Halliday, Resnick, and Walker, *Fundamentals of Physics 10e* Question Answers
Volume 1

Chapter 2 Answers

1	(a) negative; (b) positive; (c) yes; (d) positive; (e) constant
2	*E*
3	(a) all tie; (b) 4, tie of 1 and 2, then 3
4	(a) negative; (b) positive; (c) zero; (d) negative; (e) twice
5	(a) positive direction; (b) negative direction; (c) 3 and 5; (d) 2 and 6 tie, then 3 and 5 tie, then 1 and 4 tie (zero)
6	(a) 2, 3; (b) 1, 3; (c) 4
7	(a) *D*; (b) *E*
8	a and c
9	(a) 3, 2, 1; (b) 1, 2, 3; (c) all tie; (d) 1, 2, 3
10	(a) 9.8 m/s^2; (b) downward; (c) upward; (d) 2 m/s; (e) decrease
11	1 and 2 tie, then 3

Chapter 3 Answers

1	yes, when the vectors are in same direction
2	(a) -, +; (b) -, -; (c) +, +
3	Either the sequence $\vec{d}_2, \vec{d}_1$ or the sequence $\vec{d}_2, \vec{d}_2, \vec{d}_3$
4	no, but $\vec{a}$ and $-\vec{b}$ are commutative: $\vec{a} + (-\vec{b}) = (-\vec{b}) + \vec{a}$
5	all but (*e*)
6	(a) $\vec{a}$ and $\vec{b}$ are parallel; (b) $\vec{b} = 0$; (c) $\vec{a}$ and $\vec{b}$ are perpendicular

7	(a) yes; (b) yes; (c) no
8	no (the orientations of $\vec{B}$ and $\vec{C}$ can differ)
9	(a) $+x$ for (1), $+z$ for (2), $+z$ for (3); (b) $-x$ for (1), $-z$ for (2), $-z$ for (3)
10	(a) $\vec{B}$ and $\vec{C}$, $\vec{D}$ and $\vec{E}$; (b) $\vec{D}$ and $\vec{E}$
11	$\vec{s}, \vec{p}, \vec{r}$ or $\vec{p}, \vec{s}, \vec{r}$
12	On many calculators you get the correct answer for θ for $\vec{a}$ and $\vec{d}$ but not for $\vec{b}$ and $\vec{c}$ for which you must add 180°.
13	Correct: c, d, f, h. Incorrect: a (cannot dot a vector with a scalar), b (cannot cross a vector with a scalar), e, g, i, j (cannot add a scalar and a vector).

Chapter 4 Answers

1	a and c tie, then b
2	(a) $(7\text{ m})\hat{i} + (1\text{ m})\hat{j} + (-2\text{ m})\hat{k}$; (b) $(5\text{ m})\hat{i} + (-3\text{ m})\hat{j} + (1\text{ m})\hat{k}$; (c) $(-2\text{ m})\hat{i}$
3	decreases
4	(a) all tie; (b) 1 and 2 tie (the rocket is shot upward), then 3 and 4 tie (it is shot into the ground!)
5	a, b, c
6	(a) A; (b) closer
7	(a) 0; (b) 350 km/h; (c) 350 km/h; (d) same (nothing changed about the vertical motion)
8	(a) 3, 2, 1; (b) 1, 2, 3; (c) all tie; (d) 6, 5, 4
9	(a) all tie; (b) all tie; (c) 3, 2, 1; (d) 3, 2, 1
10	(a) c, b, a; (b) a, b, c
11	2, then 1 and 4 tie, then 3

12	(a) 90° and 270°; (b) 0° and 180°; (c) 90° and 270°
13	(a) yes; (b) no; (c) yes
14	(a) in your hands; (b) behind you; (c) in front of you
15	(a) decreases; (b) increases
16	(a) no; (b) same
17	maximum height
18	less

Chapter 5 Answers

1	(a) 2, 3, 4; (b) 1, 3, 4; (c) 1, $+y$; 2, $+x$; 3, fourth quadrant; 4, third quadrant
2	(a) 5; (b) 7; (c) $(2 \text{ N})\hat{\imath}$; (d) $(-6 \text{ N})\hat{\jmath}$; (e) fourth; (f) fourth
3	increase
4	(a) 2 and 3; (b) 2
5	(a) 2 and 4; (b) 2 and 4
6	a, then b, c, and d tie
7	(a) M; (b) M; (c) M: (d) $2M$; (e) $3M$
8	1, graphs a and e; 2, graphs b and d; 3, graphs b and f; 4, graphs c and f
9	(a) 20 kg; (b) 18 kg; (c) 10 kg; (d) all tie; (e) 3, 2, 1

10	(a) 17 kg; (b) 12 kg; (c) 10 kg; (d) all tie; (e) $\vec{F}$, $\vec{F}_{21}$, $\vec{F}_{32}$
11	(a) increases from initial value mg; (b) decreases from mg to zero (after which the block moves up away from the floor)
12	d, c, b, a (zero)

Chapter 6 Answers

1	(a) decrease; (b) decrease; (c) increase; (d) increase; (e) increase
2	(a) decrease; (b) decrease; (c) decrease; (d) decrease; (e) decrease
3	(a) same; (b) increases; (c) increases; (d) no
4	(a) F_1, F_2, F_3; (b) all tie
5	(a) upward; (b) horizontal, toward you; (c) no change; (d) increases; (e) increases
6	At first, $\vec{f}_s$ is directed up the ramp and its magnitude decreases from $mg \sin \theta$ to 0 as F increases. Then $\vec{f}_s$ is directed down the ramp; its magnitude increases until it reaches $f_{s,\text{max}}$. Thereafter the force is kinetic friction directed down the ramp, with magnitude f_k (a constant value smaller than $f_{s,\text{max}}$).
7	At first, $\vec{f}_s$ is directed up the ramp and its magnitude increases from $mg \sin \theta$ until it reaches $f_{s,\text{max}}$. Thereafter the force is kinetic friction directed up the ramp, with magnitude f_k (a constant value smaller than $f_{s,\text{max}}$).

8	(a) 5 m/s^2 to 10 m/s^2;
	(b) 0 to 5 m/s^2
9	4, 3, then 1, 2, and 5 tie
10	As the parachute opened, it produced a large, sudden upward force on the diver due to the increased air drag and this drag force slowed the diver suddenly. To keep the pumpkin in his grip, he had to slow the pumpkin just as much, but the effort required too much force from him. From the sky diver's viewpoint, the apparent weight of the pumpkin suddenly and surprisingly increased and the pumpkin was ripped downward from his hands. From the pumpkin's viewpoint, the sudden upward force on the sky diver ripped him upward away from the pumpkin.
11	(a) all tie;
	(b) all tie;
	(c) 2, 3, 1
12	At the lower altitude, the air density was large enough that the rounds were slowed significantly by air drag. The airplane, still propelled by the jet engine, ran into them.
13	(a) increases; (b) increases; (c) decreases; (d) decreases; (e) decreases

Chapter 7 Answers

1	all tie
2	(a) 2;
	(b) 3;
	(c) 1
3	(a) positive;
	(b) negative;
	(c) negative
4	c, b, a
5	b (positive work), a (zero work), c (negative work), d (more negative work)
6	(a) 3 m;
	(b) 3 m;
	(c) 0 and 6 m;
	(d) -x
7	all tie
8	(a) A, $\vec{F}_2$; B, $\vec{F}_1$; C, $\vec{F}_3$; D, $\vec{F}_4$;
	(b) E, A and D; F, B and C; G and H meaningless because K cannot have negative values
9	(a) A;
	(b) B
10	e through h

11	2, 3, 1
12	(a)−(d) 3, 2, 1

Chapter 8 Answers

1	(a) 3, 2, 1; (b) 1, 2, 3
2	(a) *AB*, *CD*, then *BC* and *DE* tie (zero force); (b) 5 J; (c) 5 J; (d) 6 J; (e) *FG*; (f) *DE*
3	(a) 12 J; (b) -2 J
4	(a) 4; (b) returns to its starting point and repeats the trip; (c) 1; (d) 1
5	(a) increasing; (b) decreasing; (c) decreasing; (d) constant in *AB* and *BC*, decreasing in *CD*
6	+30 J
7	+30 J
8	(a) less; (b) equal
9	2, 1, 3
10	all tie
11	-40 J

Chapter 9 Answers

1	(a) 2 N, rightward; (b) 2 N, rightward; (c) greater than 2 N, rightward
2	(a) *ac*, *cd*, *bc*; (b) *bc*; (c) *bd*, *ad*
3	b, c, a
4	all tie
5	(a) *x* yes, *y* no; (b) *x* yes, *y* no; (c) *x* no, *y* yes

6	*d, c, a, b* (zero)
7	(a) *c*, kinetic energy cannot be negative; *d*, total kinetic energy cannot increase; (b) *a*; (c) *b*
8	(a) forward; (b) stationary; (c) backward
9	(a) one was stationary; (b) 2; (c) 5; (d) equal (pool player's result)
10	*a, c, e, f*: the sum of the momenta after explosion does not equal the momentum before explosion
11	(a) *C*; (b) *B*; (c) 3
12	(a) positive; (b) positive; (c) 2 and 3

Chapter 10 Answers

1	(a) *c, a*, then *b* and *d* tie; (b) *b*, then *a* and *c* tie, then *d*

2	(a) 1: counterclockwise (positive);
	    2: counterclockwise (positive);
	    3: at $\theta = 0$;
	(b) 1: before;
	    2: at $t = 0$;
	    3: after;
	(c) 1: positive;
	    2: negative;
	    3: positive

3	all tie
4	(a) positive; (b) zero; (c) negative; (d) negative
5	(a) decrease; (b) clockwise; (c) counterclockwise
6	$\vec{F}_5, \vec{F}_4, \vec{F}_2, \vec{F}_1, \vec{F}_3$ (zero)
7	larger
8	90°, then 70° and 110° tie

9	*c, a, b*
10	(a) 1 and 2 tie, then 3; (b) 1 and 3 tie, then 2; (c) 2, 1, 3
11	less
12	b, c, a

Chapter 11 Answers

1	*a*, then *b* and *c* tie, then *e*, *d* (zero)
2	(a) 5 and 6; (b) 1 and 4 tie, then the rest tie
3	(a) spins in place; (b) rolls toward you; (c) rolls away from you
4	(a) 0 or 180°; (b) 90°
5	(a) 1, 2, 3 (zero); (b) 1 and 2 tie, then 3; (c) 1 and 3 tie, then 2
6	(a) 3; (b) 1; (c) 2; (d) 4
7	(a) same; (b) increase; (c) decrease; (d) same, decrease, increase
8	(a) 4, 6, 7, 1, then 2, 3, and 5 tie (zero); (b) 1, 4, and 7
9	*D, B*, then *A* and *C* tie
10	*b*, then *c* and *d* tie, then *a* and *e* tie (zero)
11	(a) same; (b) same
12	(a) tie; (b) wood cylinder

Chapter 12 Answers

1	(a) 1 and 3 tie, then 2; (b) all tie; (c) 1 and 3 tie, then 2 (zero)
2	(a) 1, 2, 3 (zero), 4, 5, 6; (b) 6, 5, 4, 3, 2, 1
3	*a* and *c* (forces and torques balance)

4	(a) same; (b) smaller; (c) smaller; (d) same
5	(a) 12 kg; (b) 3 kg; (c) 1 kg
6	(a) yes; (b) yes; (c) yes; (d) no
7	(a) at C (to eliminate forces there from a torque equation); (b) plus; (c) minus; (d) equal
8	(a) 15 N (the key is the pulley holding the 10 N piñata); (b) 10 N
9	increase
10	(a) equal; (b) B; (c) B
11	A and B, then C
12	(a) 20 N (the key is the pulley with the 20 N weight); (b) 25 N

Chapter 13 Answers

1	$3GM^2/d^2$, leftward
2	(a) c, b, a; (b) a, b, c
3	Gm^2/r^2, upward
4	(a) between, closer to less massive particle; (b) no; (c) no
5	b and c tie, then a (zero)
6	yes, in second quadrant, closer to y axis, at a distance that depends on its mass
7	1, tie of 2 and 4, then 3
8	(a) 1 and 2 tie, then 3 and 4 tie; (b) 1, 2, 3, 4
9	(a) positive y; (b) yes, rotates counterclockwise until it points toward particle B
10	(a) all tie; (b) all tie
11	$b, d,$ and f all tie, then e, c, a
12	b, a, c

Chapter 14 Answers

1	(a) moves downward; (b) moves downward
2	(a) 2; (b) 1, less; 3, equal; 4, greater
3	(a) downward; (b) downward; (c) same
4	e, then b and d tie, then a and c tie
5	b, then a and d tie (zero), then c
6	all tie
7	(a) 1 and 4; (b) 2; (c) 3
8	c, b, a
9	B, C, A
10	a, b, c

Chapter 15 Answers

1	a and b
2	(a) toward $-x_m$; (b) toward $+x_m$; (c) between $-x_m$ and 0; (d) between $-x_m$ and 0; (e) decreasing; (f) increasing
3	(a) 2; (b) positive; (c) between 0 and $+x_m$
4	c
5	(a) between D and E; (b) between $3\pi/2$ rad and 2π rad
6	(a) between B and C; (b) between $\pi/2$ rad and π rad
7	(a) all tie; (b) 3, then 1 and 2 tie; (c) 1, 2, 3 (zero); (d) 1, 2, 3 (zero); (e) 1, 3, 2
8	(a) A, B, C; (b) C, B, A
9	b (infinite period, does not oscillate), c, a

10	one system: $k = 1500$ N/m, $m = 500$ kg; other system: $k = 1200$ N/m, $m = 400$ kg
11	(a) greater; (b) same; (c) same; (d) greater; (e) greater
12	(a) $-\pi$, -180°; (b) $-\pi/2$, -90°; (c) $+\pi/2$, +90°

Chapter 16 Answers

1	(a) 1, 4, 2, 3; (b) 1, 4, 2, 3
2	(a) 4; (b) 4; (c) 3
3	a, upward; b, upward; c, downward; d, downward; e, downward; f, downward; g, upward; h, upward
4	(a) 3, then 1 and 2 tie; (b) all tie; (c) 1 and 2 tie, then 3
5	intermediate (closer to fully destructive)
6	a and d tie, then b and c tie
7	(a) 0, 0.2 wavelength, 0.16.1 wavelength (zero); (b) $4P_{avg,1}$
8	(a) node; (b) antinode
9	d
10	(a) 8; (b) antinode; (c) longer; (d) lower
11	c, a, b

Chapter 17 Answers

1	(a) 0, 0.2 wavelength, 0.5 wavelength (zero); (b) $4P_{avg,1}$
2	(a) 2.0 wavelengths; (b) 1.5 wavelengths; (c) fully constructive in (a), fully destructive in (b)
3	C, then A and B tie
4	(a) two; (b) antinode
5	E, A, D, C, B
6	all odd harmonics
7	1, 4, 3, 2
8	(a) 3, then 1 and 2 tie; (b) 1, then 2 and 3 tie; (c) 3, 2, 1
9	150 Hz and 450 Hz
10	d, fundamental
11	505, 507, 508 Hz or 501, 503, 508 Hz

Chapter 18 Answers

1	c, then the rest tie
2	Z, X, Y
3	B, then A and C tie
4	(a) at freezing point; (b) undergoes no freezing; (c) partly melts
5	(a) f, because ice temperature will not rise to freezing point and then drop; (b) b and c at freezing point, d above, e below; (c) in b liquid partly freezes and no ice melts; in c no liquid freezes and no ice melts; in d no liquid freezes and ice fully melts; in e liquid fully freezes and no ice melts
6	(a) all tie; (b) all tie
7	(a) both clockwise; (b) both clockwise
8	(a) cycle 2; (b) cycle 2

9	(a) greater; (b) 1, 2, 3; (c) 1, 3, 2; (d) 1, 2, 3; (e) 2, 3, 1
10	sphere, hemisphere, cube
11	*c, b, a*

Chapter 19 Answers

1	*d*, then *a* and *b* tie, then *c*
2	-4 J
3	20 J
4	(a) 0; (b) 0; (c) negative; (d) positive
5	(a) 3; (b) 1; (c) 4; (d) 2; (e) yes
6	(a) 0; (b) 0; (c) negative; (d) positive
7	(a) 1, 2, 3, 4; (b) 1, 2, 3
8	(a) 0; (b) 0; (c) negative; (d) positive
9	constant-volume process
10	(a) same; (b) increases; (c) decreases; (d) increases

Chapter 20 Answers

1	*b, a, c, d*
2	9 and -8, 8 and -5, 5 and -3, 3 and -2
3	unchanged

4	(a) AE; (b) AC; (c) AF; (d) none
5	a and c tie, then b and d tie
6	more than the age of the universe
7	(a) same; (b) increase; (c) decrease
8	c, a, b
9	A, first; B, first and second; C, second; D, neither
10	(a) same; (b) increase; (c) decrease

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Volume 2

Chapter 21 Answers

1	3, 1, 2, 4 (zero)
2	(a) 3, 1, 2; (b) all tie
3	*a* and *b*
4	(a) between; (b) positively charged; (c) unstable
5	$2kq^2/r^2$, up the page
6	(a) neutral; (b) negatively
7	*b* and *c* tie, then *a* (zero)
8	*a* and *d* tie, then *b* and *c* tie
9	(a) same; (b) less than; (c) cancel; (d) add; (e) adding components; (f) positive direction of *y*; (g) negative direction of *y*; (h) positive direction of *x*; (i) negative direction of *x*
10	$6kq^2/d^2$, leftward
11	(a)+4*e*; (b) -2*e* upward; (c) -3*e* upward; (d) -12*e* upward
12	(a) 1–3, positive direction of *x*; 4, negative direction of *x*; (b) 1 and 2 tie, then 3 and 4 tie

Chapter 22 Answers

1	*a*, *b*, *c*
2	$q/4\pi\varepsilon_0 d^2$, leftward
3	(a) yes; (b) toward; (c) no (the field vectors are not along the same line); (d) cancel; (e) add; (f) adding components; (g) toward negative *y*
4	2, 4, 3, 1 (zero)

5	(a) to their left; (b) no
6	(a) 3, then 1 and 2 tie (zero); (b) all tie; (c) 1 and 2 tie, then 3
7	(a) 4, 3, 1, 2; (b) 3, then 1 and 4 tie, then 2
8	(a) positive; (b) same
9	*a, b, c*
10	(a) rightward; (b) $+q_1$ and $-q_3$, increase; $+q_2$, decrease; *n*, same
11	*e, b*, then *a* and *c* tie, then *d* (zero)
12	*b*
13	*a, b, c*
14	all tie

Chapter 23 Answers

1	(a) 8 N·m^2/C; (b) 0
2	all tie
3	all tie
4	(a) all tie; (b) *a* uniform, *b* variable, *c* uniform, *d* variable
5	all tie
6	either $2\sigma, \sigma, 3\sigma$ or $3\sigma, \sigma, 2\sigma$
7	*a, c*, then *b* and *d* tie (zero)
8	(a) *a, b, c, d*; (b) *a* and *b* tie, then *c, d*
9	(a) 2, 1, 3; (b) all tie ($+4q$)
10	(a) all tie ($E = 0$); (b) all tie
11	(a) impossible; (b) $-3q_0$; (c) impossible
12	(a) all tie (zero); (b) all tie

Chapter 24 Answers

1	$-4q/4\pi\varepsilon_0 d$
2	(a) 1, then 2 and 3 tie; (b) 3

3	(a) 1 and 2; (b) none; (c) no; (d) 1 and 2, yes; 3 and 4, no
4	(a) 2, 4, and then a tie of 1, 3, and 5 (where $E = 0$); (b) negative x direction; (c) positive x direction
5	(a) higher; (b) positive; (c) negative; (d) all tie
6	b, then a, c, and d tie
7	(a) 0; (b) 0; (c) 0; (d) all three quantities still 0
8	(a) positive; (b) positive; (c) negative; (d) all tie
9	(a) 3 and 4 tie, then 1 and 2 tie; (b) 1 and 2, increase; 3 and 4, decrease
10	(a) $Q/4\pi\varepsilon_0 R$; (b) $Q/4\pi\varepsilon_0 R$; (c) $Q/4\pi\varepsilon_0 R$; (d) a, b, c
11	a, b, c
12	(a) B; (b) A; (c) A; (d) alpha particle, then electron and proton tie

Chapter 25 Answers

1	a, 2; b, 1; c, 3
2	(a) $C/3$; (b) $3C$; (c) parallel
3	(a) no; (b) yes; (c) all tie
4	(a) 2; (b) 3; (c) 1

5	(a) same; (b) same; (c) more; (d) more
6	(a) less; (b) less; (c) less; (d) less
7	a, series; b, parallel; c, parallel
8	(a) $V/3$; (b) $CV/3$; (c) $CV/3$ (not CV)
9	(a) increase; (b) same; (c) increase; (d) increase; (e) increase; (f) increase;
10	(a) increase; (b) increase; (c) decrease; (d) decrease; (e) same, increase, increase, increase
11	parallel, C_1 alone, C_2 alone, series

Chapter 26 Answers

1	tie of A, B, and C, then tie of $A + B$ and $B + C$, then $A + B + C$
2	b, a, c
3	(a) top-bottom, front-back, left-right; (b) top-bottom, front-back, left-right; (c) top-bottom, front-back, left-right; (d) top-bottom, front-back, left-right
4	a, b, and c all tie, then d (zero)
5	a, b, and c all tie, then d
6	(a) all tie; (b) B, C, A; (c) B, C, A
7	(a) B, A, C; (b) B, A, C
8	(a) 1 and 2 tie, then 3; (b) 1 and 2 tie, then 3; (c) 1 and 2 tie, then 3

9	(a) C, B, A;
	(b) all tie;
	(c) A, B, C;
	(d) all tie
10	C, A, B
11	(a) a and c tie, then b (zero); (b) a, b, c; (c) a and b tie, then c

Chapter 27 Answers

1	(a) equal;
	(b) more
2	(a) no;
	(b) yes;
	(c) all tie
3	parallel, R_2, R_1, series
4	(a) b and d tie, then a tie of a, c, and e;
	(b) b, d, then a tie of a, c, and e;
	(c) positive x direction
5	(a) series;
	(b) parallel;
	(c) parallel
6	2.0 A
7	(a) less;
	(b) less;
	(c) more
8	(a) $3R$; (b) $R/3$; (c) same
9	(a) parallel; (b) series
10	60 μC
11	(a) same;
	(b) same;
	(c) less;
	(d) more
12	1, c; 2, a; 3, d; 4, b
13	(a) all tie;
	(b) 1, 3, 2

Chapter 28 Answers

1	(a) no because $\vec{v}$ and $\vec{F}_B$ must be perpendicular;
	(b) yes;
	(c) no because $\vec{B}$ and $\vec{F}_B$ must be perpendicular

2	(a) 3 and 4 tie, then 1 and 2 tie (zero); (b) 4 (making the reasonable assumption that the rightward current is due to leftward motion of electrons in the wire)
3	(a) $+z$ and $-z$ tie, then $+y$ and $-y$ tie, then $+x$ and $-x$ tie (zero); (b) $+y$
4	into page: a, d, e; out of page: b, c, f (the particle is negatively charged)
5	(a) $\vec{F}_E$; (b) $\vec{F}_B$
6	2, 5, 6, 9, 10
7	(a) $\vec{B}_1$; (b) $\vec{B}_1$ into page, $\vec{B}_2$ out of page; (c) less
8	(a) upper plate; (b) lower plate; (c) out of the page
9	(a) positive; (b) $2 \rightarrow 1$ and $2 \rightarrow 4$ tie, then $2 \rightarrow 3$ (which is zero)
10	1i, 2e, 3c, 4a, 5g, 6j, 7d, 8b, 9h, 10f, 11k
11	(a) negative; (b) equal; (c) equal; (d) half-circle
12	(a) all tie; (b) all tie; (c) 3, 2, 1

Chapter 29 Answers

1	c, a, b
2	1, then 3 and 4 tie, then 2 (zero)
3	c, d, then a and b tie (zero)
4	(a) into; (b) greater
5	a, c, b
6	(a) c, a, d, b; (b) a, c, b, d; (c) a and c tie, then b and d tie; (d) greater
7	c and d tie, then b, a
8	b, d, c, a (zero)
9	b, a, d, c (zero)
10	d, then a and e tie, then b, c
11	(a) 1, 3, 2; (b) less

Chapter 30 Answers

1	out
2	1 and 3 tie (clockwise), then 2 and 5 tie (zero), then 4 and 6 tie (counterclockwise)
3	(a) all tie (zero); (b) 2, then 1 and 3 tie (zero)
4	(a) into; (b) counterclockwise; (c) larger
5	*d* and *c* tie, then *b*, *a*
6	(a) 2, 1, 3; (b) 2, 1, 3; (c) 1 counterclockwise; 2 clockwise; 3 counterclockwise
7	(a) more; (b) same; (c) same; (d) same (zero)
8	2 *a*, 4 *b*, 1 *c*, 3 *d*
9	(a) all tie (zero); (b) 1 and 2 tie, then 3; (c) all tie (zero)
10	*c*, *b*, *a*
11	*b*
12	(a) and (b): (1) and (2) tie, then (3) and (4) tie

Chapter 31 Answers

1	*b*, *a*, *c*
2	(a) less; (b) greater
3	(a) $T/4$; (b) $T/4$; (c) $T/2$; (d) $T/2$
4	with *n* zero or a positive integer, (a) $0 \pm n2\pi$, (c) $\pi/2 \pm n2\pi$, (e) $\pi \pm n2\pi$, (g) $3\pi/2 \pm n2\pi$
5	*c*, *b*, *a*
6	(a) 3, 1, 2; (b) 2, then 1 and 3 tie
7	*a* inductor; *b* resistor; *c* capacitor

8	(a) 1 and 4; (b) 2 and 3
9	(a) positive; (b) decreased (to decrease X_L and get closer to resonance); (c) decreased (to increase X_C and get closer to resonance)
10	(a) less; (b) equal; (c) greater
11	(a) rightward, increase (X_L increases, closer to resonance); (b) rightward, increase (X_C decreases, closer to resonance); (c) rightward, increase (ω_d/ω increases, closer to resonance)
12	(a) lead; (b) capacitive; (c) less
13	(a) inductor; (b) decrease

Chapter 32 Answers

1	1 *a*, 2 *b*, 3 *c* and *d*
2	(a) rightward; (b) leftward; (c) into
3	a, decreasing; b, decreasing
4	*b*
5	supplied
6	(a) increase; (b) increase
7	(a) *a* and *b* tie, then *c*, *d*; (b) none (because plate lacks circular symmetry, $\vec{B}$ not tangent to any circular loop); (c) none
8	(a) all down; (b) 1 up, 2 down, 3 zero
9	(a) 1 up, 2 up, 3 down; (b) 1 down, 2 up, 3 zero
10	(a) 1 down, 2 down, 3 up; (b) 1 up, 2 down, 3 zero
11	(a) 1, 3, 2; (b) 2
12	(a) *a*, *c*, *f*; (b) *gh* bar

Chapter 33 Answers

1	(a) positive direction of z; (b) x
2	c
3	(a) same; (b) increase; (c) decrease
4	into
5	(a) and (b) $A = 1$, $n = 4$, $\theta = 30°$
6	20° and 90°
7	a, b, c
8	b 30°; c 60°; d 60°; e 30°; f 60°
9	B
10	n_3, n_2, n_1
11	none
12	d, b, a, c

Chapter 34 Answers

1	(a) a; (b) c
2	(a) I_1 and I_4; (b) I_2 and I_3; (c) I_3; (d) I_3; (e) I_2
3	(a) a and c; (b) three times; (c) you
4	(a) from infinity to the focal point; (b) decrease continuously
5	convex
6	1 concave, 2 convex, 3 plane
7	(a) all but variation 2; (b) 1, 3, 4: right, inverted; 5, 6: left, same
8	1 converging, 2 diverging
9	d (infinite), tie of a and b, then c
10	(a) I_2 and I_3; (b) I_1 and I_4; (c) I_1; (d) I_1; (e) I_4
11	(a) x; (b) no; (c) no; (d) the direction you are facing

Chapter 35 Answers

1	(a) decrease; (b) decrease; (c) decrease; (d) blue
2	(a) increase; (b) 1λ
3	(a) $2d$; (b) (odd number)$\lambda/2$; (c) $\lambda/4$
4	*a*, *c*, *b*
5	(a) intermediate closer to maximum, $m = 2$; (b) minimum, $m = 3$; (c) intermediate closer to maximum, $m = 2$; (d) maximum, $m = 1$
6	*b*, 3 and 5; *c*, 1 and 4; *d*, 2
7	(a) maximum; (b) minimum; (c) alternates
8	(a) 300 nm; (b) exactly out of phase
9	(a) peak; (b) valley
10	(a) 0.5 wavelength; (b) 1 wavelength
11	*c*, *d*
12	(a) no; (b) $2(0) = 0$; (c) $2L$
13	*c*

Chapter 36 Answers

1	(a) $m = 5$ minimum; (b) (approximately) maximum between the $m = 4$ and $m = 5$ minima
2	4
3	(a) *A*, *B*, *C*; (b) *A*, *B*, *C*
4	(a) *A*, *B*, *C*; (b) *A*, *B*, *C*
5	(a) 1 and 3 tie, then 2 and 4 tie; (b) 1 and 2 tie, then 3 and 4 tie

6	(a) contract; (b) contract
7	(a) larger; (b) red
8	(a) increase; (b) first order
9	(a) decrease; (b) same; (c) remain in place
10	(a) decrease; (b) decrease; (c) shift to right
11	(a) A; (b) left; (c) left; (d) right
12	(a) less; (b) greater; (c) greater
13	(a) 1 and 2 tie, then 3; (b) yes; (c) no
14	the next three orders, $m = 1$, 2, and 3, for which $\sin \theta < 1.0$ (higher numbered orders would require $\sin \theta > 1.0$)

Chapter 37 Answers

1	c
2	(a) negative; (b) positive
3	b
4	(a) C_1; (b) C_1
5	(a) C_1'; (b) C_1'
6	(a) Sam; (b) neither
7	(a) 4 s; (b) 3 s; (c) 5 s; (d) 4 s; (e) 10 s
8	(a) 3, then 1 and 2 tie; (b) 2, then 1 and 3 tie; (c) 2, 1, 3; (d) 2, 1, 3

9	(a) a tie of 3, 4, and 6, then a tie of 1, 2, and 5; (b) 1, then a tie of 2 and 3, then 4, then a tie of 5 and 6; (c) 1, 2, 3, 4, 5, 6; (d) 2 and 4; (e) 1, 2, 5
10	*b, a, c, d*
11	(a) 3, tie of 1 and 2, then 4; (b) 4, tie of 1 and 2, then 3; (c) 1, 4, 2, 3

Chapter 38 Answers

1	(a) greater; (b) less
2	only b
3	potassium
4	3, 2, 1
5	only e
6	downward
7	none
8	3, 2, 1
9	(a) decreases by a factor of $1/2^{0.5}$; (b) decreases by a factor of 1/2
10	(a) decreasing; (b) increasing; (c) same; (d) same
11	amplitude of reflected wave is less than that of incident wave
12	electron
13	electron, neutron, alpha particle
14	2, 1, 3
15	all tie
16	3, 2, 1

Chapter 39 Answers

1	a, c, b
2	less
3	(a) 18; (b) 17

4	(a) $(1/L)^{0.5} \sin(\pi x/2L)$; (b) $(4/L)^{0.5} \sin(2\pi x/L)$; (c) $(2/L)^{0.5} \cos(\pi x/L)$
5	equal
6	(a) 1/4; (b) same factor
7	c
8	(a) 3; (b) 4
9	(a) decrease; (b) increase
10	(a) greater; (b) less; (c) less
11	$n = 1, n = 2, n = 3$
12	(a) wider; (b) deeper
13	(a) $n = 3$; (b) $n = 1$; (c) $n = 5$
14	12 eV (4 → 2 in A matches 1 → 2 in C); 9 eV (5 → 4 in A matches 1 → 2 in D); 24 eV (5 → 1 in A matches 1 → 3 in D); 15 eV (4 → 1 in A matches 1 → 2 in E)
15	b, c, and d

Chapter 40 Answers

1	(a) 2; (b) 8; (c) 5; (d) 50
2	0, 2, and 3
3	all true
4	$6p$
5	same number (10)
6	(a) bromine; (b) rubidium; (c) hydrogen
7	2, -1, 0, and 1
8	(a) 1, 2, 3; (b) $-z$ direction
9	(a) 2; (b) 3
10	(a) rubidium; (b) krypton

11	(a) n;
	(b) n and ℓ
12	a and b
13	In addition to the quantized energy, a helium atom has kinetic energy; its total energy can equal 20.66 eV
14	(a) unchanged;
	(b) decrease;
	(c) decrease

Chapter 41 Answers

1	b, c, d (the latter due to thermal expansion)
2	4
3	8
4	(a) 3, then a tie of 1 and 2 (zero); (b) 3, 2, 1; (c) 1, 2, 3
5	below
6	$4s^2$ and $4p^2$
7	increase
8	(a) right to left;
	(b) back bias
9	much less than
10	(a) anywhere in the lattice;
	(b) in any silicon-silicon bond;
	(c) in a silicon ion core, at a lattice site
11	b and d

Chapter 42 Answers

1	(a) ^{196}Pt;
	(b) no
2	less
3	yes
4	above
5	(a) less; (b) greater)
6	A and C tie, then B
7	^{240}U
8	7 h
9	no effect
10	2, 3, 1
11	yes
12	(a) d; (b) g

13	(a) all except ^{198}Au; (b) ^{132}Sn and ^{208}Pb
14	(a) increase; (b) same
15	d

Chapter 43 Answers

1	(a) 101; (b) 42
2	decreased
3	^{239}Np
4	more neutrons than protons
5	^{140}I, ^{105}Mo, ^{152}Nd, ^{123}In, ^{115}Pd
6	greater
7	increased
8	20
9	less than
10	larger
11	still equal to 1
12	(a) ^{93}Sr; (b) ^{140}I; (c) ^{155}Nd

Chapter 44 Answers

1	b, c, d
2	the π^+ pion whose track terminates at point 2
3	(a) 1; (b) positively charged
4	baryon number
5	a, b, c, d
6	(a)-(c) yes; (d) no
7	d
8	3, 2, 1
9	c
10	c, f
11	(a) lepton; (b) antiparticle; (c) fermion; (d) yes