..... b. condence	2. intermediate
..... c. distinguish	3. identify
..... d. medium	4. coagulate
..... e. permanent	5. harsh
..... f. recognize	6. discriminate
..... g. relative	7. line up
..... h. roughly	8. one-off
..... i. spontaneous	9. unforced
..... j. unique	10. interrelated

B. select a word in column B which is opposite in meaning to word in column A.

A	B
..... a. condence	1. addition
..... b. delay	2. asynchronous
..... c. elimination	3. accelerate
..... d. entirely	4. clear
..... e. external	5. flexible
..... f. ignite	6. expand
..... g. inner	7. quench
..... h. nebulous	8. outer
..... i. rigid	9. internal
..... j. simultaneous	10. partially

C. Fill the blank with the best choice.

Looking for Quarks Inside the Atom

In the late 1960's Three scientists ran some accelerator experiments to study the nucleus at the ...1... of the atom. They ran the experiments because they wanted to know more about the structure of the ...2... They found that the protons and neutrons in the nucleus are made of quarks. The discovery of ...3... raised new questions about the nucleus.

The three scientists are Richard Taylor, Henry Kendall and Jerome Friedman. They did their experiments from 1967 to 1973 in California at the Stanford Linear Accelerator Center, called SLAC for short. These scientists won the 1990 Nobel Prize in Physics, one of the world's greatest honors for ...4...

In the 1960's some scientists, like murray Gell – Mann, were beginning to think that each nucleon might really be made up of even samller particles. Gell – Mann even had a name for the samller ...5... He called them quarks.

Taylor, Kendall and Friedman used beams of high- energy electrons at SLAC to explore deep inside atoms. Inside the two mile long accelerator the electrons gained energy as they moved along in a beam almost as fast as light. At the end of the accelerator, some hydrogen was the target for the electrons. Sometimes an electron would ...6... into the proton inside of the hydrogen atoms. These crashes were far too tiny to see directly or even with a microscope. The three experimenters used spectrometers to ...7... what happened.

Each spectrometer consisted of huge electromagnets, about the ...8... of a bus, and some detectors. When electrons crash into a target nucleus, a spectrometer measures their angles and energies as they bounce away. The electrons were not striking solid protons. They were striking vibrating clusters of quarks. Each proton is a cluster or three ...9...; each neutron is too.

This new discovery led to new questions. Experiments at Jefferson Lab will answer new ...10... about quark and nuclei. That's how scientific research works. There is always something new to find out!

In fact, that's why Alfred B. Nobel started the Nobel ...11... in 1901. In December, 1990, Taylor, Kendall and Friedman went to Stockholm, Sweden, to receive their Nobel Prize in Physics. The three winner shared not only the honor of the Nobel, but the ...12... That comes with it: $710,000.

1 -

1) outside 2) edge 3) center 4) perimeter

2 -

1) nucleus 2) accelerator 3) electromagnet 4) spectrometer

3 -

1) alpha 2) quarks 3) nuclei 4) electron

4 -

1) teachers 2) engineers 3) farmers 4) scientists

5 -

1) nucleon 2) quarks 3) particles 4) gell

6 -

1) crash 2) glide 3) slip 4) fall

7 -

1) wonder 2) observe 3) question 4) argue

8 -

1) size 2) color 3) purpose 4) strength

9 -

1) quarks 2) bounces 3) dusters 4) protons

10 -

1) inventions 2) questions 3) discoveries 4) statements

11 -

1) medals 2) trophies 3) prizes 4) certificates

12 -

1) book 2) certificate 3) paper 4) money

LESSON 11

What are polymers?

"without knowing the force of words, it is impossible to know men"

Gonfucius Analects

quite *adv.* 1. comparatively, fairly, moderately, rather, relatively, some what 2. absolutely, completely, entirely, exactly, fully, perfectly, precisely, totally, utterly, wholly

backbone *n.* 1. basis, character, core, mainstay, spine, vertebral, column 2. courage, grit, mettle, nerve, strength, support, tenacity, toughness

combine *v.* amalgamate, associate, bind, blend, bond, compound, connect, cooperate, fuse, incorporate, integrate, join, link, marry, merge, mix, pool, synthesis, unify, unite

antonyms: detach, divide, separate

string *n.* bunch, chain, cord, fibre, file, line, number, procession, queue, row, sequence, strand, train, twine

string *v.* festoon, hang, link, loop, stretch, suspend, thread, tie up

giant *n.* Goliath, Hercules, monster, titan

giant *adj.* colossal, enormous, gigantic, huge, immense, jumbo, king-size, large, mammoth, monstrous, titanic, vast

model *n.* 1. copy, imitation, replica 2. example, mould, pattern, template 3. design, kind, mark, style, version 4. dummy, manikin, poser, sitter

model *adj.* archetypal, complete, consummate, exemplary, perfect

model *v.* base, carve, cast, create, design, fashion, showoff, wear

soft *adj.* 1. elastic, flexible, malleable, plastic 2. bland, delicate, dim, dulcet, faint, light, low, mellow, pale, pastel, quiet, sweet 3. downy, furry, silky, smooth, velvety 4. compassionate, easy-going, indulgent, permissive, sentimental, sympathetic, tender, weak

antonyms: 1. hard 2. harsh 3. rough 4. severe, strict

melt *v.* dissolve, fuse, liquefy, thaw

antonyms: freeze, harden, solidify

wriggle *v.* crawl, dodge, edge, extricate, jerk, manoevre, sidle, slink, sneak, squirm, twist, waggle, zigzag

thin *adj.* 1. attenuated, bony, emaciated, gaunt, lanky, lean, narrow, scraggy, scrawny, shallow, skinny, slender, spare, underweight 2. delicate, diluted, feeble, fine, flimsy, gossamer, watery, weak 3. deficient, inadequate, meagre, poor, scant, skimpy, sparse 4. flimsy, tenuous, unconvincing, weak

antonyms 1. broad, fat 2. dense, solid, thick 3. abundant, plentiful 4. strong

assembly *n.* 1. assemblage, building, collection, convocation, council, crowd, flock, multitude, throng 2. construction, fabrication, manufacture

resistant *adj.* 1. antagonistic, defiant, dissident, opposed, unwilling, unyielding 2. immune, impervious, proof, strong, tough

antonyms: 1. compliant, yielding

bunch *n.* assortment, band, batch, bouquet, bundle, clump, cluster, crew, flock, gang, heap, parcel, pile, sheaf, spray, swarm, team, troop, tuft

bunch *v.* assemble, bundle, cluster, collect, congregate, crowd, herd, huddle, pack

antonyms: scatter, spread out

regulation *n.* 1. commandment, decree, dictate, edict, order, precept, prodecure, statute 2. adjustment, administration arrangement, regimentation, supervision

regulation *adj.* accepted, customary, official, orthodox, prescribed, statutory, usual

permeable *adj.* penetrable, porous, spongy

antonyms: impermeable, water tight

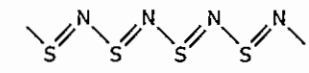
insulate *v.* cocoon, cushion, cut off, isolate, protect, separate off, shelter, shield

equipment *n.* accessories, apparatus, baggage, furnishing, furniture, gear, material, outfit, paraphernalia, rig-out, stuff, supplies, tackle, things, tools

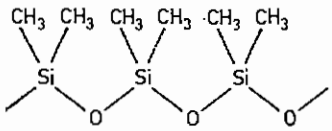
precise *adj.* absolute, accurate, actual, authentic, blow by blow, careful, exact, explicit, factual, identical, literal, meticulous, punctilious, scrupulous, succinct, unequivocal, word-for-word

antonyms: ambiguous, careless, imprecise, inexact

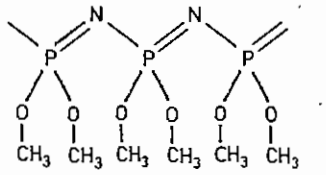
Polymers are quite different from other compounds in that they are built up from smaller molecules (monomers) linked in long chains. Usually, one polymer is built from just one two different types of monomer. A typical polymer sample made up from a collection of chains of widely differing lengths. Most common polymers have '***backbones***' based on carbon which readily forms very stable carbon-carbon covalent bonds. However, other elements also form polymers. These include ***silicon combined*** with oxygen (the resulting polymers, called ***silicones***, have many everyday applications), sulfur, nitrogen and some metals, Figure 1.



An electrical conductor



Poly(dimethylsiloxane) – an inert elastomer used as a bath sealant



A phosphonitrilic polymer

Figure1. Some inorganic polymers.

The simplest carbon polymer, polythene, is also one of the most familiar. It is sometimes called polyethylene or, more correctly, poly (ethene). Its constituent monomers are ethene molecules. Poly (ethene) consists of a ***string*** of linked carbon atoms, with each carbon joined to two hydrogen atoms, Figure 2. Some of the molecules in poly(ethene) are extremely long, having more than 50 000 carbon atoms; they are truly ***giant*** molecules.

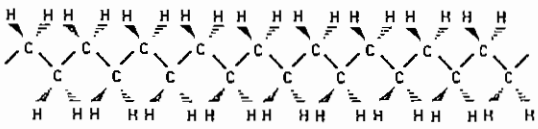


Figure 2. A frogment of a polymers.

Q. 1 *Use a ball and stick molecular* ***modelling*** *kit to make a section of a poly (ethene) molecule, say 12 carbons long. Rotate the carbon-carbon bonds and notice how many different shapes it can adopt?*

Poly(ethene)'s string-like structure gives it its familiar physical properties.In the solid, some parts of the molecule are neatly packed together in a crystalline array; how much of the molecule is crystalline depends on how it is made. We can think of this neatly packed arrangement as being rather like uncooked spaghetti in jar.

When poly(ethene) is heated it first becomes ***soft***, and then ***melts*** into a sticky, viscous fluid. (Anybody who has left a plastic washing-up bowl on a hot ceramic ***hob*** will have seen the messy results of this process). As the plastic gets hot, the stiff, extended chains soften and begin to ***wriggle*** about like cooked spaghetti. In fact, the chain movements are rather livelier than cooked spaghetti-more like a mass of writhing worms. When the molten poly(ethene) cools, it reverts to the highly-ordered crystalline form again and recovers its original properties. This behaviour allows technologists to shape the material into anything we might want-a plastic bag, a washing-up bowl or a hip-socket replacement. Materials with this kind of property are called ***thermoplstics***, which simply means they can be shaped when hot.

Q 2. *What kind of* ***intermolecular*** *forces operate between two molecules of the polymer poly(ethene)?*

b) Individually these forces are weaker than covalent bonds. State roughly how many times weaker (to the nearest factor of 10) one of these bonds is compared with a covalent bond.

C) In view of this weakness, explain why poly(ethene) is a relatively strong material.

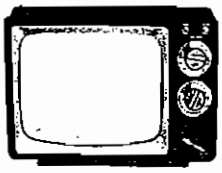
The history of polymers

Most people think of polymers as being 20th century materials. In fact, the origins of plastics technology can be traced back several centuries to the thermal softening and shaping of ***horn*** into ***utensils*** or into ***thin***, translucent sheets used as windows.

A few polymers, like Bakelite and rubber, were comercially exploited at the turn of the century, but it was not until the latter half of the 20th century that plastics made a large-scale impact. Nevertheless the theoretical base for progress in this area of science and technology was laid well before-in the early years of the 20th century.

Herman Stawdinger-one of the fathers of polymer chemistry.

Polymers were use in the music industry to make records.



Plastic have revolutionised the production of many consumer goods.

The rise of modern polymer chemistry

As recently as the 1920s the notion of very large molecules such as polymers was not accepted. That polymer science became a serious subject for study is mainly due to a German chemist called Hermann Staudinger. In 1920, Stadinger was already an established chemist. He become interested in a dispute about the nature of a group of awkward materials that were then known as *hochmolekulare Verbindungen* or 'high molecular compounds'.

The chemical theory of the time could not deal with some naturally-occurring materials like starch, cellulose, proteins, rubber and the newly invented synthetic organic plastics. The prevailing idea was that these materials could be accounted for only if they were treated as bundles of small molecules held together by some unknown force. Staudinger challenged this. His research into rubbery, apparently high molecular mass compounds was treated with contempt and dismissed as 'grease chemistry' by many of his contemporaries. For example, his colleague Professor Wieland advised him to 'Drop the idea of large molecules-organic molecules with a molecular weight higher than 5000 do not exist. Purify your rubber ... then it will crystallise'.

History has vindicated Staudinger. Of his many studies, perhaps that on a class of compounds called poly(methanal)s, Figure 3, is one of the most easily understood milestones in establishing the existence of large molecules. Poly(methanal) was treated with ethanoic acid to obtain a mixture of poly(methanal) diethanoates.

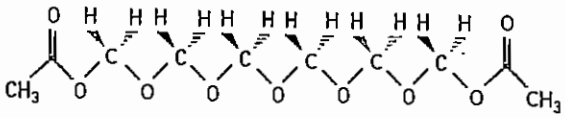


Figure 3. An example of a ploy (methanal)- a family of compounds first studied by polymer pioneer Hermann Staudinger.

Staudinger and his colleagues made a whole series of these molecules, each differing from its ***neighbour*** in the series by one- CH_2O - unit.

Relating the properties of these molecules to their sizes established that the small members of this family behaved like any other small molecule, but as the lengths of the molecule increased, their properties gradually changed to those of plastics. In this way, Staudinger and his students established by 1929 that this polymer was not an association of small molecules held together by unknown forces but consisted of chain molecules with normal, covalent bonds of the kind familiar throughout organic chemistry. The chains terminated in groups of atoms, which, if their concentration could be measured, could give a measure of the average chain length of the polymer sample.

Q 3. Outline the principle by which the average chain length of the polymer could be measured if the number of end groups in a particular sample could be measured?

i) Work out the relative molecular mass of a- CH_2O - unit;

ii) Each chain will have two end units.

Acceptance of synthetic polymers as giant molecules was the first step that ultimately led to the development of polymer chemistry, and Staudingear eventually became polymer chemistry's first Noble Prizewinner in 1953.

The second important step in polymer science was the realization that synthetic polymers are hardly ever unique molecules. A sample of polymer consists of an ***assembly*** of molecules with a variety of sizes and sometimes a variety of strtutures as well. The proportion of chains of different length and thus molecular size has important effects on the polymer's properties (and therefore its uses). Samples with very short carbon chains are liquids of soft, waxy solids, whereas those in which very long sequences of carbon atoms predominate can be hard, wear-***resistant*** materials.

Although many scientists contributed to establishing these basic points, the three figures that stand out are Staudinger, Paul Flory, who established the theoretical basis for understanding the synthesis and

properties of polymers, and Wallace Carothers. Carothers, best known as the inventor of nylon, was a major contributor to our understanding of how to make polymers.

The story of polythene

At about the same time as Staudinger was laying the theoretical basis of polymer science, industry was getting started on the practical aspects of the subject-making and finding uses for synthetic polymers. The story of what was to become the most common synthetic polymer, poly(ethene), begins in the north west of England in March 1933.

At this time a group of experimentalists employed by Imperial Chemical Industries (ICI) at its site in Cheshire was examining the effects of mixing various gases at high temperatures and pressures. The chemists involved were a determined ***bunch***; they reported that 'some 50 experimental high pressure reactions involving different gaseous mixtures had been attempted over the previous 15 months, with disappointing results'.

The experiment that starts this story was an attempt to react ethene gas (then called ethylene), C_2H_4, and benzaldehde, C_6H_5CHO, at a pressure of 1900 atmospheres (about 2×10^5 kPa) and a temperature of 17 °C (290 K).

We do not know what they expected to happen, but these open-minded and curious experimentalists found a minute amount of a white waxy solid on the walls of the reaction ***vessel***. They quickly realized that they had for the first time polymerized ethene and that the benzaldehyde was not involved at all. However, for various reasons the experiment was not repeated for almost two years-until December 1935, when 8 g of poly(ethene) was produced in a small-scale laboratory reactor.

Q 4. *Draw the displayed formula of benzaldehyde (benzenecarbaledehyde)?*

Today, in light of modern health and safety **regulations**, these early experiments seem ***crude*** and even dangerous. The reactors sometimes exploded, some reactions yielded heat, hydrogen, carbon and nothing else of interest. Nevertheless, they were to have enormous and totally unforeseen consequences.

Three years after the 1933 discovery, the ICI researchers had progressed to the stage where they believed they might have something saleable. This new material had the useful properties of being easily proessable into items which were tough and wore well.

It also had low water-**permeability** and good **insulating** properties (which made it suitable for use in high-frequency) **equipment** and as an insulator in many kinds of electrical cables).

At this stage the researchers needed a name for their polymer and in mid-1936 it was named ALKETH, before it became known as polyethylene or polythene. Its **precise** properties depended to a large extent on the conditions under which it was made. For example, the lower the relative molecular mass, the more wax-like the material, and the higher the molecular mass, the tougher it was. In 1937 batch syntheses were being carried out in a 9 dm^3 vessel at 900 atmospheres (90 000 kPa) and 200 °C (473 K). Material with an average relative molecular mass of about 10,000 was produced under these conditions. Soon progress in control of the reaction allowed samples with average relative molecular masses up to 27 000 to be produced at a rate of manufacure of up to 1.6 kg per hour.

A. General Vocabulary practice

Directions: put the number of the definition in column B beside the correct word in column A.

A	B
..... a. incorporate	1. annoying
..... b. insulate	2. beam
..... c. irritating	3. before
..... d. peak	4. chain
..... e. permeable	5. highest point
..... f. presumably	6. isolate
..... g. previously	7. mix
..... h. ray	8. move rapidly
..... i. string	9. penetrable
..... j. sweep	10. probably

B. select a word in column B which is opposite in meaning word in column A.

A	B
..... a. ancient	1. contemporary
..... b. artificial	2. divide
..... c. bunch	3. freeze
..... d. combine	4. hold together
..... e. fragment	5. inexact
..... f. invalid	6. legal
..... g. melt	7. natural
..... h. precise	8. resistant
..... i. soft	9. scatter
..... j. susceptible	10. severe

C. Each passage in this group is followed by questions based on its content. After reading a passage, choose the best answer to each question. Answer all questions following a passage on the basis of what is **stated** or **implied** in that passage.

Classical physics defines the vacuum as a state of absence: a vacuum is said to exist in a region of space if there is nothing in it. In the quantum field theories that describe the physics of elementary particles, the vacuum becomes somewhat more complicated. Even in empty space, particles can appear spontaneously as a result of fluctuations of the vacuum. For example, an electron and a positron, or antielectron, can be created out of the void. Particles created in this way have only a fleeting existence; they are annihilated almost as soon as they appear, and their presence can never be detected directly. They are called virtual particles in order to distinguish them from real particles, whose lifetimes are not constrained in the same

way, and which can be detected. Thus it is still possible to define the vacuum would always be the state that has no real particles in it.

One might expect that the vaccum would always be the state of lowest possible energy for a given region of space. If an area is initially empty and a real particle is put into it, the total energy, it seems, should be raised by at least the energy equivalent of the mass of the added particle. A surprising result of some recent theoretical investigations in that this assumption is not invariably true. There are conditions under which the introduction of a real particle of finite mass into an empty region of space can reduce the total energy. If the reduction in energy is great enough, an electron and a positron will be spontaneously created. Under these conditions the electron and positron are not a result of vacuum fluctuations but are real particles, which exist indefinitely and can be detected. In other words, under these conditions the vacuum is an unstable state and can decay into a state of lower energy; i.e., one in which real particles are created.

The essential condition for the decay of the vacuum is the presence of an intense electric field. As a result of the decay of the vacuum, the space permeated by such a field can be said to acquire an electric charge, and it can be called a charged vacuum. The particles that materialize in the space make the charge manifest. An electric field of sufficient intensity to create a charged vacuum is likely to be found in only one place: in the immediate vicinity of a super heavy atomic nucleus, one with about twice as many protons as the heaviest nuclei known. A nucleus that large cannot be stable, but it might be possible to assemble one next to a vacuum for long enough to observe the decay of the vacuum. Experiments attempting to achieve this are now, under way.

1 - Which of the following titles best describes the passage as a whole?

1)The Vacuum: Its Fluctuations and Decay
2)The Vacuum: Its Creation and Instability
3) The Vacuum: A State of Absence
4) Particles That Materialize in the Vacuum
5) Classical Physics and the Vacuum

2 - According to the passage, the assumption that the introduction of a real particle into a vacuum raises the total energy of that region of space has been cast into doubt by which of the following?

1) Findings from laboratory experiments
2) Findings from observational field experiments
3) Accidental observations made during other experiments
4) Discovery of several erroneous propositions in accepted theories
5) Predictions based on theoretical work

3 - It can be inferred from the passage that scientists are currently making efforts to observe which of the following events?

1) The decay of a vacuum in the presence of virtual particles
2) The decay of a vacuum next to a superheavy atomic nucleus
3) The creation of a superheavy atomic nucleus to an intense electric field
4) The creation of a virtual electron and a virtual positron as a result of fluctuations of a vacuum
5) The creation of a charged vacuum in which only real electrons can be created in the vacuum's region of space

4 - Physicists' recent investigations of the decay of the vacuum, as described in the passage, most closely resemble which of the following hypothetical events in other disciplines?

1) On the basis of data gathered in a carefully controlled laboratory experiment, a chemist predicts and then demonstrates the physical properties of a newly synthesized polymer.
2) On the basis of manipulations of macroceconomic theory, and economist predicts that, contrary to accepted economic theory, inflation and unemployment will both decline under conditions of rapid economic growth.
3) On the basis of a rereading of the texts of Jane Austen's novels, a literary critic suggests that, contrary to accepted literary interpretations, ; Austen's plots were actually metaphors for political events in early nineteenth-century England.
4) On the basis data gathered in carefully planned observations of several species of birds, a biologist proposes a modification in the accepted theory of interspecies competition.
5) On the basis of a study of observations incidentally recorded in ethnographers' descriptions of non-Western societies, an anthropologist proposes a new theory of kinship relations.

5 - According to the passage, the author considers the reduction of energy in an empty region of space to which a real particle has been added to be

1) a well-known process
2) a frequent occurrence
3) a fleeting aberration
4) an unimportant event
5) an unexpected outcome

6 - According to the passage, virtual particles differ from real particles in which of the following ways?

I. Virtual particles have extremely short lifetimes.
II. Virtual particles are created in an intense electric field.
III. Virtual particles cannot be detected directly.

1) I only
2) II only
3) III only
3) I and II only
3) I and III only

7 - The author's assertions concerning the conditions that lead to the decay of the vacuum would be most weakened if which of the following occurred?

1) Scientists created an electric field next to a vacuum, but found that the electric Field was not intense enough to create a charged vacuum.
2) Scientists assembled a superheavy atomic nucleus next to a vacuum, but found that no virtual particles were created in the vacuum's region of space.
3) Scientists assembled a superheavy atomic nucleus next to a vacuum, but found that they could not then detect any real particles in the vacuum's region of space.
4) Scientists introduced a virtual electron and a virtual positron into a vacuum's region of space, but found that the vacuum did not then fluctuate.
5) Scientists introduced a real electron and a real positron into a vacuum's region of space, but found that the total energy of the space increased by the energy equivalent of the mass of the particles.

Lesson 12

Light Spectroscopy

"words are of course, the most powerful drug used by man"

Rudyard kipling

emit *v.* diffuse, discharge, eject, emanate, exude, give off, give out, issue, radiate, release, shed, vent

antonym: absorb

interact *v.* have an effect on each other

range *n.* 1. amplitude, area, bounds, compass, domain, extent, field, gamut, limits, orbit, parameters, province, reach, scale, scope, span, spectrum, sphere, sweep 2. assortment, class, kind, order, selection, series, sort, string, variety

quantity *n.* aggregate, allotment, amount, bulk, capacity, content, extent, magnitude, measure, portion, proportion, spread, sum, weight

absorbing *adj.* amusing, captivating, compulsive, diverting, engrossing, entertaining, gripping, preoccupying, riveting, spellbinding, un put down able

antonyms: boring, off-putting

sensitive *adj.* 1. impressionable, irritable, perceptive, responsive, sensitized, susceptible, temperamental, tender, touchy 2. delicate, exact, fine, precise

antonyms: 1. hard, insensitive, thick-skinned 2. approximate, imprecise

sophisticated *adj.* advanced, complex, complicated, cosmopolitan, cultivated, delicate, elaborate, intricate jet-set, refined, seasoned, subtle, urbane, worldly

antonyms: artless, unsophisticated

vibrate *v.* judder, oscillate, pulsate, quiver, resonate, reverberate, shake, shudder, sway, swing, throb, tremble, undulate

Ultraviolet / visible spectroscopy

We have seen earlier that atomic spectroscopy is a powerful analytical tool. It depends on electrons jumping from one energy level in the atom to another and ***emitting*** or absorbing a characteristic frequency of light in the process, some of these transitions occur in the visible region of the spectrum and hence are easily seen.

However light spectroscopy is much richer than this. In the first place, molecule can ***interact*** with light over the whole spectral ***range*** from the ***far ultraviolet*** to the far infrared and microwave regions. Secondly, the spectral pattern of the interaction can provide quite detailed information about the structure of the molecule.

In the ultraviolet and visible of the spectrum, the interaction is with the electronic energy levels of molecules (as for atomic spectroscopy). This can provide a means of identifying what compound we have (for example, in the case of transition metal coordination compounds and some organic compounds) and can also be used for ***quantitative*** analysis-that is how much of it we have. This is because the amount of light absorbed is related to the concentration of the ***absorbing*** species. A typical ultraviolet/visible spectrum is shown in Figure 1.

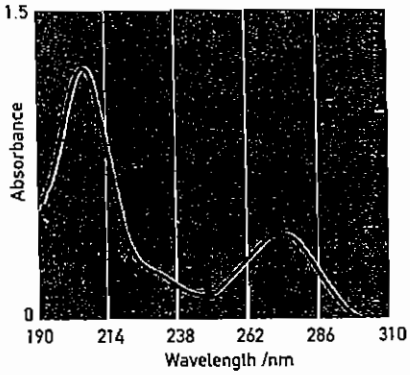


Figure 1. The UV spectrum of caffeine.

Ultraviolet / visible spectroscopy can be very ***sensitive*** if the compound absorbs light very effectively. For instance, the complex formed between iron ions and o-phenanthroline is highly coloured and provides a good method of measuring low concentrations of iron in natural waters.

The ultraviolet spectrum of organic compounds can also show the presence of particular chemical groups (called chromophores), such as those containing double bonds. Much more ***sophisticated*** use of ultraviolet/visible spectroscopy can be applied to metal coordination compounds, where the position and intensity of the spectral bands can provide a great deal of information about the electronic structure of the molecule.

Infrared spectroscopy

It is in the infrared region of the spectrum where most information about chemical bonds and ***functional groups*** can be obtained. Molecules are constantly ***vibrating*** rapidly, and the energy levels corresponding to these motions occur mostly in the infrared region of the spectrum, in the frequency range $1\times10^{14}\ s^{-1}$ to $5\times10^{12}\ s^{-1}$. This corresponds to wavenumbers (the number of waves in one cm) of 4000 to 200 cm^{-1} in the units commonly used by infrared spectroscopists.

Infrared spectroscopy probes these vibrations. Since the positions of particular bands in the infrared depend on the 'springiness' of individual bonds and on the masses of the appropriate atoms, the infrared spectrum can help identify the various chemical groups in the molecule. This is very useful in organic chemicstry, particularly if the infrared bands are very intense. For instance, an organic carbonyl (C = O) group gives a very intense band at about 1700 cm^{-1}, Figure 2.

Traditionally infrared spectra were obtained by scanning through a range of frequencies.

The situation was revolutionized with the development of ***fourier transform infrared*** spectrometers. The technique of Fourier transform is important in many areas of analytical science.

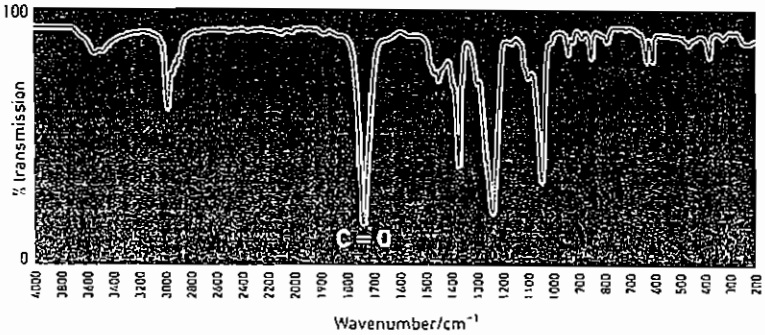


Figure 2. An infrared spectrum of ethyl ethanoate showing a C = O stretch between 1700-1800 cm^{-1}.

Although valuable for qualitative and structural analysis, infrared spectroscopy is seldom used for quantitative work, except in specialised areas, partly because it is difficult to get very accurate measurements of ***intensity***.

A. General Vocabulary practice

Directions: put the number of the definition in column B beside the correct word in column A.

A	B
..... a. arrangement	1. ascend
..... b. chronic	2. contamination
..... c. climb	3. continual
..... d. operate	4. firmly
..... e. pollution	5. layout
..... f. porous	6. perform
..... g. range	7. scope
..... h. slim	8. sponge-like
..... i. tight	9. swing
..... j. vibrate	10. thin

B. In column A are ten words. Match them correctly with their opposite meaning which you will find in column B.

A	B
..... a. approach	1. be seen
..... b. descend	2. cheap
..... c. essential	3. climb
..... d. expensive	4. dry
..... e. humid	5. dull
..... f. keen	6. filled
..... g. popular	7. hated
..... h. vacant	8. leave
..... i. vanish	9. not needed
..... j. visible	10. unseen

C. Read the following passages and answer the questions by choosing the best choice.

Adsorption on solids is classified into physisorption and chemisorption. The difference between these two is not always sharp. In physical adsorption the gas molecules are held to the solid's surface by relatively weak intermolecular van der Waal's forces. In chemisorption, a chemical reaction occurs at the solid's surface, and the gas is held to the surface by relatively strong chemical bonds.

1 - According to the passage .....

1) Absorption is classified into physical and chemical adsorption.
2) Intramolecular forces, are held to gas molecules on to the solid's surface.
3) In chemisorption, gas is held to the surface by relatively strong chemical bands.
4) In chemical adsorption gas is held to the surface by chemical bonds.

2 - According to the passage which statement is correct?

1)The separation between chemical absorption and physisorption is not always sharp.
2) physisorption is similar to ordinary chemical reactions in that it is highly specific.
3) In chemical adsorption, a chemical reaction occurs at the solid's surface.
4) In chemieal adsorption the gas is held to solid's surface by van der Waals forces.

3 - Physisorption and chemisorption have all the characteristics except.....

1)The dividing line between two is not always sharp.
2) In chemical adsorption the gas held to surface by chemical bonds.
3) In chemisorption intermolecular force is very strong.
4) In physisorption intermolecular force is relatively weak.

In rubedoxins a single iron atom is tertrahedrally surrounded by the sulfure of four cysteine ligands. In plant ferredoxins there ar two iron atoms, again tetahedrally coordinated and associated with four cysteine sulfurs, but bridged by two sulfide ligands.

4 - According to the possage, which statement is correct ?

1) There are the same number of cysteine in ferredoxins and rubredoxins.
2) In rubredoxins two S^{2-} coordinated to iron.
3) In ferredoxine four iron atoms are tertrahedrally coordinated
4) In rubredoxins, sulfide ligands can readily be displaced.

5 - Which statement is correct ?

I) In rubredoxines there are two iron in bridge.
2) In ferredoxins , two s^{2-} exist in bridge.
3) In rubredoxines there are two cysteines in bridge.
4) In ferredoxins an iron atom is octahedrally surrounded by S^{2-} and cysteine.

transitions are of little significane in organic photochemical synthesis as they $n \rightarrow \sigma^*$ and $\sigma \rightarrow \sigma^*$ The occur in far ultraviolet (< 200 nm), a region which is not readily accessible practically, owing to the transitions are responsible for the $n \rightarrow \pi^*$ and $n \rightarrow \pi^*$ absorption of radiation in this region by oxygen. The vast majority of useful photochemical reactions.

6 - Which statement is correct ?

I) the $\pi \rightarrow \pi^*$ and $n \rightarrow \pi$ transitions occur in the far uv region.
2) the $\sigma \rightarrow \sigma^*$ transitions are very important in organic photochemical synthesis.
3) In far uv, absorption of radiation can be occurred by oxygen .
4) The $\pi \rightarrow \pi^*$ transitions are not significance in organic photochemical synthesis.

Lesson 13

Nuclear magnetic Resonance NMR

"In a multitude of words there will certainly"

By error proverb

combination *n.* alliance, amalgamation, association, blend, coalition, composition, consortium, merger, syndicate, unification, union

environment *n.* ambience, atmosphere, context, domain, scene, situation, surroundings, territory

deduce *v.* conclude, derive, draw, gather, glean, infer, reason, surmise, understand

tissue *n.* agglomeration, collection, combination, fabric, fabrication, gauze, mass, mesh, network, pack, paper, structure, stuff, texture, tissue-paper, web

network *n.* arrangement, channels, circuitry, convolution, grid, grill, interconnections, meshwork, net, organization, system, tracks

identify *v.* catalogue, classify, detect, diagnose, distinguish, know, label, make out, name, notice, pick out, pinpoint, recognize, single out, specify, tag

tiny *adj.* diminutive, dwarfish, insignificant, little, microscopic, mini, miniature, negligible, petite, pocket, puny, slight, small

antonyms: enormous, huge, immense

line up *v.* align, arrange, array, assemble, dispose, engage, fall in, form ranks, hire, lay on, marshal, obtain, order, organize, prepare, procure, produce, queue up, regiment, straighten

field *n.* 1. grassland, lawn, meadow, pasture 2. area, domain, environment, limits, line, period, range, scope, territory 3. applicant, candidates, entrants

external *adj.* alien, apparent, exoteric, extramural, extrinsic, foreign, outermost, outside, outward, surface, visible

antonym: internal

radiation *n.* emanation, emission, rays

absorb *v.* assimilate, devour, engulf, enthrall, immerse, occupy, suck up, take in

antonyms: dissipate, exude

flip *v.* cast, flap, flick, jerk, pitch, spin, throw, toss, turn, twirl, twist

flip *n.* flap, flick, toss, turn, twirl, twist

strength *n.* brawn, cogency, effectiveness, firmness, force, fortitude, intensity, muscle, potency, stamina, toughness, vehemence, vigor, virtue

antonyms: feebleness, timidness, weakness

salvage *v.* conserve, glean, preserve, repair, rescue, restore, save

antonyms: abandon, lose, waste

shield *n.* aegis, buckler, bulwark, cover, defence, guard, protection, rampart, shelter, ward

shield *v.* cover, defend, guard, protect, shade, shadow, shelter

antonym: expose

probably *adv.* As likely as not, doubtless, in all likelihood, most likely, perhaps, possibly, presumably
antonym: improbably
surrounding *adj.* adjacent, adjoining, bordering, enclosing, nearby, neighboring
shift *v.* adjust, alter, budge, dislodge, move, remove, swallow, transfer, transpose
shift *n.* alteration, change, veering
proportional *adj.* commensurate, comparable, consistent, corresponding, equitable
antonym: disproportionate
resolution *n.* 1. boldness, courage, dedication, devotion, earnestness, tenacity, zeal 2. decision, declaration, finding, intention, judgment, motion
antonym: half-heartedness, uncertainty
split *v.* break, burst, crack, divide, slash, snap, splinter
adjacent *adj.* abutting, adjoining, along side, juxtaposed, neighboring, next, touching
antonyms: distanct, remote
couple *n.* duo, pair, span, team, twosome
couple *v.* accompany, buckle, clasp, hitch, join, link, marry, pair, unite, wed, yoke
ratio *n.* arrangement, balance, correlation, correspondence, equation, fraction, percentage, proportion, relation, relationship
distinguish *v.* 1. categorise, charracterise, classify, know 2. ascertain, discern, discriminate, identify, perceive, recognize, tell apart
overlap *v.* coincide, cover, flap over, overlay
simultaneous *adj.* accompanying, coinciding, concurrent, parallel, synchronic, synchronous
antonyms: asynchronous, separate
insertion *n.* addition, entry, implant, inclusion, intrusion, supplement
transient *adj.* brief, ephemeral, fleeting, momentary, passing, short, short-lived, temporary, transitory
antonyms durable, long-lasting, permanent
collapse *v.* crumple, fail, faint, fall, fold, founder, peg out, sink, subside
collapse *n.* breakdown, cave-in, debacle, disintegration, downfall, exhaustion, failure, faint, flop, subsidence

Perhaps the chemist's favourite structural analytical tool in nuclear magnetic resoanance (NMR) spectroscopy, and it is on this technique that we are going to concentrate for the rest of the chapter. It is a method that depends on an unusual ***combination*** of nuclear physics and chemistry.

Nuclear magnetic resonance depends on the magnetic properties of certain nuclei and the subtle influence of their chemical ***environment***. Since the 1960s it has been used by organic chemists to help solve the structures of relatively simple molecules. As the technique has developed, NMR has been applied to ever more complex structures including large biological molecules, complex solids and living ***tissue***. Today it can be used to ***deduce*** the ***network*** of bonds in a molecule, ***identify*** atoms close in space, and probe the complicated way in which the molecule moves and flexes over time. Nuclear magnetic resonance is not limited to a single state of matter, but is used on solids, liquid crystals, liquids and solutions. For all these reasons, NMR occupies a unique position in analytical chemistry.

How does NMR work?

As the name suggests, NMR is concerned with the nuclei of atoms. Atomic nuclei have a property called 'spin' which gives them magnetic properties. Some nuclei (ones with odd numbers of protons and neutrons such as ^{1}H, ^{13}C, ^{19}F and ^{31}P) have a value of spin which makes them behave like ***tiny*** bar magnets. Some of the 'nuclear bar magnets' will line up in the same direction as an external magnetic ***field*** (ie parallel to the field) and some ***line up*** in the opposite direction (antiparallel). There are slightly more in the parallel direction than the antiparallel direction as the parallel configuration is of lower energy. So the ***external*** field magnetises the sample.

If electromagnetic ***radiation*** of radio frequency is now applied to the sample, some of these nuclear magnets ***absorb*** energy and '***flip***' from the parallel to the antiparallel position, Figure 1. The energy, and therefore frequency, of the radiation required depends on the strength of the applied magnetic field and also the ***strength*** of the nuclear magnet. This frequency is called the resonance were first carried out shortly after World War II by physicists using electronic components ***salvaged*** from radar sets. They hoped to measure the magnetic moments of nuclei-the strength of their magnetism. However, they came across a problem-they got different values for the same nucleus in different chemical compounds. They realised that this was because the nuclei were being ***shielded*** from the applied magnetic field by the electrons, which also have spin and therefore a magnetic moments of nuclei-the strength of their magnetism. So the experiment was unable to measure nuclear magnetic moments but it was able to provide information about the electrons-the very stuff of chemistry. So the technique was taken over by chemists and went on to become ***probably*** the most usuful method for determining chemical structure.

The chemical shift

The distribution of electrons around it affects the resonance frequency of a particular magetic nucleus. If the resonance frequency of all hydrogen nuclei (which are single protons), for example, were the same, then NMR would not be much use as an analytical tool since there would only ever be one peak in an NMR spectrum. However, the ***surrounding*** electrons set up their own magnetic field which usually opposes the external field. This effectively shields the nucleus, so that it 'feels' a slightly different field from that of the applied field. Because the exact electronic ***environment*** varies from one proton to another in the same compound, their resonance frequenceies are different.

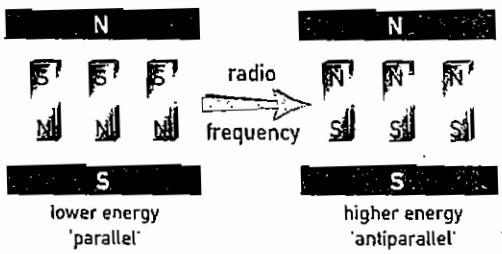


Figure 1. Nuclear magnets can 'flip' from parallel to antiparallel alignments in a magnetic filed when radiofrequency radiation is supplied.

Q 1. Consider the hydrogen nuclei in water (H_2O) and methane (CH_4). In which molecule are the hydrogen nuclei surrounded by most electrons? Explain your reasoning.

An NMR spectrum can be recorded for any magetic nucleus but the spectra for different nuclei are usually recorded separately, so, for instance, the hydrogen (^{1}H) and carbon-13 (^{13}C) spectra of an organic compound are recorded in two separate experiments.

Each spectrum consists of a series of peaks, or lines, Figure 2, corresponding to a particular nucleus in different electronic environments. The frequency of each line is known as the ***chemical shift***, which is the shift in the spectrum from a designated reference standard. In hydrogen, or proton, NMR, the standard is the compound tetramethylsilane, TMS $\left(\mathrm{Si}\left(\mathrm{CH}_3\right)_4\right)$, a small amount of which is added to the sample before the spectrum is run. Chemical shifts are given the symbol δ and measured in units of parts per million (ppm) from the TMS peak.

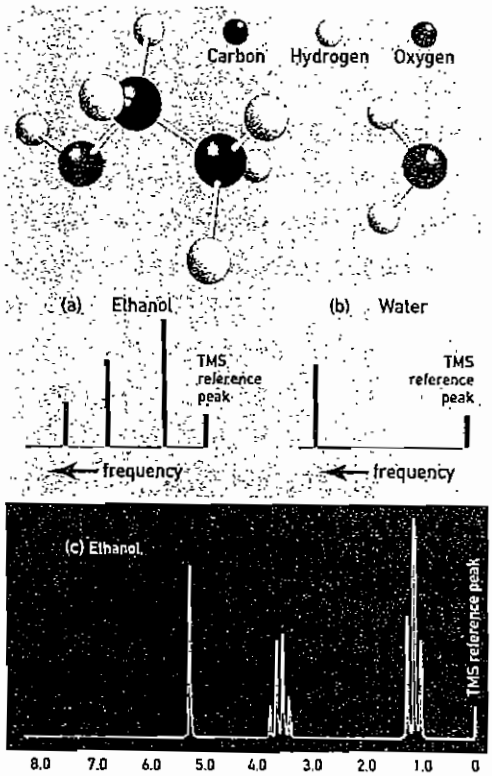
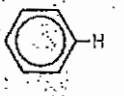


Figure 2. The proton NMR spectra for ethanol $\left(\mathrm{CH_3CH_2OH}\right)$ and water show up the different environments of hydrogen nuclei in the two compounds. (c) The bottom spectrum shows a higher resolution proton NMR spectrum of ethanol, illustrating how the lines are split by coupling between two sets of hydrogen nuclei.

Table 1. Typical proton chemical shift values (δ)

Type of proton	Chemical shift /ppm
$R-CH_3$	
$R-CH_2-R$	
$R-\overset{O}{\overset{\|}{C}}-CH_3$	
$R-CH_2-Hal$	
$R-O-CH_3$	
$R-O-H$	
$RHC=CH_2$	
$RHC=CH_2$	
	
$R-\overset{O}{\overset{\|}{C}}-H$	
$R-\overset{O}{\overset{\|}{C}}-O-H$	

Q 2. *Draw the displayed formula of TMS. What can you say about the chemical environment of each hydrogen atom?*

The intensity (peak area) of each line is ***proportional*** to the number of nuclei in the sample in that particular environment. So for instance, a proton-NMR spectrum of ethanol Figure 2(a), $\left(\mathrm{CH_3CH_2OH}\right)$ gives three signals; one from the three hydrogens in the methyl $\left(\mathrm{CH_3}\right)$ group (relative intensity 3); one from the two hydrogens in the $-\mathrm{CH_2}-$ group (relative intensity 2) and one from the single hydrogen bonded to the oxygen (relative intensity 1). In water, on the other hand, both bonded to oxygen with

identical bonds, so only one line is seen, Figure 2 (b). It is possible to use the chemical shift to identify the types of protons in a molecule. Some values are given in Table 1.

Spin-spin coupling

If we look more closely at the ethanol spectrum (a so-called high-***resolution*** spectrum), Figure 2 (c), we see that the $-CH_3$ and $-CH_2-$ signals are, in in fact, not single lines, but ***split*** into three and four components respectively. This is because the spins, or 'nuclear bar magnets', of the hydrogen nuclei 'couple' with each other. The effective magnetic fied 'felt' by one proton depends on whether the spin of an ***adjacent*** proton is lying parallel or antiparallel to the applied field. A proton with spin lying parallel to the applied field strengthens the filed slightly and one with spin lying antiparallel weakens it slightly. This gives rise to two lines, one either side of where the uncoupled peak would have been. This is called spin-spin ***coupling.***

If two or more protons are equivalent, that is, with the same chemical shift, such as the three protons in a $-CH_3$ group, they do not split each other's signal. But in the case of two or more adjacent groups of protons that are not equivalent (such as those in the $-CH_3$ group and those in the $-CH_2-$ group in ethanol), the spin-spin coupling is additive, producing clusters of lines depending on the number of ways the nearby protons can affect the applied filed. A single proton splits the line into two, two protons split it into three and so on-the so-called n +1 rule.

This is the scenario for the methyl $\left(-CH_3\right)$ hydrogens in ethanol. Each is coupled to the two $-CH_2$- hydrogens. Each methyl hydrogen 'feels' three possible net fields, one where the spins of both $-CH_2-$ hydrogens are parallel to the external field, one where they are both antiparalle, and one where one $-CH_2-$ hydrogen's spin is parallel and the other antiparalle. This third arrangement can occur in two possible ways, making it twice as likely as the other two, so the middle of the three lines has twice the intensity of the outer ones, Figure 3.

Q 3. In ethanol, the signal from the $-CH_2-$ protons is split by the $-CH_3$ protons into four peaks with intensities in the ***ratio*** 1:3:3:1. Draw a diagram similar to that of Figure 3 to show how the three protons of the $-CH_3$ group can line up to produce these intensities.

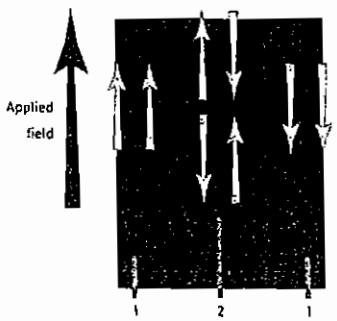
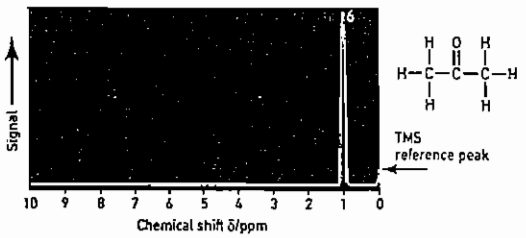
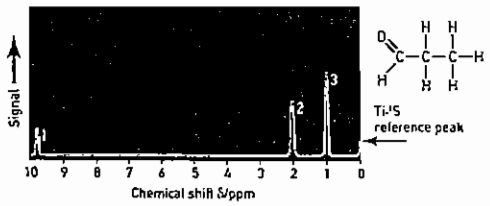


Figure 3. The possible orientations of the spins of the $-CH_2-$ protons as 'felt' the $-CH_3$ protons in ethanol. They cause the CH_3 peak to be split into three peaks of height ratios 1:2:1.

Once the chemical shift had been discovered, chemists were very quick to realise the potential of NMR. However, the pioneering chemists could not have realised the eventual power of the technique. The first real applications of NMR to problem-solving in structural chemistry began in 1953. The information NMR provided was particularly useful in deciding between different structures having the same chemical formula (isomers). A simple example of how low ***resolution*** NMR can ***distinguish*** between isomers is shown in Figure 4.



Propanone shows just one peak al all six protons are identical.



Propanal has three peaks in the ratios 3:2:1. These repreent the $-CH_3$ the $-CH_2-$ and the -CHO protons respectively.

Figure 4. Propanone and propanal are isomers. However, they have very different proton NMR spectra-even at low resolution where spin-spin coupling is not seen.

More complex molecules

Interpreting the information provided by the NMR spectrum of a complex molecule such as columbianetin, Figure 5, relies on being able to identify peaks as belonging to certain nuclei on the basis of their chemical shifts alone.

Unfortunately, our current ability to use the chemical shift is such that it is useful only for pigeonholing certain types of nuclei, as, for example, the protons in hydroxyl $(-OH)$ or methyl $(-CH_3)$ groups in the spectrum of ethanol shown earlier. What happens if you have more than one methyl group in your molecule and, therefore, more than one methyl resonance in the proton NMR spectrum?

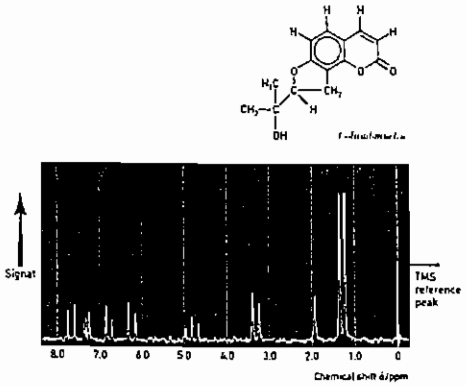


Figure 5. The NMR spectrum of a complex molecule can be difficult to interpret. Which peak belongs to which proton?

Clearly, the more peaks there are in the spectrum, the harder it is to assign them to a particular nucleus. The information is there, but how do we extract it?

There is another problem encountered with larger molecules because there is a limit to the number of peaks that can physically into a particular region of the spectrum before they start ***overlapping***. In severe cases, the peaks merge to a broad envelope in the crowded regions. How do we disentangle the spectrum?

Both of these problems have been overcome, and solving each of them represented a huge leap forward in the usefulness of NMR. The details of the techniques are complex and we will just hint at the possibilities in the examples that follow.

NMR in biochemistry

The 2-D technique is helpful in working out the structures of complex biomolecules such as proteins. The first such structure to be solved by NMR was that of BUSI (bull seminal plasma inhibitor) by a Swiss team in 1984. However other chemists were sceptical, as the structures of similar proteins were already known. However, the structure of a completely new protein. Tendamistat, has since been worked on ***simultaneously*** by both NMR and X-ray crystallography, and virtually identical structures were found by both methods. Currently proteins of relative molecular masses up to 40000 are being worked on and hundreds of structures of different proteins have been solved by NMR.

As well as $^{1}H-NMR$, ^{13}C- and $^{15}N-NMR$ are useful with proteins (^{12}C has zero spin, and it is difficult to do NMR on ^{14}N). However, these nuclei are not very abundant naturally- ^{13}C's abundance is about 1% and ^{15}N's is about 0.4%.

Proteins are made in the laboratory by ***inserting*** the gene that makes the protein into the DNA of an organism which can be grown quickly and easily in large numbers in laboratory conditions, for example, the bacterium E.coli.To make protein enriched in isotopes ^{13}C or ^{15}N, the bacteria are grown in media in which the starting materials for making the protein, glucose and ammounium chloride, are enriched with these isotopes.

Aside from structure determination, NMR is an excellent source of information on the dynamic properties of biomolecules (as it is for other chemical compounds), and is a useful probe of ***transient*** interactions, (processes where atoms such as hydrogens are exchanged), and the mechanisms of biochemical reactions. Using NMR, it is possible to gain an understanding of how biological molecules interact in nature, for example, how proteins bind to DNA and how enzymes recognize their substrates. These interactions are not only interesting for scientific at the molecular level, and so better drugs can be designed. Another useful feature of NMR is that it can be designed. Another useful feature of NMR is that it can be done in 'real time' enabling, for example, studies of the complex way in which proteins fold up. All these subjects are currently active and competitive areas of research.

NMR of solids

Although the first NMR experiments were done on solids, NMR developed in the 1950s into a technique used solely on solutions. This is because in solids, the nuclear 'bar magnets' interact strongly and give spectra with very broad lines which ***overlap*** and prevent the spectrum being analysed. This does not occur in solution because the rapid molecular motion averages out these ineractions. A similar effect can be brought about in solids by rapidly spinning the sample at a particular about in solids by rapidly spinning the sample at a particular angle to the magnetic field and this technique has been developed recently. This so-called magic angle spinning has enabled solid-state NMR to develop. So polymers can be studied and in particular the degree of crystallinity and how rotation of molecules in the solid state enables materials to absorb mechanical energy, making them tough and flexible.

Decoupling

Sometimes a spectrum can be simplified by removing some of the spin-spin coupling. For example in the NMR spectrum of propan-1-ol, Figure 1 (a), the protons labeled H_C. This means that the H_b peak is split

into four peaks by the three H_as. Each of these four sub peaks is itself split into three by the two H_Cs, giving a total of 12 peaks and making the spectrum very complicated-see inset Figure 6 (a).

It is possible to remove spin-spin couplings by saturating the sample, while the spectrum is being recorded, with radiation of the frequency at which one of the groups of protons resonates. The spins of these protons then 'flip' rapidly and are unable to line up with or against the magnetic field and their coupling disappears. So if we flood propan-1-ol with radiation of the frequency absorbed by the H_a protons, the coupling with H_b disappears and the 12 peaks '***collapse***' into three, Figure 6 (b). This simplifies the spectrum and at the same time makes it clear which protons are causing which coupling.

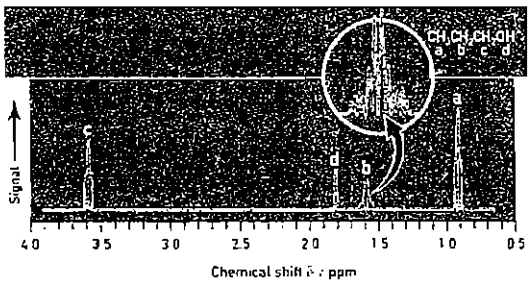


Figure 1 (a). The proton NMR spectrum of propan-1-ol. $CH_3CH_2CH_2OH$
a b c d

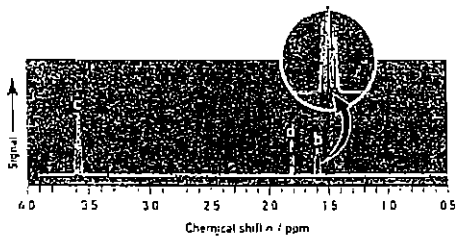


Figure 6(b). The proton NMR spectrum of propan-1-ol 'decoupled' by flooding the sample with radiation of the frequency absorbed by the H_a protons. The complex peak representing H_b had reduced from 12 sub-peaks to 3. The H_a peak also disappears.

A development of this technique, which provides the same information much more quickly, is to present the NMR spectrum in two-dimensions. The conventional spectrum is seen along the diagonal and peaks off the diagonal show which protons are coupling with which, Figure 7

Techniques such as these are made possible by the Fourier transform technique in which all the information in the spectrum is recorded from a series of pulses of radiation and the spectrum is constructed by mathematical manipulation using a computer.

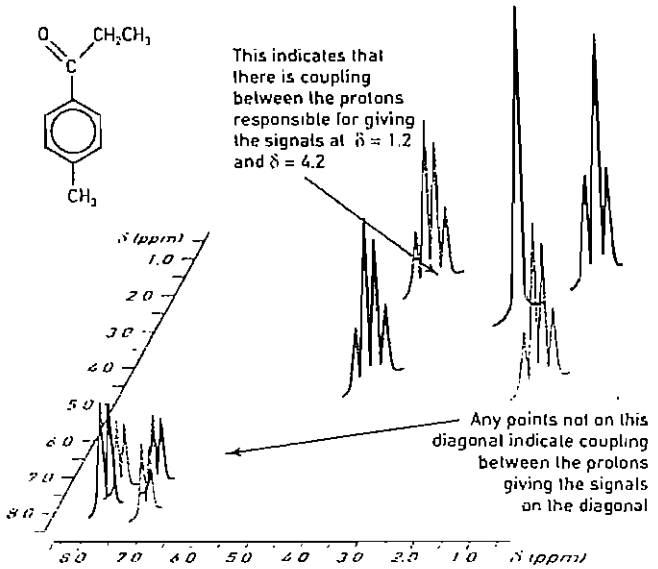


Figure 7. The 2-D proton NMR spectrum of ethyl 4-methylbenzenecarboxylate (ethyl 4-methylbenzoate).

A. General Vocabulary practice

Directions: put the number of the definition in column B beside the correct word in column A.

A	B
..... a. adjacent	1. ambience
..... b. agglomeration	2. coincide
..... c. collapse	3. conclude
..... d deduce	4. divide
..... e. departure	5. disintegration
..... f. effect	6. influence
..... g. environment	7. leaving
..... h. overlap	8. neighboring
..... i. shield	9. pack
..... j. split	10. protection

B. In column A are ten words. Match them correct with their opposite meaning which you will find in column B.

A	B
..... a. adjacent	1. enormouse
..... b. elastic	2. expose
..... c. external	3. internal
..... d. feeble	4. often
..... e. rarely	5. permanent
..... f. shield	6. remote
..... g. strength	7. rigid
..... h. ting	8. steady
..... i. transient	9. strong
..... j. unstable	10. weakness

C. Read the following passages and answer the questions by choosing the best choice.

The flow of electricity, the electric current, along a wire maybe compared to the flow of water along a pipe. If you consider water flowing along a pipe, the volume of water passing a certain point in a given time is similar to the electric current. The pressure of the water in the pipe may be compared to the electric potential. The resistance of the walls of the pipe to the water current may be compared to the resistance of the wire to the electric current.

1 - According to the passage. The writer does not compare .....

1) flow of water and flow of electricity.
2) resitance of the walls of a pipe to water and resistance of a wire to electric current.
3) volumes of pipes and volume of wires.
4) pressure of grater and electric potential.

Electricity is an invisible force that can produce heat, light motion, and many other physical effects. The electricity is generated by big machines known as generators. They are, in fact, large dynamos driven by powerful engines which drive their power from water or steam. The electricity which derives its power from water is known as hydroelectricity.

2 - Generators transform ....

1) chemical energy into mechanical energy.
2) electrical energy into mechanical energy.
3) chemical energy into electrical energy.
4) mechanical energy into electrical energy.

3 - How is hydroelectricity defined?

1) hydroelectricity is a visible force.
2) hydroelectricity drives its power from water.
3) hydroelectricity drives its power from hydrogen.
4) hydroelectricity is an invisible force.

A quantum mechanical calculation starts with the Schrodinger equation, which fully describes any atom or molecule in terms of its wavelike, quantum nature. The problem is to solve the equation and thus calculate the energy levels of the system. However, this equation can only be solved exactly for extremely simple systems, such as the hydrogen atom which consists of just one proton and one electron. No exact solution is possible even for the helium atom!

4 - According to the passage.....

1) quantum mechanics is useful for modeling large molecules.
2) quantum mechanical is methods can not describes helium atomin terms of it's wavelike quantum nature.
3) quantum mechanics mostly used on simple atoms and molecules.
4) quantum mechanical calculations are restricted to hydrogen atom.

5 - Which statement is correct?

1) The Schrodinger equation can not be solved exactly.
2) For solving Schrodinger equation approximately, a system with the minimum energy is the best solution.
3) The Schrodinger equations describes the structure of extremely simple systems.
4) quantum mechanica methods use the data derived from the energy levels.

Walter knight prepared beams of clusters from sodium atoms, by heating the metal to evaporate, which then was mixed with a cold inert gas and condensed into clusters of various sizes.

6 - Sodium clusters was prepared by.....

1) mixing of intent gas with the vapour of sodium.
2) raising of sodium metal with a condensed clusters.
3) heating the inert gas and mixing it with sodium atoms.
4) condensation of sodium atoms and inert gas clusters.

Lesson 14

Nanoparticles transport cencer – killing drug into tumor cells to increase efficacy, lower drug toxicity in mice.

"words are like leaves and where they most abound"
Much fruit of sense beneath is rarely found

toxic *adj.* baneful, deadly, harmful, lethal, noxious, poisonous, unhealthy
antonyms: harmless, safe
chronic *adj.* appalling, atrocious, awful, confirmed, deep-rooted, deep-seated, dreadful, incurable, ingrained, inveterate, persistent, severe, terrible
antonyms: mild, temporary
ingredient *n.* component, constituent, element, factor, part
diffuse *adj.* circuitous, copious, disconnected, discursive, dispersed, loose, rambling, scattered, un concentrated, vague, verbose, waffling, wordy
antonyms: concentrated, succinct
diffuse *v.* circulate, dispense, disperse, disseminate, dissipate, distribute, propagate, scatter, spread
antonyms: concentrate, suppress
delay *v.* check, defer, detain, drag, halt, hinder, hold-up, impede, loiter, setback, stoppage, tarrying, wait
antonyms: horrid, nasty, unpleasant
eliminate *v.* annihilate, cut out, delete, disregard, do away with, drop, eject, get rid of, ignore, kill, knock out, murder, omit, reject, rub out, terminate, waste

University of Michigan scientists have created the nanotechnology equivalent of a Trojan horse to ***smuggle*** a powerful chemotherapeutic drug inside tumor cells – increasing the drug's cencer – killing activity and reducing its ***toxic*** side effects. Previous studies in cell cultures have suggested that attaching anticancer drugs to nanoparticles for targeted delivery to tumor cells could increase the therapeutic response. Now, U-M scientists have shown that this nanotechnology – based treatment is effective in living animals.

"This is the first study to demonstrate a nanoparticle – targeted drug actually leaving the bloodstream, being ***concentrated*** in cencer cells, and having a biological effect on the animal's tumor, "says James R. Baker Jr./M.D., the Ruth Dow Doan Professor of Biologic Nanotechnology at the University of Michigan, who directed the study.

This simplified computer model of the U-M nanoparticle shows the dendrimer's branching structure and how molecues and drugs are attached. Photo credit: Jolanta kukowska – Latello, Michigan Nanotechnology Institute for Medicine and the Biological Sciences. Copyright University of Michigan. Chick on image for larger view.

"We're very optimistic that nanotechnology can markedly improve cancer therapy," says Baker, who directs the *Michigan Nanotechnology Insititue for Medicine and the Biological Sciences*. "Targeting drugs

directly to cancer cells reduces the amount that gets to normal cells, inceases the drugs anti – cancer effect and reduces its toxicity. By improving the therapeutic index of cancer drugs, we hope to turn cance into a ***chronic***, manageable disease."

Results of the study will be published in the June 15/2005/ issue of Cancer Research.

The drug delivery vehicle used by U – M scientists is a manmade polymer molecule called a dendrimer. Less than five nonometers in diameter, these dendrimers are small enough to slip through tiny openings in cell ***membranes***. One nanometer equals one – billionth of a meter, which means it would take 100,000 nanometers lined up side – by – side to equal the diameter of a human hair.

James R . Baker Jr./ M.D.
Copyright University of Michigan.

Dendrimers have a tree – like structure with many branches where scientists can attach a variety of molecules, including drugs. In experiments reported in Cancer Research, U-M scientists attached methotrexate, a powerful anticancer drug, to branc hes of the dendrimer. On other brances, they attached fluorescent imaging agents and their secret ***ingredient*** – a vitamin called folic acid.

Folic acid, or folate, is an important vitamin required for the healthy functioning of all cells. But cancer cells, in particular, seem to need more than average amounts. To soak up as much folate as possible, some cancer cells display more docking sites called folate receptors on their cell membrances. By taking advantage of a center cell's appetite for folate, U – M scientist are able to prevent the cells developing resistance to chemotherapeutic drugs.

"It's like a Trojan horse," Baker explains." Folate molecules on the nanparticle bind to receptors on tumor cell membranes and the cell immediately internalizes it, because it thinks it's getting the vitamin it needs. But while it's bringing folate across the cell membrane, the cell also draws in the methotrexate that will poison it."

In conventional chemotherapy, drugs like methotrexate must ***diffuse*** across a cell membrane to get inside cancer cell according to Baker. It's a slow process and requires a high concentration of drug in the extra - cellular fluid, which can damage normal cells and tissues.

When tested in laboratory mice that had received injections of human epithelial cance cells, the nanoparticle – based therapy using folic acid and methotrexate was 10 times more effective at ***delaying*** tumor growth than the drug given alone. Nanoparticle treatment also proved to be far less toxic to mice in the study than the anticancer drug alone.

"In our longest trial, which lasted 99 days, 30 percent to 40 percent of the mice given the nanoparticle with methotrexate survived, "says Jolanta Kukowska – Latallo, Ph.D., a U-M research investigator and first author of the study. "All the mice receiving free methotrexate died – either from overgrowth of the tumor or from toxic effects of the drug.

"We saw statistically significant tumor growth reduction in all the mice given targeted nanoparticle therapy, as opposed to mice receiving either free methotrexate or the dendrimer alone, "adds Kukowska – Latallo." Effectively, we achieved a 30 – day tumor growth delay. Taking into account the length of a mouse's life, that is significant. One month for a mouse is about three years for a person."

Before they began to study the effects of targeted nanoparticle therapy on cancer, U-M scientists injected dendrimers with fluorescent tags into the bloodstream of laboratory mice to determine where they would be

retained in the body. The results showed that The kindneys quickly filtered free nanoparticles from blood and ***eliminated*** them in urine. The researchers found no evidence that nanoparticles were able to leave the bloodstream and enter the brain. The nanoparticles did not appear to generate an immune response in mice in the study.

In future research, scientists at the Michigan Nanotechnology Insistute will determine the maximum therapeutic dose, in research animals, of targeted nanotherapy with methotrexate, and complete other preliminary studies in preparation for the first human clinical trial, which baker says in scheduled to begin within two years.

Researchers at the Michigan Nanotechnology insitiute also are planning to explore the use of nanotechnology -- based therapies using other chemotherapeutic drugs. "There are many cancer drugs that are very effective, but they can't be used now, because they are too toxic," Baker says. " If these drugs can be delivered with a targeted nanoparticle system, we may be able to overcome the toxicity problem and provide a broader range of therapeutic agents for people with cancer."

By attaching different targeting molecules and different drugs to the nanoparticle, baker believes scientists eventually will be able to develop effective therapies for many types of cancer, perhaps even personalized therapy for an individual's specific cancer.

The research was funded by the National Cancer Institute. The University of Michigan has filed a patent application on targeted nanoparticle technology. A licensing agreement is currently being negotiated with Avidimer Therapeutics, a biopharmaceutical company in Ann Arbor, Mich. Baker holds a significant financial interst in the company.

Other U – M collaborators in the research study are zhengyi Cao, M.D., and shraddha S. Nigavekar, Ph.D., U – M research associates; istvan J. Majoros, Ph.D., research investigator; and thommey P. Thomas, Ph.D., assistant research professor. Additional collaborators who where formerly with the U – M are Lajos P. Baloght, Ph. D, Kimberly A. Candido, and Mohamed K. Khan, M.D.

A. General Vocabulary practice

Directions: put the number of the definition in column B beside the correct word in column A.

A	B
..... a. delay	1. aggregate
..... b. diffuse	2. associate
..... c. edge	3. boundary
..... d. fusion	4. correlation
..... e. ingredient	5. constituent
..... f. relation	6. hold-up
..... g. steam	7. melting
..... h. sum	8. nil
..... i. toxic	9. noxious
..... j. unite	10. unconcentrated
..... K. zero	11. vapour

B. In column A are ten words. Match them correctly with their opposite meaning which you will find in column B.

A	B
..... a. conservation	1. attractive
..... b. cool	2. consumption
..... c. inflammable	3. destruction
..... d. inhibit	4. enforce
..... e. production	5. enlargement
..... f. reduction	6. incombustible
..... g. repulsive	7. meaningless
..... h. reverse	8. occupied
..... i. significant	9. support
..... j. vacant	10. warm

C. Read the following passages and answer the questions by choosing the best choice.

Two relatively recent independent developments stand behind the current major research effort on nitrogen fixation, the process by which bacteria symbiotically render leguminous plants independent of nitrogen fertilizer. The one development has been the rapid, sustained increase in the price of nitrogen fertilizer. The other development has been the rapid growth of knowledge of and technical sophistication in genetic engineering. Fertilizer prices, largely tied to the price of natural gas, huge amounts of which go into the manufacture of fertilizer, will continue to represent an enormous and escalating economic burden on modem agriculture, spurring the search for alternatives to synthetic fertilizers. And genetic engineering is just the sort of fundamental breakthrough that opens up prospects of wholly novel alternatives. One such

novel idea is that of inserting into the chromosomes of plants discrete genes that are not a part of the plants' natural constitution: specifically, the idea of inserting into nonlegurninous plants the genes, if they can be identified and isolated, that fit the leguminous plants to be hosts for nitrogen-fixing bacteria. Hence, the intensified research on legumes.

Nitrogen fixation is a process in which certain bacteria use atmospheric nitrogen gas, which green plants cannot directly utilize, to produce ammonia, a nitrogen compound plants can use. It is one of nature's great ironies that the availability of nitrogen in the soil frequently sets an upper limit on plant growth even though the plants' leaves are bathed in a sea of nitrogen gas. The leguminous plants – among them crop plants such as soybeans, peas, alfalfa, and clover-have solved the nitrogen supply problem by entering into a symbiotic relationship with the bacterial genus *Rhizobium;* as a matter of fact, there is a specific strain of *Rhizobium* for each species of legume. The host plant supplies the bacteria with food and a protected habitat and receives surplus ammonia in exchange. Hence, legumes can thrive in nitrogen-depleted soil.

Unfortunately, most of the major food crops-including maize, wheat, rice, and potatoes-cannot. On the contrary, many of the high-yielding hybrid varieties of these food crops bred during the Green Revolution of the 1960's were selected specifically to give high yields in response to generous applications of nitrogen fertilizer. This poses an additional,

formidable challenge to plant geneticists: they must work on enhancing fixation within the existing symbioses. Unless they succeed, the yield gains of the Green Revolution will be largely lost even if the genes in legumes that equip those plants to enter into a symbiosis with nitrogen fixers are identified and isolated, and even if the transfer of those gene complexes, once they are found, becomes possible. The overall task looks forbidding, but the stakes are too high not to undertake it.

1 - The primary purpose of the passage is to

1) expose the fragile nature of the foundations on which the high yields of modern agriculture rest
2) argue that genetic engineering promises to lead to even higher yields than are achievable with synthetic fertilizers
3) argue that the capacity for nitrogen-fixing symbioses is transferable to nonleguminous plants
4) explain the reasons for and the objectives of current research on nitrogen-fixing symbioses
5) describe the nature of the genes that regulate the symbiosis between legumes and certain bacteria

2 - According to the passage, there is currently no strain of Rhizobium <u>that</u> can enter into a symbiosis with

1) alfalfa
2) clover
3) maize
4) Peas
5) soybeans

3 - The passage implies that which of the following is true of the bacterial genus Rhizobium?

1) Rhizobium bacteria are found primarily in nitrogen-depleted soils.
2) Some strains of Rhizobium are not capable of entering into a symbiosis with any plant.
3) Newly bred varieties of legumes cannot be hosts to any strain of Rhizobium.
4) Rhizobium bacteria cannot survive outside the protected habitat provided by host plants.
5) Rhizobium bacteria produce some ammonia for their own purposes .

4 - It can be inferred from the passage that which of the following was the most influential factor in bringing about intensified research on nitrogen fixation?

1) The high yields of the Green Revolution
2) The persistent upward surge in natural gas prices
3) The variety of Rhizobium strains
4) The mechanization of modem agriculture
5) The environmental ill effects of synthetic fertilizers

5 - Which of the following situations is most closely analogous to the situation described by the author as one of nature's great ironies (line 22)?

1) That of a farmer whose crops have failed because the normal midseason rains did not materialize and no preparations for irrigation had been made
2) That of a long-distance runner who loses a marathon race because of a wrong turn that cost him twenty seconds
3) That of shipwrecked sailors at sea in a lifeboat, with one flask of drinking water to share among them
4) That of a motorist who runs out of gas a mere five miles from the nearest gas station
5) That of travelers who want to reach their destination as fast and as cheaply as possible, but rind that cost increases as travel speed increases

6 - According to the passage, the ultimate goal of the current research on nitrogen fixation is to develop

1) strains of Rhizobium that can enter into symbioses with existing varieties of wheat, rice, and other nonlegumes
2) strains of Rhizobium that produce more ammonia for leguminous host plants than do any of the strains presently known
3) varieties of wheat, rice, and other nonlegumes that yield as much as do existing varieties, but require less nitrogen
4) varieties of wheat, rice, and other nonlegumes that maintain an adequate symbiotic relationship with nitrogen-fixing bacteria and produce high yields
5) high-yielding varieties of wheat,rice, an other nonlegumes that are genetically equipped to fix nitrogen from the air without the aid of bacteria

7 - The author regards the research program under discussion as

1) original and extensive but ill – defined as to method
2) necessary and ambitious but vulnerable to failure
3) cogent and worthwhile but severely under – funded
4) prohibitively expensive but conceptually elegant
5) theoretically fascinating but practically useless

8 - Most nearly paralled, in its fundamental approach, to the research program described in the passage would be a program designed to

1) achieve greater frost resistance in frost – tender food plants by means of selective breeding, thereby expanding those plants' area of cultivation
2) achieve greater yields from food plants by interplanting crop plants that are mutually beneficial
3) find inexpensive and abundant natural substances that could, without reducing yields, be substituted for expensive synthetic fertilizers
4) change the genetic makeup of food plants that cannot live in water with high salinity, using genes from plants adapted to salt water
5) develop, through genetic engineering, a genetic configuration for the major food plants that improves the storage characteristics of the edible portion of the plants

توجه در زیر، فهرست عبارت‌های تخصصی شیمی تا حد امکان گردآوری شده است. در این مجموعه سعی بر این است که basic knowledge در زمینه شیمی تمرین شود. براین اساس، افزون بر تمرین معانی لغت‌های موجود سعی کنید مفاهیم را هم به‌خاطر بسپارید.

GLOSSARY

A

Absolute zero – the lowest possible temperature at which matter might exist; 0 K,- 273.15 °C.

Absorption spectrum - graph showing the absorption of radiaton by a substance over a range of wave length.

Acid – a substance which on being dissolved in water produces a solution in which $[H^+]$ is greater than 10^{-7} M.

Examples: HCl, HNO_3, H_2CO_3, CH_3COOH.

acid anhydride-a nonmetal oxide that reacts with water to form an acidic solution.

acid-base titration - procedure used to determine the concentration of an acid or base. A sample is reacted to the equivalence point, using a measured volume of a base or acid of known concentration.

acid dissociation constant-K_a ; the equilibrium constant for the following reaction of an acid HB:

$$HB(aq) \rightleftarrows H^+(aq) + B^-(aq)$$

$$K_a = \frac{[H^+][B^-]}{[HB]}$$

acidic solution- an aqueous solution with a pH < 7.0 $\left([H^+] > 1.0 \times 10^{-7}\ M\right)$.

actinides-elements 90(Th) through 103 (Lr).

activated complex-a species. formed by collision of energetic particles, which can react to form products or other intermediates.

activation energy, E_a - the minimum energy required for a reaction to occur.

actual yield-the amount of product obtained from reaction.

addition polymer-a polymer produced by reaction of a monomer, usually a derivative of ethylene, adding to itself; no other product is formed.

addition reaction-the insertion of a small molecule, such as H_2 or Cl_2 directly into a double or triple carbon-carbon bond.

alcohol-a substance containing an OH group attached to a hydrocarbon chain. Examples: C_2H_5OH, ethyl alcohol: C_4H_9OH. butyl alcohol.

aldehyde-a substance containing an $-\overset{H}{\underset{|}{C}}=O$ group at the end of a hydrocarbon chain. Example: $C_2H_5-\overset{|}{\underset{H}{C}}=O$, propionaldehyde.

alkali metal-a metal in Group 1. Examples: Li, Na, K.

alkaline (basic)-having a $[OH^-]$ which is greater than $10^{-7}\,M$.

alkane-a hydrocarbon containing only single carbon-carbon bonds. Examples: C_2H_6.C_6H_{14}

alkene-a hydrocarbon which contains one carbon-carbon double bond. Examples: $CH_3CH=CH_2$; $H_2C=CH_2$.

alkyne-a hydrocarbon containing one carbon-carbon triple bond. Example: $HC\equiv C\bar{H}$.

allotrope-one of two or more forms of an elementary substance. Examples: O_2 and O_3 are allotropic forms of oxygen; graphite and diamond are allotropes of carbon.

alpha (α) particle-a helium nucleus. He^{2+} ion.

amalgam-a solution of a metal in mercury.

amine-organic compound containing the –N- functional group. Examples include methylamine, CH_3NH_2, dimethylamine, $(CH_3)_2NH$, and trimethyl-amine, $(CH_3)_3N$.

α-amino acid-the monomer units of proteins. The amino acid contains an acid group $(-COOH)$ group.

amphoteric-capable of reacting with both H^+ and OH^- ions; usually an insoluble hydroxide. Examples; $Al(OH)_3$, $Zn(OH)_2$.

amplitude-the height of a standing wave.

anhydride-a substance derived from another by removalor water, Examples: SO_3 is the anhydride of H_2SO_4; CaO is the anhydride of $Ca(OH)_2$.

anion-a species carrying a negative change. Examples: Cl^-, CO_3^{-2}, $H_2PO_4^-$

anode-an electrode at which oxidation occurs. Example: If, at a copper electrode, the reaction that occurs is $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$, then the copper metal is behaving as an anode.

antibonding orbital-a molecular orbital which has decreased density between two proximate atoms. The energy of its two electrons is greater than that of those electrons in the separated atoms.

aqua regia substance-in mixture of concentrated hydrochloric and nitric acids.

aromatic substance-an organic compound containing a benzene ring. Examples: Benzene, C_8H_6, ; toluene, C_7H_8, ; naphthalene, $C_{10}H_8$,

Arrhenius acid-a species which, upon addition to water, increases the concentration of H^+.

Arrhenius base-a species which, upon addition to water, increases the concentration of OH^-.

Arrhenius equation-the equation which expresses the temperature dependence of the rate constant: $\log_{10} = A - E_a/230RT$.

atmosphere (atm)-standard unit of pressure; equal to 101.325 kPa; equivalent to the pressure exerted by a mercury column 760 mm high.

atom-smallest particle of an element; matter is composed of atoms in various chemical combinations, Example: The nitrogen atoms combine to form an N_2 molecule, the smallest particle which has the properties of nitrogen as it is ordinarily found.

atomic mass-an averaged mass of atoms of one element relative to that of another element; based upon the atomic mass of a C-12 isotope taken to be exactly 12.

atomic number-a number equal to the number of electrons around the nucleus of an atom of an element; also the number of protons in the nucleus of that atom. Example: The atomic number of carbon is 6; there are six electrons outside the nucleus of a C atom and six protons in the nucleur of that atom.

atomic radius-the radius of an atom, taken to be one half the distance between two nuclei in the ordinary form of the elementary substance. Example: The radius of the Cl atom is 0.099 nm, since the internuclear distance in the Cl_2 molecule is 0.198 nm.

autbua principle-the rule stating that electrons enter energy levels atom in order of increasing energy, filling one sublevel before moving into the next.

Avogadro's Law-a principle stating that equal volumes of gases at the same temperature and pressure contain equal numbers of molecules.

Avogadro's number- 6.022×10^{23}; the number of units in a mole.

axial-adjective used to describe an atom or group that is perpendicular to the plane of a ring molecule.

B

balanced equation-an equation for a chemical reaction in which the reactants and products contain equal numbers of each kind of atom participating in the reaction. Example: The equation $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$ is balanced since both reactants and products contain one C, four H, and four O atoms.

base anhydride-a metal oxide that reacts with water to form a basic solution.

base dissociation constant – K_b; the equilibrium constant for the following reaction of the base B^-. $B^-(aq) + H_2O \rightleftarrows HB(aq) + OH^-(aq)$

$$K_b = \frac{[HB][OH^-]}{[B^-]}$$

base-a substance which on dissolving in water produces a solution in which $[OH^-]$ is greater than 10^{-7} M. Examples: NaOH, $Na_2CO_3.NH_3$.

basic solution-an aqueous solution having a pH > 7.0 $\left(\left[H^+\right] < 1.0 \times 10^{-7}\ M\right)$.

bent-adjective. used to describe a molecule containing three atoms in which the bond angle is less than 180°

beta radiation $\left({}^{0}_{-1}e\right)$-one of the types of radiation emitted by unstable nuclei. Beta particles have properties identical to those of electrons.

body-centered cubic-a crystalline structure in which the unit cell is a cube with one atom at each of its corners and an atom at its center.

Bohr model-model of the hydrogen atom derived by Niels Bohr.

boiling point elevation-increase in the boiling point of a liquid caused by addition of a nonvolatile solute. For a nonelectrolyte, the boiling point elevation, ΔT_b, is given by the equation: $\Delta T_b = k_n \times m$, where m is the molality and k_b is a constant for a given liquid $\left(0.52^\circ C \text{ for water}\right)$.

bond-a linkage between two atoms.

bond energy-enthalpy change ΔH associated with a reaction in which a bond is broken. Example: For the reaction $HCl(g) \rightarrow H(g) + Cl(g), \Delta H = 431$ kJ; the bond energy, B.E., of the $H - Cl$ bond is431 kJ/mol of bonds.

boiling point-that temperature of a liquid at which its vapor pressure equals the applied pressure; a liquid will tend to form bubbles and vaporize at its boiling point; usually reported at one atmosphere pressure.

bonding orbital-an orbital associated with two atoms in which the energy of its two electrons is less than the energies of those electrons in the separated atoms.

The presence of a populated bonding orbital between two atoms stabilizes the bond between them.

Boyle's Law-a relation stating that when a gas sample is compressed at a constant temperature, the product of the pressure and the volume remains constant.

Branched - chain alkane-a saturated hydrocarbon in which not all of the carbon atoms are located in a single, continuous chain. The simplest branched-chain alkane is 2-methlpropane, which has the structure $CH_3 - \underset{\displaystyle CH_3}{\overset{\displaystyle C}{\overset{|}{}}} H - CH_3$

brine-a solution of a salt, usually NaCl, in water

Bronsted-Lowry acid-a species which donates a proton to another species. Example: In the reaction HB

$HB(aq) + H_2O \rightleftarrows H_3O^+(aq) + B^-(aq)$, HB behaves as a Bronsted-Lowry acid in that it donates a proton to H_2O.

Bronsted-Lowry base-a species that accepts proton from another species. Example: In the reaction just given, H_2O behaves as a Bronsted-Lowry base, since it accepts a proton from HB.

buffer-a solution which resists change of pH more effectively than would a solution of strong acid or base having the same pH; usually contains a weak acid and its conjugate base. Example: A solution containing 0.5 M H_2CO_3 and 0.5 M $NaHCO_3$ is a buffer with pH of about 6.4; the pH is relatively resistant to change caused by addition of small resistant to change caused by addition of small amounts of either H^+ or OH^- ions.

C

calorie-a unit of thermal energy equal to 4.184 J.

calorimeter-a device used to measure the heat flow in a chemical reaction or physical change.

calorimeter constant (C) – the product of the mass times the specific heat of a bomb calorimeter.

carbohydrate-a class of organic compounds in which the general formula is $C_m(H_2O)_n$ .Example include glucose, sucrose, starch, and cellulose

carbonate ion- CO_3^{2-}

carboxylic acid-an organic compound containing the functional group $-\overset{\overset{O}{\|}}{C}-OH$

acid, $CH_3-\overset{\overset{O}{\|}}{C}-OH$

catalyst-a substance which affects the rate of reaction without being used up itself. Example: A piece of platinum foil can act as a catalyst converts CO to CO_2 and unburned hydrocarbons to CO_2 and H_2O.

cathode-an electrode at which reduction occurs. Example: If, at silver electrode, the reaction that occurs is $Ag^+(aq)+e^- \rightarrow Ag(s)$, then the silver metal is serving as a cathode.

cation-an ion having a positive charge. Examples: Fe^{2+}, K^+ and NH_4^+ are all cations.

cation exchange-process by which a cation a water solution is "exchanged" for a different cation, originally present in a solid resin. Used to soften water by exchanging Ca^{2+} for Na^+ ions.

Celsius degree-a unit of temperature, based on there being $100°$ between the freezing and boiling points of water; ultimately defined by means of a gas volume thermometer, the absolute temperature scale, and the $100°$ interval noted above.

centi-prefix on a metric unit indicating a multiple of 10^{-2}, Example: 1 cm= 10^{-2} m.

chain reaction-a type of chemical reaction occurring in steps in which the product of a late step serves as a reactant in an earlier step, thereby allowing a reaction, when once begun, to continue.

Charles' Law-a relation stating that the volume of a gas sample at constant pressure is directly proportional to its absolute temperature.

chelating agent-a complexing ligand that can form more than one bond with a central ion. Example:

Ethylenediamine, $H_2N-CH_2-CH_2-NH_2$, en, is a chelating agent which can form two bonds with a metal ion; its complex ion with Cu^{2+}. coordination number 4, has the formula $Cu(en)_2^{2+}$.

chemical equation-an expression which qualitatively and quantitatively describes the reactants and products of a chemical reaction as to their nature and amount. Example: $N_2(g)+3H_2(g)\rightarrow 2NH_3(g)$, a chemical equation, tells us that one mole of nitrogen gas reacts with three moles of hydrogen gas to form two moles of ammonia gas.

chemical property-property of a substance related to its chemical changes.

chemical symbol- a one or two letter abbreviation of the name of an element. Example: Pb for lead (Latin, plumbum).

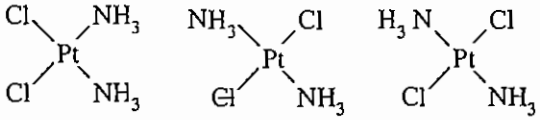
chemical thermodynamic-use of thermodynamic principles to predict whether a chemical reaction will be spontaneous ordinarily involves calculation of $\Delta H, \Delta S$, and/or ΔG for the reaction.

chiral center-atom in a molecule which is bonded to four different groups; a source of optical isomerism.

chromatography-separation method in which the components of a solution are adsorbed at different locations on a solid surface.

cis isomer-a geometric isomer in which two identical bonded atoms or groups are relatively close to one another. Example: In square planar Pt $(NH_3)_2Cl_2$,

the cis isomer has the structure



trans isomer has the structure

coefficient-a number preceding a symbol or formula in a chemical equation.

colligative property- a physical property of a solution which depends on the concentration, but not the kind, of solute particles. Example: The vapor pressure depression of a solution depends on the mole fraction of the solute but not on the nature of the solute, and so is a colligative property.

common ion effect-if, to solution containing ions, a solute is added which furnishes one of the ions originally present, the common ion effect will change some of the properties of the solution. Example: The solubility of NaCl in water is decreased by addition of 6 M HCl.

complex ion-an ion containing a central metallic cation to which two or more groups are attached by coordinate covalent bonds. Example: In the $Ag(NH_3)_2^+$ complex ion the electrons in the coordinate covalent bonds between Ag^+ and NH_3 are furnished by the NH_3 molecules.

compound-a chemical substance containing more than one kind of atom.

concentrated-adjective used to describe a solution which contains a relatively high concentration of solute.

concentration-refers to relatively amounts of solute and solvent in a solution; may be stated in many ways, such as per cent solute by mass, or mole fraction, but very often is given terms of the number of moles of solute per cubic decimeter of solution. Example: In 6 M NaOH, there are 6 mol of NaOH in cubic decimeter of solution.

condensation polymer-a polymer formed from monomer units joined by splitting out a small molecule, usually water.

condensation-conversion of a gas to liquid or solid.

conductivity- a term referring to the relative ease with which a sample will transmit electricity or heat (should specify which). Example: Since a much larger electrical current will flow through an aluminum rod at a given voltage tan through an aluminum rod at a given voltage than through a glass rod of the same shape, the electrical conductivity of aluminum is much greater than that of glass.

configuration-a structure; a geometric arrangement.

Example: Carbon tetrachloride molecules have a tetrahedral configuration.

conjugate-refers to related acids and bases, often in connection with Bronsted-Lowry description. Example: In the reaction and H_3O^+ behave as acids, while H_2O and NO_2^- act as bases. The NO_2^- is the conjugate base of the H_3O^+ ion. Or, HNO_2 is the conjugate acid of the NO_2^- ion and H_3O^+ ion is he conjugate acid of H_2O.

Conservation of Energy-law which states that energy can neither be created nor destroyed.

contact process-process used in the industrial preparation of sulfuric acid. SO_2 and O_2 are converted to SO_3 by bringing them into contact with a solid catalyst, which may be V_2O_5 or Pt.

continuous spectrum-a spectrum containing light of all wavelengths.

conversion factor-a ratio, numerically equal to one, by which a quantity is multiplied to obtain an equivalent quantity; often expressed as the equation from which the ratio can be obtained. Example: From the conversation factor, 1 km = 1000m, one can set up the ratio 1 km/1000 m, which can be used to convert a distance in metres into kilometers.

coordinate covalent bond – covalent bond in which the electrons are furnished by the hydroxide ions; most commonly encountered in complex ions. Example: In the $Zn(OH)_4^{2-}$ ion, ts; these bonds are, therefore, coordinate covalent bonds.

coordination number-the number of bonds formed from the central metal the ligands in a coordination complex.

corrosion-a destructive chemical process, most often applied to the conversion of a metal to one of its compounds. An example is the corrosion of iron in contact with O_2 and H_2O to form first $Fe(OH)_2$ and eventually hydrated $Fe(OH)_3$.

Coulomb's Law-a relation expressing force between charged particles; $F = \frac{q_1 q_2}{Dr^2}$, where F is the force between two particles having charges q_1 and q_2 and r is the distance between them. If q_1 and q_2 have the same sign, force is repulsive; otherwise it is attractive. In a medium having dielectric constant D, the force is decreased by the factor D; D is 1 in a vacuum.

covalent bond-a chemical link between two atoms, produced by shared electrons in the region between the atoms. Example: In the H_2O atom and each H atom; each bond contains two electrons, one furnished by the H atom and one by the O atom; both atoms share the electrons in the bond.

critical pressure-the pressure at the critical temperature.

critical temperature-the highest temperature at which a substance can exhibit liquid-vapor equilibrium. Equilibrium pressure at that point is called the critical pressure. Above that temperature, liquid cannot be condensed from the vapor at any pressure. Example: Since water has a critical temperature of $374°C$ above $374°C$ one cannot have liquid water in equilibrium with its vapor.

crystal field model-model of the bonding in complex ions. The bonding is considered to be essentially ionic; the only effect of the ligands is the change the relative energies of the d orbitals of the central metal ion.

crystal field splitting energy-the difference in energy between the two sets of d orbitals in a complex ion: cubic centimetre (cm^3) -volume unit equal to the volume of a cube 1 cm on each edge.

crystal-a sample of matter in which the component atoms or ions are arranged in a regular geometric pattern.

D

Dalton's Law-a relation stating that the total pressure of a gas mixture is equal to the sum of the partial pressures of its components.

deionization-removal of ions from water. Can be achieved by passing through two successive columns. In one column, cations are exchanged for H^+ ions; in the other, anions are exchanged for OH^- ions. After reaction of H^+ with OH^- ions, no ions remain in solution.

de Broglie relation-equation used to describe the wave properties of matter: $\lambda = h/mv$.

desiccant-a drying agent.

deuterium- a heavy isotope of hydrogen, ${}^2_1H$.

diamagnetic-a descriptive term indicating that a substance does not contain unpaired electrons and so is not attracted into a magnetic field, Example: Since all of the electrons in NH_3 molecules are paired, NH_3 is diamagnetic.

diamond-one of the crystalline forms of carbon,

diffusion-a process by which one substance, by virtue of the kinetic properties of its particles, will gradually mix with another. Example: $H_2S(g)$ prepared in a test tube will slowly diffuse into the surrounding air.

dilute-refers to a solution containing a relatively small amount of solute; opposite of concentrated.

dipole force- refers to attractive force between molecules possessing separate positive and negative poles. Example: Since the HCl molecule has positive and negative ends, there will be dipole forces between neighboring HCl molecules.

dipole-species in which there is a separation of charge, i.e., a positive charge at one point and a negative charge at different point. Examples of dipoles are HF and H_2O .

disaccharide-a dimmer of two monosaccharide units.

The units may be alike, as in maltose (both glucose), or different, as in sucrose (glucose and fructose).

dispersion force-an attractive force between molecules which arises because of the presence of temporary dipoles. Usually increases with MM.

disproportionation-a reaction in which a species undergoes oxidation an reduction simultaneously. Example: 2

$Cu^{+}(aq) \rightarrow Cu(s) + Ch^{2+}(aq)$.

dissociation constant, K_d -equilibrium constant for the dissociation of complex ion. The expression for K_d of the Cu $(NH_3)_4^{2+}$ ion is

$$\frac{[Cu^{2+}][NH_3]^4}{[Cu(NH_3)_4^{2+}]}$$.

dissociation-separation into two or more species; usually applied to weak acids or bases or complex ions. Example: The dissociation of acetic acid in water to form H^+ ions and acetate ions only occurs to small extent.

distillation-a procedure in which a liquid is vaporized under conditions where the evolved vapor is later condensed and collected.

double bond-two shared electron pairs between two bonded atoms.

ductility-ability of a solid to retain strength on being forced through an orifice; characteristic of metals.

E

efflorescence-the loss of water of hydration from a hydrate.

effusion-the movement of a gas through a capillary or porous solid into another gaseous region or vacuum.

Einstain's equation-

the relation $\Delta E = \Delta mc^2$ relating mass and energy changes.

electrode- a general name for anode or cathode.

electrolytic cell-a cell in which the flow of electrical energy from an external source causes a redox reaction to occur.

electrolysis-the passage of a direct electric current through a solution containing ions, producing chemical changes at the electrodes.

electrolyte-a substance which exists as ions in water solution. Example: $NaCl$ (Na^+ and Cl^- in water solution).

electron configuration-a statement of the populations of the Li atom is $1s^2 2s$, there are two electrons in the 1s sublevel and one electron in the 2s sublevel.

electron cloud-a region of negative charge around an atomic nucleus; associated with an atomic orbital.

electron pair repulsion - principle used to predict the geometry of molecule or polyatomic ion. Electron pairs around a central atom tend to orient themselves so as to be as far apart as possible.

electron spin-a property of an electron loosely related to its spin around an axis. Only two spin states are allowed, usually described by quantum number m_s, which can assume the values +1/2 and -1/2.

electron-sea model-model ofmetallic bonding in which cations are considered as fixed points in mobile "sea" of electrons.

electron-the negatively charged component of atoms; exists in a roughly spherical cloud around atomic nucleus; carries 1 unit of negative charge and has a very low mass.

electrostatic forces- the forces between particles caused by their electric charges.

element-a general name given to each of the 106 different atoms. Example: Sulfuric acid, H_2SO_4, contains three elements, hydrogen, sulfur, and oxygen; this is equivalent to saying that in H_2SO_4 there are three different kinds of atoms, H, S, and O.

elementary substance-ordinarily observed form of a chemical substance containing only one kind of atom. Examples: Elementary oxygen consists of O_2 molecules; elementary sodium is metallic Na.

empirical formula-an expression which furnishes relative numbers of atoms of the elements in a chemical substance; expressed as the lowest possible set of integers. Often called the simplest formula. Examples: NaCl, H_2SO_4, CH_2, Fe, HO (hydrogen peroxide).

enantiomer-one, of a pair of optical isomers.

end point-the point during a reaction, usually in the course of a titration, at which a chemical indicator changes color. Example: The end point in a titration using phenolphthalein indicator occurs at a pH of 9.

endothermic-describes a reaction during which heat must be furnished to the reacting mixture to maintain its temperature at the initial value; ΔH for the reaction is a positive quantity.

energy level-the value of the n quantum number.

energy-a property of a system which is related to its capacity to cause change; can be altered only by exchanging that or work with the surroundings; given the symbol E.

enthalpy-a property of a system which reflects its surroundings, given the symbol H; defined so that $\Delta H = Q$ for changes in the system that occur at constant pressure.

enthalpy change, ΔH -difference in enthalpy between products and reactants.

enthalpy of formation $\left(\Delta H_f\right)$ -heat flow for the reaction in which a pure substances.

Entropy-a property of a system related to its degree of organization; highly ordered systems have low entropy; given the symbol S.

entropy change, ΔS -difference in entropy between products and reactants.

enzyme-a protein catalyst in biological systems.

equatorial-adjective used to describe an atom or group that is parallel to the plane of ring molecule.

equilibrium concentration-concentration, in moles per liter, of a species at equilibrium. Represented by the symbol [ ].

equilibrium constant-a number which imposes a condition on reactant and product on reactant and product concentrations in an equilibrium system; formulated according to Law Chemical Equilibrium, given the symbol K_c . Example: For the reaction $PCl_3(g) + Cl_2(g) \rightleftharpoons PCl_5(g)$, $K_c = 20$ at $240^\circ C$; therefore, at equilibrium at $240^\circ C$, $\frac{[PCl_5]}{[PCl_3][Cl_2]} = 20$.

equilibrium-a state of dynamic balance, where rates term does not change with time. Example: At 100° C, liquid water is in equilibrium with its vapor when the vapor is at a pressure of 1 atm.

equivalence point-the point during a reaction between A and B, usually during a titration, when an amount of B has been added that is required to react exactly with the amount of A present. Example: The equivalence point in the reaction $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$ occurs when the number of moles of OH^- ion added to an acid solution equals the number of moles of H^+ ion in the solution.

ester-the product of the reaction between and alcohol and an acid. Example: When methanol, CH_3OH, reacts with acetic acid, CH_3COOH , the ester called methyl acetate, $CH_3 - O - CO - CH_3$, is formed.

ether-an organic compound containing an oxygen atom connected to two alkyl groups. Examples: CH_3OCH_3, $C_2H_5OC_2H_3$.

excited state-an electronic state of a higher energy than the ground state.

exclusion principle-the rule stating that in an atom no two electrons can have the same set of four quantum numbers.

exothermic-describes a reaction during which heat must be removed from the reacting mixture to maintain its temperature at the initial value; ΔH for the reaction is a negative quantity.

expanded octet-more than four electron pairs about a central atom.

F

face-centered cubic-a type of crystal structure in which the unit cell is a cube with identical atoms at each corner and at the center of each face.

Fahrenheit degree-a degree based on the temperature scale on which water freezes at $32°$ and boils at 1 atm at $212°$.

fat-an ester made from glycerol and a long-chain **carboxylic acid;** found in seeds and in fatty tissue of animals.

fatty acid-a long-chain carboxylic acid. Example: Stearic acid, $CH_3(CH_2)_{16}COOH$.

filtration-a process for separating a solid-liquid mixture by passing it through a barrier with fine pores, such as filter paper.

First Law of Thermodynamics-the statement that the change in energy, ΔE, of a system equals the heat flow, Q, into the system from the surroundings minus the work, W, done by the system on the surroundings $(\Delta E = Q - W)$.

first order-a term describing a reaction whose rate depends on reactant concentration raised to the first power. Example: Since the rate of the reaction $2N_2O_5(g) \rightarrow N_2O_4(g) + O_2(g)$ is given by the equation rate = k(conc. N_2O_5), the reaction is first order.

five per cent rule **approximation a** - $x \approx a$ valid if $x \leq 0.05$ a. The rule depends upon the generalization that the value of the constant in the equation in which x appears is seldom known to better than $\pm 5\%$.

fixation of nitrogen-any process which converts $N_2(g)$ into a nitrogen-containing compound. Example: The fixation of nitrogen by the Haber process occurs via the reaction of N_2 with H_2 to make ammonia, NH_3.

flotation-a separation process used to free finely divided ore from rocky impurities. With a soapy emulsion of oil and water, the ore concentrates at the surface and can be skimmed off.

flow sheet- a diagram used to summarize a separation scheme in qualitative analysis.

formula-the expression used to describe the relative number of atoms of the different elements present in a substance; molecular formula is used with substances having molecules; empirical formula is used with nonmolecular substances.

formula mass-the sum of the atomic masses of the atoms in a formula.

fractional crystallization-process used to separate a pure solid from a mixture with another solid. The mixture is dissolved in the minimum amount of hot solvent. Upon cooling, one solid should crystallize from solution while the other remains in solution.

fractional distillation-a procedure used to separate components with different boiling points from a solution; based on passing vapors from a boiling solution up a column along which the temperature gradually decreases; higher boiling components condense on column and return to solution, lowest boiling component goes out of top of column, where it is condensed and collected.

free energy-a property of a system which reflects its capacity to do useful work, given the symbol G; ΔG for a reaction at constant temperature and pressure is equal to minus the amount of useful work the reaction can produce; spontaneous reactions are those for which ΔG is negative.

free radical-a species having an unpaired electron.

Examples: The H atom, the NO molecule, the NO molecule, and the CH_3 group are all free radicals.

freezing point-the temperature at which a solid and liquid phase can coexist at equilibrium; applies to both pure liquids and solutions. Example: The ***freezing point of a solution*** containing one mole NaCl in 1.00 dm^3 of water is $-3.37\,^{\circ}C$; at that point pure ice and the solution are in equilibrium.

freezing point depression-decrease in the freezing point of a liquid caused by addition of a solute. For a nonelectrolyte, the freezing point depression ΔT_f is given molality and k_f is a constant for a given liquid (1.86° C for water).

functional group-a small group of atoms in an organic molecule which give the molecule its distinctive chemical behavior.

fusion-the melting of solid to liquid; also refers to reaction between small atomic nuclei to form a larger one. Example: The fusion reaction $2\,{}^{2}_{1}H \rightarrow {}^{4}_{2}He$ would produce a large amount of energy.

faraday-one mole of electrons; 96 485 C of electric charge.

G

gamma radiation-high energy photons emitted by radioactive nuclei.

gas constant(R)-the constant which appears in the Ideal Gas Law equation, PV = nRT; depends upon units of P, V, and T; equals 8.31 $\frac{k\,Pa.dm^3}{mol.K}$ in the units listed.

Geiger-Muller counter-device used to measure rate of radioactive decay

geometric isomer-a species having the same kind and number of atoms as another species, but in which the geometric structure is different. Example: There are two geometric isomers with the molecular formula $Pt(NH_3)_2Cl_2$:

(structures are both planar).

Gibbs-*Helmholtz equation*-a relationship among ΔG, ΔH, and ΔS: $\Delta G = \Delta H - T\Delta S$.

Graham's Law-a relation stating that the rate of effusion of a gas is inversely proportional to the square root of its density or molecular mass.

gram-a unit of mass in the metric system; equal to mass of on cubic centimetre of water at 4° C.

gram molecular mass in grams of a mole of a molecular substance. Example: Since the molecular mass of N_2 is 28, the gram molecular mass of nitrogen gas is 28 g.

gray-a unit of absorbed dose of radiation: one joule per kilogram of tissue.

greenhouse effect-phrase used to describe the effect of water and carbon dioxide in absorbing outgoing IR radiation, thereby raising the earth's temperature.

ground state-the lowest allowed energy state of an atom, ion, or molecule.

group-a vertical column of Periodic Table.

Groups, I, II, III, IV-cation groups in qualitative analysis.

Roman numberals are used to distinguish from groups in the Periodic Table.

heat of vaporization-ΔH for the conversion of unit amount (one gram or one mole)of a liquid to a vapor at constant P, T.

H

Haber process-industrial process used to make ammonia from nitrogen and hydrogen.

half-cell-half of a voltaic or electrolytic cell, at which either oxidation or reduction occurs. Example:

half-equation written to describe a half-reaction of oxidation or reduction. An example of an oxidation half-equation is $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$.

half-life $\left(t_{1/2}\right)$ - the time required for a reaction to convert half of the initial reactant to products(s).

halide ion-F^-, Cl^-, Br^- or I^-.

halogen-an elementary substance in Group 7. Examples: F_2, Cl_2, Br_2.

head water-water containing excessive Ca^{2+} or Mg^{2+}.

head-to-tail polymerization-process leading to the formation of a polymer of the type:

heat capacity-the amount of heat required to raise the temperature of a sample by $1^\circ C$.

heat flow-the amount of heat, Q, passing into or out of a system; Q is positive if flow is into system, negative if out of system.

heat of fusion-ΔH for the conversion of unit amount (one gram of one mole) of a solid to a liquid at constant P, T.

heat of sublimation-ΔH for the conversion of unit amount (one gram or one mole)of a solid to vapor at constant P, T.

hydrolysis-a reaction in which a water molecule is split as a result of interaction with another species.

heat-that form of energy which flows between two samples of matter because of their difference in temperature.

Hess's Law-a relation stating that the heat flow in a reaction which is the sum of two other reactions is equal to the sum of the two heat flows in those reactions.

heterogeneous-having nonuniform composition.

high- spin complex-complex which, for a particular metal ion, has the largest possible number of unpaired electrons.

homogeneous-having uniform composition.

Hund's rule-a relation stating that, ordinarily, electrons will not pair in an orbital until all orbitals of equal energy contain one electron.

hybrid atomic orbital-an orbital made from a mixture or *s, p, d,* or *f* orbitals. Example: An sp^2 hybrid orbital is derived from an s and two p orbitals.

hydrate-a substance containing bound water. Example: $BaCl_2.2H_2O$ is a common hydrate.

hydrocarbon-a substance containing only hydrogen and carbon atoms.

hydrogen bonds-attractive forces between molecules, arising from interaction between a hydrogen atom in one molecule and a strongly electronegative atom (N, O , F)in a neighboring

molecule. Example: Hydrogen bonding in water is due to interaction between the H atoms and O atoms on different H_2O molecules.

Example: The hydrolysis of CN^- involves the reaction. $CN^- + H_2O \rightarrow HCN + OH^-$

hydronium ion-the H_3O^+ ion characteristic of acidic water solutions.

hydroxide ion- OH^-

I

Ideal Gas Law-states the relationship between pressure, volume, temperature, and amount for any gas at moderate pressures; PV = nRT.

indicator, acid-base- a chemical substance which changes color with pH change; usually color change occurs over about two pH units.

inert complex-a complex ion which exchanges ligands very slowly.

inert gas-noble gas.

infrared-describes light having a wavelength greater that about 700 nm.

intermolecular-between molecules.

ion pair-a species made up of a cation and anion held together by strong electrostatic forces. Examples: In solutions of magnesium sulfate one would find appreciable amounts of $\left(Mg^{2+}SO_4^{-2}\right)$ ion pairs.

ion product (Q)- the product of the actual concentrations of ions, each raised to the appropriate power.

This is in comparison to the product of the equilibrium concentrations of the ions.

ion-a charged species.

ionic compound-a substance in which component species are cations and anions. Examples: Some common ionic compounds are $NaCl, CaO,$ and NH_4HO_3.

ionic radius-the radius of an ion as based on the assumption that ions in crystal are in contact with nearest neighbors.

ionization constant-a general term for dissociation constant of a weak acid or base.

ionization energy-the energy required to remove the outermost electron from a gaseous atom.

isoelectronic(with)-having the same number of electrons as.

isomer-a species having same number and kind of atoms an another species; but having different properties; structural, geometric, optical, and stereoisomers may occurs. Example: Dimethyl ether, is structural isomer of ethyl alcohol, $CH_3 - CH_2 - OH$.

isomerization - process in which straight-chain isomers. isotope-an atom having same number of nuclear protons as another, but with a different number of neutrons. Example: Ordinary oxygen has three isotopes, all with eight protons in the nucleus, but with eight, nine, and ten neutrons, respectively.

J

joule-the base SI unit of energy; equal to kinetic energy of a two-kilogram mass moving at a speed of one metre per second.

K

Kelvin temperature scale-an absolute temperature scale based on definition that volume of a gas at constant (low) pressure is directly proportional to temperature, and that 100 degrees separate the freezing and normal boiling points of water.

ketone-an organic compound containing a nonterminal carbonyl, C=O, group, Example: The simplest ketone is acetone, $CH_3 - CO - CH_3$.

killojoule-unit of energy: 1000 J.

kilo-a prefix or metric units indicating multiple of 1000.

Example: One kilojoule equals 1000 J.

kilogram-basic unit of mass in SI: 1000 g.

kilopascal(kPa)-a pressure unit: 1 kPa is approximately the pressure exerted by a 10-g mass resting on a $1\,cm^2$ area; 101.3kPa = 1 atm.

kinetic theory-model of molecular motion used to explain many of the properties of gases.

kinetic-associated with motion. Example: The kinetic energy of particle of mass m at speed v is equal to $\frac{1}{2}mv^2$.

kinetics-the study of rates of chemical reactions.

L

labile complex-a complex ion which rapidly reaches equilibrium with ligands in surrounding solution.

Law of Chemical Equilibrium-a relation stating that in a reaction mixture at equilibrium there is a condition, given by the equilibrium constant, relating the concentrations of reactants and products; for the reaction

$$aA(g)+bB(g)\rightleftharpoons cC(g)+dD(g), K_c=\frac{[C]^c[D]^d}{[A]^a[B]^b}.$$

Law of Combining Volumes-a relation stating that relative volumes of gases in chemical reaction are in the ratio of small integers (all gases at same T and P): also called Gay-Lussac's Law. Example: In the reaction $H_2(g)+O_2(g)\rightarrow H_2O(g), 2$ volumes H_2O.

Law of Conservation of Mass-a relation stating that in a chemical reaction the mass of the products equals the mass of the reactants.

Law of Constant Composition-a relation stating that the relative masses of the elements in a given chemical substance are fixed.

Law of Dulong and Petit-a relation stating that the heat capacity of one gram atomic mass of any metal is about $25\,J/^\circ C$.

Law of Mass Action-same as Law of Chemical Equilibrium.

Law of Multiple Proportions-a relation stating that when two elements, A and B, form two compounds, the relative amounts of A are in a ratio of small integers. Example: In water and hydrogen peroxide, both of which contain hydrogen and oxygen, there are 8 and 16 g of oxygen, respectively, for each gram of hydrogen.

Le Chatellier's Principle-a relation stating that, when a system at equilibrium is disturbed, it will respond in such a way as to counteract the change.

Lewis acid-a species which can accept a pair of electrons.

Example: In the reaction $BF_3+NH_3\rightarrow BF_3NH_3$ the BF_3 accepts a pair of electrons from NH_3 and so behaves as a Lewis acid.

Lewis base-a species which can donate a pair of electrons. Example: NH_3, in the above reaction.

Lewis structure-electronic structure of a molecule or ion in which electrons are shown by dots or dashes (electron pairs).

ligand-a molecule or anion bonded directly to the central metal in a complex ion.

limiting reagent-the least abundant reactant, based on the equation, in a chemical reaction; dictates the maximum amount of product which can be formed.

linear molecule-molecule containing three atoms in which the bond angle is 180°. Examples of linear molecules include BeF_2 B and CO_2.

litre-1 dm^3 = 1000 cm^3.

logarithm of a number-the exponent to which another number, usually 10, must be raised to give the number. Examples: The logarithm of 100 to the base of 10 is 2, since $10^2=100$, the logarithm of 3.00 is 0.477 sine $10^{0.477}=3.00$.

lowspin complex-complex which, for a particular metal ion, has the smallest possible number of unpaired electrons.

lanthanides-elements with atomic numbers 58-71; series in which 4f sublevel is being filled. Example: Europiun, atomic number 63,is one of the lanthanides.

M

macromolecular-having a structure in which all the atoms in a crystal are linked by chemical bonds.

Example: Since all the atoms in a silicon crystal are bonded chemically into a unit, silicon is macromolecular.

main group-a numbered of the Perlodic Table.

malleable-capable of being shaped, as by pounding with a hammer.

mass number-an integer equal to the sum of the number of protons and neutrons in an atomic nucleus.

Example: The mass number of a $^{37}_{17}Cl$ isotope is 37; the nucleus of that isotope contains 17 protons and 20 neutrons.

mass-a property reflecting the amount of matter in a sample.

matter-a general term for any kind of material; the stuff of which pure substances are made.

Maxwellian distribution-a relation describing the way in which molecular speeds, or energies, are shared among the molecules in a gas.

mechanism-a sequence of steps that occurs during the course of a chemical reaction.

melting point-same as freezing point.

Metal-a substance having characteristic luster, mallability, and high electrical conductivity; readily loses electrons to form positive ions.

metalloid-an element with properties intermediate between those usually associated with metals and nonmetals. Examples of metalloids are B, Si, Ge, As, Sb, and Te.

metallurgy-the science and processes of extracting.

metre-unit of length in the metric system.

milli-prefix on metric unit indicating multiple of $1-10^{-3}$. Example: One millimeter equals one one thousandth of a metre, 0.001 m.

miscible(with)-soluble in

mixture-two or more substances combined so that each substance retains its chemical identity.

mm Hg-a unit of pressure: 1 atm=760 mm Hg.

molality-a concentration unit, defined equal to the number of moles of solute divided by number of kilograms of soivent. Example: A solution made by dissolving 0.10 mole of KNO_3 in 200 of water would be 0.50 molal in $KNO_3\left(0.50\,\mathrm{m}\,KNO_3\right)$.

molar mass-mass of one mole of substance. Most often expressed in grams $\left(GMM\,O_2=32.0\,\mathrm{g}\right)$, but can be expressed in kilograms $\left(KMM\,O_2=0.032\,\mathrm{kg}\right)$.

molarity-a concentration unit, taken to the number of moles of solute divided by number of cubic decimeters of solution. Example: In 6 M HCl, there is 6 mol of HCl in 1 dm^3 .

mole fraction-a concentration unit, defined equal to number of moles of component divided by total number of moles in solution. Example: In a solution in which there is 1 mol benzene, ***2 mole*** CCl_4 , and 7 mole acetone, the mole fraction of the acetone is 0.7.

mole-a convenient chemical mass unit; defined as containing 6.022×10^{23} molecules, atoms, or other units; the mass of the mole is equal to the gram formula mass of the substance. Examples: One mole of NH_3 contains 6.22×10^{23} molecules and weighs just about weighs 63.54 g; one mole KNO_3 weighs just about 17 g; one mole Cu contains 6.22×10^{23} atoms and weighs 63.54g; one mole KNO_3 weighs 101.1 g.

molecular formula-an expression stating the number and kind of each atom present in the molecule of substance. Example: Since the molecular formula of hexane is C_6H_{14} , there are six C atoms and 14 H atoms in hexane molecule.

molecular geometry-the shape of molecule describing the relative positions of atomic nuclei.

molecular mass-a number equal to the sum of the atomic masses of the atoms in a molecule; tells the mass of the molecule relative to a ^{12}C atom, taken to have a mass of 12. Example: The molecular mass of C_2H_6 is about $30\left[(2\times 2)+(6\times 1)\right]$, so the molecule is about 2.5 times as heavy as a ^{12}C atom, and the same mass as an NO molecule, whose molecular mass is also $30\,(\text{i.e.}, 14+16=30)$.

molecular orbital-an orbital involved in the chemical bond between two atoms, and taken to be a linear combination of the orbitals on the two bonded atoms.

molecule-an aggregate of atoms, which is the characteristic component particle in all gases, many pure liquids, and some solids; often contains only a few atoms; has relatively little physical interaction with other molecules. Examples: In nitrogen gas, liquid benzene, and solid glucose, one finds N_2 molecules, C_6H_6 molecules, and $C_6H_{12}O_6$ molecures.

monomer-a small molecule which joins with other monomers to form a polymer.

monosaccharide-a class of sugars which cannot be broken down chemically to simpler sugars.
multiple equilibria, rule of-rule stating that if Equation 1 + Equation 2 = Equation 3, then $K_1 \times K_2 = K_3$.

N

nanometer-a unit of length equal to 10^{-9} m.

natural logarithm- a logarithm based upon the numbere, 2.7182818....; if $\log_e X = Y$, then $e^Y = X$, $\log_{10} X = \dfrac{\log_e X}{2.303}$; base e comes from the calculus, where certain derivatives-and integrals are most easily expressed in terms of e.

Nernst equation-an equation relating the voltage of a cell to its standard voltage and the concentrations of reactants and products.

net ionic equation-a chemical equation for a reaction, in which only those species which actually react are listed. Example: When 1 M HCl and 1 M NaOH solutions are mixed, the net ionic equation for the reaction is H^+ (aq) + OH^- (aq) $\rightarrow H_2O$; the Cl^- and Na^+ ions in the solution do not react and so are not in the equation.

neutral solution-an aqueous solution with a pH = 7.0 $\left(\left[H^+\right] = 1.0 \times 10^{-7}\ M\right)$.

neutralization-a reaction of an acid and a base to produce a neutral $(pH = 7)$ solution.

neutron-one of the particles in an atomic nucleus; mass = 1, charge = 0.

noble gas structure-$ns^2 np^6$ outer electron structure in an atom or ion; a particularly stable structure attained by atoms obeying the octet rule; sometimes called an inert gas structure.

noble gas-element in Group 8, at the far right of the Periodic Table.

nonelectrolyte-a substance that does not exist as ions in water solution. Example; Since ethyl alcohol does not ionize when dissolved in water, it is a nonelectrolyte.

nonmetal-one of the elements in the upper right corner of the Periodic Table that does not show metallic properties. Example: Nitrogen gas, N_2 , is a nonmetal.

nonpolar bond-a chemical bond in which there are no positive and negative ends; found in homonuclear diatomic molecules such as H_2 and O_2 .

nonpolar molecure-molecule in which there is no separation of charge and hence no negative and positive poles. Nonpolar molecules include H_2 and CO_2 .

nonspontaneous reaction-a reaction which cannot occur by itself without input of work from an external source; $\Delta G > 0$ for nonspontaneous reactions at T and P.

normal boiling point-boiling point at one atmosphere pressure.

n-type semiconductor-semiconductor in which current is carried through a solid by "extra" electrons introduced by electron-rich impurity atoms.

nuclear fission-the splitting of a heavy nucleus by a neutron into two lighter nuclei, accompanied by the release of energy.

nuclear fusion-the combining of light nuclei to form a heavier nucleus, accompanied by the release of energy.

nuclear reactor-device used to generate electrical energy using the heat given off by nuclear fission.

nucleus-the small, dense, positively charged region at the center of an atom.

O

octahedral-having the symmetry of regular octahedron, a solid with six vertices and eight faces, each of which is an equilateral triangle.

octane number-number used to indicate the knocking resistance of a motor fuel. Based on a scale in which isooctane is rated 100 and heptane 0.

octet-group of eight valence electrons surrounding an atom. All the noble-gas atoms except He have an octet of valence electrons.

octet rule-the principle that bonded atoms tend to have a share in eight outermost electrons.

olefin-a hydrocarbon containing a carbon-carbon double bond. Same s alkene.

optical activity-the ability to rotate the plane of a beam of transmitted polarized light; a property possessed by substances having a chiral center.

optical isomerism-the phenomenon in which each member of a pair of molecules having the same molecular formula rotates a beam of plane polarized light in opposite directions. Such molecules have at least one chiral center.

orbital-an electron cloud with an energy state characterized by given values of n, ℓ, and m_ℓ quantum numbers; has a capacity for two electrons having paired spins; often associated with a particular region in the atom. Example: In an atom the electrons in the $2p_x$ orbital are in a dumbbell-shaped cloud concentrated along the x axis.

orbital diagram-a sketch showing electron populations of atomic orbitals, including electron spins.

order of reaction-exponent to which concentration of a reactant needs to be raised to give observed dependence of reaction rate on concentration. Example: If, for the reaction $A \rightarrow$ products, rate = $k\,(\text{conc.A})^2$, the reaction is second order.

ore-natural mineral deposit from which a metal can be extracted profitably.

organic-used to characterize any compound containing carbon, hydrogen, and possibly other elements.

Example: Propionic acid CH_3CH_2COOH, is an organic compound; SiO_2 is not.

osmotic pressure-the excess pressure which must be applied to a solution to prevent the pure solvent from diffusing into the solution through a semipermeable membrane.

Ostwald process-industrial process used to make nitric acid from ammonia.

overall order-number obtained by summing all the exponents in the rate expression. If rate = $k\,(\text{conc.A})^m \times (\text{conc.B})^n$, then overall order = m + n.

oxidation-a half-reaction involving a loss of electrons or, more generally, an increase in oxidation number. Example: If, at an electrode, the reaction is $Ag(s) \rightarrow Ag^+(aq) + e^-$, silver is undergoing oxidation, number is increasing from 0 to +1.

oxidation number-a number which can be assigned to an atom in molecule or ion which reflects, qualitatively, its state of oxidation; the number is determined by applying a set of rules. Examples: In the NO_3^- ion the oxidation numbers of the N and O atoms are +5 and -2, respectively.

oxide-compound containing oxygen. The oxide ion, found in metal oxides, has the formula O^{2-} .

oxidizing agent-a species which accept electrons from another. Example: In the reaction $Cl_2(aq) + 2Br^-(aq) \rightarrow 2Cl^-(aq) + Br_2(aq)$, Cl_2 serves as an oxidizing agent.

oxyacid-an acid containing oxygen. Examples: HNO_3 , H_2SO_4 , and HClO are oxyacids.

oxyanion-an anion containing oxygen. Examples: NO_3^- , SO_4^{2-} , and ClO^- are oxyanions.

ozone-an allotropic from of oxygen, in which the molecule is O_3 .

P

paired electrons-two electrons in the same orbital with spins equal to $+\frac{1}{2}$, $-\frac{1}{2}$; an electron pair.

paraffin-a hydrocarbon in which all carbon-carbon bonds are single; an alkane.

paramagnetic-having magnetic properties, caused by unpaired electrons. Examples: The NO molecule, H atom, and CH_3 radical are paramagnetic.

partial pressure of A-that part of the total pressure in a gaseous mixture which can be attributed to component. A. The partial pressure of A is equal to the pressure A would exert in the container if A were there by itself. Example: In a mixture f 3 mol N_2 and 1 mol O_2 at a total pressure of 2 atm, the partial pressure of N_2 is 1.5 atm and that of O_2 is 0.5 atm.

parts per billion (ppb)-for gases, the number of molecules of solute per billion molecules of gas; for liquids and solids, the number of grams of solute per billion grams of sample.

parts per million (ppm)-for gases, number of molecules solute per million molecules of gas; for liquids and solids, number of grams solute per million grams of sample. Example: If a gas sample contains 6 parts per million CO, then in one mole of gas there would be 6×10^{-8} mol CO.

peptide linkage-the $\begin{matrix} -N- & C- \\ | & \| \\ H & O \end{matrix}$ group in proteins; also called peptide bond.

per cent A- parts A in 100 parts of a sample; usually in mass per cent but may be in mole per cent or volume per cent. Example: A 5% NaOH solution contains 5 g NaOH in 100 g solution.

per cent composition-percentages by mass of the elements in a compound.

per cent yield-quantity equal to $100\times$ actual yield/theoretical yield.

period-a horizontal row of elements in the Periodic Table.

periodic-occurring in cycles.

Periodic Table-an arrangement of the elements into rows and columns in which those elements with similar properties occur in the same column.

peroxide-a binary compound containing an oxygen-oxygen single bond or the peroxide ion, O_2^{2-} .

pH-alternate way to express H^+ ion concentration; $pH = -\log_{10}\left[H^+\right]$.

"proof"-twice the volume percentage of ethyl alcohol in an alcoholic beverage.

phase diagram-for one-component systems, a graph of pressure vs. temperature, showing conditions under which the pure substance will exist s a liquid, solid, or gas and also the conditions under which two-phase and three-phase equilibria can exist.

photon-an individual quantum of radiant energy of wavelength λ .

photosynthesis-the process by which sunlight makes possible the synthesis of organic compounds from CO_2 and H_2O.

physical property-property of a substance related to its physical characteristics. Examples: Density, melting point.

pi (π) ***bond***-a bond in which electrons are concentrated in orbitals which are located off the internuclear axis; one bond in a double bond is a pi bond, and there are two pi (π) bonds in a triple bond.

pi orbital-a molecular orbital in which electron density is concentrated in lobes which do not lie on the internuclear axis.

Planck's constant-constant in the equation: $E = h\nu = hc/\lambda . h = 6.626 \times 10^{-34}$ J.s.

polar bond-a chemical bond which has positive and negative ends; characteristic of all bonds

polar molecule-molecule in which there is a separation of charge and hence a positive and a negative pole. Polar molecules include HF and H_2O .

polarization-distortion of the electron distribution in a molecule, tending to produce positive and negative poles.

pollutant-a contaminant, or foreign, species, present in a sample; usually has a deleterious effect on quality of sample as far as living things are concerned.

polyamide-a condensation polymer formed from carboxylic acid and amine units.

polyatomic ion-a charged species containing more than one atom.

polyatomic ion-a charged species containing more than one atom.

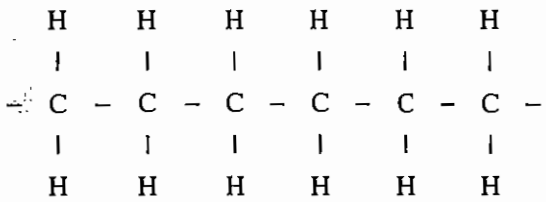
polydentate ligand-a ligand which forms two or more bonds to a central metal.

precipitate-a solid which forms when forms when two solutions are mixed.

pressure-force per unit area; often expressed in pascals, kilopascals, or atmospheres.

polyester-a condensation polymer made up of ester units.
Dacron and Kodel are polyesters.

polymer-a molecule made up from many units which are linked together chemically. Example: In the polymer called polymer called polyethylene, many $H_2C=CH_2$ units become linked together by chemical reaction to form chains which have the structure:



polyamide-a condensation polymer formed from carboxylic acid and amine units.

polypeptide-a condensation polymer in which the monomer units are α -amino acids; in the polymer the amino acid residues are linked by petide bonds; another name for a protein.

polysaccharide-natural polymer (e.g., starch, cellulose) consisting of a large number of monomer units derived from simple sugars such as glucose.

positron $\left({}^{0}_{1}e\right)$ - a particle having the mass of an electron but a + 1 charge.

post-transition metals-lower members of Periodic Table Groups 3 , 4 and 5.

principal quantum number-quantum number n; the most important quantum number, since it has greatest effect on energy of electron; cited first in the set of four quantum numbers associated with an electron.

product-a substance formed as a result of a chemical reaction. Example: In the reaction $Ag^{+}_{(aq)} + Cl^{-}_{(aq)} \rightarrow AgCl_{(s)}$ is the product.

principle energy level-energy level designated by the principal energy level.

property-a characteristic of a sample of matter that is fixed by its state. Example: The density and energy of a mole of H_2 at $100^{\circ}C$ and 1 atm are properties of that sample of hydrogen gas.

protein-a polypentide.

proton-the nucleus of a hydrogen atom, the H^{+} ion; a component of atomic nuclei, with mass = 1, charge = + 1.

psi (ψ) -the amplitude (height) of an electron wave at various points in space.

p-type semiconductor-a semiconductor in which current is carried through a solid by electron flow into "positive holes" in the crystal, introduced by electron deficient impurity atoms.

pyramidal-adjective used to describe the geometry of a molecule such as NH_3, in which one atom lies directly above the center of an equilateral triangle formed by three other atoms.

Q

quadratic formula-formula used to obtain the two roots of the general quadratic equation: $ax^2 + bx + c = 0$.

The formula is $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

qualitative analysis-the determination of the nature of the species present in a sample. Example: By qualitative analysis she found that the solution contained Cu^{2+}, Sn^{4+}, and Cl^- ions.

quantitative analysis-the determination of how much of a given component is present in sample. Example: The students discovered, by quantitative analysis, that the ore contained 42.45% iron by mass.

quantum mechanics-approach used to calculate the energies and spatial distributions of small particles confined to very small regions of space.

quantum number-a number used in the description of the energy levels available to atoms and molecules; an electron in an atom or ion will have four quantum numbers to describe its state.

quantum theory-general theory which describes the allowed energies of atoms and molecules.

R

rad-a unit of absorbed radiation equal to 10^{-2} J absorbed per kilogram of tissue.

radioactivity-the ability possessed by some natural and synthetic isotopes(induced radioactivity) to undergo reactions involving nuclear transformations to other isotopes:

rare earth-the name sometimes given to members of the lanthanide series.

rate constant-the proportionality constant in the rate equation for a reaction. Example: If the equation is rate $= k(\text{conc.A})^n$, then k is the rate constant.

rate expression(law)-a mathematical relationship describing the dependence of the reaction rate upon the concentration (s) of reactant (s) or product(s).

rate of a reaction-the magnitude of the change in concentration of a reactant or product divided by the time required for the change to occur (with both quantities relatively small). Example: For the reaction $A \rightarrow B, \text{rate} = \frac{\Delta(\text{conc.B})}{\Delta t} = \frac{-\Delta(\text{conc.A})}{\Delta t}$.

rate of radioactive decay-the rate of emission of radiation by a radioactive species.

rate-determining step-the slowest step in a multistep reaction.

reactant-the starting material in a chemical reaction.

Example: In the reaction $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$, H_2 and O_2 are both reactants.

reaction-a chemical change in which new substances are formed. Example: When aluminum burns in air, the chemical reaction 2 Al(s) $+\frac{3}{2}O_2(g) \rightarrow Al_2O_2(s)$.

reciprocal relation-relation between equilibrium constants for forward (K_f) and reverse (K_r) reactions: $K_r = 1/K_f$.

redox reaction-a reaction involving oxidation and reduction.

redox titration-titration of an oxidizing agent by a reducing agent, or vice versa.

reducting agent-a species which furnishes electrons to another. Example: In the reaction $Zn(s) + 2H^+(aq) \rightarrow Zn^{2+}(aq) + H_2(g)$, the Zn(s), metallic zinc, is the reducing agent.

reduction-a half-reaction in which a species gains electrons or, more generally, decreases in oxidation number.

Example: In the reaction $Zn(s) + 2H^+(aq) \rightarrow Zn^{2+}(aq) + H_2(g)$, the H^+ ions (oxid.no. = +1) are reduced to H_2 (oxid. no.=0).

relative humidity-$100 \times P/P_0$, where P= pressure of water vapor in air, P_0 = equilibrium vapor pressure of water at same T. Can also be thought of as a measure of the amount of water in the air divided by the amount that sample of air could hold. Example: When the relative humidity is 75%. there is three fourths as much water in the air as the air can hold at that temperature.

rem-a unit of absorbed radiation equal to n times the number of grays. The factor n depends upon the type of radiation absorbed (see p. 573).

resonance-used to rationalize properties of octet rule species for which one Lewis structure is inadequate; resonance. structure is taken to be an average of two or more Lewis structures which differ only in positions of electrons; species are said to exhibit resonance.

reverse osmosis-process by which pure water is obtained from a salt solution. Under pressure, the water passed out of the salt solution through a semipermeable membrane.

S

salt-a solid ionic compound made up from a cation other than H^+ and an anion other than OH^- or O^{2-} . Example: $NaCl, CuSO_4, NH_4NO_3$.

saturated hydrocarbon-an alkane, a hydrocarbon in which all carbon-carbon bonds are single.

saturated solution-a solution containing as much solute as the amount of solvent can dissolve at a specific temperature.

shielding-a term used to describe effect of inner electrons in decreasing the attraction of an atomic nucleus on outermost electrons.

SI unit-unit associated with the International System of Units; see Appendix 1.

Schrodinger equation-wave equation which relates mass, potential energy, kinetic energy, and coordinates of a particle.

scintillation counter-device used to measure the rate of radioactive decay by converting energy of radiation into light, which activates photoelectric cell.

second order reaction-a reaction whose rate depends on second power of reactant concentration; may be sum of exponents of two reactant concentration; may be sum of exponents of two reactant concentration.
Examples: The two expressions, rate = $k(\text{conc.A})^2$ and rate = $(\text{conc.A}) \times (\text{conc.B})$, are both associated with second order reactions.

semiconductor-a substance used in transistors and thermistors whose electrical conductivity depends on presence of tiny amounts of impurities such as As or B in a very pure crystal of an element such as silicon or germanium; conductance increases dramatically as temperature goes up.
semipermeable membrane-a film which allows passage of solvent molecules such as H_2O but does not pass solute molecules such as proteins or, in some cases, ions.

sigma(σ) **bond**-a chemical bond in which electron density on internuclear axis is high, which is the case with all single bonds; double bonds contain one sigma and one pi bond, triple bonds contain one sigma and two pi bonds.
sigma(σ) **orbitals** - molecular orbitals associated with sigma bonds between atoms.

significant figures-meaningful digits in a measured quantity; number of digits in number when expressed in exponential notation. Example: 1.035×10^3 has four significant figures (exponential doesn't count).

significant figures-meaningful digits in a measured with sigma bonds between atoms.
simple cubic cell-a unit cell containing atoms at each corner of cube.

single bond-a pair of electrons shared between two bonded atoms.

smog-smoky fog containing harmful species such as $SO_2, SO_3, NO_2,$ and O_3.

soap-soduim salt of a fatty acid.

solubility product constant(K_{sp}) -
equilibrium constant for the solution reaction of a relatively insoluble ionic compound. Example: For the reaction Ca

$$(OH)_2(s) \rightleftharpoons Ca^{2+}(aq) + 2OH^-(aq),$$

$$K_{sp} = \left[Ca^{2+}\right]\left[OH^-\right]^2$$

solubility rules-rules used to classify ionic compounds as to their solubility in water

solubility-the amount of a solute that will dissolve in a given amount of solvent at a specified temperature; may be stated in various ways, with almost solute per cubic decimeter of solution being common.

solute-the solution component present in smaller amount than the solvent.

solution-a liquid, gas, or solid phase containing two or more components dispersed uniformly throughout the phase.

Solvay process-industrial process used to make $NaHCO_2$ and Na_2CO_3 starting with sodium chloride, calcium carbonate, and water.

solvent-a substance, usually a liquid, in which another substance, called the solute, is dissolved.

species-a general term referring to a molecule, ion, or atom.

specific heat-the amount of heat required to raise the temperature of one gram of a substance by one degree Celsius.

spectrochemical series-arrangement of ligands in order of decreasing tendency to split d orbitals of decreasing tendency to split d orbitals of transition metal cation. Substitution of a ligand for another higher in the seires gives a smaller splitting and hence a longer wavelength of light absorbed.

spectrum-a pattern of characteristic wavelengths associated with excitation of an atom, molecule, or ion; also used as name of a pattern having similar appearance obtained as a result of chromatographic or mass spectroscopic experiments.

spontaneous reaction-a reaction which can occur by itself, without input of work from outside; $\Delta G<0$ for spontaneous reactions at T and P.

stable-will not change spontaneously. Nature of change should be specified. Example: Water is stable at $25^\circ C$ with respect to thermal decomposition to hydrogen and oxygen.

standard free energy change, ΔG^0 – ΔG when reactants and products are in their "standard state": 1 atm for a gas, effectively 1 M for a species in aqueous solution.

standard molar entropy, S^0 – S of a substance in its standard state (1 atm for a gas, 1 M for an ion in water solution).

standard oxidation voltage $\left(E^\circ_{ox}\right)$ -the voltage associated with an oxidation reaction at an electrode, when all solutes are 1 M (strictly speaking, unit activity) and all gases are at 1 atm.

standard potential-identical with the standard reduction voltage (described below).

standard reduction voltage $\left(E^{0}_{red}\right)$ - the voltage associated with reduction reaction at an electrode, when all solutes are 1 M and all gases are at 1 atm. Given the E^{0}_{red} for an electrode reaction, the voltage for the reaction in the opposite directionis equal to $-E^{0}_{red}$, and is the E^{0}_{ox} for the latter reaction. Example: For the reaction $Cu^{2+}(aq) + 2e^{-} \rightarrow Cu(s), E^{0}_{red} = 0.34\ V$; therefore, for the reaction $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^{-}$, $E^{0}_{ox} = -0.34\ V$.

standard voltage $\left(E^{0}\right)$ -voltage of a cell in which all species are in their standard states (solids and liquids are pure, solutes are unit activity, often taken to be 1 M, and gases are at 1 atm).

state property-property of a system which is fixed when the temperature, pressure and composition are specified. One mole of water at $25^{\circ}C$ and 1 atm has a fixed volume, enthalpy, and entropy; V , H, and S are state properties.

state-condition of a system when its properties are fixed. Example: A mole of H_2O at $25^{\circ}C$ and 1 atm is in a definite state in that all of its properties have values which are fixed.

stoichiometric-having to do with masses (grams, moles) of reactants and product in a chemical equation.

straight-chain alkane-saturated hydrocarbon in which all the carbon atoms are arranged in a single, continuous chain.

strong-as applied to acids, bases, and electrolytes, indicates complete dissociation into ions when in water solution. Example: HCl is a strong acid, since is exists as H^{+} and Cl^{-} ions in aqueous solution.

structural formula-a formula showing the arrangement of atoms in a molecule or polyatomic ion.

structural isomers-two or more isomers having the same molecular formula but different molecular structures.

sublevel-a subdivision of an energy level as designated by the quantum number ℓ.

sublimation-a change in state from solid to gas. Example: Iodine slowly sublimes in an open container; the sublimation is endothermic.

substitutin reaction – reaction in which one atom or group is substituted for another. Example: $C_6H_6(l) + Br_2(l) \rightarrow C_5H_5Br(l) + HBr(g)$.

substrate-the reactant in an enzyme-catalyzed reaction.

sugar-a carbohydrate containing an aldehyde or ketone group and an OH and H group on all noncarbonyl group carbon atoms; sometimes, loosely, sucrose.

superoxide-an ionic oxygen compound containing the superoxide ion, O_2^{-}.

supersaturated-containing more solute than equilibrium conditions would allow; unstable to addition of solute crystal. Example: It is easy to make a supersaturated solution of sodium acetate by cooling a hot concentrated solution of the salt carefully to 25° C.

surroundings-everything outside the system being studied.

system-the sample of matter under consideration.

T

temperature- a property of matter reflecting the amount of energy of motion of its component particles; measured value based on one of several possible scales.

tetrahedral-adjective describing the geometry of a molecule in which a central atom forms four bonds directed toward the corners of a regular tetrahedron (a solid with four vertices and four sides, all of which are equilateral triangles).

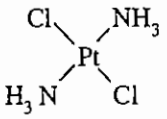
theoretical yield-the amount of product obtained from the complete conversion of the limiting reactant.

thermal-having to do with heat.

thermochemical equation-the study of heat, work, and the related properties of mechanical and chemical systems.

titration-a process in which a solution is added to another solution with which it reacts under conditions such that the volume of added solution can be accurately measured.

trans-as related to geometric isomers, referring to structures in which two identical groups are as far apart as possible, as opposed to cis, where they are as close as possible. Example:



would be the structure of the trans isomer of the square planer $Pt(NH_3)_2Cl_2$ molecule.

transition metal-any one of the metals in the central groups in the fourth, fifth, and sixth periods in the Periodic Table. Examples; Fe, Zr, and W would all be classified as transition metal atoms.

translational energy-energy of motion through space.
Example: A failing raindrop has translational energy.

triangular bipyramid-solid with five vertices and six sides; may be regarded as two pyramids fused through a base that is an equilateral triangle.

triple bond-three electron pairs shared between two bonded atoms.

triple point-that temperature and pressure at which the solid, liquid, and vapor of a pure substance can coexist in equilibrium.

U

ultraviolet radiation-light having a wavelength than about 400 nm but greater than about 10 nm.

unit cell-the smallest unit of a crystal which, if repeated indefinitely, could generate the whole crystal.

unpaired electron-single electron occupying an orbital by itself.

unsaturated-referring to solutions, being able to dissolve more solute; referring to organice compounds, containing double or triple carbon-carbon bonds.

useful work-the work produced during a change in state in excess of that required to accomplish the change. Example: In the reaction $H_2O(1) \rightarrow H_2O(g)$, since the volume of the gas is larger than that of the liquid, work of expansion will be required to push back the surrounding air to make room for the water vapor; the useful work will be that work done during the change which is in excess of the work of expansion.

V

valence bond model-the theory that atoms tend to be come bonded by pairing, and sharing, their outer, or valence, electrons; also referred to as the atomic orbital model.

valence, electrons; also referred to as the atomic orbital model.

valence electrons-those electrons in the outermost shell. Example: In the carbon atom, with electron configuration $1s^2 2s^2 2p^2$, there are four valence electrons, those in the *2s* and *2p* orbitals.

van der Waals equation-equation used to express the relation between P, V, and T of a real gas, used under conditions where the Ideal Gas Law is not sufficiently accurate.

van der Waals forces-a general name sometimes given to intermolecular forces.

vapor-a condensable gas.

vapor pressure-the pressure exerted by a vapor when it is in equilibrium with the liquid from which it is derived. Example: If liquid water is admitted to an evacuated container at $60°C$, the pressure in the container when the liquid and vapor reach equilibrium becomes 19.92 kPa; therefore, the vapor pressure of water at $60°C$ is 19.92 kPa.

vapor pressure lowering-decrease in the vapor pressure of liquid caused by addition of a nonvolatile solute.

visible light-radiation having wavelengths between 400 and 700 nm.

volatile-easily evaporated.

voltage-electric potential; a measure of tendency of a cell or other device to force electrons through and external circuit.

voltaic cell-a device in which a spontaneous chemical reaction is used to produce electrical work.

vulcanization-the cross-linking of rubber chains by short chains of sulfur atoms.

W

water dissociation constant (K_w)-equal to $[H^+][OH^-] = 1 \times 10^{-14}$ at $25^\circ C$.

water softening-the removal of ions, particularly Ca^{2+} and Mg^{2+}, from water.

wave function-the solution to Schrodinger wave equation, the square of whose magnitude at any point is proportional to probability of finding at that point the particle concerned; name arises from fact that solutions look roughly like waves when plotted on a graph.

wavelength-a characteristic property of light, similar to its color, and equal to the length of a full wave; often expressed in nanometers; can be measured with a spectroscope.

weak-as applied to acids and bases, being partially ionized in water solution. Example: Acetic acid, $HC_2H_3O_2$, is weak acid because in water solution it is only slightly ionized to H^+ and $C_2H_3O_2^-$ ions.

weak electrolyte-species which, in water solution, forms an equilibrium mixture of molecules and ions. Examples include HF and NH_3.

work-one of the effects which may be associated with an energy change; during a change a system may do work on its surroundings, equivalent to the raising of a mass; work may be electrical, mechanical, or due to expansion or compression, and may be done by, or on, the system.

X

X-an unknown quantity.

x-rays-light rays having a wavelength from 0.01 to 1.0 nm.

Y

yield-the amount of product obtained from a reaction.

Z

zeolite-type of silicate mineral used to soften water by cation exchange.

zero order reaction-a reaction whose rate is independent of reactant concentration.

Zwitter ions-the dipolar form on an amino acid which occurs when an H^+ ion is transferred from an acid group to an amine group.

MSc Entrance Examinations

A. Words

در سوال‌های ۱ و ۲ و ۳ معادل انگلیسی واژه فارسی را مشخص نمایید.

۱. «سیرشدگی»: (1384)
1) supersaturation 2) saturate 3) saturated 4) saturation

۲. «نوار رسانش»: (1384)
1) conduction band 2) induction band 3) conductivity band 4) conductance band

۳. «گزینش‌پذیری»:(1384)
1) selective 2) selectivity 3) selection 4) selector

معادل انگلیسی واژه‌های زیر کدام است؟

۴. «القایی»:(1383)
1) instructive 2) conductive 3) inductive 4) constructive

۵. «فرسایش»:(1383)
1) destruction 2) cohesion 3) corrosion 4) erosion

۶. «همگون»:(1383)
1) homologize 2) homogeneous 3) homogeneity 4) homogeny

در سوالات ۷ تا ۱۱ معادل انگلیسی واژه‌های فارسی را از میان گزینه‌های پیشنهادی انتخاب نمایید.

۷. «پیکربندی»:(1380)
1) conformation 2) shape 3) configuration 4) arrangement

۸. «نقطه آتش‌گیری»:(1380)
1) flammable 2) flammability 3) flash point 4) fire point

۹. «شناورسازی»:(1380)
1) fluctuation 2) floatation 3) flocculation 4) florination

۱۰. «ستون پرشده»:(1380)
1) stacked column 2) filled column 3) stuffed column 4) packed column

۱۱. «هدایت‌کننده به پارا»(1380)
1) para director 2) para conductor 3) para direction 4) para indicator

معادل انگلیسی واژه فارسی زیر از میان گزینه‌های پیشنهادی کدام است؟

۱۲. ایزومری اتصال: (1379)

1) binding isomerism 2) bonding isomerism 3) joint isomerism 4) linkage isomerism

۱۳. مرحله آغازی: (1379)

1) initial step 2) first step 3) primary step 4) primitive step

۱۴. آرایش الکترونی: (1379)

1) electron arrangement 2) electronic configuration
3) electron contribution 4) electron distribution

۱۵. سفیدکننده: (1379)

1) bleach 2) cleanser 3) detergent 4) soap

۱۶. واکنش خودبه‌خودی(1379)

1) stationary reaction 2) spontaneous reaction
3) instantaneous reaction 4) concerted reaction

17- Quantum mechanics, in place of the electron-sea model, for metals offers a more quantitative model called.....(1384)

1) metallic conduction 2) conductance theory
3) delocalized valence electron 4) band theory

18-A species with unpaired electrons is paramagnetic, therefore, a species with all electrons paired exhibits.....(1384)

1) antiferromagnetic 2) antiferromagnetism 3) diamagnetic 4) diamagnetism

19-Anything in the universe, such as air, glass, planets, which has mass and volume is called.....(1384)

1) substance 2) matter 3) body 4) entity

سوالات زیر را به دقت بخوانید و گزینه درست را در پاسخنامه علامت بزنید.

20- ..... is a substance that has both acidic and basic properties. (1383)

1) amphoteric oxide 2) adduct 3) amorphous solid 4) activator

21-The hydrolysis of an ester in the presence of a base is called.....(1383)

1) fatty acid extraction 2) esterification 3) saponification 4) glycerol production

22-..... is a substance, such as sodium chloride, that dissolves in water to give an electrically conducting solution. (1383)

1) conductor 2) crystal 3) solute 4) electrolyte

سوالات زیر را با دقت بخوانید و گزینه صحیح را در پاسخنامه مشخص کنید:

23 -The energy of anything ..... its ability to do mechanical work.(1383)

1) denotes 2) dedicates 3) design 4) dictates

24 -An electronically ..... molecule has many choices, one of them is dissociation. (1383)

1) excited 2) active 3) disturbed 4) activated

25 -Choose the synonyms for the word: DISINTEGRATION. (1383)

1) survival 2) division 3) breakdown 4) disparity

26 -Choose the synonym for the word: RANGE. (1383)

1) length 2) scope 3) sphere 4) wilderness

جای خالی را در جمله‌های زیر با واژه مناسب پر کنید.

27 -A liquid used to extract one material from another as in chromatography is called.....(1382)

1) eluant 2) eluate 3) elution 4) extractor

28 -One should always be concerned with the extent to which the calculations using the data are significant and recognize ..... of carrying out computations to too many digits. (1382)

1) the absurdity 2) high precision 3) high sensitivity 4) the intensity

29 -The concentration of the unknown substance in sample can be determined by atomic absorption spectrophotometry from ..... of absorption lines or bands. (1382)

1) the quality 2) the intensities 3) the energy 4) the radiation

30 -The remarkable properties of diamond can be traced to the fact that each sp^3 hybridized carbon atom is..... to four neighbouring carbon atoms arranged in a tetrahedral array. (1382)

1) tightly bound 2) lossely bound 3) randomly bound 4) weakly bonded

31 -CO shows a strong tendency to ..... into metal alkyl bonds to give metal acyls. (1382)

1) intrude 2) dislodge 3) extrude 4) insert

32 -..... polymer, is a polymer with deifinite order of arrangement of molecules in space as in isotactic polyethylene. (1382)

1) stereoregularity 2) stereospecific 3) stereoselctive 4) space selective

33 -Any physical object whose mirror image is not identical with itself is said to be.....(1382)

1) right-handed 2) mirror negative 3) chiral 4) superimposable

34 -A (an) ..... is essentially a battery, but it differs by operating with a continuous supply of energetic reactants. (1382)

1) combustion cell 2) fuel cell 3) fusion cell 4) ignition cell

35 -Emission spectra, which are produced by ..... of the atomized species to their ground states are useful for qualitative and quantitative analysis. (1382)

1) the radiation 2) the excitation 3) the relaxation 4) the transition

سوالات زیر را به دقت بخوانید و گزینه صحیح را در پاسخنامه مشخص کنید.

36 -..... isomers are isomers consisting of complex cations and complex anions that differ in the way that ligands are distributed between the metal atoms.(1380)

1) coordination 2) structural 3) linkage 4) constitutional

37 -..... energy is the minimum energy of collision required for two molecules to react. (1380)

1) promotion 2) collision 3) activation 4) excitation

38 -..... is an spontaneous radiation from unstable elements

1) x – ray emission 2) radioactivity 3) nuclear fusion 4) fragmentation

39 -..... refers to a liquid or solid having a relatively high vapor pressure at normal temperatures. (1380)

1) volatile 2) sublimate 3) volatility 4) volcanic

40 -A substance composed of two or more elements chemically combined is called a .....(1380)

1) complex 2) composite 3) compound 4) composition

سوالات زیر را به دقت بخوانید و گزینه صحیح را در پاسخنامه مشخص کنید.

41 -Sound travels in the form of ..... (1379)

1) heat 2) Praticles 3) waves 4) wind

42 -..... is the simplest arrangement of point that, when repeated in all three directions, gives the lattice. (1379)

1) cubic system 2) cubic close – packed 3) face – centered cubic 4) unit cell

43 -A measure of the resistance of a liquid to flow is called.....(1379)

1) fluidity 2) flow sheet 3) viscosity 4) viscometer

44 -A clear set of procedural steps that tests a hypothesis is called.....

1) experiment 2) extrapolation 3) experience 4) interpolation

45 -Any imaginary representation of the electron rapidly changing its position around the nucleus over time is called.....(1379)

1) electron motion 2) electron orbital 3) electron probability 4) electron cloud

سوالهای زیر را به دقت بخوانید و گزینه صحیح را انتخاب کنید.

46 -..... is a stable solution in which the maximum amount of solute has been dissolved.(1378)

1) ideal solution 2) saturated solution 3) stock solution 4) standard solution

47 -Sunlight that can not pass through on object is: (1378)

1) Absorbed by that object 2) Changed by the transmission
3) Sent back to the sun 4) transmitted by the object

48 -A substance which increases the rate of a reaction, but does not take part in the stoichiometry of the reaction is called a (an).....

1) Auto catalyst 2) catalyst 3) Initiator 4) porous substance

سوال‌های زیر را به دقت بخوانید و گزینه صحیح را انتخاب و در پاسخنامه مشخص کنید:

49 -Acceleration is the name for: (1377)

1) A steady speed
2) An increase in speed
3) Any kind of movement
4) The movement of a plane

50 -The enthalpy of mixing is zero, as we should expect for a system in which there are no interactions ..... particles. (1377)

1) amid
2) among
3) between
4) beyond

51 -The ..... of this result is that the chemical potentials of a mixture cannot change independently: in a binary mixture, if one increases the other must decrese. (1377)

1) significance
2) significant
3) simplicity
4) specification

52 -As soon as means:

1) as well as
2) after
3) before
4) the moment that

53 -The chemical properties of alcohol are determined by its functional ..... (1374)

1) Form
2) group
3) phase
4) state

54 -The coordinate covalent bond is a covalent bond in which both electrons are ..... by one atom. (1374)

1) approached
2) absorbed
3) donated
4) leaved

55 -On the ..... of the following evidence which structures must compound (X) have? (1374)

1) agreement
2) definition
3) basis
4) reason

56 -Most phenols are made industrially by the same ..... that are used in the laboratory. (1374)

1) expenses
2) processes
3) persons
4) vessels

57 -A change of a reaction rate in the presence of a catalyst is called..... (1374)

1) activation
2) catalysis
3) pyrolysis
4) promotion

58 -..... cell is a chemical source of current in which energy evolves during the combustion of a fuel is transformed directly into electric energy. (1374)

1) Fuel
2) Dry
3) Solar
4) Storage

59 -In multiplication and division, the ..... uncertainty is not simply the sum of the uncertainties in the factors. (1374)

1) calculated
2) derived
3) principal
4) significant

60 -Bromination of anthracene or phenthrene ..... at the9-position. (1374)

1) eliminates
2) evaluates
3) precipitates
4) takes place

61 -Ethylbenzene contains a benzene ring and an ..... side chain. (1374)

1) aliphatic
2) aromatic
3) allylic
4) aryl

62 -These ..... orbitals are called sp^2 orbitals since they are considered to arise from the mixing of ones orbital and two p orbitals. (1374)

1) conjugated
2) hybrid
3) overlap
4) simple

63 -The energy that reactants must have for reaction to occur, is termed..... . (1374)

1) activation energy 2) energy of formation 3) energy of reaction 4) heat energy

64 -A solution with an accurately known concentration is a ..... solution. (1374)

1) molar 2) normal 3) primary 4) standard

65 - In this experiment you will be assigned to work ..... partner. (1374)

1) in a 2) out of 3) over the 4) with a

66 - Heat transferred during a phase change, which does not cause a change in temperature is called..... (1374)

1) heat of fusion 2) heat capacity 3) latent heat 4) specific heat

67 -A state intermediate between a solution and a suspension, in which solute particles are large enough to scatter light but too small to settle out is called.....(1374)

1) colloid 2) emulsion 3) slurry 4) sol

B. Reading comprehension.(1386)

Directions: Read the following passage and answer the questions by choosing the best choice (1), (2), (3), or (4). Then mark the correct choice on your answer sheet.

An extract from the herb St John's Wort is helping researchers shed new light on cancer detection and treatment. Andrew Rawicz, an engineering scientist at Simon Fraser University (SFU) in Canada, is working in collaboration with Prof Iean Melnik and PhD student Sergiy Vets from the University of Kiev, testing the properties of the herbal extract hypericin, which they say can be used to detect and treat areas where cancer is present. The extract is either given orally or applied topically to the patient's skin and when the patient is `illuminated' with blue filtered light, the light intensifies on areas where the cancer is present, which show up as red spots. `"Tumours are greedy', explained Rawicz.' Cancer cells grow fast and eat more, and tend to accumulate more of the hypericin-even 10 times more than normal cells - so once it is absorbed, we can illuminate the patient in a dark room and see these localised red spots'. The researchers have set up a makeshift laboratory using a modified theatre stage light to provide the blue light source and a highly sensitive camera, which reads only the emitted red light and then transmits the image to a computer. Rawicz claims that hypericin has almost no side-effects and costs much less than the synthetic substances that are currently used to track cancer cells. So far the researchers at SFU have tested the extract on dogs at a local veterinary clinic and Rawicz and his team plan to put hamsters under the spotlight next.

68 - It is stated in the passage that .....

1) the herbal extract can help detect areas with cancer no matter if it is applied orally or topically
2) St John's Wort is used mainly to treat the areas affected by cancer.
3) hypercin and St John's Wort are two of the most effective medicines for the treatment of cancer
4) red cancerous spots are very sensitive to hypercin and need some intensified light for treatment

69 - What does the word 'makeshift' (underlined) mean?

1) medicinal
2) experimental
3) professional
4)temporary

70 - Hypercin can help detect areas infected by cancer because it .....

1) grows fast up to ten times in normal size in the area with cancer.
2) eats up all the cancerous cells and `cleans up' the infected area.
3) can illuminate the area and make it easy to see.
4) is absorbed in large quantities in those areas.

71 - It is implied in the passage that .....

1) hypercin acts best if it used in red light
2) hypercin has not been used on human beings so far
3) we need an expensive laboratory to apply hypercin
4) hypercin is used only in patients who are about to die

72 - Which of the following is NOT an advantage of hypercin according to the passage? has no side-effects

1) It has no side – effects
2) It is cost-effcctive
3) It is easy to produce
4) It is easy to apply

Most organic reactions are done is solution, and it is therefore important to recognize some of the ways in which solvent can affect the course and rates of reactions. Some of the more common solvents can be roughly classified on the basis of their structure and dielectric constant. There are important differences between protic solvents – solvents that contain relatively mobile protons such as those bonded to oxygen, nitrogen, or sulfur – and aprotic solvents, in which all hydrogens are bound to carbon. Similarly, polar solvents, those that have high dielectric constants have effects on reaction rates that are different from those of nonpolar solvent media.

When discussing solvent effects, it is important to distinguish between the macroscopic effects and those which depend upon details of structure. Macroscopic properties refer to properties of the bulk solvent. An important example is the dielectric constant, which is a measure of the ability of the bulk material to increase the capacitance of a condenser. In terms of structure, the dielectric contant is a function of both the permanent dipole of the molecule and its polarizability. Polarizability refers to the ease of distortion of the molecule's electron distribution. Dielectric constants increase with dipole moment and with polarizability because of the ability of both the permanent and the induced molecular dipole to align with an external electric field. An important property of solvent molecules is the response of the solvent to changes in charge distribution as reaction occurs. The dielectric constant of a solvent is a good indicator of the ability of the solvent to *accommodate* separation of charge.

73 - Which of the following is TRUE according to the passage?

1) Common solvents are developed according to their dielectic constant.
2) The course and rates of a reaction often depend on its solvents.
3) The structural basis of some common solvents makes them easy to classify.
4) Organic reactions can generally take place in common solvents.

74 - It is stated in the passage that .....

1) The high dielectic constants in polar solvents increases the rate of reaction.
2) Protic solvents are usually bonded to oxygen, nitrogen or surfur.
3) There is an interconnection of hydrogen and carbon in aprotic solvents.
4) Polar and aprotic solvents are both different from nonpolar solvent media.

75 - It is mentioned in the passage that .....

1) The dielectric constant is, in fact, a permanent dipole of a molecule
2) Polarizability is a feature of the macrosopic properties of bulk solvents
3) solvent effects are made up of macroscopic effects together with details of structure
4) the dieclectic constant and the capacitance of a condenser are closely related

76 - Which of the following is NOT true according to the passage?

1) Solvent molecules are not affected by changes in charge distribution as reaction occurs.
2) Polarizability affects the molecule's electron distribution.
3) Dieclectic constants might change depending on the dipole moment and polarizability.
4) The permanent and induced molecular dipole can match their position in line with an external electric field.

77 - The word "accommodate" in the last sentence is most closely related to .....

1) contain 2) create 3) provide 4) produce

A special type of substituent effect which has proved very valuable in the study of reaction mechanisms is the replacement of an atom by one of its isotopes. Isotopic substitution most often involves replacing protium by deuterium (or tritium) but is applicable to nuclei other than hydrogen. The quantitative differences are largest, however, for hydrogen, because its isotopes have the largest relative mass differences. Isotopic substitution usually has no effect on the qualitative chemical reactivity of the substrate, but often has an easily measured effect on the rate at which reaction occurs. Let us consider how this modification of the rate arises. Initially, the discussion will concern *primary kinetic isotope effects*, those in which a bond to the isotopically substituted atom is broken in the rate – determining step. We will use C – H bonds as the specific topic of discussion, but the same concepts apply for other elements.

Any C – H bond has characteristic vibration which impart some energy to the molecule in its normal state. This energy is called the *zero – point* energy. The energy associated with these vibrations is related to the mass of the vibrating atoms. Because of the greater mass of deutermium, the vibrations associated with a C – D bond contribute less to the zero – point energy than those associated with the corresponding C – H bond. For this reason, substitution of protium by deuterium lowers the zero – point energy of a molecule. For a reaction involving cleavage of a bond to hydrogen (or deuterium), a vibrational degree of freedom in the normal molecule is converted to a translational degree of freedom as the bond is broken. The energy difference due to this vibration disappears at the transistion state. The transition state has the same energy for the protonated and deuterated species. Because the deuterated molecule has the lower zero – point energy, it has a higher activiation energy to reach the transition state.

78 - Which of the following about isotopic substitution is TRUE according to the passage?

1) It works best, quantitatively, with hydrogen isotopes.
2) It does not generally apply to non-hydrogen nuclei.
3) It is often concerned with deuterism taking the place of protium.
4) It directly affects the qualitative chemical reactivity of the substrate.

79 - The C-H bond in the first paragraph is used mainly in connection with ..... .

1) the rate-determining step of the substrate
2) isotopically substituted rates of reaction
3) primary kinetic isotope effects
4) the modification of reaction rates

80 - Which of the following is TRUE according to the passage?

1) Zero- point energy is the energy molecules apply in their normal state.
2) A C-H bond is capable of producing more energy than a C-D bond.
3) The mass of the vibroating atoms in a C-H bond is much larger than that in a C-D bond.
4) Proteum and deuterium can both be substituted to lower the energy of a molecule.

81 - It is stated in the passage, with regard to the transition state mentioned in the second paragraph, that.....

1) it often results in the conversion of the vibrations of the bond to translational energy.
2) the activation energy needed to reach this state is the same in protenated and deuteratcd molecules.
3) the protonated and deuterated species do not differ in terms of energy in this state.
4)the vibrational degree of freedom associated with the cleavage of a bond go up in this state.

82 - The word `impart' in the second paragraph is closest in meaning to ..... .

1) take
2) turn
3) get
4) give'

Comprehension(1385)

Directions: Read the following three passages and answer the questions by choosing the best choice. Then mark the correct choice on your answer sheet.

Passage one:

Phase change are also determined by the balance between kinetic energy and intermolecular forces. As the temperature increases, so does the kinetic energy, and the faster moving particles can overcome the attractions more easily: conversely, lower temperatures allow the forces to draw the slower moving particles together. When water vapor cools, a mist apprears as the particles from tiny droplets of liquid that then collect into a **bulk** sample with a process, changing from a liquid into a gas, is called vaporization.

With further cooling, the particles move even more slowly, and become fixed in position as the liquid solidifies in the process of freezing; the opposite change is called melting, or fusion. In common speech, freezing implies low temperature because we typically think of water, **which** solidifies at $0^{\circ}C$. However, many substances freeze at temperatures much greater than room temperature; for example, gold freezes (solidifies) at $1064^{\circ}C$.

As the molecules of a gas attract each other and come closer together in the liquid, and then become more organized in the solid, the system of particles loses energy, which is released as heat; thus, condensing and freezing are exothermic changes. On the other hand, energy must be absorbed to overcome attractive forces that **restrict** motion in a liquid or solid, thus, melting and vaporizing are endothermic changes.

83 -What does the paragraph preceding this passage most probably discuss?

1) The effects of phase changes
2) The interplay between kinetic energy and intermolecular forces
3) A variable affecting phase changes
4) Chemists' reasons for studying phase changes

84 -All of the following are the result of an increase in temperature EXCEPT that .....

1) the kinetic energy loses force
2) the moving particles overcome the attraction more swiftly
3) the moving particles are drawn together
4) the attractions referred to in the passage become stronger

85 -All of the following are used in paragraph 1 to develop the topic EXCEPT.....

1) a difference in the outcome due to a change in one variable
2) a series of causes and effects
3) a number of steps in a process
4) a series of events chronologically reported

86 -The word "bulk" in line 5 is closest in meaning to .....

1) distinct 2) aggregate 3) slight 4) elevated

87 -According to the passage, fusion is the same as .....

1) condensation 2) melting 3) freezing 4) vaporization

88 -The word "which" in line 9 refers to .....

1) freezing 2) temperature 3) water 4) fusion

89 -The term "exothermic" is used to refer to .....

1) loss of energy 2) overcoming attractive forces
3) lack of motion 4) trapped that

90 -The word "restrict" in line 15 is closest in meaning to .....

1) initiate 2) stimulate 3) delay 4) confine

1385

Passage two:

Nitrogen occurs in many essential natural and synthetic compounds. By far the richest source of nitrogen is the atmosphere, where four of every five molecules are N_2. Despite this abundance the supply of usable nitrogen for biological and manufacturing processes is limited because of the low chemical reactivity of N_2. As a result of the strong triple bond holding the two N atoms together, the nitrogen atom is very difficult to "**fix**," that is, combine with other atoms.

Natural nitrogen fixation is accomplished either through the activity of certain enzymes found in bacteria that live on plant roots or through the brute force of lightning storms. Nearly 13% of all the nitrogen fixation on Earth is accomplished industrially, through the Haber process for the formation of ammonia from its elements:

$$N_2(g) + 3H_2(g) \rightleftarrows 2NH_3(g) \quad \Delta H^0_{rxn} = -91.8\,kJ$$

The process was developed by the German chemist Fritz Haber and first used in 1913. From **its** humble beginnings in a plant with a capacity of 12,000 tons a year, current world production of ammonia has **exploded** to more than 110 million tons a year. On a mole basis, more ammonia is produced than any other compound. Over 80% of this ammonia finds its way into fertilizer applications. In fact, the most common form of fertilizer is compressed liquid NH_3 sprayed directly onto soil. Other uses in include the production of explosives, via the formation of HNO_3, and the making of nylons and other polymers. Smaller amounts are used as refrigerants, rubber stabilizers, household cleaners, and in the synthesis of pharmaceuticals and other organic chemicals.

91 -According to the passage, nitrogen is plentiful in .....

1) natural compounds 2) the atmosphere
3) synthetic compounds 4) in combination with other molecules

92 -In the passage, the word "fix" (line 5) means the same as .....

1) become inactive 2) remain constant
3) blend 4) hold

93 -Which of the following is true about the Haber process?

1) It accounts for about 13 percent of all nitrogen fixation on Earth
2) It is accomplished through the activity of certain enzymes.
3) It is concerned with the function of bacteria in nitrogen fixation.
4) It attracted a German chemist in 1913.

94 -The word "its" in line 11 refers to .....

1) capacity 2) plant 3) process 4) Fritz Haber

95 -The word "exploded" in line 13 is closest in meaning to .....

1) reached 2) burst 3) destroyed 4) spread

96 -According to the passage, liquid NH_3 is the most common product used in.....

1) the clothing industry 2) agriculture 3) medicine 4) making explosives

97 -Ammonia is NOT used in the production of .....

1) household cleaners 2) cooling agents 3) nitric acid 4) nitrogen

در سوال‌های ۸۳ و ۸۴ و ۸۵ و ۸۶ باتوجه به متن داده شده کدام گزینه با متن داده شده مطابقت دارد؟

(1384)

98 -A face-centred cubic lattice forms octahedral and tetrahedral holes. Although it is more densely packed than the body-centred cubic version, in which the coordination number is 8 rather than 12, there are fewer larger holes. While the site in the body-centred cubic lattice is too small to accommodate the carbon without significant distortion, the site in the face-centred lattice is suitable, and the carbon can be accommodated. Approxiamtely one-third of the empty octahedral sites can be occupied; giving the formula Fe_3C.

1) carbon atom can be accommodated in a body-centred cubic lattice of iron without significant distortion.
2) a body-centred cubic lattice of iron is more densely packed that the face-centred cubic lattice.
3) coordination number of iron in a face-centred cubic lattice is higher than that of body-centred version
4) Approximately one-third of empty octahedral sites in body-centred cubic lattice of iron can accommodate carbon atoms, giving the formula Fe_3C.

99 -Acid rain dissolves the calcium carbonate in the marble and limestone of building and monuments. Ironically, the same chemical process that destryoes these structures is responsible for saving those lakes that lie on or are bounded by limestone-rich soil. In essence, limestone-bounded lakes function as enormous HCO_3^-/CO_3^{2-} buffer solution, absorbing the additional H_3O^+ and maintaining a relatively stable pH. In fact, lakes, rivers and ground water in limestone-rich soils actually remain mildly basic.

1) acid rain saves the lakes that lie on limestone-rich soils.
2) acid rain reacts with dissolved bicarbonate in the lake.
3) as a result of acid rain the lakes that lie on limestone-rich soil remain mildly acidic.
4) marble structures can stand against acid rain and remain intact.

100 - For a general reaction aA + bB + ... → cC + d D + ... the rate law has the form Rate = k $[A]^m[B]^n$ ... The rate constant k, is specific for a given reaction at a given temperature. The exponents m and n, called the reaction orders, define how the rate is affected by reactant concentration. Thus, if the rate doubles when $[A]$ doubles, the rate depends on $[A]$ raised to the first power, $[A]^1$, so m = 1. Similarly, if the rate quadruples when $[B]$ doubles, the rate depends on $[B]$ raised to the second power, $[B]^2$, so n = 2. Keep in mind that the coefficients *a* and *b* in the general balanced equation are not necessarily related in any way to m and n.

1) If the rate quadruples when $[B]$ doubles, the rate depends on 4 $[B]$.

2) The rate constant, k, is specific for a given reaction at all temperatures.

3) If the reaction rate doubles when $[A]$ doubles, and similarly, if the rate quadruples when $[B]$ doubles, the rate law for the reaction is expressed as: Rate = $k[A][B]^2$

4) The coefficients *a* and *b* in the general balanced equation, are related to the reaction orders m and n

101 - Concentrated sulfuric acid is an excellent dehydrating agent. Its loosely held proton transfers to water in a highly exotherimic formation of hydronium ions. This process can occur even when the reacting substance contains no free water. For example, H_2SO_4 dehydrates wood, natural fibers, and many other structure, leaving behind a carbonaceous mass.

1) concentrated H_2SO_4 is a very good hydrating agent.

2) concentrated H_2SO_4 can remove the components of water from many organic substances, leaving behind a black mass.

3) dehydration process with H_2SO_4 can occur only when the reacting substance contains free water.

4) wood and natural fibers are not affected by concentrated H_2SO_4.

۱۰۲ - کدام عبارت باتوجه به متن داده شده درست است؟(1383)

The energies of the inner orbitals of an atom and the energy changes between them depend on the nuclear charge. Therefore, the photon energies and the frequenceise of emitted X-rays depend on the atomic number of the metal atom in the target. The direct dependence of the X-ray spectrum on atomic number provides an unequivocal way of deciding whether a substance is a pure element or not.

1) The energies of the inner orbitals of an atom depend on the mass of the nucleus.

2) purity of an element is revealed by its X-ray spectrum.

3) Frequencies of emitted X-rays are independent of the atomic number of the metal atom.

4) There is a direct relationship between the emitted X-rays and the atomic mass of the metal target.

۱۰۳ - کدام عبارت باتوجه به متن داده شده درست است؟ (1383)

Liquid hydrogen is a favorite rocket fuel. Burning it produces more heat per gram than any other fuel. When hydrogen burns in air, the product is simply water. The burning of fossil fuels is a source of environmental pollutants. Acid rain, which has been shown to be injurious to the environment, is believed to be partially a result of burning coal and petroleum. These fuels contain sulfur compounds that burn to give sulfur dioxide, which reacts in moist air to form sulfuric acid, a major component of acid rian. It appears that carbon dioxide, a main product in the burning of fossile fuels, may also be a major pollutant. Climatologists believe that the increase in carbon dioxide in the atmosphere is responsible for the greenhouse effect. The increased concentration of carbon dioxide can act like the glass on a greenhouse, retaining heat energy by absorbing and radiating infrared rays back to the surface of the earth, and perhaps drastically affecting climate.

1) Acid rain which is harmful to the environment is totally due to carbon dioxide.
2) Carbon dioxide can absorb and radiate infrared rays back to the surface of the earth.
3) It is believed that the release of sulfur dioxide into the atmosphere is responsible for the greenhouse effect.
4) Burning hydrogen produces more heat per mole than any other fuel.

۱۰۴ - عبارت کدام گزینه نتیجه‌گیری درستی از متن بالاست؟(1383)

1) The burning of fossil fuels which have less sulfur compounds does not reduce the air pollution.
2) Liquid hydrogen as a fule is not environmentally friendly.
3) The increased concentration of carbon dioxide would lead to global warming.
4) Carbon dioxide is less harmful to the environment than sulfur dioxide.

۱۰۵ - کدام عبارت باتوجه به متن داده شده درست است؟(1383)

Many different kinds of lasers now exist, but the general principle of a laser can be understood by looking at the ruby laser, the first type constructed in 1960. Ruby is aluminum oxide containing a small concentration of chromium (III) ions, in place of some aluminum ions. The electron transitions in a ruby laser are those of Cr^{3+} ions in solid Al_2O_3. Most of the Cr^{3+} ions are initially in the lowest energy level (level 1). If you shine light of wave length 545 nm on a ruby crystal, the light is absorbed and Cr^{3+} ions undergo transitions from level 1 to level 3. A few of these ions in level 3 emit photons and return to level 1, but most of them undergo radiationless transitions to level 2. In these transitions, the ions lose energy as heat to the ruby crystal, rather than emit photons.

1) In transition of Cr^{3+} ions from level 3 to level 2, the ions lose energy as heat rather than photons.
2) The first ruby crystal was constructed in 1960.
3) If a light of wavelength 545 nm is shone on a ruby crystal Cr^{3+} ions undergo transitions from level 1 to level 2.
4) Most of the ions in level 3 emit photons and return to level 1.

۱۰۶ - کدام عبارت باتوجه به متن داده شده درست است؟(1383)

Smaller amounts of oxygen are used for life-support purposes in medicine and in aviation, space, and diving systems. A diver, for example, must have a breathing mixture supplied at the pressure to which the body is subjected. As a diver goes to greater depths, this pressure increases. Compressed air can be used for breathing at moderate depths, but as the partial pressures of oxygen and nitrogen increase, this mixture becomes hazardous. Both oxygen and nitrogen are toxic at high partial pressures. For this reason, breathing mixtures for deep diving replace nitrogen with nontoxic helium and have partial pressures of oxygen close to that in the atmosphere at normal pressure (about 0.21 atm).

1) Oxygen is mainly used for life support purposes in medicine and in aviation and in diving systems.
2) In breathing mixtures for deep diving nitrogen is replaced with any of the noble gases.
3) A diver must have a breathing mixture at normal atmospheric pressure for deep diving.
4) Mixtures of nitrogen and oxygen at high partial pressures are dangerous for the diver.

107 - Some European scientists believe that chronic carbon monoxide poisoning does occur. Some people who can easily be poisoned, particularly susceptible people, such as those who already have a disease that decreases the oxygen capacity of the blood, may be affected by the carbon monoxide levels in the streets.(82)

According to the passage, carbon monoxide seems to be especially toxic for people who are .....

1) in contact with hemoglobin
2) cleared of their carbon monoxide
3) susceptible for some reason
4) exposed to low concentration

108 - Formaldehyde, $H_2C=O$, is a simple compound known to all biologists because of its usefulness as a tissue preservative. When pure, formaldehyde trimerizes to give trioxane, $C_3H_6O_3$. Trioxane, surprisingly enough, has no carbonyl groups. Only one monobromo derivative of trioxane is possible. Propose a structure that fits these data. According to the passage.....(1382)

1) Formaldehyde is a tissue destroyer that has only one bromo derivative.
2) Trioxane is a dimmer of formaldehyde.
3) The number of carbonyl groups of $C_3H_6O_3$ is nil.
4) From the given data it is not possible be propose a structure for trioxane.

109 - Through cooking, fire also increased the variety to edible food supplies and provided some protection of the food from bacterial decay. Today fuels not only heat our homes and move our cars but are absolutely necessary for every facet of modern technology. According to the passage ..... (1382)

1) modern techknology surely depends on fuels.
2) food supplies can be protected from fire through cooking.
3) bacterial decay of food can be completely prevented by cooking.
4) modern tecknology could have been achieved even without discovery of fuels.

110 - A catalyst is a substance that speeds up a chemical reaction without being consumed by it. Catalytic activity operates by providing a reaction mechanism that has lower activation energy. Catalysis is classified as homogeneous or heterogeneous.

According to the passage .....(1382)

1) in homogeneous cataysis the reactants and the catalyst form two separate phases.
2) activation energy is the energy needed for the catalyst to become operational.
3) in homogeneous catalysis the activation energy is lower compared to the heterogeneous one.
4) the catalyst is used up in one step of the reaction mechanism but regenerated in a later step.

111 - Solubilities usually vary with temperature. At higher temperatures, most gases will become less soluble in water, whereas most ionic solids will become more souble. Pressure has a significant effect on the solubility only of a gas. A gas is more soluble in a liquid if the partial pressure of the gas is increased, which is in agreement with LeChatellier's principle. According to Henry's law, the solubility of a gas is directly proportional to the partial pressure of the gas.

According to the passage.....

1) tempreture has a significant effect on the solubility of solids and gases.
2) solubility of most ionic solids will increase at higher temperature
3) solubility of a gas according to LeChatellier's principle is directly proportional to the partial pressure of the gas.
4) most ionic solids and gases will be more soluble in water at lower temperatures.

112 - According to the passage, Henry's law relates the solubility of a gas to .....(1382)

1) its interaction with the solvent
2) the nature of the solvent
3) its molecular weight
4) its partial pressure

Comprehension 1381

If a drawing is made with a greasy substance such as printer's ink or oil paint on a smooth, nonabsorbent surface and piece of soft paper is then pressed down on it, the pigment will leave the smooth surface and stick to the paper. The pressure can be applied in various ways, such as rubbing the back of the paper with wooden block or running the surface and the paper through an etching press. Prints made in this way are called monotypes because only one good impression of each can be made.

113 - Some prints are called "monotypes" because only one .....(1381)

1) type of press can be used
2) color of ink is used
3) plate is needed for copies
4) print can be produced at a time

114 - According to the passage, soft paper is used because it.....(1381)

1) has a smooth surface
2) holds the ink well
3) is strong
4) dries quickly

115 - Pressue is applied to the paper in order to .....(1381)

1) transfer the drawing to the paper
2) squeeze out the excess paint
3) flatten the paper fibers
4) make the paper less absorbent

116 - Which of the following could best be used to make the original drawing mentioned in the passage?(1381)

1) An absorbent paste 2) A colorless oil 3) An oily ink 4) A watery paint

The mass spectrometer is an instrument used for accurately measuring atomic mass and for finding the number of isotopes of an element present. The sample being tested is introduced into the instrument and is then ionized by heating, electrical discharge or electron bombardment. The ions produced are accelerated and passed through a slit to give a fine beam of ions all moving with the the same velocity. The individual ions in the beam will differ slightly in mass and charge. The beam of ions is then subjected to a magnetic filed which bends the beam into a circular path. Depending upon the mass and charge, the radius of the circular path for each ion is slightly different. The lighter the ion or the grater the charge on the ion the greater will be the deflection. The ions are detected by means of photographic plate.(1381)

117 - The individual ions in the beam are slightly different in .....

1) mass and velocity
2) charge and velocity
3) charge, velocity and mass
4) reflection

118 - Based on the passage, the lighter the ion, the smaller will be the .....

1) detection 2) velocity of the ion 3) radius of the path 4) refelection

A batch of freshly brewed coffee is frozen and then placed in a container from which air is removed by a vacuum pump. The vacuum causes the ice component to sublime. When most of the ice has been removed, the freeze-dried coffee is ready for packaging. Freeze drying has an important advantage over other methods of instant coffee processing. The molecules responsible for the flavor are not destroyed, as they are when coffee is dried by prolonged heating. Furthermore, freeze-dried coffee has a long shelf life weighs less than other form of coffee.

119 - According to the passage, freeze-dried coffee has all the following characteristics except,.....(1381)

1) it is lighter than other forms of coffee
2) it lasts longer than other forms of coffee
3) it is more flavorful than other forms of coffee
4) it has all the molecules responsible for the flavor, destroyed

120 - According to the passage, which of the following statements is correct?(1381)

1) Prolonged heating is a better method of drying coffee.
2) Air is removed from a solution of freshly brewed coffee by vacuum pump.
3) Other forms of coffee have a longer shelf life than freeze-dried coffee.
4) The ice component in freeze-dried coffee sublimes by vacuum.

Cisplatin is usually used in a combination chemotherapy. Over the intervening years people have played games with varying the combinations, and with the use of radiation in combination with cisplatin.

121 - Cisplatin is a .....(1381)

1) form of cold medication
2) game played by many people over the intervening years
3) drug used in the treatment of cancer
4) compound that is used for radiation therapy

Although modern laboratory practice forbids it, Michael Sveda was smoking a cigarette while working in his organic chemistry laboratory at the university of Illinois. He put his cigarette down for a moment on the edge of the lab bench, and, when he picked it up, it tasted sweet. He traced it to a small particle of the compound he had just made, a compound now known as cyclamate.

122- According to the passage,.....(1381)

1) Michael Sveda discovered cyclamate after many years of research on artificial sweeteners
2) smoking is permitted in chemistry laboratories today
3) Michael Sveda was the discoverer of the cigarette
4) sweetness of cyclamate was discovered accidentally

In any collision that leads to reaction, some chemical bonds are broken and some new bonds may be formed. During and individual reactive collision, the total energy of the colliding particles remains constant, but the relative amounts of kinetic energy and potential energy of the participating atoms will changes as one kind of energy is converted into another. The origin of the activation-energy requirement is most easily explained if we assume that the atomic arrangement we call products and that called reactants, there is an atomic arrangement with a potential energy greater than that of reactants or producsts. It order to pass from reactants to products, a colliding pair of molecules must possess a total energy at least equal in magnitude to the potential energy of this intermediate atomic configuration.

123- According to the above passage, the potential energy of the ..... is greater than that of reactants or products.(1381)

1) participating atoms
2) atomic arrangements
3) individual reactive molecules
4) atomic arrangement

124- Any collision that leads to reaction is a ..... collision.(1381)

1) relative
2) reactant
3) reactive
4) reagent

Emphasis has been placed on using half-reactions. If two electrodes can be assembled so that an oxidation-reduction reaction takes place to produce an external current flow, this forms an electrochemical cell called a galvanic cell. These cells are capable of using the free energy of the reactants of form the products. The standard cell potential is the voltage a cell can produce when the reactants and products are both present in the cell in their standard states. The Nernst equation relates other possible voltages of a cell to the calculated using tabulated values of standard reduction potentials. These potentials are related to chemical free energies and can be used to calculate equilibrium constants.

125- According to the passage, which of the following uses the free energy of the reactants to achieve electrical work?(1381)

1) the standard reduction potential
2) the standard cell potential
3) a chemical reactor
4) a galvanic cell

126- According to the passage, which of the following relate the voltage to the concentrations of the reactants and products in a galvanic cell?(1381)

1) chemical free energy
2) chemical reaction
3) Nernst equation
4) half-reaction

127 - The word "equilibrium" (last line) is closest in meaning to ".....".(1381)

1) the state of being physically balanced
2) fighting for one's own emancipation
3) the state of being quite reactive
4) mixing an equal amount of chemicals

متن‌های زیر را با دقت مطالعه کنید و سوال‌هایی را که به‌دنبال آن‌هاطرح شده‌اند با دقت بخوانید و از بین گزینه‌های داده شده گزینه‌ای را که با متن مطابقت دارد انتخاب و شماره آن را در برگ پاسخنامه بنویسید.

(1379)

128 - The vast majority of chemical substances do not have the characteristics of ionic materials; we need only think of water, gasoline, banana peelings, hair, antifreeze, and plastic bags as examples. Most of the substances with which we come in daily contact tend to be gases, liquids, or solids with low melting points; many vaporize readily-for example, mothball crystals. Many in their solid forms are plastic rather than rigidly crystalline-for example, paraffin or plastic bags. (1379)

1) banana peelings are plastics
2) gasoline is an ionic material
3) most chemical substances are solids with low melting points
4) plastic bags are non-crystalline material

129 - Over thirty molecular H_2 complexes have now been reported in which the H-H bond remains intact. A particularly simple example is $Cr(CO)_5(H_2)$, which is produced by the UV photolysis of Cr $(CO)_6$ dissolved in liquid xenon doped with H_2 at about 200K. This compound and its HD and D_2 analogs are readily identified by the respective H-H, H-D and D-D stretching vibration in their IR spectra. As expected, the increase in reduced mass in going from H_2 to D_2 leads to a decrease in energy of the associated stretching vibration.

1) It is expected that the stretching vibration of D-D to be higher than that of H-H
2) In $Cr(CO)_5(H_2)$ the H_2 molecule remains essentially intact.
3) Liquid xenon doped with H_2 is photolyzed at about 200K
4) Reduced mass for HD is more than that of D_2

130 - About 30 million tons of HNO_3 are produced annually. Nitric acid is converted to nitrate salts in the soil. These nutrients are taken up by plants, which in turn are ingested by animals to make proteins and other essential biomolecules. Denitrification completes the cycle by reversing nitrogen fixation. For exmpale, certain anaerobic organisms decompose animal wastes as well as dead plants and animals to produce free N_2 from nitrates.(1379)

1) certain aeorobic organisms decompose animal wastes as well as dead plants and animals to produce nitrogen.
2) denitrification completes the cycle by reversing nitrogen fixation
3) nitric acid is converted to nitrate salts in the atmosphere
4) nitrates are taken up by plants as nutrients, which in turn are digested by animals to make proteins.

131 - Formaldehyde is a gas with a pungent, disagreeable odour, very soluble in water. It possesses excellent antiseptic and tanning properties. A 40 percent solution of formaldehyde in water under the name of formalin is widely used for disinfection, for preserving anatomical preparations, for pickling seeds before sowing, etc. Considerable quantities of formaldehyde are used for the preparation of products of its reaction with phenol.(1379)

1) Formualdehyde has excellent antiseptic and disinfection properties
2) Formaldehyde damages the seeds before sowing
3) Formaldehyde is used for the preparation of products of phenol
4) Formaldehyde is a gas with a pleasant odour

By the late 1960s more than 2,500,000 individual substances had been isolated or synthesized, purified, studied and described by chemical scienctists. All of the these substances are composed of one or more of the 103 elements which are the fundamental building blocks of a matter in the universe.

132 - Chemical scientists are those who:(1379)

1) Construct storage battery to produce electricity
2) Design and build chemical laboratories and factories
3) Synthesize, isolate, purify and study various substances
4) Travel to different parts of the world to discover blocks of matter

133 - The fundamental building blocks of all matter in the universe are: (1379)

1) chemicals 2) compounds 3) elements 4) molecoules

Chemistry is the study of the composition, structure, and properties of matter, and the changes which it undergoes. The substances of chemistry consist of all types of materials found or in the earth, oceans, and atmosphere. There substances and those produced as a result of other substances with each other are called chemicals. The reaction is known as a chemical process:

134 - The sciecne of chemisty is defined as: (1379)

1) The study of phsical changes in matter
2) The study of chemical changes in matter
3) The study of living matter
4) The study of vaporization of matter

135 - "Undergo" in this passage means: (1379)

1) combine 2) experience 3) realize 4) recognize

136 - "Process" in this passage means: (1379)

1) composition 2) detection 3) determination 4) treatment

متن‌های زیر را با دقت مطالعه کنید و سؤال‌هایی را که به‌دنبال آن‌ها طرح شده‌اند با دقت بخوانید و از بین گزینه‌های داده شده گزینه‌ای را که با متن مطابقت دارد انتخاب کنید و شمارهٔ آن‌ها را در برگ پاسخنامه مشخص کنید.(1377)

137 - What does the expression "leaving behind a relatively involatile components" mean?
It means that:

1) involatile components are distilled after volatile components.
2) a large quantities of volatile solvent is removed rapidly.
3) some high boiling point materials are left in evaporation flask.
4) volatile compounds are all distilled.

138 - Should your clothing catch on fire, do not run, but rather walk purposefully toward the nearest fire blanket or fire shower station. Running will fan the flames and intensify them. Wrapping yourself in the fire blanket will smother the flames quickly.

1) If you clothing catch on fire, run toward the fire station.
2) In some cases, your clothing should catch on fire
3) In case of fire, don't wrap yourself in the fire blanket because it would smother fire.
4) In case of fire, walk purposefully toward the nearest fire blanket.

139 - The molecular structures of limonene and polystyerne, the raw material from which styroform is made, are similar, As a result only styroform dissolves. Since the dissolution process takes place without adding heat, the drop in molecular weight seen with the thermal-shrinking method is minimized and there is almost no loss of mechanical properties. This makes it possible to create high-quality recycled products.

1) In thermal-shrinking method there is minimum drop in molecular weight of the styroform and there is almost no loss of mechanical properties.
2) Styroform can be dissolved in limonene at standard temperature with minimum drop in molecular weight.
3) The molecular weight of limonene and styroform are similar and therefore styroform dissolve in limonene.
4) We can create high-quality recycled products by thermal-shrinking method.

140 - A major precondition to re-manufacturing is that the finished re-manufactured product be equal to or surpass the quality of the original product. This requirement is the incentive that makes it possible to have meticulous cleaning work done by hand.

1) A major precondition to re-manufacturing is that the hands of workers should be meticulously clean.
2) For a re-manufactured product to surpass the quality of the original product, cleaning work should be done by hand.
3) For a re-manufactured product to be equal in quality to the original, it should be possible to wash it by hand.
4) The incentive for re-manufacturing a product is easy cleaning work which is done by hand.

متن‌های زیر را با دقت مطالعه کنید و سوال‌هایی را که به‌دنبال آن‌ها طرح شده‌اند با دقت بخوانید و از بین گزینه‌های داده شده گزینه‌ای را که با متن مطابقت دارد انتخاب و شماره آن را در برگ پاسخنامه بنویسید.

141 - Industrially, nitrogen is obtained by the fractional distillation of liquid air. Nitrogen (boiling point – 196°C boils off first, followed by oxygen (boiling point – 183 C). Much of the nitrogen produced is used for making ammonia.

The oxides of nitrogen have been frequently discussed in newspapers and other media because they are present in car exhaust gases. Sometimes they are represented as NO. When exhaust gases through a converter containing a platinum catalyst, the oxides of nitrogen are broken down.

1) liquid nitrogen is more volatile than liquid oxygen
2) nitrogen is only obtained by the fractional distillation of liquid air
3) the oxides of nitrogen are always discussed in newspapers
4) the oxides of nitrogen are formed in a converter containing platinum catalyst

142 - Teeth are protected by a hard enamel layer about 2mm thick that is composed of a mineral called hydroxyapatite, $Ca_5(PO_4)_3$ OH, when it dissolves (a process called demineralization), the ions go into solution in the saliva. Because phosphates of alkaline earth metals suchas calcium are insoluble, this reaction produced only to small extent. The reverese process, is called remineralization. In children, the growth of the the enamel layer (mineralization) occurs faster than demineralization.

1) by demineralization of $Ca_5(PO_4)_3$ OH, the ions go into solution in saliva
2) In children, mineralization occurs slower than demineration
3) phosphates of alkaline earth metals are soluble
4) teeth are protected by a hard enamel layer that is composed of a mineral called fluorapatite

143 - Oil and natural gas are cleaner-burning and more efficient fuels than coal, so they are preferred for most purposes. However, supplies of oil and natural gas are being depleted at an alarming rate, and research in under way to devise ways of making coal a move versatile source of energy.(1375)

1) coal, oil and natural gas are renewable resources and will last forever.
2) coal is a clean-burning and more efficient fuel than oil and natural gas.
3) oils and natural gas are preferred to coal as a fuel since they are clean-buring.
4) research is underway to devise ways of making natural gas a move versatile source of energy.

It was realized in due course that of all distinct forms of matter (substances or chemical compounds) which gradually become known, some occurred in lifeless mineral matter, while others were invariably found in association with living, or 'organized' matter. A distinction was thus recognized in the eighteenth century, between inorganic and organic substances. Thus arose the two great divisions of the science known as inorganic chemistry and organic chemistry.

144 - A distinction between inorganic and organic substances were made as early as:

1) the seventeenth century
2) the nineteenth century.
3) the early 20th century
4) the eighteenth century

145 - Inorganic substances are found in .....

1) artificaial matter
2) all matter composed of carbon compounds
3) lifeless mineral matter
4) living matter

146 - "Distinction" in this passage means:

1) disagreement
2) difference
3) distribute
4) unusual

147 - The d-block elements from scandium to zinc are silvery metals (apart from copper). They all (except zinc) have high melting points and densities because the atoms are strongly bonded together and closely packed. Zinc has a low melting point because it has full 3d and 4s orbitals, and these electrons are not used in the same way in bonding the atoms together. The d-block elements are good conductors of electricity because the 3d and 4s electrons are free to move through the structure. (1379)

1) all of the d-block elements have high melting points.
2) all of the d-block elements have a silvery luster
3) the 3d and 4s orbitals of zinc are full and are not used in bonding
4) the 3d and 4s electrons in d-block elements easily move through the lattice

148 - The best way to fight tooth decay is to eat a diet low in sugar and always brush one's teeth immediately after eating. Most toothpastes contain a fluoride compound such as NaF or SnF_2, that also helps to reduce tooth decay. The F^- ions from these compounds replace some of the OH^- ions during the remineralization process. Because F^- is a weaker base than OH^-, the modified enamel, called fluorapatite, is more resistant to acid. (1379)

1) because F^- ion is a stronger base than OH^-, the modified enamel is more resistant to acid
2) most toothpastes contain a fluoride compound that improves the protective layer of the tooth.
3) the best way to fight tooth decay is to check with a dentist regularly.
4) the F^- ions from NaF of SnF_2 replace some of the H^+ ions during the remineralization.

149 - Naphthalene, $C_{10}H_8$, is the largest single constituent of coal-tar (9%). It is obtained by cooling the middle and heavy oils whereupon naphthalene crystallieses out. The oil is pressed free from the naphthalene, the crude naphthalene cake melted, treated with concentrated sulphuric acid (to remove basic impurities), washed with water, and then treated with aqueous sodium hydroxide (to remove acidic impurities). Finally the naphthalene is distilled to give the pure product. (1379).

1) concentrated H_2SO_4 is used to remove the basic impurties from the melt
2) naphthalene has the largest single composition of the coal-tar
3) the middle and heavy oils are free from the naphthalene
4) the crude naphthalene cake is treated with aqueous $NaOH$

150 - The specific application of the first law of thermodynamics to the study of chemical reactions in referred to as thermochemistry. Thermochemistry deals with measurements or calculation of the heat adsorbed or given out in chemical reaction. The subject has therefore great immediate practical importance.(1374)

1) Thermochemistry is one of the consequences of the first law of thermodynamics.
2) The first law of thermodynamics solely deals with thermochemistry.
3) Thermochemistry has only practical importance.
4) The first law of thermodynamic has only great practical importance.

151 - All of the possible group IV tetrahalides are known except for $PbBr_4$ and PbI_4. In addition, silicon forms a number of catenated halides; with bromine and iodine, Si_2X_6 is the highest, but with fluorine and chlorine many higher one are known $(X = F, Cl, Br \text{ or } I)$ (1374)

1) $PbBr_4$ and PbI_4 are catenated halides.
2) silicon forms only catenated halides as Si_2X_6
3) All group IV elements form tetrahalide compounds
4) Fluorine and chlorine form catenated compounds with silicon which are higher than Si_2X_6

152- Several excellent oxidizing agents are available for the preparation of standard solutions. The number of reducing standard reagents is much more limited because their solution are susceptible to air oxidation; storage therefore is inconvenient.(1374)

1) It is more convenient to store oxidizing agents than reducing agents.
2) Oxiditing agents are more plentiful than reducing agents.
3) The oxidation of standard reducing agents by air is not serious.
4) It is impossible to store reducing agents to be used for standardization

153- Orthophosphoric acid, H_3PO_4 commonly called phosphoric acid is one of the, oldest known and most important phosphorus compund. It is made in vast quantities, usually as 85% sirupy acid, by the direct reaction of ground phosphate rock with H_2SO_4 and also by the direct buring of phosphorus and subsequent hydration of the Oxide P_4O_{10}.

1) Hydration of phosphorus results in orthophosphoric acid.
2) Direct burning or phosphours produces orthophosphoric acid.
3) H_3PO_4 is produced in large amount usually as thick liquid.
4) Orthophosphoric acid is usually produced in a very pure form.

154- We have already encountered hydrogenation as the most useful methods for preparing alkanes, It is not limited to the synthesis of alkanes, but is a general method for conversion of carbon-carbon double bond into a carbon-carbon single bond: using the same apparatus, the same catalyst, and very nearly the same conditions:

1) An unsaturated bond: using the same apparatus, the same catalyst, and very nearly the same conditions.
2) Hydrogenation is the sole method for synthesis of alkanes.
3) In the process of hydrogenation a carbon-carbon double bond is broken
4) In a hydrogenation process all carbon-carbon bonds alter their characteristics.

155- Many of the molecules to which we apply the methods of quantum mechanics are symmetric. Examples of simple symmetric molecules are CO_2, CH_4, C_2H_6 and SF_6. Many inorganic coordination compounds,e,g. the tetrahedral and octahedral complexes of the transition metals are also symmetric.

1) Molecules to which we apply the methods of quantum machanics are symmetric.
2) Symmetric molecules include a number of inorganic complexes as well as some other simpler molecules.
3) Only inorganic coordination compounds are symmetric
4) We can only apply the method of quantum mechanics to asymmetric molecules.

متن‌های زیر را با دقت مطالعه کنید و سؤال‌هایی را که به دنبال آن‌ها طرح شدند با دقت بخوانید و از بین گزینه‌های داده شده گزینه‌ای را که با متن مطابقت دارد انتخاب کرده و شماره آن‌ها را در برگ پاسخنامه مشخص کنید.(1374)

Louis Paster (1822-95), professor in Strasburg and Paris, and from 1889 director of the Pasteur Institute, investigated optical activity, observing hemihedral facets on crystals of tartaric acid and tartrates, but not on recemtes, and resolving an optically inactive compound, sodium ammonium recemate, by crystallization (1848-50). He also resolved racemic or optically inactive substances by fractional crystallization with an

optically active acid or base (1853) or by the growth of a mould which preferentialy uses up one form (1860). He discovered laevotartaric acid and mesotartaric acid. Paster provided experimental proofs for the vitalistic theory of ferementation (1857), and later carried out fundamental researches in bacteriology, disproving "spontaneous generation".

156 - According to the above passage which of te following was not done by louis Pasteur?

1) study of optical activity
2) resolution of racemic substances
3) research in bacteriology
4) investigation of coordination compounds

The products obtained by condensation of phenol with formaldehyde are known as phenol-formaldehyde resins, which possess a remarkable property: when heated they at first soften, and then, if future heated (especially in the presence of suitable catalysts), become hard again. Phenol-formaldehyde resins are mixed with various fillers (wood pulp, finely divided paper, asbestos, graphite, etc). with plasticizers and dyes, and the articles required are manufactured from the resulting mass by hot pressing. Phenol-formaldehyde resing have recently found new outlets in the manufacture of construction parts from wood wastes, for making shell moulds" etc.

157 - According to the above paragraph, phenol-formeldehyde resins are:

1) soft materials but if heated may become hard.
2) soft materials which possess remarkable properties.
3) solids which at first soften upon heating.
4) liquids and become hard upon heating.

The accepted standard electrode against which the potentials of all other metals are determined is known as the normal hydrogen electrode. The later consists of a platinum plate coated with a thin layer of pure hydrogen is passed continuously through the solution under a pressure of 1 atm, On coming into contact with the platinum, the hydrogen is absorbed by it to a considerable degree. A platinum plate saturated with hydrogen behaves as if it were made entirely of hydrogen. When it is in contact with acid solution, a definite difference of potentials (the potential of the hydrogen electrode) arises, this value being accepted as the zero point when measuring relative potentials.

158 - According to the above paragraph, in the normal hydrogen electrode:

1) a simple finely divided platinum is suspended in solution.
2) only platinum plate is used.
3) the solution of hydrochloric acid is 1 molar.
4) the vapor pressure of solution is 1 atm.

159 -

1) the platinum plate absorbs H^+ ions from the solution.
2) the pressure of hydrogen gas is 1 atmosphere.
3) the hydrogen gas is absorbed contiuously by the solution.
4) the hydrogen gas is produced continuously by the solution.

C. Translation

هریک از عبارت‌های زیر را به‌دقت بخوانید و بهترین برگردان فارسی هریک را از بین گزینه‌ها انتخاب کنید. (1380)

160 - Coagulation is the process by which the dispersed phase of a colloid is made to aggregate and thereby separate from the continuous phase.

۱) لخته‌شدن فرایندی است که به‌وسیلهٔ آن فاز بخشیدهٔ یک کلویید به‌صورت یک توده جمع‌شده و از فاز پیوسته جدا می‌شود.

۲) فرایند انعقاد فاز پراکندهٔ کلویید را مجتمع نموده آن را از فاز پیوسته جدا می‌کند.

۳) فرایند لخته‌شدن فاز بخشیدهٔ یک کلویید را جمع می‌کند و درنتیجه از فاز پیوسته جدا می‌شود.

۴) انعقاد فرایندی است که به‌وسیلهٔ آن فاز پاشیدهٔ یک کلویید وادار به انبوهش و در نتیجه جداشدن از فاز پیوسته می‌شود.

161 - Dipole-dipole force is an attractive intermolecular force resulting from the tendency of polar molecules to align themselves such that the positive end of one molecule is near the negative end of another.(1380)

۱) نیروی دوقطبی ـ دوقطبی یک نیروی جاذبه درون مولکولی است که از تمایل مولکول‌های قطبی برای همسوکردن خودشان به طریقی که سر مثبت یک مولکول در مجاورت مولکول دیگر قرار گیرد حاصل می‌شود.

۲) نیروی دوقطبی ـ دوقطبی یک نیروی جاذبهٔ بین مولکولی است که از تمایل مولکول‌های برای صف‌بندی به‌گونه‌ای که سر مثبت یک مولکول نزدیک سر منفی مولکول دیگر باشد، نتیجه می‌شود.

۳) نیروی دوقطبی ـ دوقطبی یک نیروی جاذبه درون مولکولی است و از تمایل مولکول‌های قطبی به خط‌شدن آن‌ها از انتهای مثبت یک مولکول به انتهای منفی مولکول دیگر به‌دست می‌آید.

۴) نیروی دوقطبی ـ دوقطبی نتیجهٔ ردیف‌شدن مولکول‌های قطبی از سر مثبت یک مولکول به سر منفی مولکول دیگر برای ایجاد یک نیروی جاذبه بین مولکولی نتیجه می‌شود.

162 - The rate of eefusion of gas molecules from a particular hole is inversely proportional to the square root of the molecular weight of the gas at constant temperature and pressure.

۱) نرخ پخش مولکول‌های گاز از یک حفرهٔ معین به‌طور معکوس با مربع ریشه وزن مولکولی گاز در دما و فشار ثابت نسبت دارد.

۲) نرخ پراش مولکول‌های گاز از درون یک حفره خاص به‌طور معکوس متناسب با مجذور ریشه وزن مولکولی گاز در دما و فشار ثابت است.

۳) سرعت نفوذ مولکولی مولکول‌های گاز از یک حفره خاص با ریشه دوم وزن مولکولی گاز در دما و فشار ثابت نسبت عکس دارد.

۴) سرعت پخش مولکول‌های گاز از یک حفره معین با ریشه دوم وزن مولکولی گاز در دما و فشار ثابت نسبت عکس دارد.

163 - Humans lack the biochemical ability to break C-C links in cellulose, so we cannot digest it, but microorganisms in the digestive tracts of some animals, can.(1379)

۱) هضم سلولز یک واکنش زیست شیمیایی است که ما انسان‌ها برای انجام آن مانند بعضی حیوانات به موجودات ریز ذره‌بینی نیاز داریم.

۲) انسان فاقد توانایی زیست‌شیمیایی برای شکستن اتصال‌های سلولز است به‌طوری که نمی‌توانند سلولز را هضم کنند اما میکروارگانیسم‌ها در جهاز هاضمه بعضی از حیوانات این کار را انجام می‌دهند.

۳) انسان‌های فاقد قدرت بیوشیمیایی برای شکستن پیوندهای C-C سلولز نمی‌توانند آن را خرد کنند ولی موجودات ذره‌بینی در بعضی حیوانات که دستگاه خردکن دارند از عهده این کار برمی‌آیند.

۴) اگر توانایی بیوشیمیایی انسان‌ها از عهده هضم سلولز برنیاید موجودات ریزی هستند که در روده حیوانات این کار را انجام می‌دهند.

164 - Properties such as vapor pressure lowering, boiling point elevation and freezing point depression are known as colligative properties.(1379)

۱) خواصی مانند کاهش فشار بخار، صعود نقطه جوش و نزول نقطه انجماد به‌عنوان خواص کولیگاتیو شناخته می‌شوند.

۲) خواصی مانند کم‌بودن فشار بخار، زیادبودن نقطه جوش و پایین‌آوردن نقطه انجماد به‌عنوان خواص کولیگاتیو شناخته شده‌اند.

۳) خواصی از قبیل فشار بخار کم، دمای جوش زیاد و افسردگی نقطه انجماد را رویهم خواص کولیگاتیو نام می‌برند.

۴) برای بیان فرایندهایی مانند پایین‌آوردن فشاربخار، بالابردن نقطه جوش و کم‌کردن نقطه انجماد از واژه کولیگاتیو استفاده می‌شود.

165 - The total energy required to obtain Al is about 20 times needed for recyling it.(1379)

۱) کل انرژی مصرفی برای ساخت آلومینیوم حدوداً 20 برابر انرژی لازم برای به چرخش‌درآوردن آن است.

۲) کل انرژی به‌کاررفته برای به‌دست‌آوردن آلومینیم در حدود 20 برابر انرژی موردنیاز برای بازیابی آن است.

۳) کل انرژی مصرفی برای به‌دست‌آوردن آلومینیم حدود 20 برابر چیزی است که برای گرداندن آن لازم است.

۴) کل انرژی موردنیاز برای تهیه آلومینیم حدوداً 20 برابر انرژی لازم برای بازگردانی آن است.

هر یک از عبارت‌های زیر را به دقت بخوانید و بهترین برگردان فارسی هریک را از بین گزینه‌ها انتخاب کنید.

166 - This method of precipitation of hydroxides reqruies imeediate removal of the product by vaccume filtration.

۱) این روش باعث رسوب‌دادن هیدروکسیدها و احتیاج به خروج محصول به‌وسیله عمل تقطیر است.

۲) این روش برای رسوب هیدروکسیدها سرعت زیادی برای تولید محصول در خلاء دارد.

۳) این روش رسوب‌دادن هیدروکسیدها مستلزم جداکردن فوری محصول توسط صافی خلاء است.

۴) این روش موجب رسوب هیدروکسیدها به‌عنوان محصول به‌دست آمده در پمپ خلاء می‌شود.

167- Liver is intricate chemical factory, it takes the particle of glucose and change them in to another kind of carbohydrate called glycogen, which it then stores. When the body needs sugar, the liver turns the glycogen in to glucose again and sends it to body tissues through the blood stream.(1378)

۱) کبد یک کارخانه شیمیایی پیچیده است. ذره‌های گلوکز را دریافت کرده آن‌ها را به کربوهیدرات دیگری به‌نام گلیکوژن تغییر می‌دهد و در خود ذخیره می‌کند. هروقت که بدن نیاز دارد کبد گلیکوژن را مجدداً به گلوکز تبدیل می‌کند و آن را از طریق جریان خون به بافت‌ها می‌رساند.

۲) کبد یک کارخانه شیمیایی زنده است، که ذره‌های شیرینی را به نوع دیگری از کربوهیدرات به‌نام گلیکوژن تغییر می‌دهد که در بدن ذخیره می‌شود، به‌هنگام نیاز بدن به شیرینی گلیکوژن مجدداً به گلوکز تبدیل می‌شود و وارد خون می‌شود تا بافت‌ها را سیراب کند.

۳) کبد یک کارخانه شیمیایی حساس است، از یک طرف گلوکز را به گلیکوژن تبدیل می‌کند و از طرفی گلوکز را ذخیره می‌کند، هرگاه بدن به گلوکز احتیاج داشته باشد آن را از طریق بافت‌های بدن وارد جریان خون می‌کند.

۴) کبد یک کارخانه شیمیایی معجزه است، ذره‌های شکر را به کربوهیدرات دیگری به‌نام قند تبدیل می‌کند و درصورت نیاز بدن به شکر کبد آن را مجدداً تبدیل کرده و به خون وارد می‌کند تا به بافت‌ها برسند.

168- The discovery of the ozone hole precipitated a revolution in scientific thinking. In particular it demonstrated that a global environmental change was not only a possibility for the distant future, but a reality of the twentieth century.

۱) برای کشف حفره اوزن باید تحولی در تفکر علمی ما به وجود آید به‌خصوص که با ایجاد حفره نشان داده شده است که باتوجه به واقعیت‌های قرن بیستم هر تغییری در محیط زیست در آینده‌ای دور محتمل است.

۲) کشف لایه اوزون تحولی در تفکر علمی ایجاد کرد بخصوص این پدیده نشان داد که یک تغییر زیست‌محیطی جهانی نه‌تنها یک احتمال دوردست نیست بلکه واقعیتی مربوط به قرن بیستم است.

۳) کشف حفره اوزون چرخشی در طرز تفکر علمی ما به‌وجود آورد، به‌ویژه این حفره نشان داد که تغییر در کره محیط زیست یک احتمال مربوط به قرن آینده نیست بلکه در قرن بیستم به واقعیت پیوسته است.

۴) کشف سوراخ اوزن رسوب‌شده‌ای است که با گردش علمی به‌وجود آمده و این یک تغییر کروی در محیط زیست را به نمایش می‌گذارد که امکان آن نه‌تنها در آینده‌ای دور بلکه در قرن بیستم به‌وقوع می‌پیوندد.

169 - To treat a decayed tooth, a dentist opens two small vials, one contains a red gel with three amino acids and the other a weak solution of sodium hypochlorite, the dentist mixes the two vials and applies a few drops to the decayed tooth, it dissolves the decay and the dentist fills the tooth in the normal way.

۱) برای معالجه کرم‌خوردگی دندان، دندانپزشک از دو شیشه آمپول یکی شامل ژلی از سه آمینواسیدقرمز و دیگری شامل محلول رقیق سدیم هیپوکلریت چند قطره‌ای روی دندان کرم‌خورده می‌ریزد تا کرم‌خوردگی پاک شده و او دندان را به طریق عادی پر می‌کند.

۲) برای پانسمان دندان فاسد دندانپزشک از دو شیشه کوچک دارو، سه آمینواسیدقرمز و یک محلول رقیق سدیم هیپوکلریت را چند قطره‌ای روی دندان فاسد می‌ریزد و روی آن را مطابق معمول پر می‌کند.

۳) برای درآوردن یک دندان فاسد دندانپزشک دو شیشه برمی‌دارد که یکی ژله سه آمینو اسیدی و دیگری محلول رقیق سدیم هیپوکلریت دارد، دو شیشه را مخلوط‌کرده، چند قطره از آن را به بیمار می‌خوراند دندان فاسد حل شده و دندانپزشک آن را با راه نرمال پر می‌کند.

۴) دندانپزشک برای درمان دندان کرم‌خورده دو شیشه کوچک را باز می‌کند در یکی ژل قرمز رنگی با سه آمینو اسید و در دیگری محلول ضعیفی از سدیم هیپوکلریت وجوددارد و دندانپزشک محتوی این دو شیشه را مخلوط کرده و چند قطره از آن را روی دندان کرم‌خورده می‌ریزد، کرم‌خوردگی حل شده و دندانپزشک دندان را به طریق عادی پر می‌کند.

170 - Hence, the current-carrying ions are not necessarily discharged at the electrodes.(1377)

۱) ازاین رو، جریان برق یون‌های ناقل را بطور مؤثر در الکترودها، تخلیه نمی‌کند.

۲) از این رو، یون‌های دارای بار الکتریکی درصورت لزوم بار خود را در الکترودها از دست نمی‌دهند.

۳) بنابراین، یون‌های حامل جریان، الزاماً بار خود را در الکترودها تخلیه نمی‌کنند.

۴) بنابراین، یون‌های درحال حمل‌کردن جریان، درصورت لزوم بار خود را در الکترودها تخلیه نمی‌کنند.

171 - The passage of any particle in the gel matrix depends upon the relative size of the particle and the pores in the gel matrix.(1377)

۱) عبور هر ذره از داخل ماتریس ژل بستگی به اندازه نسبی ذره و خلل و فرج داخل ژل دارد.

۲) عبور هر ذره از سطح ژل بستگی به نسبت اندازه ذره به حفره‌ها در زمینه ژل دارد.

۳) عبور ذرات از روی ژل به اندازه نسبی سوراخ‌های ریزتر دارد.

۴) عبور ذرات از ماتریس ژل بستگی به جنس و نوع حفره‌های ژل دارد.

172 - Your text book is going to be your companion for quite a long time. As with a friend, it is helpful to get acquainted. When you first get the book, skim through it to see what is included and how it is organized.(1377)

۱) کتاب درسی برای یک سال در دست شماست آن را دوست خود بپندارید و نخستین‌بار که آن را به دست می‌گیرید ورق بزنید تا با صفحات و مطالب سازمان‌داده شده در کتاب آشنا شوید.

۲) کتاب درسی شما برای مدتی طولانی یار و همراه شما خواهد بود، مانند یک دوست بهتر است با آن آشنا شوید. وقتی کتاب را می‌خرید آن را ورق بزنید تا متوجه شوید چه مطالبی را شامل می‌شود و چگونه سازمان‌دهی شده است.

۳) کتاب یک دوست ابدی است و آشنایی با آن مانند آشنایی با یک دوست است. اولین‌بار که کتابی را می‌خرید آن را صفحه به صفحه ورق بزنید عنوان‌های آن را ببینید و با روال نوشته کتاب آشنا شوید.

۴) یک کتاب درسی می‌رود که زمانی آرام و طولانی با شما همراه باشد. مانند یک دوست با آن رفتار کنید. وقتی کتاب را می‌خرید از میان صفحات آن عبور کنید تا ببینید که در آن چه نوشته شده و چگونه صفحه‌بندی شده است.

173 - Supporters of genetic engineering say the process makes it possible to produce food more cheaply because the crops give a greater yield using less land, water, insecticide and pesticide.(1377)

۱) مهندسی ژنتیک در حمایت از تولید غذای بیشتر و ارزان‌تر است زیرا می‌گوید با این روش می‌توان محصولات بزرگتری به دست آورد که آب، حشره‌کش و علف‌کش کمتری نیاز دارد و در سطح زیر کشت کمتری به عمل می‌آید.

۲) طرفداران مهندسی ژنتیک می‌گویند که با سطح زیر کشت کمتر، آب، حشره‌کش و آفت‌کش می‌توان محصولات بیشتری و درنتیجه غذای بیشتری و ارزانتری به‌دست آورد.

۳) طرفداران مهندسی ژنتیک بر این عقیده‌اند که تولید غذای فراوان‌تر و ارزانتر امکان‌پذیراست زیرا محصولات بزرگتری به دست می‌آید وقتی از آب، زمین و حشره‌کش و علف‌کش کمتری استفاده می‌کنیم.

۴) حامیان مهندسی ژنتیک می‌گویند که این فرایند تولید غذای بیشتر با قیمت ارزانتر را امکان‌پذیر می‌سازد، زیرا با استفاده از زمین کمتر و به کاربردن آب، حشره‌کش و آفت‌کش کمتر، بازده محصولات بیشتر است.

174 - The Shuttle's countdown got underway monday after engineers spent the weekend studying a hydraulic leak in Endeavor's engine compartment. NASA managers decided to press ahead with launch preparations because the leakage did not present a safety hazard.(1377)

۱) شمارش معکوس فضاپیمای رفت و برگشت روز دوشنبه شروع شد پس از اینکه مهندسین پایان هفته را به بررسی نشت هیدرولیک در قسمت موتور اندور پرداختند. مدیران ناسا تصمیم گرفتند به فراهم‌کردن مقدمات پرتاب موشک بپردازند زیرا نشت مذکور هیچ‌گونه خطر ایمنی در برندارد.

۲) شمارش شاتل روز دوشنبه به حرکت درآمد پس از اینکه مهندسین بررسی خود روی نشتی هیدرولیک موتور اندور در پایان هفته به اتمام رساندند. مدیران ناسا تصمیم گرفتند هرطور که هست به پرتاب موشک اقدام کنند زیرا این نشتی خطری برای پرواز ندارد.

۳) مهندسان پس از بررسی یک شکست هیدرولیک در قسمت موتور هواپیمای اندرو در پایان هفته شمارش شاتل را روز دوشنبه شروع کردند.

۴) مهندسین یک هفته صرف بررسی نقص هیدرولیک فضاپیمای اندرو کردند تا شمارش رفت و برگشت در روز دوشنبه به حرکت درآمد. مدیران ناسا هم‌آمادگی خود را برای پرتاب اعلام کردند زیرا خطری از سوی این نقص پرواز را تهدید نمی‌کند.

175 - Notice that the average rate steadily decreases as the reaction proceeds.(1376)

۱) توجه داشته باشید که ضمن پیشرفت واکنش، سرعت میانگین، به‌طورمحسوس کاهش می‌یابد.

۲) توجه کنید که ضمن پیشرفت واکنش سرعت میانگین به‌طورمداوم کاهش می‌یابد.

۳) توجه کنید که سرعت میانگین بعد از پیشرفت واکنش مطلقاً کاهش می‌یابد.

۴) توجه کنید که سرعت میانگین واکنش همزمان با انجام واکنش کاهش می‌یابد.

176 - Bequerel had discovered that uranium mineral fluoresce afer exposure to sunlight?(1376)

۱) بکرل کشف کرد که ترکیبات معدنی فلوئوردار اورانیوم در مقابل نور خورشید پرتوافشانی می‌کند.

۲) بکرل کشف کرده بود که ترکیبات معدنی اورانیوم پس از قرارگرفتن در معرض نورخورشید فلوئورسان می‌شود.

۳) بکرل کشف کرده بود که سنگ‌های معدن اورانیوم توسط نور خورشید فلوئورسان می‌شوند.

۴) بکرل کشف کرده بود که اورانیوم موجود در معدن توسط نورخورشید پرتوافشان می‌شوند.

177 - Despite the small number of atoms in the molecule, there are quite a few ways to represent the structure of benzene without violating the tetravalency of carbon. (1376)

۱) با اینکه تعداد اتم‌ها در مولکول کوچک است، راه‌های کاملی برای نشان‌دادن ساختار کربن چهار والانسی در بنزن وجود دارد.

۲) صرفنظر از تعدادی اتم‌های کوچک در این مولکول می‌توان ساختار بنزن را درنظرگرفتن کربن چهاروالانسی با تعداد کمی راه نشان داد.

۳) علیرغم تعداد کم اتم‌ها در این مولکول، چندین طریق برای نمایش ساختار بنزن بدون تخطی از چهاروالانسی‌بودن کربن وجود دارد.

۴) علیرغم تعداد اتم‌های کوچک در این مولکول، راه‌های کمی با درنظرگرفتن والانس چهارکربن برای نمایش ساختار بنزن باقی می‌ماند.

178 - Electorlytic refining is an important and widely used method of purification. (1376)

۱) تصفیه الکترولیتی روش مهم و وسیع برای کاربرد خالص‌سازی است.

۲) تصفیه به روش الکترولیز روشی مهم و دارای کاربرد زیاد در خالص‌سازی است.

۳) خالص‌سازی به روش الکترولیز، روشی مهم و دارای کاربرد زیاد در تصفیه‌خانه است.

۴) خالص‌سازی به روش الکترولیز، روشی مهم و وسیع برای کاربرد در تصفیه است.

179 - The lewis theory of chemical bonding, although useful and easy to apply, does not tell us how and why bonds form. (1376)

۱) کاربرد تئوری پیوند شیمیایی لوویس ساده نیست و مطلبی درباره چگونگی تشکیل پیوند ارائه نمی‌دهد.

۲) تئوری لوویس از کاربرد شیمیایی به‌سادگی و به‌طور سودمندی سخن می‌گوید و چگونگی تشکیل آن را توضیح می‌دهد.

۳) نظریه لوویس دربارهٔ دلیل تشکیل پیوند شیمیایی مطلبی به دست نمی‌دهد درحالی که مفید و ساده به‌نظر می‌رسد.

۴) نظریهٔ لوویس دربارهٔ پیوند شیمیایی، اگرچه سودمند و به‌کاربردن آن آسان است، دربارهٔ چگونگی و دلیل تشکیل پیوند مطلبی به‌دست نمی‌دهد.

180 - The reactant used up first in a reaction is called the limiting reagent. (1376)

۱) آنچه را واکنش‌دهنده نامیده می‌شود در ابتدای واکنش به‌کار می‌برند.

۲) واکنشگری که در یک واکنش اول به کار برده می‌شود واکنش‌دهنده حد است.

۳) واکنشگری که در یک واکنش تمام می‌شود مانع پیشرفت واکنش است.

۴) واکنش‌دهنده‌ای که در واکنش جلوتر از همه مصرف می‌شود واکنشگر محدود کننده است.

181 - The most obvious approach is to coat the metal surface with paint. However, if the paint is scratched or pitted to expose even the smallest area of bare metal, rust will form under the paint layer. (1375)

۱) آشکارترین نحوه تقرب این است که فلز را رنگ بزنیم. اما چنانچه رنگ ساییده شود یا فرورفتگی پیداکند، به‌طوری که سطح فلز نمایان شود، آهن شروع به زنگ‌زدن می‌کند.

۲) بهترین راه این است که فلز را رنگ بزنیم، اما اگر رنگ را خراش دهیم یا سوراخ شود به‌طوری که کوچکترین سطح فلز ظاهر شود در آن صورت خوردگی رنگ شروع می‌شود.

۳) بدیهی‌ترین راه این است که سطح فلز را با رنگ بپوشانیم. اما چنانچه رنگ خراش بردارد یا سوراخ شود به‌طوری که حتی سطح خیلی کوچکی از فلز عریان شود، زنگ‌آهن در زیر لایه رنگ تشکیل می‌شود.

۴) عادی‌ترین راه این است که روی فلز را با رنگ بپوشانیم. اما، اگر رنگ صدمه ببیند یا فروبرود به‌طوری که کوچکترین سطح فلز لخت شود لایه رنگ شروع به خورده‌شدن می‌کند.

182 - A tough substance is difficult to break, because it is felexible and not brittle. (1375)

۱) یک ماده سفت به دشواری می‌شکند، زیرا انعطاف‌پذیر است و ترد نیست.

۲) یک ماده سفت به دشواری خرد می‌شود، زیرا ضربه‌پذیر است و خم نمی‌شود.

۳) شکستن یک ماده سفت دشوار است، زیرا انحراف‌پذیر و ضربه‌پذیر نیست.

۴) شکستن یک ماده سفت دشوارست، زیرا ضربه‌پذیر است و انحراف‌پذیر نیست.

183 - Recent advances in ultra violet instrumentation have been mainly in the area of detector improvement. (1375)

۱) پیشرفت‌های اخیر در دستگاهوری فرابنفش اصولاً در سطح آشکارساز اصلاح شده است.

۲) پیشرفت‌های اخیر در دستگاهوری فرابنفش عمدتاً در زمینه بهبود آشکارساز بوده است.

۳) پیشرفت‌های اخیر در دستگاهوری فرابنفش در زمینه اصلاح آشکارساز اصلی صورت گرفته است.

۴) پیشرفت‌های اخیر عمدتاً درخصوص بهبود دستگاهوری فرابنفش بوده‌اند.

184 - The thermal conductivities of hydrogen and helium are roughly six to ten times greater than those of most organic compounds. (1375)

۱) رسانایی گرمایی هیدروژن و هلیوم حدوداً شش تا ده برابر بزرگتر از رسانایی گرمایی اکثر ترکیبات آلی است.

۲) رسانایی گرمایی هیدروژن و هلیوم به‌ترتیب شش و ده برابر بزرگتر از اکثر ترکیبات آلی است.

۳) رسانایی گرمایی هیدروژن و هلیوم به سختی شش تا ده برابر بزرگتر از اکثر ترکیبات آلی است.

۴) رسانایی گرمایی هیدروژن و هلیوم شش تا ده برابر مهم‌تر از اکثر ترکیبات آلی است.

185 - The major sources of benzopyrene in urban atmosphere are coal burning power plants. (1375)

۱) منابع عمده بنزوپیرن در نیروگاه‌های شهری در موارد سوختن زغال‌سنگ است.

۲) منابع عمده بنزوپیرن در هوای شهری زغال‌سنگ سوختهٔ نیروگاه‌ها هستند.

۳) منابع عمده بنزوپیرن در هوای شهری سوختن زغالهای درختان قوی‌هیکل هستند.

۴) منابع عمده بنزوپیرن در هوای شهری، نیروگاه‌های زغال‌سنگ‌سوز هستند.

186 - Thus, a fairly broad range of sulfide ion concentration will allow for effective separation of Cu^{2+} ion. (1375)

۱) بنابراین اختلاف بین غلظت یون سولفید و یون Cu^{2+} باعث جداسازی کامل یون Cu^{2+} می‌شود.

۲) بنابراین گسترهٔ نسبتاً وسیعی از غلظت یون سولفید جداسازی موثر یون Cu^{2+} را مجاز خواهد ساخت.

۳) بنابراین ازدیاد غلظت یون سولفید باعث جداسازی موثر یون Cu^{2+} می‌شود.

۴) بنابراین با تغییر غلظت یون سولفید جداسازی یون Cu^{2+} موثرتر می‌شود.

187 - Chemists have identified the elements and isolated them from their natural sources. (1374)

۱) شیمیدان‌ها عناصر موجود را شناسایی نموده و آن‌ها را به‌عنوان عایق در منابع طبیعی به‌کار برده‌اند.

۲) شیمیدان‌ها عناصر موجود را شناسایی و تقسیم‌بندی نموده‌اند.

۳) شیمیدان‌ها عناصر را شناسایی نموده و آن‌ها را از منابع طبیعی آن‌ها جداسازی نموده‌اند.

۴) شیمیدان‌ها عناصر طبیعی را شناخته و آن‌ها را از منابع خود جدا کرده‌اند.

188 - Aluminum is an extremely versatile metal pure alluminum, however is too soft to be used in construction industries. (1374)

۱) آلومینیوم فلزی است که قابلیت تغییرپذیری فوق‌العاده دارد ولی آلومینیوم خالص آن قدر نرم است که در صنایع ساختمانی قابل استفاده نمی‌باشد.

۲) آلومینیوم فلزی فوق‌العاده چکش‌خوار است آلومینیوم خالص بسیار نرم است و در صنایع ساختمانی مصرف دارد.

۳) آلومینیوم فلزی فوق‌العاده تورق‌پذیر است و بدین‌جهت قابل استفاده در صنایع ساختمانی است.

۴) آلومینیوم فلزی فوق‌العاده براق است و در صنایع ساختمانی مصرف دارد.

189 - The overwhelming majority of chemical studies are performed in the solution phase, so it behooves us to understand the role of solvent in determining the species persent in the solution we study.(1374)

۱) در بیشتر واکنش‌هائی‌که در فاز محلول انجام می‌گیرند حلال نقش اصلی را برعهده دارد.

۲) در بیشتر واکنش‌های شیمیایی در فاز محلول انجام می‌گیرند و جسم حل‌شونده در تشخیص تعداد اجزاء موجود در آن نقش مهمی را دارا می‌باشد.

۳) به مراتب اکثر واکنش‌های شیمیایی در فاز محلول انجام می‌گیرند بنابراین رفتار حلال در تعیین اجزا موجود در محلول نقش‌های عمده‌ای دارد.

۴) اکثریت بررسی‌های شیمیایی در فاز محلول صورت می‌پذیرد و بدین‌ترتیب می‌توانیم نقش حلال را در تعیین گونه‌های موجود در محلول مورد بررسی درک نماییم.

190- The product of this reaction is a purple viscous liquid, which solidifies in ethanol upon stirring. (1374)

۱) محصول این واکنش مایع غلیظ و نارنجی رنگ است که بر اثر همزدن در اتانل متبلور می‌شود.

۲) محصول این واکنش مایع چسبناک نیلی رنگ است که اگر مدتی در اتانل بماند، متبلور می‌شود.

۳) محصول این واکنش مایع غلیظ بنفش رنگ است که به حال خود در اتانل منجمد می‌شود.

۴) محصول این واکنش مایعی چسبنده ارغوانی‌رنگ است که بر اثر همزدن در اتانل جامد می‌شود.

191- To many, this is the essence of chemistry and area in which chemists can display real creativity. (1374)

۱) به نظر بسیاری از افراد این اصل شیمی است و زمینه‌ای است که شیمیدان‌ها می‌توانند خلاقیت واقعی خود را به نمایش گذارند.

۲) برای خیلی‌ها این اساس شیمی است و در این زمینه‌ها شیمیدان‌انها می‌توانند فعالیت حقیقی نشان دهند.

۳) برای بسیاری، اساس شیمی زمینه‌ای است که شیمیدان‌ها می‌توانند فعالیت حقیقی نشان دهند.

۴) به‌نظر خیلی از افراد، شیمیدان‌ها می‌توانند ماهیت واقعی شیمی را با فعالیت خود به نمایش گذارند.

192- In the early 1950's the scientific community was started and even skeptical to learn that it was possible to prepare these compounds.

۱) در آغاز ۱۹۸۵، جامعه علمی مأیوس و خلی دچار دردسر شده تا آموخت که تهیه این ترکیبات ممکن است.

۲) در اوایل دهه ۱۹۸۵، جامعه علمی از این که دریافت تهیه این ترکیب‌ها ممکن شد، دچار حیرت و حتی تردید شد.

۳) از سال‌های ۱۹۸۵ به بعد انجمن علمی به تلاش و حتی فداکاری دست زد تا دریافت که تهیه این ترکیبات ممکن است.

۴) در اوایل دهه ۱۹۸۵،انجمن علمی از این که دریافت تهیه این ترکیب‌ها امکان دارد، خوشحال و حتی هیجان‌زده شد.

193- Paradichlorobenzene is widely used as a deodorant, sometimes in pure form and sometimes scented with artificial fragrance. (1374)

۱) پارادی‌کلروبنزن به‌صورت خالص یا همراه با بوهای مصنوعی کاربرد زیادی به‌عنوان بوگیر دارد.

۲) پارادی کلروبنزن به‌صورت خالص یا همراه با بوهای مصنوعی کاربرد جهانی به‌عنوان خوشبوکننده دارد.

۳) پارادی کلروبنزن به‌صورت خالص یا مخلوط با مواد معطر مصنوعی کاربرد وسیعی به‌عنوان خوشبوکننده دارد.

۴) پارادی کلروبنزن به‌صورت خالص یا خوشبوکننده عطرهای مصنوعی کاربرد وسیعی به‌عنوان بوزدا دارد.

194- $EDTA^{4-}$ is often added to commercial salad dressing to remove traces of metal ions from solution: without $EDTA^{4-}$ the dressing would become rancid. (1374)

۱) برای حذف مقادیر کم یون‌های فلزی از محلول اغلب به سس سالاد تجارتی $EDTA^{4-}$ می‌افزایند، لباس بدون $EDTA^{4-}$ می‌پوسد.

۲) برای جداکردن مقادیر بسیار کم از یون‌های فلزی از محلول اغلب به سس سالاد تجارتی $EDTA^{4-}$ می‌افزایند، زیرا بدون آن سس سالاد تند می‌شود.

۳) $EDTA^{4-}$ اغلب به‌عنوان لفاف سالاد بکار می‌رود تا یون‌های فلزی از محلول جدا شوند چون سالاد بدون لفاف خراب می‌شود.

۴) برای پوشاندن سالاد تجارتی به‌منظور جلوگیری از حل‌شدن مقادیر کم یون‌های فلزی اغلب $EDTA^{4-}$ اضافه می‌کنند زیرا بدون $EDTA^{4-}$ لباس می‌پوسد.

195 - Cracking is a petroleum refining process in which large alkanes are broken down by a catalyst into smaller; branched alkanes more suitable for use in gasoline. (1374)

۱) در پالایش نفت توسط فرآیند کراکینگ آلکان‌های بزرگ با هم ترکیب شده و تولید آلکان‌های کوچکتری می‌کند که در بنزین از آن‌ها استفاده می‌شود.

۲) پالایش نفت فرآیندی است که در آن آلکان‌های بزرگ از آلکان‌های کوچکتر که مناسب مصرف در بنزین هستند، بدست می‌آید.

۳) روش پالایش نفت که در آن کاتالیزور با آلکان‌های بزرگ شکسته می‌شود و آلکان‌های کوچکتری می‌دهد که مناسب بنزین هستند، کراکینگ نامند.

۴) کراکینگ فرآیندی است که برای پالایش نفت که در آن آلکان‌های بزرگ به‌وسیله کاتالیزور به آلکان‌های کوچکتر با زنجیر شاخه‌دار شکسته می‌شوند و این آلکان‌ها برای استفاده در بنزین مناسبترند.

196 - The deformed molecule in the transition state is called the activated complex. (1373)

۱) مولکول تغییر شکل‌یافته در حالت گذار، کمپلکس فعال شده نامیده می‌شود.

۲) مولکول از نو تشکیل شده در حالت عبور از راه کمپلکس فعال شده است.

۳) کمپلکس فعال شده مولکول تازه‌ای است که حالت‌گذار نامیده می‌شود.

۴) تغییر شکل یافته مولکول فعال شده، حالت عبور نامیده می‌شود.

197 - Reacting gases combine in volumes that are ratios of small whole numbers. (1373)

۱) اعداد نسبت‌های حجم‌های گازهای ترکیب‌شونده کاملاً کوچک است.

۲) حجم‌های گازهایی که با یکدیگر واکنش می‌دهند نسبت‌های کوچکی از اعداد کامل است.

۳) گازهای واکنش‌دهنده در حجم‌هایی با یکدیگر ترکیب می‌شوند که نسبت‌های آن‌ها اعداد کوچک و غیرکسری است.

۴) مجموع حجم‌های گازهای ترکیب‌شونده به نسبت‌های اعداد کوچک و غیرکسری است.

198 - The lowest energy level in which the electron normally resides, is the ground state for the electron. (1373)

۱) پایین‌ترین سطح انرژی که الکترون معمولاً در آن می‌چرخد، حالت عادی برای آن الکترون است.

۲) پایین‌ترین سطح انرژی که الکترون معمولاً به آن جهش می‌کند، حالت برانگیخته برای آن الکترون است.

۳) پایین‌ترین تراز انرژی که الکترون معمولاً از آن جهش می‌کند، حالت اصلی برای آن الکترون است.

۴) پایین‌ترین تراز انرژی که الکترون معمولاً در آن قرار دارد، حالت پایه برای آن الکترون است.

199 - This method for the preparation of aldehydes requires the immediate removal of the aldehyde from the reaction medium. (1373)

۱) این روش تهیه برای آلدهیدها، مستلزم خارج‌کردن فوری آلدهید از محیط عمل است.

۲) این روش تهیه برای آلدهیدها، موجب خارج‌شدن فوری آلدهید از محیط عمل است.

۳) این روش تهیه برای تهیه آلدهیدها، مستلزم دقت زیادی برای حذف فوری آلدهید از محیط واکنش است.

۴) این روش تهیه برای آلدهیدها، موجب دسترسی سریع به آلدهید در محیط واکنش است.

200 - Obviously many more molecules are capable of effective collisions at higher temperatures. (1373)

۱) آشکارا مولکول‌های بسیاری قادرند بهم برخورد کرده و دما را به‌طور موثر بالا ببرند.

۲) آشکارا در دماهای بالاتر، مولکول‌های خیلی بیشتری قادر به برخوردهای مؤثرند.

۳) ظاهراً مولکول‌های خیلی بیشتری قادرند برخورد موثر کرده و دما را بالا ببرند.

۴) ظاهراً در دماهای بالاتر، بسیاری از مولکول‌ها به‌طور موثر به یکدیگر برخورد می‌کنند.

201 - The product of the molar concentration of ions in a nonsaturated or nonequilibrium solution, is called the ion product. (1373)

۱) حاصلضرب غلظت مولی یون‌ها در یک محلول سیرنشده یا غیرتعادلی، حاصلضرب یونی نامیده می‌شود.

۲) حاصلضرب غلظت مولار یون‌ها در یک محلول سیرنشده یا نامتعادل، حاصلضرب حلالیت نامیده می‌شود.

۳) غلظت مولی محصول در یک محلول سیرنشده یا غیرتعادلی، محصول یونی نامیده می‌شود.

۴) غلظت مولی محصول در یک محلول سیرنشده یا نامتعادل، حاصلضرب حلالیت نامیده می‌شود.

202 - The five d orbitals of central metal ion are no longer equivalent or degenerate. (1373)

۱) پنج اوربیتال d یون فلز مرکزی، دیگر اکی والان و در سطح انرژی پایین نخواهند بود.

۲) پنج اوربیتال d یون فلز مرکزی، دیگر هم‌ارز یا همتراز نیستند.

۳) پنج اوربیتال d یون مرکزی فلز، همواره هم‌ارز یا همترازند.

۴) پنج اوربیتال d یون فلز مرکزی همواره اکی‌والان و در سطح انرژی پایین خواهند بود.

203 - Statistical calculations based on quantum mechanics, show that $k_1 = \frac{kT}{h}$, where h is plank constant.

۱) محاسبه‌های احتمالات بر مکانیک‌های کوآنتومی مبتنی است و نشان می‌دهد که $K_1 = KT/h$ است که در آن K ثابت پلانک است.

۲) محاسبه‌های آماری بر مکانیک‌های کوآنتومی مبتنی است و نشان می‌دهد که $K_1 = KT/h$ است که در آنجا h ثابت پلانک است.

۳) محاسبه‌های احتمالات مبتنی بر مکانیک‌های کوآنتومی نشان می‌دهد که $K_1 = KT/h$ است، جایی که h ثابت پلانک است.

۴) محاسبه‌های آماری مبتنی بر مکانیک‌های کوآنتومی نشان می‌دهد که $K_1 = KT/h$ است که در آن h ثابت پلانک است.

در سوال‌های زیر عبارت داده شده با کدام واژه مطابقت دارد؟

D: Basic Knowledge

204 - The ease with which a particle's electron can be deformed. (1374)

1) polarity 2) polar 3) polarizability 4) polarizable

205 - A material that, when deformed, retains its new shape. (1374)

1) plastic 2) elastic 3) plastisol 4) plaster

206 - Crude, high-carbon iron produced by reduction of iron ore in a blast furnace. (1374)

1) galvanized iron 2) wrought iron 3) pig iron 4) scrap iron

207 - A type of synthetic polymer containing-Si-O chains, with organic groups and crosslinks. (1384)

1) silicone 2) silicate 3) silica 4) silicon

208 - A substance whose electrical conductivity is poor at room temperature but increases significantly with temperature. (1384)

1) silicide 2) superconductor 3) semimetal 4) semiconductor

۲۰۹ - از بین عبارت‌های داده شده کدام ترتیب از راست به چپ معانی درست کلمات زیر است:

الف) atomic number ب) atomic theory ج) chiral د) atomic weight

1) A scheme used to reproduce the electron configurations of ground states of atoms by successively filling subshells with electrons in a specific order.
2) The number of protons in the nucleus of an atom
3) The average atomic mass for the naturally occurring element
4) An explanation of the structure of matter in terms of different combinations of very small particles.
5) possessing the quality of handedness

۱) ۳ و ۵ و ۱ و ۴ ۲) ۳ و ۵ و ۴ و ۲ ۳) ۲ و ۱ و ۵ و ۳ ۴) ۲ و ۴ و ۵ و ۳

۲۱۰ - از بین عبارت‌های داده شده کدام ترتیب از راست به چپ معانی درست کلمات زیر است؟ (۱۳۸۰)

الف) chelate ب) catenation ج) catalysis د) cathode

1) The electrode at which reduction occurs.
2) A substance that increases the rate of reaction without being consumed in the overall reaction
3) The covalent bonding of two or more atoms of the same element to one another
4) A complex formed by polydenatate ligands
5) The increase in rate of a reaction as the result of the addition of a catalyst

۱) ۱ و ۵ و ۳ و ۴ ۲) ۴ و ۳ و ۵ و ۱ ۳) ۱ و ۲ و ۳ و ۴ ۴) ۴ و ۳ و ۲ و ۱

۲۱۱ - از بین عبارت‌های داده شده کدام ترتیب از راست به چپ معانی درست کلمات الف) Base ب) bonding pair ج) catalyst د) decomposition reaction است؟(۱۳۷۹)

1) Substance that produces OH^- ions when dissolved in water.
2) An electron pair being shared between two nuclei and forming a covalent bond.
3) the breaking of a compound into simpler components.
4) A substance that increases the rate of a reaction without being used up in the process.
5) A reaction in which one reactant forms two or more products.

۱) ۵ و ۴ و ۲ و ۱ ۲) ۳ و ۴ و ۵ و ۱ ۳) ۱ و ۲ و ۴و ۵ ۴) ۱ و ۲ و ۴ و ۳

۲۱۲ - از بین عبارت‌های داده شده کدام ترتیب از راست به چپ معانی درست کلمات الف) distill ، ب) ductile ج) fraction د) disperse است؟(۱۳۷۹)

1) To break up and scatter in all directions.
2) The act or process of fractionating.
3) To cause or allow to fall in drops.
4) A part separated by fractional crystallization
5) That can be stretched, drawn, or hammered thin without breaking.

۱) ۲ و ۵ و ۴ و ۳ ۲) ۳ و ۴ و ۵ و ۲ ۳) ۳ و ۵ و ۴ و ۱ ۴) ۳ و ۵ و ۲ و ۱

۲۱۳ - از بین عبارت‌های داده شده کدام ترتیب از راست به چپ معانی درست کلمات: الف) polar compound ب) molality ج) glue د) moisture است؟

1) any viscous preparation used to stick things together.
2) water that is dispered through a gas in the form of water vapor.
3) concentration given as moles per 1000g of solvent.
4) property of a physical system which has two points with different characteristics.
5) molecules which contain polar covalent bonds.

۱) ۵ و ۳ و ۱ و ۲ ۲) ۴ و ۳ و ۱ و ۲ ۳) ۲ و ۱ و ۳ و ۵ ۴) ۲ و ۱ و ۳ و ۴

۲۱۴ - از بین عبارت‌های داده شده کدام ترتیب از راست به چپ معانی درست کلمات: الف) glacier ب) precipitation ج) solidify د) erode است؟

1) make or become solid, hard or firm
2) mass of ice, formed by snow in mountains, moving slowly down a valley.
3) matter that settles to the bottom of a liquid.
4) to eat into, wear away.
5) fall of rain, sleet, snow or hail.

۱) ۱ و ۴ و ۳ و ۲ ۲) ۳ و ۵ و ۱ و ۴ ۳) ۲ و ۵ و ۱ و ۴ ۴) ۵ و ۳ و ۴ و ۱

Answer Key

پاسخ‌نامه

۱ـ گزینه ۴ صحیح می‌باشد.

سیرشدگی اسم است. معانی گزینه‌های ۱ تا ۳ به‌ترتیب فوق اشباع‌شدگی، اشباع‌شدن (فعل) و سیرشده (صفت) است.

۲ـ گزینه ۱ صحیح می‌باشد.

معانی گزینه‌ها عبارتند از:

۱) نواررسانش ۲) نوارالقا ۳) نواررسانایی

۳ـ گزینه ۲ صحیح می‌باشد.

معانی گزینه‌ها عبارتنداز:

۱) گزینش‌کردن ۲) گزینش‌پذیری ۳) گزینش ۴) انتخابگر

۴ـ گزینه ۳ صحیح می‌باشد.

معانی گزینه‌ها عبارتند از:

۱) ساختاری ۲) رسانایی ۳) القایی ۴) ساختاری

۵ـ گزینه ۴ صحیح می‌باشد.

معانی گزینه‌ها عبارتند از:

۱) تخریب ۲) چسبندگی ۳) خوردگی ۴) فرسایش

۶ـ گزینه ۲ صحیح می‌باشد.

معانی گزینه‌ها عبارتند از:

۱) همسان‌کردن ۲) همگون ۳) یک‌جورسازی ۴) تشابه، همانندی

۷ـ گزینه ۳ صحیح می‌باشد.

معانی گزینه‌ها عبارتند از:

۱) صورتبندی ۲) شکل ۳) پیکربندی ۴) آرایه

۸ـ گزینه ۳ صحیح می‌باشد.

معانی گزینه‌ها عبارتند از:

۱) قابل اشتعال ۲) قابلیت اشتعال ۳) نقطه آتش‌گیری ۴) نقطه آتش

۹ـ گزینه ۲ صحیح می‌باشد.

معانی گزینه‌ها عبارتند از:

۱) انحراف ۲) شناورسازی ۳) لخته‌شدن ۴) فلوئوردارکردن

۱۰ـ گزینه ۴ صحیح می‌باشد.

معانی گزینه‌ها عبارتند از:

۱) ستون فشرده ۲) ستون پرشده ۳) ستون پرشده ۴) ستون پرشده

توجه داشته باشید در این موارد باید اصطلاح مورد استفاده در شیمی استفاده شود.

۱۱ـ گزینه ۱ صحیح می‌باشد.

معانی گزینه‌ها عبارتند از:

۱) هدایت‌کننده پارا ۲) رسانایی پارا ۳) جهت پارا ۴) معرف پارا

۱۲ـ گزینه ۴ صحیح می‌باشد.

معانی گزینه‌ها عبارتند از:

۱) ایزومری متصل‌شدن ۲) ایزومری پیوند ۳) ایزومری اتصال ۴) ایزومری اتصال

واژه مرسوم در شیمی برای ایزومری اتصال "linkage isomerism" است.

۱۳ـ گزینه ۱ صحیح می‌باشد.

معانی گزینه‌ها عبارتند از:

۱) مرحله آغازی ۲) مرحله اول ۳) مرحله اولیه ۴) مرحله ابتدایی (نخستین)

۱۴ـ گزینه ۲ صحیح می‌باشد.

معانی گزینه‌ها عبارتند از:

۱) آرایه الکترونی ۲) آرایش الکترونی ۳) سهم الکترونی ۴) توزیع الکترونی

۱۵ـ گزینه ۱ صحیح می‌باشد.

معانی گزینه‌ها عبارتند از:

۱) سفیدکننده ۲) تمیزکننده ۳) شوینده ۴) صابون

۱۶ـ گزینه ۲ صحیح می‌باشد.

معانی گزینه‌ها عبارتند از:

۱) واکنش ساکن ۲) واکنش خودبه‌خودی ۳) واکنش فوری ۴) واکنش هماهنگ

۱۷ـ گزینه ۴ صحیح می‌باشد.

ترجمه: کوانتوم مکانیک در مقایسه با مدل دریای الکترون، برای فلزات الگوی کمی‌تری را پیشنهاد می‌کند که **نظریه نوار** نامیده می‌شود.

۱۸ـ گزینه ۴ صحیح می‌باشد.

ترجمه: گونه‌ای که در آن تمامی الکترون‌ها زوج نشده (منفرد) هستند پارامغناطیس است، بنابراین، گونه‌ای که تمام الکترون‌های آن زوج شده‌اند **خصلت دیامغناطیسی** نشان می‌دهد (diamagnetism: خصلت دیامغناطیسی)

۱۹ـ گزینه ۲ صحیح می‌باشد.

هر چیزی در عالم، مانند هوا، شیشه و سیاره که جرم و حجم دارند **ماده** نامیده می‌شود.

۲۰ـ گزینه ۱ صحیح می‌باشد.

ترجمه: **اکسیدآمفوتری** ماده‌ای است که هر دو خصلت اسیدی و بازی دارد.

۲۱ـ گزینه ۳ صحیح می‌باشد.

هیدرولیز یک استر در حضور باز **صابونی‌شدن** نامیده می‌شود.

۲۲ـ گزینه ۴ صحیح می‌باشد.

الکترولیت ماده‌ای مانند سدیم کلرید است که در آب حل می‌شوند و محلول رسانای الکتریکی می‌دهد.

۲۳ـ گزینه ۱ صحیح می‌باشد.

انرژی هرچیز **دلالت** بر توانایی‌اش برای انجام کار مکانیکی است.

۲۴ـ گزینه ۱ صحیح می‌باشد.

ترجمه: مولکول برانگیخته الکترونی انتخاب‌های زیادی دارد که یکی از آن‌ها تفکیک است.

۲۵ـ گزینه ۳ صحیح می‌باشد.

ترجمه: مترادف لغت Disintegration را انتخاب کنید.

۱) بقا ۲) تقسیم ۳) متلاشی‌شدن، شکستن ۴) تمایز

۲۶ـ گزینه ۲ صحیح می‌باشد.

ترجمه: مترادف لغت Range را انتخاب کنید.

۱) طول ۲) گستره ۳) کره ۴) بیابانی

۲۷ـ گزینه ۱ صحیح می‌باشد.

مایعی که برای استخراج یک ماده از ماده دیگر در کروماتوگرافی استفاده می‌شود **شوینده** نامیده می‌شود.

۲۸ـ گزینه ۲ صحیح می‌باشد.

همیشه باید میزان استفاده از ارقام با معنی در داده‌ها مشخص شود و محاسبات با دقت بالاتر با تعداد ارقام با معنی بیشتر تشخیص داده شود.

۲۹ـ گزینه ۲ صحیح می‌باشد.

غلظت یک ماده ناشناخته در نمونه را می‌توان با طیف‌سنجی جذب اتمی از **شدت** خطوط جذبی یا نوارها تعیین کرد.

۳۰ـ گزینه ۱ صحیح می‌باشد.

ویژگی‌های بارز الماس را می‌توان با توجه به اینکه هر اتم کربن با هیبرید sp^3 با چهار اتم کربن مجاور که آرایه منظم چهاروجهی دارند **به‌طور محکم پیوند** شده است، توجیه کرد.

۳۱ـ گزینه ۴ صحیح می‌باشد.

CO تمایل زیادی دارد که بین پیون فلز ـ آلکیل **جای گیرد** تا آسیل‌های فلزی تشکیل شود.

۳۲ـ گزینه ۲ صحیح می‌باشد.

پلیمر **فضاویژه** پلیمری است که در آن ترتیب آرایش مولکول‌ها در فضا مشابه پلی‌اتیلن هم آرایش می‌باشد.

۳۳ـ گزینه ۳ صحیح می‌باشد.

هر شیء فیزیکی که تصویر آینه‌ای آن مشابه خودش نباشد در اصطلاح **کایرال** گفته می‌شود.

۳۴ـ گزینه ۲ صحیح می‌باشد.

پیل سوختی در اصل یک باتری است اما اختلاف آن با باتری این است که بوسیله منبع پیوسته‌ای از واکنش‌گرهای فعال عمل می‌کند.

۳۵ـ گزینه ۳ صحیح می‌باشد.

طیف نشری که با **آسایش** گونه اتمیزه شده به حالت پایه‌اش ایجاد می‌شود برای آنالیز کیفی و کمی مفید است.

۳۶ـ گزینه ۱ صحیح می‌باشد.

ایزومرهای **کوئوردیناسیون** ایزومرهایی شامل کاتیون و آنیون کمپلکس می‌باشند که در لیگاندهای توزیع شده بین اتم‌های فلزی با هم متفاوتند.

۳۷ـ انرژی **فعالسازی** کمترین انرژی برخورد موردنیاز برای واکنش دو مولکول است.

۳۸ـ گزینه ۲ صحیح می‌باشد.

رادیواکتیویته تابش خودبه‌خودی از عناصر ناپایدار است.

۳۹ـ گزینه ۱ صحیح می‌باشد.

فرار اشاره به جامد یا مایعی دارد که در دماهای عادی فشار بخار به نسبت بالایی دارند.

۴۰ـ گزینه ۳ صحیح می‌باشد.

ماده‌ای که مخلوط شیمیایی دو یا چند عنصر است **ترکیب** نامیده می‌شود.

۴۱ـ گزینه ۳ صحیح می‌باشد.

صدا به شکل **موج** منتقل می‌شود.

۴۲ـ گزینه ۴ صحیح می‌باشد.

سلول واحد ساده‌ترین آرایه از نقاط است که با تکرار آن در سه بعد فضا شبکه را می‌دهد.

۴۳ـ گزینه ۳ صحیح می‌باشد.

میزان مقاومت یک مایع در برابر جاری‌شدن ویسکوزیته نامیده می‌شود.

۴۴ـ گزینه ۱ صحیح می‌باشد.

سری مشخصی از مراحل روشی که یک فرضیه را تست می‌کند **آزمایش** نامیده می‌شود.

۴۵ـ گزینه ۴ صحیح می‌باشد.

نمایش تصوری از الکترون که به سرعت موقعیت خود را در اطراف هسته با زمان تغییر می‌دهد **ابر الکترونی** می‌گویند.

۴۶ـ گزینه ۲ صحیح می‌باشد.

محلول اشباع، محلولی پایدار است که بیشترین مقدار حل‌شونده در آن حل شده است.

۴۷ـ گزینه ۱ صحیح می‌باشد.

نوری از خورشید که نمی‌تواند از جسم عبور کند **به‌وسیله‌آن جسم جذب** می‌شود.

۴۸ـ گزینه ۲ صحیح می‌باشد.

ماده‌ای که سرعت یک واکنش را افزایش داده اما در استوکیومتری واکنش شرکت نمی‌کند **کاتالیزگر** نامیده می‌شود.

۴۹ـ گزینه ۲ صحیح می‌باشد.

شتاب نامی برای **افزایش در سرعت** است.

۵۰ـ گزینه ۲ صحیح می‌باشد.

آنتالپی مخلوط‌شدن همانگونه که انتظار می‌رود برای سیستمی که در آن برهم‌کنشی **بین** ذرات وجود ندارد صفر است.

۵۱ـ گزینه ۱ صحیح می‌باشد.

اهمیت این نتیجه این است که پتانسیل‌های شیمیایی یک مخلوط بطور مستقل نمی‌تواند تغییر کند. در یک مخلوط دوتایی اگر یکی افـزایش یابـد، دیگری کاهش می‌یابد.

۵۲ـ گزینه ۴ صحیح می‌باشد.

۵۳ـ گزینه ۲ صحیح می‌باشد.

خواص شیمیایی یک الکل به‌وسیله **گروه** عاملی‌اش تعیین می‌شود.

۵۴ـ گزینه ۳ صحیح می‌باشد.

پیوند کواوالانسی کوئوردینانسی، پیوندی کووالانسی است که هر دو الکترون به‌وسیله یک اتم **داده** می‌شود.

۵۵ـ گزینه ۳ صحیح می‌باشد.

طبق **دلیل** زیر ترکیب X چه ساختاری باید داشته باشد؟

۵۶ـ گزینه ۲ صحیح می‌باشد.

همان **فرایندهایی** که در صنعت برای تهیه بیشتر فنول‌ها به‌کار برده می‌شود در آزمایشگاه نیز مورد استفاده قرار می‌گیرد.

۵۷ـ گزینه ۲ صحیح می‌باشد.

تغییر سرعت واکنش در مجاورت کاتالیزگر، **کاتالیزشدن** نامیده می‌شود.

۵۸ـ گزینه ۱ صحیح می‌باشد.

پیل **سوختی** یک منبع شیمیایی جریان است که در آن انرژی حاصل از احتراق یک سوخت به‌طور مستقیم به انرژی الکتریکی تبدیل می‌شود.

۵۹ـ گزینه ۱ صحیح می‌باشد.

در ضرب و تقسیم، عدم قطعیت **محاسبه شده** فقط مجموع عدم قطعیت‌ها در ضرایب نیستند.

۶۰ـ گزینه ۴ صحیح می‌باشد.

برم‌دارشدن آنتراسن یا فناترن در موقعیت 9 **اتفاق** می‌افتد.

۶۱ـ گزینه ۱ صحیح می‌باشد.

اتیل بنزن شامل یک حلقه بنزنی و یک شاخه جانبی **آلیفاتیک** است.

۶۲ـ گزینه ۲ صحیح می‌باشد.

اوربیتال‌های sp^2 اوربیتال‌های **هیبریدی** نامیده می‌شوند. چون از ترکیب یک اوربیتال s و دو اوربیتال p حاصل می‌شود.

۶۳ـ گزینه ۱ صحیح می‌باشد.

انرژی که باید واکنش‌دهنده‌ها برای انجام واکنش داشته باشند در اصطلاح **انرژی فعالسازی** نامیده می‌شود.

۶۴ـ گزینه ۴ صحیح می‌باشد.

محلولی با غلظت مشخص را محلول **استاندارد** می‌گویند.

۶۵ـ گزینه ۴ صحیح می‌باشد.

در این آزمایش شما موظف هستید که با **یک همکار** کار کنید.

۶۶ـ گزینه ۳ صحیح می‌باشد.

گرمای انتقال یافته در طی یک تغییر فاز که باعث تغییر در دما نمی‌شود **گرمای نهان** نام دارد

۶۷ـ گزینه ۱ صحیح می‌باشد.

حالت میانی بین محلول و تعلیق که در آن ذرات مادهٔ حل شده به اندازهٔ کافی برای پراکنده‌کردن نور بزرگ هستند اما کوچکتراز آن هستند که ته‌نشین شوند **کلوئید** نام دارد.

B . Reading Comprehension

Vocabulary Q.68 – 72

Extract	استخراج	Hamster	حیوانی شبیه موش
Herb	گیاه	Infect	تحت تأثیر قرار گرفتن
Shed	ساطع کردن	Veterinary	دامپزشکی
Collaboration	همکاری	Topically	به طور موضعی
Orally	زبان ـ دهانی	Accommodate	تطبیق دادن
Makeshift	موقتی	Claim	ادعا کردن

۶۸ ـ گزینه ۱ صحیح می‌باشد.

۶۹ ـ گزینه ۴ صحیح می‌باشد.

۷۰ـ گزینه ۴ صحیح می‌باشد.

۷۱ـ گزینه ۲ صحیح می‌باشد.

۷۲ ـ گزینه ۳ صحیح می‌باشد.

Vocabulary Q.73 – 77

solution	محلول	Capacitance	ظرفیت
solvent	حلال	Polarizability	قطبش‌پذیری
nonpolar	غیرقطبی	Permanent	دائمی
		distortion	واپیچش

۷۳ـ گزینه ۲ صحیح می‌باشد.

۷۴ـ گزینه ۳ صحیح می‌باشد.

۷۵ ـ گزینه ۴ صحیح می‌باشد.

۷۶ ـ گزینه ۱ صحیح می‌باشد.

۷۷ـ گزینه ۳ صحیح می‌باشد.

Vocabulary Q.78 – 82

Substituent	استخلاف	impart	سهم دادن، رساندن
Quantitative	کمی	Primary	اولیه
Modification	اصلاح	Transition state	حالت گذار

۷۸ـ گزینه ۱ صحیح می‌باشد.

۷۹ـ گزینه ۳ صحیح می‌باشد.

۸۰ـ گزینه ۲ صحیح می‌باشد.

۸۱ـ گزینه ۳ صحیح می‌باشد.

۸۲ـ گزینه ۴ صحیح می‌باشد.

Vocabulary Q. 83 - 90

intermolecular	بین مولکولی	chronologically	به‌ترتیب زمان
increase	افزایش	distinct	مجزا
particle	ذره	slight	جزئی، ناچیز
overcome	غلبه‌کردن	bulk	حجیم
confine	محدودکردن	surface	سطح
attraction	جاذبه	condensation	تراکم
converse	معکوس	melting	جوشش، ذوب
vapor	بخار	fusion	گداخت، جوشش، ذوب
trap	دام، تله	release	آزادسازی
mist	مه، غبار	exothermic	گرمازا
tiny	ریز	restrict	محدود
droplet	ریزقطره	endothermic	گرماگیر
delay	تأخیر	swiftly	به‌سرعت

۸۳ـ گزینه ۳ صحیح می‌باشد.

۸۴ـ گزینه ۱ صحیح می‌باشد.

۸۵ـ گزینه ۴ صحیح می‌باشد.

۸۶ـ گزینه ۲ صحیح می‌باشد.

۸۷ـ گزینه ۲ صحیح می‌باشد.

۸۸ـ گزینه ۳ صحیح می‌باشد.

۸۹ـ گزینه ۱ صحیح می‌باشد.

۹۰ـ گزینه ۴ صحیح می‌باشد.

Vocabulary 91 – 97

essential	ضروری	industrial	صنعتی
natural	طبیعی	explode	منفجرشدن
source	منبع	fertilizer	کود
abundance	فراوانی	refrigerant	سردکننده
supply	ذخیره، منبع	pharmaceutical	دارویی
manufacture	تولید	plentiful	فراوان
humble	پست، متواضع	burst	ترکیدن
storm	طوفان		

۹۱ـ گزینه ۲ صحیح می‌باشد.

۹۲ـ گزینه ۳ صحیح می‌باشد.

۹۳ـ گزینه ۱ صحیح می‌باشد.

۹۴ـ گزینه ۳ صحیح می‌باشد.

۹۵ـ گزینه ۴ صحیح می‌باشد.

۹۶ـ گزینه ۲ صحیح می‌باشد.

۹۷ـ گزینه ۴ صحیح می‌باشد.

Vocabulary Q. 98

Lattice	شبکه	hole	حفره
Dense	سنگین	distortion	انحراف
approxiamate	تقریبی	occupy	اشغال کردن

۹۸ـ گزینه ۳ صحیح می‌باشد.

vocabulary, Q 99

Dissolve	حل‌کردن	enormous	بسیار بزرگ
Marble	سنگ مرمر	relatively	به‌طورنسبی
Monuments	بناهای تاریخی	mildly	به‌طورملایم

۹۹ـ گزینه ۱ صحیح می‌باشد.

Vocabulary, Q 100

exponent	نما	quadruple	چهاربرابر
order	درجه	equation	معادله
coefficient	ضریب		

۱۰۰ـ گزینه ۳ صحیح می‌باشد.

Vocabulary, Q 101

Excellent	عالی	leaving behind	برجای‌گذاشتن
Dehydrate	آب‌زدایی	carbonaceous	ذغالی

۱۰۱ـ گزینه ۲ صحیح می‌باشد.

Vocabulary, Q 102:

Inner	داخلی	target	هدف
nuclear charge	بار هسته	unequivocal	بی‌پرده، صریح
emit	نشرکردن	pure	خالص

۱۰۲ـ گزینه ۲ صحیح می‌باشد.

Vocabulary Q 103 - 104:

favorite	مطلوب	moist	مرطوب
burn	سوختن	climatologist	اقلیم‌شناس
pollutant	آلاینده	harmful	مضر

۱۰۳ـ گزینه ۲ صحیح می‌باشد.

۱۰۴ـ گزینه ۳ صحیح می‌باشد.

Vocabulary Q, 105

Ruby	یاقوت	return	بازگشت
Initial	آغازی، اولیه	toxic	سمی
Level	تراز	radiationless	بی‌تابشی

۱۰۵ـ گزینه ۱ صحیح می‌باشد.

Vocabulary Q, 106

Aviation	هواپیمایی	hazardous	مخاطره‌آمیز
Diving	غواصی	toxic	سمی
Breathing	تنفسی	partial	جزیی
Pressure	فشار	noble gas	گاز نجیب

۱۰۶ـ گزینه ۴ صحیح می‌باشد.

Vocabulary Q, 107

Chronic	کهنه، مزمن	susceptible	تأثیرپذیر
poison	زهر، سم	expose	درمعرض قرارگرفتن

۱۰۷ـ گزینه ۳ صحیح می‌باشد.

Vocabulary Q, 108

tissue	بافت	derivative	مشتق
preservative	نگاهدارنده	nil	صفر

۱۰۸ـ گزینه ۳ صحیح می‌باشد.

Vocabulary Q, 109

Variety	تنوع	decay	زوال
Edible	خوراکی	facet	جنبه، سطح

۱۰۹ـ گزینه ۱ صحیح می‌باشد.

Vocabulary Q, 110

Consume	مصرف‌شدن	homogeneous	همگن
Operate	عمل‌کردن	heterogeneous	ناهمگن

۱۱۰ـ گزینه ۴ صحیح می‌باشد.

Vocabulary Q, 111-112

solubility	حلالیت	directly	به‌طور مستقیم
proportional	متناسب	soluble	قابل حل
interaction	برهم کنش		

۱۱۱ـ گزینه ۲ صحیح می‌باشد.

۱۱۲ـ گزینه ۴ صحیح می‌باشد.

Vocabulary Q, 113 – 116

greasy	روغنی	absorbent	جاذب
ink	جوهر	surface	سطح
paint	رنگ	rubbing	مالیدن
smooth	نرم	running	غلتاندن

۱۱۳ـ گزینه ۴ صحیح می‌باشد.

۱۱۴ـ گزینه ۲ صحیح می‌باشد.

۱۱۵ـ گزینه ۱ صحیح می‌باشد.

۱۱۶ـ گزینه ۳ صحیح می‌باشد.

Vocabulary Q, 117 – 118

instrument	دستگاه	path	مسیر
discharge	تخلیه	radius	شعاع
accelerate	شتاب‌دادن	slightly	به‌طورجزئی
beam	پرتو		

۱۱۷ـ گزینه ۴ صحیح می‌باشد.

۱۱۸ـ گزینه ۳ صحیح می‌باشد.

Vocabulary Q, 119 – 120

batch	پیمانه	packaging	بسته‌بندی
brew	دم‌کشیدن	instant	آنی، فوری
container	ظرف	prolong	طولانی‌کردن
component	جزء		

۱۱۹ـ گزینه ۴ صحیح می‌باشد.

۱۲۰ـ گزینه ۴ صحیح می‌باشد.

Vocabulary Q,121

Combination	ترکیب	chemotherapy	شیمی درمانی
Intervening	متمادی	radiation	تابش
Treatment	عملکرد، معالجه، درمان	cancer	سرطان

۱۲۱ـ گزینه ۳ صحیح می‌باشد.

Vocabulary Q, 122

Forbid	ممنوع	artificial	مصنوعی
Edge	لبه –	accidental	تصادفی، اتفاقی
Trace	ردیابی کردن	sweet	شیرین

۱۲۲ـ گزینه ۴ صحیح می‌باشد.

Vocabulary Q, 123 – 124

collision	برخورد	arrangement	آرایه
reactive	فعال	reagent	واکنشگر
participating	شرکت‌کننده	relative	نسبی

۱۲۳ـ گزینه ۴ صحیح می‌باشد.

۱۲۴ـ گزینه ۳ صحیح می‌باشد.

Vocabulary Q, 125 – 127

emphasis	تأکید	tabulate	جدول‌بندی کردن
assemble	سوارکردن، سرهم‌بندی	equilibrium	تعادل
external	خارجی	balance	توازن

۱۲۵ـ گزینه ۴ صحیح می‌باشد.

۱۲۶ـ گزینه ۳ صحیح می‌باشد.

۱۲۷ـ گزینه ۳ صحیح می‌باشد.

Vocabulary Q, 128

Substance	ماده	vaporize	تبخیرکردن
Characteristic	ویژگی	readily	به‌سهولت
Gasoline	بنزین	mothball	گلوله نفتالین
banana peeling	پوست موز	rigid	صلب

۱۲۸ـ گزینه ۴ صحیح می‌باشد.

Vocabulary Q, 129

Bond	پیوند	dissolve	حل‌شدن
Essential	ضروری	stretching vibration	ارتعاش کششی
Intact	دست‌نخورده		

۱۲۹ـ گزینه ۲ صحیح می‌باشد.

Vocabulary Q, 130

annually	سالیانه	nutrient	مواد مغذی
convert	تبدیل‌کردن	ingest	خوردن
soil	خاک	reverse	وارون، عکس
fixation	ثبات	anaerobic	بی‌هوازی
digest	هضم		

۱۳۰ـ گزینه ۲ صحیح می‌باشد.

Vocabulary Q, 131

Pungent	تند	disinfection	گندزدایی، ضدعفونی
Odour	بو	preserve	نگهداری، محافظت‌کردن
Antiseptic	گندزدا، ضدعفونی‌کننده	pickling	نمک‌سودکردن
Tanning	دباغی	sowing	کاشتن

۱۳۱ـ گزینه ۱ صحیح می‌باشد.

Vocabulary Q, 132 - 133

individual	منحصربه‌فرد	element	عنصر
isolate	جداکردن، ایزوله‌کردن	universe	جهان، عالم

۱۳۲ـ گزینه ۳ صحیح می‌باشد.

۱۳۳ـ گزینه ۳ صحیح می‌باشد.

Vocabulary Q, 134 – 136

composition	ترکیب	proess	فرایند
earth	زمین	detection	تشخیص
realize	فهمیدن	recognize	شناختن
experience	تجربه		

۱۳۴ـ گزینه ۲ صحیح می‌باشد.

۱۳۵ـ گزینه ۲ صحیح می‌باشد.

۱۳۶ـ گزینه ۴ صحیح می‌باشد.

Vocabulary Q, 137

leaving behind	برجای‌گذاشتن	quantity	کمیت
Involatile	غیرفرار	evaporation	تبخیر
Distillation	تقطیر		

۱۳۷ـ گزینه ۳ صحیح می‌باشد.

Vocabulary Q, 138

Catch	گرفتن، سرایت‌کردن	intensify	شدت
Blanket	پتو	wrapping	پیچاندن
Flame	شعله		

۱۳۸ـ گزینه ۴ صحیح می‌باشد.

Vocabulary Q, 139

Raw	خام	recycle	بازیابی
Shrink	چروک‌شدن	shrinkage	انقباض

۱۳۹ـ گزینه ۴ صحیح می‌باشد.

Vocabulary Q, 140

Surpass	عقب‌گذاشتن، بیشتربودن از	incentive	محرک
Quality	کیفیت	meticulous	موشکاف، دقیق

۱۴۰ـ گزینه ۲ صحیح می‌باشد.

Vocabulary Q, 141

Industrail	صنعتی	volatile	فرار
fractional distillation	تقطیر جزبه‌جز	converter	مبدل

۱۴۱ـ گزینه ۱ صحیح می‌باشد.

Vocabulary Q, 142

Thick	ضخامت	enamel	مینا
Saliva	بزاق	mineralization	کانه‌ای شدن
Insoluble	نامحلول		

۱۴۲ـ گزینه ۱ صحیح می‌باشد.

Vocabulary Q, 143

deplete	تهی‌کردن	versatile	متنوع
rate	سرعت	renewable	قابل تجدید

۱۴۳ـ گزینه ۳ صحیح می‌باشد.

Vocabulary Q, 144 – 146

distinct	مجزا	division	قسمت، بخش
gradually	به‌تدریج	lifeless	بی‌جان
artificial	مصنوعی		

۱۴۴ـ گزینه ۴ صحیح می‌باشد.

۱۴۵ـ گزینه ۳ صحیح می‌باشد.

۱۴۶ـ گزینه ۲ صحیح می‌باشد.

Vocabulary Q, 147

apart	جدا، غیر	copper	مس

۱۴۷ـ گزینه ۴ صحیح می‌باشد.

Vocabulary Q, 148

deay	زوال	resistant	مقاوم
diet	رژیم		

۱۴۸ـ گزینه ۲ صحیح می‌باشد.

Vocabulary Q, 149

Constituent	تشکیل‌دهنده	impurity	ناخالصی
coal tar	قطران ذغال‌سنگ	crude	خام
Whereupon	که درنتیجه آن		

۱۴۹ـ گزینه ۲ صحیح می‌باشد.

Vocabulary Q, 150

Application	کاربرد	calculation	محاسبه
Deal	ارتباط‌داشتن	adsorb	جذب سطحی
Measurement	اندازه‌گیری	immediate	فوری

۱۵۰ـ گزینه ۱ صحیح می‌باشد.

Vocabulary Q, 151

Silicon	سیلیسیم	except	به جز

۱۵۱ـ گزینه ۴ صحیح می‌باشد.

Vocabulary Q, 152

available	در دسترس	reagent	واکنشگر
Preparation	تهیه	inconvenient	نامناسب
Susceptible	حساس، تأثیرپذیر	plentiful	فراوان

۱۵۲ـ گزینه ۱ صحیح می‌باشد.

Vocabulary Q, 153

Vast	وسیع	rock	سنگ معدن
Syrupy	شیره	burning	احتراق
thick liquid	مایع غلیظ		

۱۵۳ـ گزینه ۳ صحیح می‌باشد.

Vocabulary Q, 154

Encounter	مواجه‌شدن	conversion	تبدیل
Apparatus	دستگاه، اسباب	alter	تغییردادن

۱۵۴ـ گزینه ۱ صحیح می‌باشد.

Vocabulary Q, 155

Symmetric	متقارن	octahedral	هشت وجهی
Tetrahedral	چهاروجهی	asymmetric	نامتقارن

۱۵۵ـ گزینه ۲ صحیح می‌باشد.

Vocabulary Q, 156

Optical	نوری	inactive	غیرفعال
Mould	کپک، قالب، خاک نرم	fractional	جزء به جزء
Vitalistic	حیاتی	fermentation	تخمیر
Disprove	ردکردن	spontaneous	خودبه‌خودی

۱۵۶ـ گزینه ۴ صحیح می‌باشد.

Vocabulary Q, 157

Condensation	تراکم	outlet	خروجی
wood pulp	خمیرچوب	manufacture	تولید
Waste	زاید	construction	ساختمان

۱۵۸ـ گزینه ۳ صحیح می‌باشد.

Vocabulary Q, 158 – 159

determine	تعیین‌کردن	pressure	فشار
plate	صفحه	saturated	سیرشده
coated	پوشیده شده	contact	تماس
thin	نازک	relative	نسبی
absorb	جذب‌شدن		

۱۵۸ـ گزینه ۴ صحیح می‌باشد.

۱۵۹ـ گزینه ۳ صحیح می‌باشد.

۱۶۰ـ گزینه ۴ صحیح می‌باشد.

۱۶۱ـ گزینه ۲ صحیح می‌باشد.

۱۶۲ـ گزینه ۳ صحیح می‌باشد.

۱۶۳ـ گزینه ۲ صحیح می‌باشد.

۱۶۴ـ گزینه ۱ صحیح می‌باشد.

۱۶۵ـ گزینه ۲ صحیح می‌باشد.

۱۶۶ـ گزینه ۳ صحیح می‌باشد.

۱۶۷ـ گزینه ۱ صحیح می‌باشد.

۱۶۸ـ گزینه ۲ صحیح می‌باشد.

۱۶۹ـ گزینه ۴ صحیح می‌باشد.

۱۷۰ـ گزینه ۳ صحیح می‌باشد.

۱۷۱ـ گزینه ۱ صحیح می‌باشد.

۱۷۲ـ گزینه ۲ صحیح می‌باشد.

۱۷۳ـ گزینه ۴ صحیح می‌باشد.

۱۷۴ـ گزینه ۱ صحیح می‌باشد.

۱۷۵ـ گزینه ۲ صحیح می‌باشد.

۱۷۶ـ گزینه ۲ صحیح می‌باشد.

۱۷۷ـ گزینه ۳ صحیح می‌باشد.

۱۷۸ـ گزینه ۱ صحیح می‌باشد.

۱۷۹ـ گزینه ۴ صحیح می‌باشد.

۱۸۰ـ گزینه ۴ صحیح می‌باشد.

۱۸۱ـ گزینه ۳ صحیح می‌باشد.

۱۸۲ـ گزینه ۱ صحیح می‌باشد.

۱۸۳ـ گزینه ۲ صحیح می‌باشد.

۱۸۴ـ گزینه ۱ صحیح می‌باشد.roughly به‌معنی «تقریباً» یا «حدوداً» است.

۱۸۵ـگزینه ۴ صحیح می‌باشد.

۱۸۶ـ گزینه ۲ صحیح می‌باشد.

۱۸۷ـگزینه ۳ صحیح می‌باشد.

۱۸۸ـ گزینه ۱ صحیح می‌باشد.

۱۸۹ـگزینه ۴ صحیح می‌باشد.

۱۹۰ـ گزینه ۴ صحیح می‌باشد.

۱۹۱ـگزینه ۱ صحیح می‌باشد.

۱۹۲ـگزینه ۲ صحیح می‌باشد.

۱۹۳ـ گزینه ۴ صحیح می‌باشد.

۱۹۴ـ گزینه ۲ صحیح می‌باشد.

۱۹۵ـ گزینه ۴ صحیح می‌باشد.

۱۹۶ـ گزینه ۱ صحیح می‌باشد.

۱۹۷ـ گزینه ۳ صحیح می‌باشد.

۱۹۸ـ گزینه ۴ صحیح می‌باشد.

۱۹۹ـ گزینه ۱ صحیح می‌باشد.

۲۰۰ـ گزینه ۲ صحیح می‌باشد.

۲۰۱ـگزینه ۱ صحیح می‌باشد.

۲۰۲ـگزینه ۲ صحیح می‌باشد.

۲۰۳ـگزینه ۴ صحیح می‌باشد.

۲۰۴ـ گزینه ۳ صحیح می‌باشد.

۲۰۵ـ گزینه ۱ صحیح می‌باشد.

۲۰۶ـ گزینه ۳ صحیح می‌باشد.

۲۰۷ـ گزینه ۱ صحیح می‌باشد.

۲۰۸ـ گزینه ۴ صحیح می‌باشد.

۲۰۹ـ گزینه ۴ صحیح می‌باشد.

۲۱۰ـگزینه ۲ صحیح می‌باشد.

۲۱۱ـگزینه ۳ صحیح می‌باشد.

۲۱۲ـ گزینه ۳ صحیح می‌باشد.

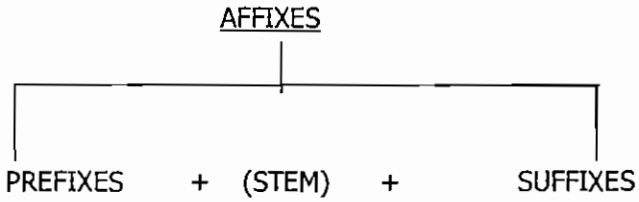
۲۱۳ـ گزینه ۲ صحیح می‌باشد.

۲۱۴ـ گزینه ۳ صحیح می‌باشد.

APPENDIX 1

SUFIXES & PREFIXES

Word formation - Suffixes



SUFFIXES

NOUNS	VERBS	ADJECTIVES	ADVERBS
-ance	-ize	-able	-ly
-once	-ate	-ible	
-or	-ty	-less	
-er	-en	-ic	
-ist	-ify	-ical	
-ness		-i sh	
		-ive	

Noun – forming suffixes

SUFFIX	MEANING	EXAMPLES
-ance	State	performance
-ence	quality of	independence
-er,or	a person who	programmer, operator
	a thing which	compiler, accumulator
-ation	the act of	execution
-tion	a person who	analyst, typist
-ist	condition of	cleanliness
-yst	action/state	conversion
-ness	activity	multiplexing
-ion	state, action	measurement
-ing	state, quality	electricity
-ment	pertaining to	electrician
-ian	condition/state	magnetism
-ism	domain/condition	freedom
-dom	condition/state	relationship, partnership,
-ship		friendship
-ary		binary

Verb – forming suffixes

SUFFIX	MEANING	EXAMLES
-ize	to make	Computerize
-ate		Automate, activate , calculate
-fy		Simplify
-en		harden, widen

Adverb – forming suffix

SUFFIX	MEANING	EXAMPLES
-ly	In the manner of	Electronically, logically, Comparably, helpfully

Adjective – forming suffixes

SUFFIX	MEANING	EXAMPLES
-al	have the quality of	Computational, logical
-ar		Circular
-ic		Magnetic
-ical		Electrical
-able	Capable of being	Comparable
-ible		Divisible
-ous	Like, full of	dangerous
-ious		Religious
-ful	Characterized by	Helpful
-less	Without	Careless
-ish	Like	Yellowish
-ed	having	Computed, punched
-ive	quality of	Interactive
-ing	to make or do	Programming coding Processing, multiplexing

Word formation - prefixes

PREFIXES

NEGATIVE AND POSITIVE	SIZE	LOCATION	TIME AND ORDER	NUMBER
Un-	Semi-	Inter-	Pre-	Mono-
Non-	Mini-	Super-	Ante-	Bi-
In-	Micro-	Trans-	Fore-	Hex-
Dis-		Ex-	Post-	Oct-
Re-		Extra-		Multi-
		mid-		

Negative an positive prefixes

PREFIX	MEANING	EXAMPLES
Negative		
un-	not,	ummagnetized, unpunched
in-	not good enough	incomplete
im-		impossible
il-		illegal
ir-		irregular, irrelevant
non-	mot connected with	non – programmable, non-impact
mis-	bad, wrong	mispronounce
dis-	opposite feeling	disagree
	opposite action	disconnect
anti-	against	antisocial
de-	reduce, reverse	demagnetize, decode
under-	too little	underestimate
positive		
re-	do again	reorganize
over-	too mich	overheat, overuse

Prefixes of size

PREFIX	MEANING	EXAMPLES
semi-	half, partly	semiconductor
equi-	equal	equidistant
maxi-	big	maxicomputer
micro-	small	microcomputer
mini-	little	minicomputer
macro-	large	macroeconomics
mega-		megabyte

Prefixes of location

PREFIX	MEANING	EXAMPLES
inter-	between, among	interface, interactive
super-	over	supersonic
trans-	across	transmit, transfer
ex-	out	exclude, extrinsic
extra-	beyond	extraordinary
sub-	under	subschema
infra	below	infra – red
peri-	around	peripheral

Prefixes of time and order

PREFIX	MEANING	EXAMPLES
ante-	before	atecedent
pre-		pefix
prime-	first	pimary, primitive
post-	after	pstdated
retro-	backward	retroactive

Prefixes of numbers

PREFIX	MEANING	EXAMPLES
semi-	half	semicircle
mono-	one	monochromatic
bi-	two	binary
tri-	three	triangle
quad-	four	quadruple
penta	five	pentagon
hex-	six	hexadecimal
septem-	seven	september
oct	eight	octal
dec-	ten	decimal
multi	many	multiprogramming, multiplexor

Other prefixes

PREFIX	MEANING	EXAMPLES
pro-	for	program
auto	self	automatic
co-	together	coordinate
neo-	new	neoclassical
pan-	all	pan - American

Prefixes

A. With the meaning "not"

Prefixes (un-, im-, in-, it-, it-, and dis-) are often used to give adjectives (and some verbs and nouns) a negative meaning. Here are common examples:

Happy	Unhappy	Like (v.)	Dislike (v.)
Possible	Impossible	Legal	Illegal [against the law]
Correct	Incorrect	regular	Irregular, e.g., irregular verbs

un- is used with many different words, e.g., unfriendly, unable, unemployed [without a job], unreasonable, unknown.

im- is used before some words beginning with m or p, e.g., impolite [rude], impatient [someone who is impatient wants things to happen now; they cannot wait].

il- is used before some words beginning with 1, e.g., illegible [cannot be read because the writing or the copy is very bad].

ir- is used only before words beginning with r, e.g., irresponsible.

dis- is used before some adjectives, e.g., dishonest, and a few verbs, e.g., dislike, disagree.

in- is used before a limited number of words, e.g., invisible [cannot be seen].

Note: A prefix does not usually change word stress, e.g., happy/unhappy; possible/impossible.

B. Verb prefixes: un- and dis

These prefixes have two meanings: They can have a negative meaning (as above), but they can also mean "the opposite of an action" or "to reverse an action."

I locked the door when I left, but then I lost the key, so I couldn't unlock it. I had to pack my suitcase [put clothes, etc., in it] very quickly, so when I unpacked [took everything out] at the hotel, most of my clothes looked terrible.

The plane appeared in the sky, then suddenly disappeared behind a cloud.

In the morning you get dressed [put on your clothes]. Before you go to bed, you get undressed [take off your clothes].

C. Other verb prefixes with specific meanings

Re- [again] My homework was all wrong, so I had to redo it.

The store closed down, but it will reopen next month. I failed my exam, but I can retake it next year.

Over – [too much] You can get a stomachache from overeating.

I went to bed late and overslept this morning. [slept too long] The cashier overcharged me. [charged me too much money].

Mis – [badly or incorrectly] I'm sorry, but I misunderstood what you said. Two of the students misread the first question. A lot of people misspell the word misspell.

Noun suffixes

A. Verb + suffix

Many nouns are formed by adding a suffix to a verb.

Verb	Suffix	*Noun*
improve [get better]	-ment	Improvement
manage [e.g., a store or business]	-ment	management
elect [choose somebody by voting]	-ion	information, election
discuss [talk about something seriously]	-ation	administration
administer [manage a company, government, etc.]	-ing	spelling
spell [e.g., S-P-E-L-L]		

Note: Sometimes there is a spelling change, for example, the omission of the final e before the suffixes -ion and -anon: organize - organization; translate - translation.

B. Adjective + suffix

Nouns are also formed by adding a suffix, such as -ness or -ity, to an adjective. Notice that the y changes to **i** before the suffix -ness: happy - happiness.

Adjective	Suffix	Noun	weakness
weak [strong]	-ness	darkness	happiness
dark [e.g., at night, when you can't see]	-ness	stupidity	punctuality
happy	-ness	similarity	
stupid [" intelligent, smart]	-ity		
punctual [always arrives on time]	-ity		
similar [almost the same; different]	-ity		

C. -er, or , and – ist

These common noun suffixes, added to nouns or verbs, describe people and their occupations. Notice the common spelling changes: translate - translator, economy - economist, psychology - psychologist.

-er	-er	-or	-ist
dancer	driver	actor	artist
singer	manager	director	economist
teacher	writer	translator	psychologist
farmer	employer	operator	journalist

Eight Keys to Vocabulary Building

1 . Read as much as you Can

By reading as many related texts (books, journals, reports, etc.) as you can will encounter new words and technical terms. You can. guess the meanings of many of these words by their context - that is, you will get a clue to the meaning from the words that surround the new word. If you are still not sure, you can look up the word in an appropriate dictionary to check if you were right

2. Use a dictionary

Buy a good comprehensive dictionary , preferably a university - level dictionary along with a dictionary of scientific and technical terms. The dictionary should he all in English, not a bilingual one. A good dictionary should include the following , information about a word

-its pronunciation

-its part of speech (noun, adjective, verb)

-a clear, simple definition

- an example of the word used in a sentence or phrase (if necessary)

-its origin (roots, prefix)

You can also use a pocket dictionary if you travel back and forth to classes.

3. Learn roots, prefixes, and suffixes

Roots and prefixes from Latin and Greek make up many English words. It has been estimated that more than half of all English words come from Latin and Greek. Prefixes are added to the beginning of a root and suffixes are added to the end to modify the meaning of words. Learning these will help you increase your vocabulary.

4. Learn from listening

Listening to good programs on the radio and television as well as to people "who speak English well is another way of improving your vocabulary. Since you cannot always ask the speaker to tell you what a particular word means. write down the words and look them up later.

5. use a dictionary of synonyms and antonyms

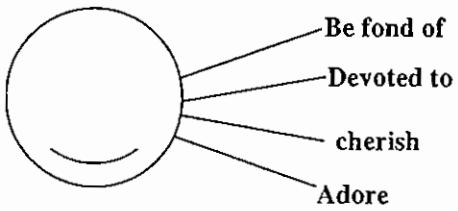
Synonyms are words that have almost the same meaning; antonyms are words that have almost the opposite meaning Knowing the synonyms and antonyms of a word %v ill expand your vocabulary. Some dictionaries of synonyms and antonyms explain each synonym and how it differs in meaning for other synonyms. Since no two words have the exact same meaning this is very useful for \ you.

6. Make your own word list

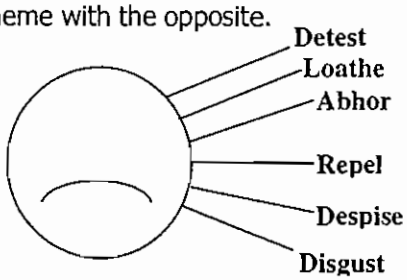
Get a notebook for your vocabulary study and use it to create your own word list. Whenever you read and come across a word you don't know, write it down in your notebook together with the sentence in which you found it. try to work out the meaning of the word from its context. Then look the word up in a dictionary and "write the definition in your notebook. Also write down any other information such as the root of the word, and see how it is connected to the meaning. Lastly , write your own sentence using the word. Writing will help you remember the word and its meaning. Try to add a new word to your list every day.

7. Create your own theme groups

Words are easier to remember and learn when you group words with similar meanings under a theme. For example,



Then you can make another theme with the opposite.



8. Use your new words

Using your new words whether it be in speaking or writing is an important step in learning them.

طبقه بندی سؤالات درک متن

۱- سؤالات کلی درباره متن (Overview questions)

- سؤالات ایده اصلی (Main idea questions)

از ما می خواهند تا مهمترین ایده متن را مشخص کنیم.

سؤالات نمونه:

Sample Questions:

▶What is the main idea of the passage?

▶The primary idea of the passage is .....

▶Which of the following best summarizes the author's main idea?

- سؤالات موضوع اصلی متن

این نوع سؤالات می پرسند که متن درباره چیست.

سؤالات نمونه:

Sample Questions:

▶The main topic of the passage is .....

▶What does the passage mainly discuss?

▶The passage is primarily concerned with .....

MAIN PURPOSE QUESTIONS: ask why an author wrote a passage.

Sample Questions:

▶The author's purpose in writing is .....

▶What is the author's main purpose in the passage?

▶The main point of this passage is .....

▶Why did the author write the passage?

Sample Answer Choices

To define ..... .

To relate ..... .

To discuss .....

To purpose .....

To illustrate .....

To support the idea that ..... .

To distinguish between..... and ..... .

To compare ..... and ..... .

تذکر: به سؤالات کلی در باره متن پس از اینکه به سایر سؤالات پاسخ دادید بپردازید چون‌که در این صورت شما اطلاعات لازم را در مورد متن خواهید داشت.

۲- سایر سؤالات کلی درباره متن

- **سؤالات لحن کلام نویسنده(TONE QUESTIONS)**

این نوع سؤالات از ما می خواهند تا احساس نویسنده را در باره موضوع متن با توجه به نوع زبانی که در نوشتن به کار برده است، مشخص کنیم. این احساس می تواند مثبت، منفی، و یا بی تفاوت باشد.

نمونه سؤالات

Sample Questions:

What tone does the author take in writing this passage?

The tone of this passage could best be described as _____.

نمونه پاسخ به سؤالات لحن کلام

Sample Answer Choices:

Positive = مثبت / Favorable = موافق / Optimistic= خوش بین / Amused = خوشحال / Pleased= خرسند

Respectful = متواضع / Humorous = شوخ / Negative = منفی / Critical = منتقد / Unfavorable = مخالف

Angry = عصبانی / Defiant = ستیزه جو / Worried = نگران / Outraged = توهین آمیز / Neutral = بی طرف

Objective = واقع گرا / Impersonal = بی غرض

تمرین ۳ـ۱

متن زیر را بخوانید و آنگاه با استفاده از روش زیر به سؤالات متن پاسخ دهید.

C	I	X	G	S
Correct	Irrelevant	Incorrect	Too General	Too Specific
درست	نامربوط	نا درست	بسیار کلی	بسیار خاص

اولین تمرین به عنوان نمونه انجام شده است.

There are two main types of cell division: Most cells are produced by a process called mitosis. In mitosis, a cell divides and forms two identical daughter cells, each with an identical number of chromosomes. Most one-celled creatures reproduce by this method, as do most of the cells in multi-celled plants and animals. Sex cells, however, are formed in a special type of cell division called meiosis. This process reduces the number of chromosomes in a sex cell to half the number found in other kinds of cells. Then, when sex cells unite, they produce: a single cell with the original number of chromosomes.

1 - What is the main topic of this passage?

_____S_____ (A) The method by which one-celled organisms reproduce

_____C_____ (B) A comparison between mitosis and meiosis

_____X_____ (C) Meiosis the process by which identical cells are produced

The last gold rush belongs as much to Canadian history as it does to American. The discovery of gold along the Klondike River, which flows from Canada's Yukon Territory into Alaska, drew some 30.000 fortune hunters to the north. The Yukon became a territory and its capital of the time Dawson, would not have existed without the gold rush. The gold strike furnished material for a dozen of Jack London's novels: it inspired Robert Service to write "The Shooting of Dan McGrew" and other poems and it provided the background for the wonderful Charlie Chaplin movie, *The Gold Rush*. It also marked the beginnings of modern Alaska.

2 - This author's main purpose in writing is to _____.

_____ (A) discuss the significance of mining in Canada and the United states

_____ (B) show the influence of the Klondike gold strike on the creative arts

_____ (C) point out the significance of the Klondike gold strike

پاسخ:

2	
A.	I
B.	S
C.	C

The keystone arch was used by almost every early civilization. To build a keystone arch stones are cut so that the opposite sides taper toward each other slightly. The upper and lower surfaces are canoed so that when several stones are placed side by side, the upper and lower surfaces meet in smooth, continuous curves.

Some form of scaffolding is built under the arch and shaped to accept the curved underside of the stones. Then the stones are fined in place one by one. The keystone is the top center stone the last to be dropped into position. Afterwards, the scaffolding is removed and the arch is self-supporting.

3 - The passage mainly concerns

_____ (A) the basic principles of building keystone arches

_____ (B) the uses of arches in modern architecture.

_____ (C) the role of scaffolding in building keystone arches

پاسخ:

3	
A.	C
B.	G
C.	S

Circumstantial evidence is evidence not drawn from the direct observation of a fact. If, for example, there is evidence that a piece of rock embedded in a wrapped chocolate bar is the same type of rock found in the vicinity of the candy factory. and that rock of this type is found in few other places then there is circumstantial evidence that the stone found its way into the candy during manufacture and suggests that the candy maker was negligent. Despite a popular notion to look down on the quality of circumstantial evidence it is of great usefulness if there is enough of it and if it is properly interpreted. Each circumstance taken singly may mean little, but a whole chain of circumstances can be as conclusive as direct evidence.

4 - What is the main idea of the passage?

_____ (A) A manufacture's negligence can be shown by direct only.
_____ (B) Enough circumstantial evidence is as persuasive as direct evidence.
_____ (C) Circumstantial evidence can be very useful in service.

پاسخ:

4	
A.	X
B.	C
C.	G

تمرین ۳ـ۲

به سؤالات درک متن پاسخ دهید.

While fats have lately acquired a bad image, one should not forget how essential they are. Fats provide body's best means of storing energy far more efficient energy sources than either carbohydrates or proteins. They act as insulation against cold, as cushioning for the internal organs, and as lubricants. Without fats, energy would be: no way to utilize fat soluble vitamins. Furthermore, some fats contain fatty acids that contain necessary growth factors and help with the digestion of other foods.

An important consideration of fat intake is the ratio of saturated fats to unsaturated fats. Saturated fats, which are derived from dairy products, animal fats, and tropical oils, increase the amount of cholesterol in the blood. Cholesterol may lead to coronary heart disease by building up in the arteries of the heart. However, unsaturated fats, derived from vegetable oils, tend to lower serum cholesterol if taken in a proportion twice that of saturated fats.

The consumption of a variety of fats is necessary, but the intake of too much fat may lead to a variety of health problems. Excessive intake of fats, like all nutritional excesses, is to be avoided.

1 - The main idea of the first paragraph is that

_____(A) fats have a bad image
_____(B) fats serve important functions in the body
_____(C) fats store food more efficiently than proteins or carbohydrates

2 - What is the main idea of the second paragraph?

_____ (A) Unsaturated fats may reduce cholesterol levels.

_____ (B) The consumption of any type of fat leads to heart disease.

_____(C) Fats taken in the proper proportion may reduce serum cholesterol.

3 - The main idea of the third paragraph is that

_____ (A) people are eating less and less fat today

_____ (B) fats should be gradually eliminated from the diet

_____ (C) excessive consumption of fats may be dangerous to one's health

4 - With which of the following is the whole passage primarily concerned?

_____ (A) The role of fats in human health

_____ (B) The dangers of cholesterol

_____ (C) The benefits of fats in the diet

_____ (D) The importance of good nutrition

پاسخ:

1.	B
2.	C
3.	C
4.	A

۳- سؤالات اطلاعاتی (Factual questions)

این نوع سؤالات اطلاعاتی را در مورد متن می پرسند. این سؤالات معمولا با کلمات پرسشی از قبیل: *who, what, when, where, why, how much, ...* شروع می شوند.

۴- سؤالات منفی (Negative Questions)

این نوع سؤالات از ما می پرسند که کدامیک از گزینه ها در متن نیامده است. این نوع سؤالات دارای کلماتی از قبیل: NOT, EXCEPT, or LEAST هستند که اغلب با حروف بزرگ نو شته می شوند.

سؤالات نمونه

Sample questions:

According to the passage, all of the following are true **EXCEPT**

Which of the following is **NOT** mentioned in the passage?

Which of the following is the **LEAST** likely _____.

تمرین ۳ـ۳

در تمرین زیر محل پاسخ را در متن با ذکر شماره سطر مشخص کنید.

Antlers grow from permanent knoblike bones on a deer's skull. Deer use their antlers chiefly to fight for mates or for leadership of a herd. Among most species of deer, only the males have antlers, but both male and female reindeer and caribou have antlers. Musk deer and Chinese water deer do not have antlers at all.

Deer that live in mild or cold climates lose their antlers each winter. New ones begin to grow the next spring. Deer that live in tropical climates may lose their antlers and grow new ones at other times of year.

New antlers are soft and tender. Thin skin grows over the antlers as they develop. Short, fine hair on the skin makes it look like velvet. Full-grown antlers are hard and strong. The velvety skin dries up and the deer rubs the skin off by scraping its antlers against trees. The antlers fall off several months later.

The size and shape of a deer's antlers depend on the animal's age and health. The first set grows when the deer is from 1 to 2 years old. On most deer, the first antlers are short and straight. As deer get older, their antlers grow larger and form intricate branches.

1. How do deer primarily use their antlers? 1-2
2. In what way are reindeer and caribou different from other types of deer? _____
3. When do deer that live in temperate climates begin to grow their antlers? _____
4. According to the article, which of the following does the skin on deer's antlers most closely re resemble? _____
5. Which of the following factors influences the size and shape of a deer's antlers?___
6. At what age do deer get their first antlers? _____
7. What happens to deer's antlers as the deer grow older? _____

تمرین ۳ـ۴

متن های زیر را بخوانید و به سؤالات درک متن پاسخ دهید.

Dulcimers are musical instruments that basically consist of wooden boxes with strings stretched over them. In one form or another, they have been around since ancient times, probably originating with the Persian santir. Today there are two verities: the hammered dulcimer and the Appalachian, or mountain dulcimer. The former is shaped like a trapezoid has two or more strings and is played with wooden mallets. It is the same instrument played in a number of Old World countries. The Appalachian dulcimer is classified by musicologists as a box zither. It is a descendant of the Pennsylvania Dutch scheitholt and the French epinette. Appalachian dulcimers are painstakingly fashioned by artisans in the mountains of West Virginia, Kentucky, Tennessee and Virginia. These instruments have three or four strings and are plucked with quills or the fingers. They are shaped like teardrops or hourglasses. Heart-shaped holes in the sounding board are traditional. Most performers play the instruments while seated with the instruments in their laps, but others wear them around their necks like guitars or place them on tables in front of them. Originally used to play

dance music, Appalachian dulcimers were popularized by performers such as John Jacob Niles and Jean Ritchie during the folk music revival of the 1960s.

1 - According to the passage a hammered dulcin1er is made in the shape of

_____ (A) an hourglass
_____ (B) a heart
_____ (C) a trapezoid
_____ (D) a teardrop

2 - According to the passage which of the following is NOT an ancestor of the Appalachian dulcimer?

_____ (A) the box zither
_____ (B) the santir
_____ (C) the scheitholt
_____ (D) the epinette

3 - According to the passage, how many strings does the Appalachian dulcimer have?

_____ (A) one or two
_____ (B) three or four
_____ (C) four or five
_____ (D) six or more

4 - According to the author most performers play the Appalachian dulcimer

_____ (A) while sitting down
_____ (B) with the instrument strapped around their neck
_____ (C) while standing at a table
_____ (D) with wooden hammers

5 - According to the author, what are *John* Jacob Niles and Jean Ritchie known for?

_____ (A) playing dance music on Appalachian dulcimers
_____ (B) are artisans who design Appalachian dulcimers
_____ (C) helped bring Appalachian dulcimers to the public's attention
_____ (D) began the folk music revival of the 1960s

6 - Where in the passage does the author describe the hammered dulcimer?

_____ (A) lines 1-2
_____ (B) lines 3-4
_____ (C) lines 4-5
_____ (D) lines 8-10

A

Aberration	انحراف
Aufbau method	روش بناگذاری آفبا
Ab initio introduction	مقدمه ریشه‌ای
Abelian group	گروه آبلی
Aberration	انحراف
Abnormal	غیرعادی
Abrasion	سایش، ساییدگی
Absolute	مطلق
Absolute deviation	انحراف مطلق
Absolute humidity	رطوبت مطلق
Absolute uncertainty	عدم اطمینان مطلق
Absorbance	جذب
Absorbent	جاذب
Absorptivity	ضریب جذب
Abstraction	ربایش
Abundance	فراوانی
Accelerant	ماده تسریع‌کننده
Acceptor	پذیرنده
Accommodation	تطابق، همراهی
Account	شرح، علت
Accumulate	انباشتن، جمع کردن
Accumulator	انبار، باطری، مخزن
Accuracy	صحت
Acerbity	ترشی
Acerous	سوزنی
Acetify	سرکه‌ای شدن
Achiral	ناکایرال
Actinoides	اکتینوئیدها
Activated complex	کمپلکس‌فعال شده
Activated sludge	سیستم لجن فعال‌شده
Activity	فعالیت
Actual yield	بازده حقیقی
Addition reaction	واکنش افزایشی
Adduct	ترکیب افزایشی
Adiabatic demagnetization	مغناطیس‌زدایی آدیاباتیک
Adjacent charge rule	قاعده، بار، مجاور
Adsorption	جذب سطحی
Affinity	میل ترکیبی
Agglomerate	به هم چسبیدن، جوش آتشفشانی
Aggregate	توده، متراکم
Aging	پیرسازی، زمان‌دادن
Agitate	به‌هم‌زدن
Air damper	خفه‌کن هوایی
Alicyclic	زنجیری، حلقه‌ای سیرشده
Alkali metal	فلز قلیایی
Alkylated agent	عامل آلکیل‌دهنده
Allotrope	آلوتروپ، همشکل
Allowed transitions	انتقالات مجاز
Alloy	آلیاژ
Alpha decay	زوال آلفا
Alpha particle	ذره آلفا
Alter	تغییردادن
Alternant	یک درمیان
Ambidentate	دوسر دندانه

Acicular	سوزنی
Acidity	قدرت اسیدی
Actinides	اکتینیدها
Actino	تابش
Amplifier	تقویت‌کننده
Amplitude	دامنه
Analogy	شباهت
Analyte	جسم مورد تجزیه، آنالیت
Analytical	تجزیه‌ای
Analyzer	کافنده، تجزیه‌گر
Analyzer prism	منشورکافنده
Anchimeric assistance	کمک همسایه
Angle strain	کشش زاویه‌ای
Angular dispersion	پاشندگی زاویه‌ای
Angular momentum	اندازه حرکت زاویه‌ای
Anhydide	بی‌آب
Anisotropy	ناایزوتروپی
Annealing	تابکاری
Anodizing	آندی‌کردن
Anomalous dispersion	پاشندگی بی‌هنجار
Anti acid	آنتی‌اسید، ضد ترشح معده
Anti elimination	حذف آنتی
Antibonding	ضدپیوندی
Anticodon	پادرمز ژنتیکی
Antiparallel	ضدموازی
Antiparticle	پادذره
Antrafacial	دورخی
Aperture	روزنه
Approximate	تقریبی

Amorph	بی‌شکل
Amorphous	بی‌شکل، بی‌ریخت
Amphiprotic	دوخصلتی
Ampholyte	خنثی
Aromaticity	آروماتیستی
Aryl radical	رادیکال آریل
Ascending chromatography	کروماتوگرافی صعودی
Ascends	بالارفتن
Assay	عیارگری، سنجش
Associative law of multiplication	قانون شرکت‌پذیری ضرب
Associative process	فرایند پیوستی
Asymmetric	نامتقارن
Asymptitic saturation	اشباع‌شدگی مجانبی
Atactic	بی‌آرایش
Atomization	اتم‌سازی
Atomizer	افشانه، اتم‌ساز
Attaining	رسیدن
Attenuator	تضعیف‌کننده
Attraction	جاذبه
Auger electron spectroscopy	طیف‌سنجی الکترون اوژه
Automation	خودکارسازی
Autoprotolysis	خودپروتون کافت
Average	متوسط، میانگین
Azeotrope	همجوش

Aprotic solvent	حلال بی‌پروتون
Aqueous	آبی
Arc process	فرایند قوس الکتریکی
Argentometric method	روش نقره‌سنجی
Arithmetic mean	میانگین حسابی
Aromatic compound	ترکیب آروماتیک

B

Back titration	تیترکردن معکوس
Back bonding	پیوندبرگشتی
Background radiation	تابش زمینه‌ای
Band	نوار
Band theory	نظریهٔ نوار
Band width	عرض نوار
Barrier layer cell	سلول لایهٔ سدی
Barry center	مرکز ثقل
Base dissociation constant	ثابت تفکیک باز
Base line method	روش خط مبنا
Basicity	قدرت بازی
Basketlike arrangement	آرایش باز یا سبد مانند
Batch process	فرایندپیمانه‌ای، فرایند خزینه‌ای
Bathochromic shift	جابه‌جایی به طرف طول موج بلندتر
Beam	پرتو
Bending	خمش
Benefication	تغلیظ
Bent	خمیده
Bidentate	دو دندانه
Binary compound	ترکیب دوتائی
Binding curve	منحنی اتصال
Binding energy	انرژی وابستگی
Blend	مخلوط، ترکیب
Blue shift	جابه‌جایی آبی
Boat conformation	صورتبندی قایق
Body centered cubic	مکعبی مرکز پر
Boiler	دیگ، دیگ بخار
Boiling point	نقطه جوش
Bolometer	بولومتر
Bolometer	هواسنج
Bond angle	زاویه پیوندی
Bond distance	طول پیوند
Bond order	درجه پیوند
Bonding pair	زوج پیوندی
Bound	محدودشده
Branched chain structure	ساختار زنجیری شاخه‌دار
Breathing vibration	ارتعاش تنفسی
Breeder reactor	واکنشگاه زایا
Bridging	پلساز
Brine	آب نمک، نمک‌سودکردن
Brittleness	شکنندگی
Bronsted acid	اسید برونستد
Bronsted base	باز برونستد
Brute	جانور

Bubble point	نقطه حباب
Buffer capacity	ظرفیت بافر
Buffer solution	محلول بافر
Buffered supporting electrolyte	الکترولیت کمکی بافری
Buret	بورت
Burner	مشعل
Bio molecule	زیست مولکول
Biogenesis	زیست ساخت
Biomass	زیست توده
Biosynthesis	زیست سنتز
Bituminous	قیر طبیعی
Bivariant	دومتغیری
Black body	جسم سیاه
Blank	شاهد
Blast furnace	کوره بلند

C

cermet	سرامیک‌های فلزی
Charcoal	زغال چوب
Chain initiation	آغازگر زنجیری
Chain termination	مرحله پایان زنجیر
Chair form	فرم صندلی
Chalk	گل سفید، گچ، کلسیم
Chamber	محفظه، اتاقک
Chamotte	شاموت، آجرنسوز
Change	تغییر
Character	خصلت، ویژگی
Charge	بار
Charge transfer	انتقال بار
Check	کنترل
Check sample	نمونه شاهد
Check value	شیر یکطرفه
Chiller	سردکننده
Chopper	قطع‌کننده (ساطور)
Chromatic	رنگی
Chrome alum	زاج کروم
Cable	کابل
Cage compounds	ترکیب‌های قفسی
Cake	لایه، قشر
Calcination	تکلیس، کلسینه‌کردن
calculation	محاسبه
Calendering	اطوزنی، غلتک‌زنی
Calibrate	مدرج‌کردن
Caloric value	ارزش حرارتی
Calorimeter	گرماسنج
Can	ظرف، حلب
Candle	شمع
Canjugate	مزدوج
Cap	کلاهک، پوشش، درپوش
Capacitance	ظرفیت
Capillary	مویین
Capillary imbitition	نفوذمکشی موئی
Capped octahedron	هشت‌وجهی، کلاهک‌دار
Capture	ربایش، به دام انداختن
Carbocyclic compound	ترکیب حلقوی کربن

Chromophore	رنگ‌زا
Chronological	ترتیب‌زمانی
Cinder	تفاله
Circuit	مدار
Circular	چرخشی
Circular dichroism	دورنگ‌نمایی دورانی
Clad	پوشش
Clamp	گیره
Clarification	تصفیه
Clarify	تصفیه‌کردن
Clathrate	کلاترات، اندرون‌گیر
Clay	خاک‌رس
Compounding	ربط‌دادن
Compress	فشردن، متراکم‌کردن
Compressible	تراکم‌پذیر
Compressor	
Comproportionation	نامتناسب
Concave	مقعر
Concentration	غلظت
Concentric	متحدالمرکز
Concerted	همزمان، پیوسته
Concidence	انطباق
Concrete	بتن
Condensation	تراکم
Conductance	رسانایی
Conductor	رسانا
Cone	مخروط
Confidence interval	فاصله اطمینان
Configuration	پیکربندی
Confine	تنگ، محدود

Carbon black	دوده
Carbonaceous	ذغالی، ذغال‌دار
Carcinogen	سرطانزا
Carding	ریسندگی
Carrier	حامل
Cascade	متوالی
Cast iron	چدن
Casting	ریخته‌گری
Catalysis	کاتالیست کردن
Catalyst	کاتالیست
Centrifugal	گریز از مرکز
Centripetal	جذب به مرکز
Cleavage	گسستن
Cleft	شکاف
Climate	مکعبی، آب و هوا
Close packed cubic	انباشته‌ترین فشردگی
Cloud	ابر
Cluster	خوشه
Co current	هم‌جهت
Coal tar	قطران ذغال‌سنگ
Coalescence	به‌هم‌پیوستگی، جوش‌خوردن
Coating	پوشش‌دادن
Cock	شیر معمولی
Coefficient	ضریب
Cofactor	کوفاکتور، عامل کمکی
Cohesion	چسبندگی
Collaboration	فروریختن، آمیخته‌شدن
Collection	مجموعه
Collision	برخورد
Color	رنگ

Conformation	صورت‌بندی
Connection	اتصال
Conrotation	چرخش‌هم‌جهت
Consecutive	پی‌درپی
Conservation law	قانون بقا
Constant	ثابت
Constituent	جزء سازنده، تشکیل‌دهنده
Constructive interference	تداخل سازنده
Consumption	مصرف
Contact angle	زاویه تماس
Container	ظرف
Contamination	آلودگی
Continuous	پیوسته
Critical	بحرانی
Cross current	متقاطع
Cross link	اتصال عرضی
Crown ether	اتر تاجی
Crucible	بوته
Crude	سنگ معدن خام
Crude oil	نفت خام
Crush	شکستن، خردکردن
Crust	پوسته، قشر جامد
Cryogenie	سرمازایی
Crystal	بلور
Cube	مکعب
Cubic	مکعبی
Cumulated	پی‌درپی، مجاور
Current	جریان
Curvature	انحنا
Curve	منحنی

Colorimertry	رنگ‌سنجی
Combination	ترکیب
Combine	ترکیب‌دادن
Combustion	احتراق
Commutative	تعویض‌پذیر
Compact	فشرده
Compartment	قسمت
Compass	قطب‌نما
Compatibility	سازگاری
Compensation	جبران، خنثی‌کردن
Component	خرد، جزء، ذره
composite	ترکیبی
Composition	ترکیب
Contour	تراز
Contraction	انقباض
Contuse	یک در میان
Convection	جابه‌جایی، همرفت
Convergence	همگرایی
Conversion	تراکم
Convert	تبدیل
Converter	مبدل
Convex	محدب
Conveyor	نقاله
Coolant	سردکننده
Coordinates	مختصات
Coordinative	نیمه‌قطبی
Coplanar	همسطح
Copper	مس
Coppering	آب مس‌دادن
Coprecipitation	هم رسوبی

Core	هسته، مغزه
Correction factor	ضریب تصحیح
Correlation	همبستگی،ارتباط
Correspondence	سازگاری، وابستگی
Corrosion	خوردگی
Corrosive	خورنده
Cotton	پنبه
Counter	شمارنده
Counter current	جریان ناهمسو، متقابل
Counting	شمارش کردن
Couple	زوج، جفت
Coupling	کوپلاژ، جفت‌شدن
Cover	سرپوش
Cracking	شکستن
Cutting	پریدن، تراشیدن
Cycle	چرخه
Cyclic	حلقوی
Cycloaddition reaction	واکنش حلقه‌زایی

D

Dendrimer	درخت‌سان
Damp	مرطوب
Damper	ضربه‌گیر، خفه‌کن
Dark current	جریان تاریک
Dative bond	پیوند داتیو
Deactivation	غیرفعال‌سازی
Decant	لبریز کردن
Decay	زوال، تباهی
Decimal	اعشاری
Decompose	تجزیه‌شدن
Decontamination	آلودگی زدایی
Decrease	کاهش
Defect	نقص
Deflection	انحراف، خمش
Dew point	نقطه شبنم، نقطه میعان
Dextrogyric	راست‌گردان
Diagonal	قطری
Dial	صفحه مدرج
Diamagnetic	دیامغناطیس
Diamagnetism	دیامغناطیسی
Diamond	الماس
Dichroism	دورنگ نمایی
Diffraction	پراکندگی، پراش
Diffuse	پراکندن
Diffusion	نفوذ، پخش
Digestion	هضم
Digit	رقم
Dilation	انبساط

Diluent	رقیق‌کننده
Dilute	رقیق
Dimension	بعد
Dipolar	دوقطبی
Direct	مستقیم
Direction	جهت
Discharg tube	لامپ خلاء
Discharge	تخلیه
Discharge potential	پتانسیل احیاء
Discrete	مجزا، گسسته
Discrimination	تمایز، تبعیض
Disinfectant	ماده گندزدا
Disintegration	تجزیه، تلاشی
Dislocation	جابه‌جایی
Dislodge	خارج‌کردن، درآوردن
Disorder	بی‌نظمی
Disperse	منتشرشدن، تجزیه کردن
Dispersion	پراکندگی، پاشیدگی
Donor	دهنده
Dope	ماده بهساز
Dopping	دوپینگ
Doppler effect	اثر داپلر
Downfield	میدان پایین
Drilling	حفاری، سوراخ‌کردن
Drip	چکاندن
Dropper	قطره‌چکان
Ductility	قابلیت مفتول‌شدن
Durability	پایداری، دوام
Dust	گرد و غبار
Dyad	عنصر دوظرفیتی

Deform	تغییرشکل‌دادن
Degasify	گاززدایی
Degeneracy	چندگانگی
Dehydrated	آب‌زدایی
Delay unit	عامل تأخیر
Delocalization Design	عدم استقرار
Desorption	واجذب
Design	طراحی کردن
Detect	آشکارکردن
Detector	آشکارساز
Detergent	شوینده
Deterioration	فساد
Detinning	قلع‌زدایی
Developer	دوای ظهور
Developing	ظهور
Deviation	انحراف
Device	دستگاه، وسیله
Devitrification	کدرکردن
Displacement	جابه‌جایی
Disposal	دفع
Dissociation	تفکیک
Distillation	تقطیر
Distortion	انحراف، واپیچش
Distribution	توزیع
Disturbance	اختلال
Ditch	کانال
Divergent	واگرا
Diversion plate	صفحه انحرافی
Diving	غواصی
Division	بخش، تقسیم

Dodecahedron	دوازده وجهی
Domain	حوزه، ناحیه
Dye	رنگ
Dystetic mixture	مخلوط دیر ذوب

E

Ebuliometry	اندازه‌گیری صعود نقطه جوش
Ebullition	جوشش
Eclipsed	پوشیده
Economizer	پیش‌گرم کن
Edge	لبه
Educe	خارج‌کردن، جداکردن
Effective porosity	تخلخل مؤثر
Efficiency	بازده
Efflorescence	شکفتگی
Effluent	مایع بیرون‌ریزنده، فاضلاب
Effusion	نفوذ مولکولی، نشت
Eigenfunction	تابع ویژه
Ejection	بیرون‌اندازی، خارج‌کردن
Elastic	کشسان
Electrophile	الکترون‌دوست
Electroplating	آبکاری برقی
Element	عنصر
Elimination	حذف
Elipse	بیضی
Elongation	طویل‌شدن
Eluant	شوینده
Eluent	شستشوکننده
Emanate	تشعشع
Emery	سنباده
Emission	نشر
Emit	نشرکردن
Endogenic	درونی
Endothermic	گرماگیر
Endurance	دوام
Energetic	پرانرژی
Engine	موتور
Entrance	درون‌رو
Equation	معادله
Equatorial	استوایی
Equilibrium	تعادل
Equipartition	اصل همبخشی
Erosion	فرسایش
Error	خطا
Erupt	منجرشدن
Erupt	منجرشدن
Evacuation	تهی‌ساختن
Evaporate	تبخیرکردن
Evolution	تکامل، پیشرفت
Excitation	تحریک
Excited	برانگیخته
Exclusion principle	اصل طرد
Exhaust	خروجی
Exoergic	انرژی‌زا
Exotherm	گرمازا
Expansion	انبساط
Explode	ترکیدن، منفجرشدن
Exploration	اکتشاف

Explosive	ماده منفجره
Exponential	نمایی
Exposure	نوردهی، درمعرض تابش قرارگرفتن
Extinction	خاموشی
Extraction	استخراج
Extrude	بیرون‌انداختن
Extrusion	برون‌رانی
Emittance	شدت نشر
Emperical	تجربی
Encage	قفسی شکل
End point	نقطه پایان
Endoergic	انرژی‌گیر
Extrapolate	برون‌یابی کردن
Extrinsic	غیرذاتی

F

Flow	جریان
Fluctuation	انحراف
Fluid	سیال
Flux	شار
Foam	کف
Folding	چین‌خوردگی
Forbidden	غیرمجاز
Foundring	ریخته‌گری
Fraction	جزء
Fragmentation	قطعه‌ای شدن
Framework	اسکلت، چهارچوب
Freezing	انجماد
Friction	اصطکاک
Fuel	سوخت
Fumigant	دودشونده، حشره‌کش
Fungi	قارچ
Fungicide	قارچ‌کش
Funnel	قیف
Furnace	کوره
Fusing point	نقطه ذوب
Fusion	گداخت
Face centered cubic	مکعبی‌مرکز وجوه پر
Factual matter	ماده مصنوعی
Falling ball	سقوط قطره‌ای
Fast	سریع
Fat	چربی
Fatigue	فرسودگی
Feedback	بازگرداندن، پس‌خوراندن
Fermentation	تخمیر
Field	میدان
Figure	شکل
Filament	سیم
Fill	پرکردن
Filtration	صاف‌کردن
Final point	نقطه پایان (تقطیر)
Fine	ظریف
Fingerprint region	ناحیه اثرانگشت
Finish	تکمیل‌کردن
Fire retardant	اشتعال کاه
Firebrick	آجر نسوز
Fireproof	ضد آتش
Firing	سوختن

Fissilty	قابلیت تورق، شکاف‌پذیری
Fission	شکاف
Fixative	ثابت‌کننده
Flame	شعله
Flammable	اشتعال‌پذیر
Flexible	انعطاف‌پذیر
Flocculation	لخته‌شدن، انعقاد
Flotation	شناورسازی

G

Gage	اندازه‌گیر	*Geometrical*	هندسی
Crout	دوغاب	*Glacial*	یخی شکل
Gain	بهره	*Glass*	شیشه
Galvanization	آبکاری	*Gradient*	شیب
Galvanoplastics	ابکاری	*Granular*	دانه‌ای
Gangue	ناخالصی‌سنگ معدن	*Grating*	منشور، شبکه
Gap	شکاف	*Grit*	ماسه، شن
Gas oil	نفت گاز	*Ground state*	حالت پایه
Gas scrubber	گازشوی	*Growth*	رشد
Gaseous	گازدار	*Gum*	صمغ
Gasoline	بنزین	*Gypsum*	گچ
Gauche form	شکل گوش، شکل کج		

H

Half life	نیمه عمر	*Heterogen*	ناهمگن
Half cell	نیم پیل	*Hexagonal*	شش گوشه‌ای
Half width	عرض باند در نصف ارتفاع	*Hexagonal closest packing*	انباشته‌ترین فشردگی شش
Halite	نمک طعام	*Hindered*	ممانعت‌شده
Haloide	نمکی	*Hint*	راهنمایی

Hamster	چکش
Hard	سخت
Hardness	سنگینی، سختی
Head	کلاهک
Head on	روبرو
Heating oil	نفت کوره
Helical	مارپیچی
Helix	مارپیچ
Hydrophile	آبدوست
Hydrophobe	آب‌گریز
Hydrotropism	آب‌گرایی
Hydrous	آبدار
Hygroscopic	نم‌گیر
Hyperbolic	هذلولی
Hyperfine	فوق ظریف
Hoist	بالاکشیدن
Holdup	ظرفیت
Hole	سوراخ
Holohedron	تمام وجهی
Homolytic	شکستن یکنواخت
Horizental	افقی
Housing	محفظه
Humidity	رطوبت
Hypertonic	تراوایی زیاد
Hypnotic	خواب‌آور
Hypothesis	فرضیه
Hypotonic	تراوایی کم
Hypsometry	عمق‌سنجی
Hysteresis	پس‌ماند مغناطیسی

I

Icosahedron	بیست وجهی
Identical	مشابه
Identification	شناسایی
Identity	یکسانی
Ignition	اشتعال
Illumination	روشن‌سازی
Imbibition	آب‌پذیری
Immersion	غوطه‌ور
immiscibility	امتزاج‌ناپذیری
Impact	ضربه، برخورد
Impart	سهم دادن، رساندن
Impedance	مقاومت ظاهری
Impermability	نفوذناپذیری
Industrial	صنعتی
Inert	بی‌اثر
Inertia	اینرسی
Infilitration	تراوش، نفوذ
Infinity	بی‌نهایت
Inflammable	احتراق‌پذیر
Inflection point	نقطع عطف
Infrared	مادون قرمز
Infusion	۱ـ القا ۲ـ خیساندن
Ingredient	جزء
Inhibitor	بازدارنده
Initial	آغازی، اولیه

Impervious	نفوذناپذیر
Impurity	ناخالصی
Incandescent	گداخته، ملتهب
Incentive	محرک
Inclusion	ناخالص، اضافی
Incoherent	جدا از هم
Incoming group	گروه واردشونده
Indicator	معرف
Induction effect	القایی
Inductive	القایی
Instrument	دستگاه
Insulator	عایق
Integer	عدد صحیح
Intensity	شدت
Interconversion	تبدیل درونی
Interconversion	تبدیل درونی
Interface	مرز
Interference	تداخل
Intermediate	حد واسط
Intermetallic	بین فلزی
Intermolecular	بین مولکولی
Interplay	اثر متقابل
Interpolate	درون‌یابی کردن
Intersection	تقاطع
Interstitial	درون شبکه‌ای
Interval	فاصله
Initiator	آغازگر
Inject	تزریق کردن
Inner sphere	فضای داخلی
Inorganic	معدنی
Input	ورودی
Insecticide	حشره‌کش
Insertion	جایگیری
Insoluble	نامحلول
Instability	ناپایداری
Instantaneous	آنی، فوری
Intramolecular	درون مولکولی
Intrinsic	ذاتی
Intrinsic	ذاتی
Intrude	داخل‌شدن، واردشدن
Invariant	بی‌تغییر
Inversion	وارونگی
Iron alum	زاج آهن
Irradiate	تابش دادن
Irreducible	کاهش‌ناپذیر
Irregular	نامنظم
Irreversible	برگشت‌پذیر
Isolate	عایق
Isomorph	هم‌شکل
Isotacticity	هم‌آرایشی
Isotherm	هم‌دما

J

Jacket	پوشش
Joint	اتصال
Junction	اتصال
Juxtacyclic bond	پیوند دوتایی کاملاً بیرون از حلقه

K

Kalium	پتاسیم
Kaoline	خاک چینی
Kernel	مغزه، هسته اتم
Kerosine	نفت سفید
Knocking	ضربه

L

Labeled	نشان‌دار
Labile	تغییرپذیر
Lagging	عایق‌بندی
Lamellar	تیغه‌ای، لایه‌ای
Laminate	پوشاندن سطحی
Lamp	چراغ
Latent	مخفی، نهان
Lathering	کف‌کنندگی
Lattice	شبکه
Leaching	خیساندن، عصاره‌کشی
Lead	سرب
Lead minium	سرنج
Leaf	برگ
Leak	نشت‌کردن
Lean	باریک، ضعیف، رقیق
Least square	کمترین مربع‌ها
Leather	چرم
Leaving group	گروه ترک‌کننده
Lens	عدسی
Lethal	کشنده
Level	تراز
Levigation	شستشو با آب
Life	عمر
Lime	آهک
Limit	حد
Linear	خطی
Linen	کتان
Linkage	اتصال
Labeled	نشان‌دار
Liposoluble	محلول در چربی
Liquate	ذوب‌کردن
Liquefaction	میعان
Litmus	تورنسل
Loading	بارگذاری
Loam	گل، لجن
Local	موضعی
Localization	استقرار
Location	موقعیت
Lone pair	زوج تنها
Longitudinal	طولی
Loss	افت، شیب
Low spin	کم اسپین
Lubricant	روان‌کننده
Luminance	درخشانی
Luminescence	درخشندگی
Luster	درخشندگی، جلادادن

Lift	بالاآوردن
Lighting	برق

M

Maceration	خیساندن
Magic	سحرآمیز
Magnetic compass	قطب‌نمای مغناطیسی
Magnified	بزرگ‌شده
Magnitude	بزرگی
Makeshift	بدل، موقتی
Malleable	چکش‌خوار
Manometer	فشارسنج
Massive	حجیم
Material	ماده
Mazout	نفت کوره
Mean	متوسط
Measurment	اندازه‌گیری
Medium	محیط
Melting	ذوب
Membrane	غشاء
Mercury	جیوه
Meta director	هدایت‌کننده به متا
Metalloid	شبه فلز
Meticulous	بسیاردقیق
Micelles	مولکول‌های بزرگ آلی بادم غیر قطبی و سرقطبی
Microwave	ریزموج
Middle	میانی
Migration	مهاجرت
Mill	آسیاب
Mineral	معدنی
Miscibility	امتزاج‌پذیری
mist	مه، غبار
Mixing	مخلوط‌کردن
Modify	تغییردادن، اصلاح‌کردن
Modulus	ضریب
Moisture	نم، رطوبت
Mold	قالب
Mole fraction	جزء مولی
Mollify	نرم‌کردن
Molten	مذاب
Momentum	اندازه حرکت
Monocapped	تک‌کلاهکی
Motif	الگو، واحد تکرار در بلورنگاری
Movement	حرکت
Mud	گل، لجن
Multiple	مضرب
Multiplet	چندتایی
Mutation	جهش

N

Nomenclature	نامگذاری
Nonbonding	غیرپیوندی
Nonmetal	غیرفلز
Nonsymmetric	غیرمتقارن
Nonvolatile	غیرفرار
Notation	نمایش، علامت‌گذاری
Novel	جدید
Nozzle	افشانه
Nuclear	هسته‌ای
Nucleation	هسته‌زایی
Nucleon	هسته
Nucleophile	هسته دوست
Nucleus	هسته
Null point	نقطه خنثی
Numerical	عددی
Narcotic	مخدر
Natural	طبیعی
Naught	گره
Nebulizer	افشانه، مه‌پاش
Neighboring group	گروه همسایه
Nephelometric	کدری سنجی
Net	شبکه، خالص
Network	شبکه
Neutral	خنثی
Nitriding	ازت‌دهی
Noble gas	گاز نجیب
Nodal	گرهی
Node	گره
Noise	گره
Narcotic	مخدر

O

Odor	بو
Oil	روغن، چربی
On site	درجا
Ooze	گل، لجن
Ooze out	نشت‌کردن
Opacity	کدری
Opalesent	نیمه شفاف
Opaque	کدر
Open loop	مدار باز
Operation	عمل
Opium	تریاک
Objective	شیئی
Oblique	مایل
Observable	قابل مشاهده
Obtain	به دست آوردن
Occluded	جذب شده
Occlusion	محبوس
Occupy	اشغال‌کردن
Occurrence	وجود، پیدایش
Ocher	اخری
Octahedron	هشت‌وجهی
Octet	هشت‌تایی

Optic	نوری
Optical image	تصویر نوری
Optical resolution	تفکیک نوری
Optical rotatory dispersion	پاشندگی چرخش نوری
Optimize	بهینه ساختن
Orbit	مدار
Order	نظم
Ore	کانه، سنگ معدن
Organic	آلی
Organometallic	آلی فلزی
Orientation	جهت‌گیری
Orifice	روزنه
O-ring	واشر
Orpiment	زرنیخ
Orthogonal	متعامد
Oscillate	نوسان‌کردن
Ose	قند ساده
Oside	چند قندی
Osmotic	اسمزی
outcome	نتیجه
Outer	خارجی
over come	غلبه‌کردن
Overflow	سرریز
Overlap	همپوشانی
Overload	اضافه‌بار
Oxidant	آکنده

P

Packed	پرشده، انباشته
disproportionation	تسهیم نامتناسب
Packing	انباشتگی
Paddle	پره‌دار
Paint	رنگ
Pair	زوج، جفت
Parallel	موازی
Paralysis circuit	مدار قطع
Parent chain	زنجیر اصلی
Parity	زوجیت
Partial	جزئی
Particle	ذره، جزء
Partition	تقسیم
Packed	پرشده، انباشته
Periodic	تناوبی
Passive	اثرناپذیر، کم‌اثر
Pasty	خمیرمانند، خمیری
Pattern	الگو
Peak	پیک
Pellicle	پوسته، لایه
Penetration	نفوذ
Pentagon	پنج گوشه
Percentage	درصد
Percolation	تراوش، نفوذ، نشت
Perfect	کامل
Performance	عمل، عملکرد
Perfume	خوش‌بو
Perimeter	محیط
Period	دوره
Polarizer	قطبنده

Pole	قطب
Pollution	آلودگی
Polygon	چندگوشه‌ای
Polymorph	چندشکل
Population	جمعیت
Porcelaine	چینی
Pore	خلل و فرج
Porous	متخلخل
Port	روزنه، سوراخ
Positive	مثبت
Power	قدرت
Precession	حرکت تقدیمی
Precipitation	رسوب
Precision	دقت
Precursor complex	کمپلکس پیشتاز
Preheat	پیش‌گرم کردن
Pressure	فشار
Precise	دقیق
Prilling	دانه‌سازی
Primary	اولیه، اصلی
Primer	آستر، ماده اولیه
Primitive	ماده
Prism	منشور
Probability	احتمال
Procedure	روش
Process	فرایند
Product	۱) فراورد ۲) حاصلضرب
Production	تولید
Profile	نیمرخ
Programming	برنامه‌ریزی

Permability	نفوذ
Permanent	دائمی
Permutation	تبدیل
Pesticide	آفت‌کش
Petrol	بنزین
Pharmaceutical	مواد داروئی
Phyto chemistry	گیاه شیمی
Picking of metal	خوراندن زنگ روی فلز
Pickling	اسیدشویی
Pig	شمش
Pig iron	آهن خام
Pillar	ستون، پایه
Pipe	لوله
Pitch	قیر
Planar	مسطح
Planet	سیاره
Planetary	سیاره‌ای
Plant	کارخانه، دستگاه
Plaster	گچ
Plasticity	شکل‌پذیری
Plasticizer	نرم‌کننده
Plate	صفحه
Plating	آبکاری، روکش‌دادن
Plentiful	فراوان
Plumbism	مسمومیت با سرب
Pointer	عقربه، شاهین
Poison	سم
Polar	قطبی
Polarimetry	قطبش سنجی
Polarity	قطبیت

Promoter	پیش‌برنده	*Polarization*	قطبش‌پذیری
Pulp	خمیر کاغذسازی، لجن	*Propagation*	انتشار
Pulse	ضربه	*Proportion*	نسبت
Pure	خالص	*prospection*	اکتشاف
Purify	خالص کردن	*Protective*	محافظ
Pyramidal	هرمی	*Psedo*	شبه
Pyrogenic	آتش دمایی،دمای بالا	*Psychrometry*	رطوبت‌سنجی

Q

Quantity	کمیت، مقدار	*Quadrapole*	چهارقطبی
Quarternary	چهارتایی	*Quadratic*	درجه دوم
Quasi	شبه	*Qualitative*	کیفی
Quenching	خاموشی	*Quality*	کیفیت
Quintet	پنج‌تایی	*Quantitative*	کمی

R

Reactant	واکنش‌دهنده	*Radiant*	بازتاب
Reactive	فعال	*Radial*	شعاعی
Reagent	معرف	*Radiation*	تابش
Real	حقیقی	*Radiography*	پرتونگاری
Rearrangement	نوآرایی	*Radius*	شعاعی
Receiver	دریافت‌کننده	*Raffinate*	پالایش
Reciprocation	متناوب، پیستونی	*Random*	اتفاقی
Reconstruction	ترمیم	*Range*	گسترده
Recovery	بازیابی	*Rare earth*	خاک نادر
Rectangle	مستطیل	*Rate*	سرعت
Rectangular	مستطیل شکل	*Ratio*	نسبت
Redox	اکسایش ـ کاهش	*Raw*	خام

Reduce	کاهش
Response	پاسخ
Restrict	محدودکردن
Resultant	برآیند، نتیجه نهایی
Retardation	تأخیر
Retention	ابقاء، نگهداری
Retention	زمان بازداری
Reticle	شبکه
Return	بازگشت
Reverse	معکوس
Reversibility	برگشت‌پذیری
Revolution	گردش
Rigid	صلب
Rigidity	سختی
Rigorous	دقیقاً درست
Ring	حلقه
Roasting	تشویه، برشته‌کردن
Rock salt	نمک طعام
Rocking	گهواره‌ای
Rod	میله
Roller	غلطک
Rotary	روتاری، دستگاه گردان
Rotation	چرخش
Roughly	به ترتیب
Rubber	لاستیک
Ruby	یاقوت
Rule of thumb	قاعده سرانگشتی
Run	به‌کارافتادن، راه‌انداختن
Rupture	گسیختگی
Rust	زنگ‌زدگی

Ray	پرتو
Reductant	کاهنده
Reel	قرقره
Refine	تصفیه‌کردن
Refinery	پالایشگاه
Reflection	انعکاس، بازتاب
Reformer	مبدل
Refraction	شکست، انکسار
Refrence	مرجع، شاهد
Refrigration	سردسازی
Regeneration	بازسازی
Regioselectivity	جهت‌گزینی
Register	ثبات
Regular	منظم
Relative	نسبی
Relativity	نسبیت
Relaxation	آسایش
Repress	مهارکردن
Repression	توقف
Repulsion	دافعه
Reserve	ذخیره
Reservior	منبع
Reside	باقی‌مانده
Residual	باقیمانده
Resistance	مقاومت
Resolution	قدرت تفکیک
Resolve	تفکیک
Resource	منبع
Respiratory	تنفسی

S

Separatory funnel	قیف جداکننده
Septet	هفت‌تایی
Septum	درپوش
Sequence	ترتیب، توالی
Sequestering	استتار
Set	دستگاه، قاب، گروه، چهارچوب
Setting	ته‌نشینی
Sewage	فاضلاب
Sextet	شش‌تایی
Shadow zone	ناحیه سایه‌ای
Shaping	شکل‌دادن
Sharp	سریع، تیز
Shat	تیر، ساچمه
Shatter	خردشدن
Shearing	برش‌دادن
shed	ریختن، ساطع کردن
Sheet	لایه‌ای
Shell	پوسته، قشر
Shield	پوشش
Shielding effect	اثر حفاظتی
Shift	جابه‌جایی
Shimming	جبران
Shock	ضربه
Shrinkage	انقباضی
Side	جانبی
Sieve	الک
Signal	علامت
Significant	معنی‌دار

Soda ash	سودا، سدیم کربنات
Saddle	زینی
Safety	ایمنی
Saline	نمکی
Salt	نمک
Sample	نمونه
Sand	شن
Sandpaper	سنباده
Saponifier	ماده تمیزکاری
Saturation	اشباع
Scalar	عددی
Scale	مقیاس
Scattering	پراکندگی
Scheme	شما، طرح
Scissoring	قیچی‌وار
Scope	گستره
Screening	پوشش
Screw	پیچ
Scrubber	گازشوی
Scum	کف‌کردن
Sealing	بستن، مسدودکردن
Section	بخش، مقطع
Sediment	رسوب
Seed	دانه
Selection	انتخاب
Selectivity	گزینش‌پذیری
Self consistent	خودسازگار

Silk	ابریشم
Simulation	همانندسازی
Simultaneaus	همزمان
Singlet	یکتایی
Speed	سرعت
spherical	کروی
Spin lattice relaxation	آسایش اسپین شبکه
Spin multiplicity	چندگانگی اسپینی
Spinning	ریسندگی
Spiral	مارپیچی
Splitting	شکافتگی
Sponge	اسفنج
Spontaneous	خودبخودی
Spool	پیچیدن
Spray	افشاندن
Spot	محل، نقطه
Stability	پایداری
Stack	انباشتن
Staggered	نپوشیده
Stand by	یدکی
Starch	نشاسته
Static	ساکن
Stationary	ساکن، ثابت
Statistic	آماری
Steady	پایا
Steam	بخار
Steel	فولاد
Step	مرحله‌ای
Step by step	گام‌به گام
Stereochemistry	شیمی فضایی
Semiconductor	نیمه هادی
Semipermable	نیمه تراوا
Sensitive	حساس
Separation	جداسازی
Sinter	کلوخه‌سازی
Skew	پیچ‌دار
Skimming	کف‌گیری
Slag	سرباره
Slip	لغزش، جابه جایی
Slit	شکاف
Slop	تفاله
Slot	شکاف
Sludge	لجن
Slurry	دوغاب
Smog	دود
Soap	صابون
Soft	نرم
Softening	گرفتن سختی
solar	خورشیدی
Solid	جامد
Solidification	انجماد
Solidity	استحکام
Solute	ماده حل شده
Solution	محلول
Solvation	حلالپوشی
Solvent	حلال
Sorting	جورکردن
Sox Helt	سوسکه
space lattice	شبکه فضایی

Stereoscopy	برجسته‌بینی
Steric	فضایی
Stick	چسبیدن، پیوستگی
Still	تقطیرکردن
Stirrer	همزن
Stone	سنگ
Stop	شیر متوقف‌کننده
Summation	جمع‌کردن
Supercapillary	فوق مویین
Superimposable	قابل انطباق
Supersonic	ابرصوتی
Suprafacial	تک‌رخی
Surface	سطح
Surfactant	ماده فعال سطحی
Survival	بازماندگی، بقا
Susceptibility	تأثیرپذیری
Sweet	شیرین
Swell	متورم‌شدن
Swift	تند، سریع
Symmetry	تقارن
Synchronism	همزمانی
Syndiotactic	هم‌آرایشی
Spacing	فاصله‌بندی
Spark	جرقه
Spatula	اسپاتول
Species	جزء
Specific	ویژه
Spectra	طیف
Spectroscopy	طیف‌سنجی
Storage	نگهداری، ذخیره
Storage cell	باتری
Storm	توفان
Strain	کشش
Stripping	تفکیک‌کننده
Structural	ساختاری
Sub shell	لایه فرعی
Sublimation	تصعید
Submerged	شناور
Substance	ماده
Substarate	سوبستراء، جزء موردعمل
Substitution	استخلاف
Successar complex	کمپلکس پسایند
Successive	متوالی
Suction	مکش

T

Tear	درز، شکاف
Tear gas	گاز اشک‌آور
Tee joint	سه‌راهی
Temper	آب‌دادن
temperature	دما
Transition	واسطه، گذار
Table	جدول
Tableting	قرص‌سازی
Tabulate	جدول‌بندی کردن
Tacticity	آرایشمندی

Tagged atom	اتم نشاندار
Tail to tail	دم‌به‌دم
Tangential	مماسی
Tank	مخزن، انبار
Tanning	دباغی
Tar	قیر، قطران
Target	هدف
Ternary	سه‌تایی
Tertiary	نوع سوم
Tetragonal	چهارگوشی
Tetrahedral	چهاروجهی
Textile	نساجی
Theorem	قضیه، نظریه
Theory	نظریه
Thermal	حرارتی
Thermoplastic	گرمانرم
Thermoset	گرماسخت
Thicken	ضخیم‌شدن
Thickness	ضخامت
Thin	نازک
Thinner	رقیق‌کننده
Thread	نخ
Threshold	آستانه، آغازی
Tickling	قلقلک‌دادن
Tight	فشرده، کم منفذ
Time lag	تأخیر
Tin	قلع
Tint	ته‌رنگ، رنگ روشن
Tintometer	رنگ‌سنج
Template	اندرون‌گیر
Temporary	موقتی
Tendency	تمایل
Tensile	کشش
Tension	تنش
Term	جمله، دوره
Terminal	انتهایی
Termination	پایان، اختتام
Traditional	سنتی
Transducer	مبدل
Transformation	تبدیل
Translation	انتقال
Transmission	عبور
Transmutation	تحول، تبدیل
Transparency	شفافیت
Transverse	موج عرضی
Trap	تله، دام
Treatment	عملکرد
Tricapped	سه‌کلاهکی
Trigonal	مثلثی
Trigonal bipyramid	دو هرمی مثلثی
Trip	لغزش، قطع‌کردن
Trip point	نقطه سه‌گانه
Triplet	سه‌تایی
Trivalent	سه‌ظرفیتی
Truncate	برش
Tube	لوله
Tuff	خاکستر آتشفشانی
Turbidimetry	کدری سنجی
Turnings	تراشه

Tool	ابزار	*Turquoise*	فیروزه
Topped crude	پس‌مانده نخستین تقطیر	*Twin*	دوقلو
Torsion	پیچش	*Twisting vibration*	ارتعاش رقاصکی
Total	کل	*Type metal*	آلیاژ چاپ
Tower	برج	*Typical sample*	نمونه فرعی
Toxic	سمی		
Trace	ناچیز، ردیابی کردن		
Tracer	ردیاب		

U

Uiverse	جهان	*Unidentate*	تک‌دانه
Ultimate	نهایی	*Uniform*	یکنواخت
Ultrafilter	صافی بسیار ریز	*Unit cell*	سلول واحد
Ultramarine	لاجورد	*Unknown*	مجهول
Ultrasonic	فراصوتی	*Unpaired*	منفرد، جفت نشده
Ultraviolet	ماوراء بنفش	*Unsaturate*	غیراشباع
Unaltered	تغییرنیافته	*Unsheared*	غیرمشترک
Unattainability	دسترس ناپذیری	*Unstable*	ناپایدار
Uncertainty	عدم قطعیت	*Unsymmetrical*	نامتقارن
Undulatory	موجی	*Upfield*	میدان بالا
Unequivocal	بی‌ابهام، صریح	*Urea*	اوره

V

Variation	تغییر	*Violent*	شدید
Varnish	جلا، رنگ‌روغن	*Violet*	بنفش
Vector	بردار	*Virtual*	مجازی
Vegetable fat	چربی گیاهی	*Visible*	مرئی
Velocity	سرعت	*Vitality*	حیاتی
Ventilation	هوادهی	*Vitreous*	شیشه‌ای
Ventilator	هواکش	*Vitriol*	زاج، کات

Vertical	عمودی	*Volatile*	فرار
Vertinary	دامپزشکی		
Vesicant	تاول‌زا	*Volcanic*	آتشفشانی
Vessel	ظرف	*Volume*	حجم
Vibration	ارتعاش	*Vulcanization*	گوگردی کردن، ولکانیزاسیون

W

Wire	سیم	*Weed killer*	علف‌کش
Wagging	گهواره‌ای	*Weight*	وزن
Wastage	ضایعات	*Weir*	حوضچه
Waste	زائد، فاضلاب	*Well*	چاه
Waterflooding	آب‌روبی	*Wick*	فتیله
Waterproof	ضدآب	*Wine yeast*	مخمر شراب
Wave	موج	*Wollen*	پشمی
Wax	موم	*Wood pulp*	خمیرچوب
Weak	ضعیف	*Wrought*	خمیری

X

Xerography	خشک‌نگاری	*X-ray*	اشعه ـ ایکس

Y

Yeild	بازده، بهره، تسلیم‌شدن	*Yeast*	مخمر

Z

Zenith	رأس، بلندترین نقطه	*Zonar*	منطقه‌ای
Zinc	روی	*Zone*	منطقه، حوزه
Zefran	زعفران	*Zwitterion*	یون دوتایی
Zymurgy	شیمی تخمیر		

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