

## Numerical Answers to Applying the Concepts

### 1.3

1.  $2.6 \times 10^6$  s
2. 1.4 km
3.  $5.5 \times 10^2$  ml

### 1.4

1. 14 m/s [N]
2. a) 1.6 km/h  
b) 0.40 km/h [E]
3. a) 1.1 m/s [E]  
b) 0

### 1.6

1.  $9.4 \times 10^3$  m
2.  $1.7 \times 10^{-2}$  m/s
3. a) 1.8 s  
b) 4.4 m
4.  $-7.7 \times 10^5$  m/s<sup>2</sup>
5. 14 m/s
6. 4.9 s
7. a) 2.7 s  
b) 43 m/s

### 1.7

1. a) 330 m  
b) 8.16 s  
c) 16.3 s
2. a) 2.1 s  
b) 2.9 s
3. 7.2 m/s [up]

### 1.8

1. a)  $2.0 \text{ m/s}^2$ ,  $0 \text{ m/s}^2$ ,  $12 \text{ m/s}^2$   
b) 455 m
2. a) S.D. Sr.: 6 s, S.D. Jr.: 5 s  
b) S.D. Junior by 1 s  
c) S.D. Senior by 1.5 s
3. a) 2.5 m/s, 0 m/s,  $-1.25 \text{ m/s}$ , 1.5 m/s  
b) 0.65 m/s

### 1.12

1. a)  $5.0 \text{ m/s}^2$   
b)  $2.5 \text{ m/s}^2$   
c)  $2.5 \text{ m/s}^2$
2. 270 N
3.  $-2000$  N
4.  $F_{\text{engine}} = 4.66 \times 10^3$  N,  
 $F_f = -1.94 \times 10^3$  N
5.  $-280$  N

### 1.13

3. a)  $2.25 \times 10^4$  N  
b)  $1.35 \times 10^4$  N,  $6.0 \times 10^3$  N
4. a)  $0.83 \text{ m/s}^2$   
b) 350 N

### 1.14

1. a)  $-6.7 \times 10^3$  N  
b)  $0.17 \text{ m/s}^2$
2. b)  $1.5 \text{ m/s}^2$
3. 42 m

### 1.15

1.  $5.5 \times 10^{-67}$  N
2.  $2.1 \times 10^{20}$  N
3. a)  $\frac{1}{8}F$   
b)  $\frac{2}{9}F$   
c)  $F$
4.  $2.6 \times 10^6$  m
5.  $24 \text{ m/s}^2$

### 2.1

2. a) 49 m [S] + 12 m [E]  
b) 100 m/s [S] + 173 m/s [W]  
c)  $12 \text{ m/s}^2$  [N] +  $8.4 \text{ m/s}^2$  [E]
3.  $v_x = 4.5 \text{ m/s}$ ,  $v_y = -2.1 \text{ m/s}$
4. 5.0 m/s [up  $53^\circ$  forward]
5. a) 26 m/s [N $78^\circ$ E]  
b) 49 m [W $18^\circ$ N]  
c) 30.1 N [N $53^\circ$ W]
6. 26 m/s [N $87^\circ$ W]

### 2.2

1. a) [S $76^\circ$ E]  
b) 19 km/h [E]  
c) 5.2 h
2. a) [N $9.6^\circ$ E]  
b)  $t_{\text{girl}} = 169$  s,  $t_{\text{boy}} = 167$  s  
c) 83 m  
d) girl
3. 12 km/h [N $59^\circ$ E]
4. a) [S $76^\circ$ E]  
b) 2.6 s

### 2.3

1. a) 1.7 s  
b) 44 m
2. a) 2.3 s  
b) 120 m

3. a) 89 m  
b) 163 m/s  $23^\circ$  to vertical
4. 66 m/s  $17^\circ$  above horizontal

### 2.4

1.  $1.8 \text{ m/s}^2$  [N $56^\circ$ W]
2. a) 15.8 N [N $80^\circ$ W]  
b)  $0.20 \text{ m/s}^2$  [N $80^\circ$ W]
3. 104 N [S $3.3^\circ$ W]
4.  $1.38 \text{ m/s}^2$

### 2.5

1. 1.6 s
2. 1.2 s
3. 9.8 m
4. (3.36)(mass) N

### 2.6

1. a)  $5.1 \text{ m/s}^2$  [right], 71 N  
b)  $3.5 \text{ m/s}^2$  [right], 32 N  
c)  $1.1 \text{ m/s}^2$  [left],  $1.8 \times 10^2$  N  
d)  $0.82 \text{ m/s}^2$  [left],  $T_1 = 122$  N,  
 $T_2 = 106$  N

### 2.7

1.  $21 \text{ m/s}^2$
2.  $8.9 \text{ m/s}^2$
3. a) increases by 4  
b) halved  
c) doubled
4. a)  $2.7 \times 10^{-3} \text{ m/s}^2$   
b) toward Earth
5. 0.31 m/s
6. 2724 rotations per day

### 2.8

1. a) 3.5 m/s  
b) 24 N
2. 972 N
3. 3.4 m/s
4. b) 19 m/s
5. 22.8 days
6.  $7.57 \times 10^3$  m/s
7.  $7.4 \times 10^4$  s

### 3.3

1.  $F_h = 5.0 \times 10^3$  N,  $F_v = 8.7 \times 10^3$  N
2. 68.4 N
3. b) 0.39 m  
c) 0.45 kg

4. a) 20.7 N  
b) 6.71 N  
c) 19.6 N [down]  
6.  $1.11 \times 10^3$  N

### 3.4

1. b) 425 N·m  
2. a)  $1.3 \times 10^3$  N  
3. a) 98.0 N  
b) B  
c)  $1.7 \times 10^2$  N·m

### 3.5

1. 0.332 m  
2. a) 147 N·m  
b) 2.63 m  
c) 2.6%  
3. a) 24.5 N  
b) 24.5 N [left], 49 N [up]  
4. left: 919 N [up], right: 306 N [up]

### 3.6

1. 41.6 N·m [clockwise]  
2.  $5.3 \times 10^2$  N  
3. a)  $T = 5.57 \times 10^3$  N,  
 $F_h = 5.55 \times 10^3$  N [right],  
 $F_v = 1.05 \times 10^3$  N [up]

### 3.7

1. a) 49.8 cm  
b) 36.5 cm  
2. a) 3-wheel:  $13.3^\circ$ , 4-wheel:  $31.0^\circ$

### 3.8

1. a)  $3.0 \times 10^{-2}$  N  
b)  $1.11 \times 10^1$  m/s<sup>2</sup>  
2.  $8.0 \times 10^{-2}$  m  
3. 36.0 N

### 3.9

1.  $1.83 \times 10^{-3}$  m  
2. a)  $9.8 \times 10^4$  N/m<sup>2</sup>  
b)  $2.0 \times 10^{-5}$   
c)  $3.0 \times 10^{-4}$  m  
3. a)  $4.4 \times 10^4$  kg

### 4.2

1.  $1.3 \times 10^2$  kg·m/s [W20°N]  
2.  $4.5 \times 10^3$  kg  
3. c) 38.5 kg·m/s [N]

### 4.3

1. a)  $4.2 \times 10^3$  N·s [forward]  
b) 6.0 N·s  
c) 15 N·s [down]

2.  $2.4 \times 10^3$  N·s [up]  
3. a)  $1.3 \times 10^4$  N  
b) 3.3 m  
4. a) 62.5 N·s [S]  
b) 1875 N·s [W]  
c) 45 N·s [E]

### 4.4

1. 2.5 m/s [forward]  
2. 11.8 m/s [back]  
3. 2.0 m/s [forward]  
4.  $6.9 \times 10^{-23}$  kg  
5.  $\frac{5}{9}v$

### 4.5

1. 4.1 m/s [S37°W]  
2. 8.3 m/s [N16°E]  
3. 1.7 m/s [R47°D]  
4. 10 m/s [S5°W]

### 4.6

1. a) 1.5 m  
b) 17 cm (from the 5 kg ball)  
c) 6.7 km (from the larger satellite)  
2. a)  $p_{1o} = 0.22$  kg·m/s [S20°E],  
 $p_{2o} = 0.17$  kg·m/s [S10°W],  
 $p_{1f} = 0.26$  kg·m/s [S5°W],  
 $p_{2f} = 0.15$  kg·m/s [S30°E],  
 $p_{cm} = 0.39$  kg·m/s [S8°E]

### 5.2

1. a) 6.0 J  
b)  $9.6 \times 10^2$  J  
c)  $4.4 \times 10^2$  J  
2.  $1.6 \times 10^5$  J  
3.  $4.5 \times 10^2$  J  
4.  $1.1 \times 10^7$  J  
5. a) 9625 J  
b) 0.80 J  
6. 16 m

### 5.3

1. a)  $5.6 \times 10^{11}$  J  
b) 5.6 m/s, 15.4 J  
c)  $2.4 \times 10^3$  J  
2. 5.6 m/s  
3. 6.5 kg  
4.  $4.2 \times 10^{-23}$  N·s  
5.  $-5.1 \times 10^3$  J  
6. a)  $1.1 \times 10^2$  J  
b)  $1.1 \times 10^2$  J  
c)  $4.6 \times 10^3$  N

### 5.4

1. a)  $4.1 \times 10^1$  J

- b) 0 J  
c)  $3.7 \times 10^4$  J  
2. a) 23 m/s  
b) 23 m/s  
3. a) 60 m/s  
b)  $1.8 \times 10^2$  m  
c)  $E_k = 2.4 \times 10^3$  J,  
 $E_p = 3.0 \times 10^3$  J  
4.  $3.0 \times 10^5$  N/m

### 5.5

1. a)  $2.0 \times 10^2$  N/m  
b) 1.0 J  
c)  $7.0 \times 10^{-2}$  J  
2. 2.45 N/m  
3. a)  $4.4 \times 10^{-2}$  J  
b)  $2.7 \times 10^{-1}$  J  
4. 8.0 m/s  
5. 9 cm  
6. 0.49 m

### 5.6

1.  $6.9 \times 10^4$  J  
2. a) 590 W  
b) 10 600 J  
3.  $2 \times 10^7$  W  
4.  $4.6 \times 10^5$  J

### 5.7

3. a) 30 m/s [W]  
c)  $4.5 \times 10^5$  J  
4. a)  $p = 16.5$  kg·m/s,  $E_k = 270$  J;  
 $p = 0$ ,  $E_k = 0$   
b) -12 m/s  
c) 36 J, 3.4 J  
5.  $v_{1f} = -3.3$  m/s,  $v_{2f} = 1.7$  m/s  
6.  $v_{1f} = -68.8$  cm/s,  $v_{2f} = 15.2$  cm/s  
8. a) 1.0 J  
b) 0.425 J  
9. a)  $\approx 28$  J  
b)  $\approx 10$  J  
c) 64%

### 6.1

1. a)  $2.64 \times 10^{33}$  J  
b)  $-5.26 \times 10^{33}$  J  
c)  $-2.63 \times 10^{33}$  J  
2. 7.323 m/s<sup>2</sup>  
3. b)  $4.7 \times 10^6$  m

### 6.2

1. a)  $2.7 \times 10^{11}$  m  
b) 0.97  
c) 55 000 m/s  
2. 56 000 m/s

3. a) 423 m/s  
b)  $3.84 \times 10^{28}$  J  
5. 297.2 days

### 6.3

1. a) 0.872 85 J  
b) 0  
c) 1.9 m/s  
2. a) 51.83 s  
b) 1.32 m/s  
c) 0.4224 J

### 7.2

1. a) 0.17 rad  
b) 1.0 rad  
c) 1.6 rad  
d) 3.07 rad  
e) 4.47 rad  
2. a)  $180^\circ$   
b)  $45^\circ$   
c)  $675^\circ$   
d)  $639^\circ$   
e)  $2.3 \times 10^{30}$   
3. a) 1.57 rad  
b) 4.56 rad  
c) 2.62 rad  
d) 161 rad

### 7.3

2. a)  $1.1 \times 10^2$  m/s  
b)  $5.0 \times 10^{-5}$  rad/s<sup>2</sup>,  
0.090 rad/s  
3. a) 0.13 rad/s  
b)  $24 \text{ m/s}^2$   
c) 0  
d) 2.4

### 7.4

1. a)  $3.58 \times 10^3$  rad  
b)  $44 \text{ rad/s}^2$   
2. a) 8.3 s  
b) 7.3 rad  
c) 1.2 cycles  
d) 5.9 s  
3. a) 6.03 s  
b)  $-0.266 \text{ rad/s}^2$

### 7.5

2. a)  $-0.086 \text{ N}\cdot\text{m}$   
b)  $-2.8$  turns,  $-0.93$  turns,  
 $-0.51$  turns  
3.  $0.693 \text{ kg}\cdot\text{m}^2$   
4. a)  $4.13 \text{ kg}\cdot\text{m}^2$   
b)  $18.4 \text{ N}\cdot\text{m}$   
c)  $4.46 \text{ rad/s}^2$

### 7.6

1. a) 29 J  
b) 6.9 J  
c) 7.7 J  
2. a) 5.3 J  
b) 0

### 7.7

1. 0.23 J  
2.  $2.0 \times 10^3$  J

### 7.8

1. a)  $1.1 \times 10^4$  J  
b)  $4.1 \times 10^5$  J  
c)  $4.2 \times 10^5$  J  
2. a)  $2.6 \times 10^2$  J  
b) 10.8 m/s  
c)  $1.9 \times 10^2$  rad/s

### 7.9

1.  $1.94 \times 10^{31} \text{ kg}\cdot\text{m}^2/\text{s}$   
2.  $7.1 \times 10^2 \text{ kg}\cdot\text{m}^2/\text{s}$   
3.  $1.003 \times 10^{42} \text{ kg}\cdot\text{m}^2/\text{s}$ ,  
 $1.003 \times 10^{42} \text{ kg}\cdot\text{m}^2/\text{s}$

### 7.10

2.  $4.69 \times 10^4$  rad/s,  $1.34 \times 10^{-4}$  s  
3. 29.3 km/s

### 7.11

3.  $0.56 \text{ m/s}^2$

### 8.4

1. 49 N  
2.  $3.5 \times 10^{-2}$  m  
3. c)  $56^\circ$

### 8.6

1. a)  $-1.7 \text{ N}$  [right]  
b)  $3.4 \text{ N}$  [right]  
2.  $-1.7 \text{ N}$  [left]  
3. b)  $6.8 \times 10^7 \text{ N/C}$ ,  $1.7 \times 10^7 \text{ N/C}$ ,  
 $7.5 \times 10^6 \text{ N/C}$   
c) decreases  $\frac{1}{4}$ , decreases  $\frac{1}{9}$   
e)  $4.2 \text{ N}$  [right]  
4. a)  $3.7 \times 10^6 \text{ N/C}$  [left],  
0,  $3.2 \times 10^6 \text{ N/C}$  [left]

### 8.7

1. a)  $-6.8 \times 10^{-1}$  J  
b)  $-4.5 \times 10^5$  V  
c)  $-4.5 \times 10^5$  V  
2. a)  $q_1: 2.0 \times 10^{-8}$  J,  $q_2: 5.0 \times 10^{-9}$  J  
b) 2

### 8.8

1.  $3.0 \times 10^{-14}$  m  
3. 6.0 m/s [left]  
4. a)  $3.8 \times 10^5$  m/s  
b)  $2.7 \times 10^5$  m/s  
5. a)  $3.2 \times 10^{-15}$  J  
b)  $8.4 \times 10^7$  m/s

### 8.9

1.  $3.7 \times 10^2$  V  
2.  $4.7 \times 10^4$  N/C  
3.  $4.8 \times 10^{-19}$  C

### 9.5

1. 0.90 N  
2. 18 A  
3. a)  $7.1 \times 10^{-5}$  T  
4.  $2.4 \times 10^{-2}$  A  
5. a) 0.66 m  
b)  $4.7 \times 10^{-1}$  m [S],  $4.7 \times 10^{-1}$  m  
below wire  
6. a)  $1.4 \times 10^{-2}$  N/m  
7. 0.36 N  
8.  $1.0 \times 10^{-14}$  N [into page]

### 10.2

1. a) 75 min  
b) 0.67 s  
c) 1.80 s  
d) 0.838 s  
2. a) 60 Hz  
b) 0.75 Hz  
c) 0.009 23 Hz  
d) 1.35 Hz  
3. a) i)  $2.22 \times 10^{-4}$  Hz  
ii) 1.49 Hz  
iii) 0.556 Hz  
iv) 1.19 Hz  
b) i) 0.0167 s  
ii) 1.33 s  
iii) 108 s  
iv) 0.74 s  
5. a) 26 cm  
b)  $-30$  cm  
c) 0 cm  
d) 30 cm  
e) 21 cm

### 10.3

4. a)  $4.7 \times 10^{14}$  Hz  
b)  $2.5 \times 10^8$  Hz  
c)  $1.5 \times 10^{17}$  Hz  
5. a)  $2.0 \times 10^{-5}$  m  
b) 0.15 m  
c)  $1.0 \times 10^{-14}$  m

## 10.4

- a)  $2.3 \times 10^8$  m/s  
b)  $1.24 \times 10^8$  m/s  
c)  $2.0 \times 10^8$  m/s
- a) 1.43  
b) 2.0  
c) 1.27
- a)  $18^\circ$   
b)  $10^\circ$   
c)  $16^\circ$

## 10.5

- a)  $1.81 \times 10^8$  m/s,  
 $2.02 \times 10^8$  m/s  
b) 11.6%

## 11.4

- 713 nm
- 20 cm
- 42 cm

## 11.5

- 1.8  $\mu\text{m}$

## 11.6

- 6.9  $\mu\text{m}$
- 55

## 11.8

- a)  $11.5^\circ$   
b) 22 cm
- a) 22 cm  
b)  $11.5^\circ$
- 11 cm
- a) 197 nm  
b) 5 km

## 11.9

- $12^\circ$ ,  $24^\circ$ ,  $38^\circ$
- a) 4  
b) 4  
c) 5
- a) 8.40  $\mu\text{m}$   
b) 2334 slits

## 11.10

- 3000 lines/cm
- $\theta_{\text{red}} = 22.7^\circ$ ,  $\theta_{\text{violet}} = 12.2^\circ$ ,  
 $\theta_{\text{green}} = 15.6^\circ$
- 52 pm
- $168^\circ$ ,  $192^\circ$

## 12.2

- a)  $2.4 \times 10^{-7}$  m  
b)  $3.2 \times 10^{-6}$  m

## 12.3

- a)  $8 \times 10^{-34}$  J·s, 2.9 eV  
b)  $5.79 \times 10^{-19}$  J

## 12.4

- a)  $4.53 \times 10^{-26}$  N·s  
b)  $3.1 \times 10^{-27}$  N·s  
c)  $1.27 \times 10^{-17}$  J  
d)  $5.27 \times 10^6$  m/s

## 12.5

- $7.27 \times 10^{-7}$  m

## 12.6

- $3.05 \times 10^{-7}$  m
- Lyman: 10.2 eV, 13.6 eV;  
Balmer: 1.89 eV, 3.4 eV;  
Paschen: 0.66 eV, 1.51 eV

## 12.8

- $6.3 \times 10^{-2}$  m
- $1.32 \times 10^{-13}$  m

## 13.2

- $1.5 \times 10^8$  m/s
- 1.1c [R]
- $5.93 \times 10^8$  m/s

## 13.3

- 189 m
- $2 \times 10^{-8}$  s (Phillip),  
 $2.5 \times 10^{-8}$  s (Barb)
- 49.9 bpm
- $2.60 \times 10^8$  m/s
- $2.95 \times 10^8$  m/s

## 13.4

- 0.7c
- 0.8c
- 10.59 a
- $3.97 \times 10^8$  m

## 13.5

- $5.980\,000\,03 \times 10^{24}$  kg
- $3.33 \times 10^{-14}$  kg
- $6.98 \times 10^5$  m

## 13.6

- c
- $1.76 \times 10^{10}$  ca

## 13.7

- B
- $2.8 \times 10^{-5}$  g
- $5.85 \times 10^{18}$  J

## 13.8

- $1.88 \times 10^{-28}$  kg
- $939.4 \text{ MeV}/c^2$
- $2.96 \times 10^8$  m/s
- $9.38 \times 10^{-6}$  m/s

## 14.1

- a) 2.23 MeV  
b) 1.12 MeV/nucleon
- 35.48 u

## 14.2

- a)  ${}_{90}^{234}\text{Th}$   
b)  ${}_{94}^{244}\text{Pu}$   
c)  ${}_{84}^{219}\text{Po}$   
d)  ${}_{92}^{240}\text{U}$   
e)  ${}_{27}^{60}\text{Co}$
- a)  ${}_{16}^{32}\text{S}$   
b)  ${}_{11}^{23}\text{Na}$   
c)  ${}_{17}^{35}\text{Cl}$   
d)  ${}_{21}^{45}\text{Sc}$   
e)  ${}_{30}^{64}\text{Zn}$
- a)  ${}_{9}^{19}\text{F}$   
b)  ${}_{10}^{22}\text{Na}$   
c)  ${}_{23}^{46}\text{V}$   
d)  ${}_{92}^{239}\text{U}$   
e)  ${}_{28}^{64}\text{Ni}$

## 14.3

- $\frac{1}{256}$
- $2.97 \times 10^9$  a
- $1.7 \times 10^9$  a

## 14.4

- Bi
- 1800 doses
- 191 mSv

## 14.5

- 50% effective
- 7.87 GW
- 2

## 14.6

- $4.0 \times 10^{-16}$  m
- 11 kHz
- a)  $4.35 \times 10^7$  m/s  
b) 0.216 m

## 14.7

- a) 1  
b) -1  
c) 1  
d) 0  
e) -1
- 57.1 MeV/ $c^2$

# Numerical Answers to End-of-chapter Problems

## Chapter 1

16. a) 200 m  
b) 0 m
17. a) 23 m  
b) 11 m [E]
18. 32 ft/s<sup>2</sup>
19. a) 18.5 km/h  
b) 5.14 m/s
20.  $9.5 \times 10^{17}$  cm
21. 6.5 m/s, 7.1 m/s
22. a)  $2.1 \times 10^{-3}$  m/s  
b)  $2.1 \times 10^{-3}$  m/s [left]
23. a) 5.3 s  
b) 17 s
24. 5.0 m/s
25. 6.6 s
26. 400 m/s<sup>2</sup> [E]
27. 9.5 s
28. a) 6.0 s  
b) 50 m  
c) 12.0 s
30. a) 107
31. 3.7 m
32. a) 9.8 m/s<sup>2</sup> [down]  
c) 2.3 m
33. 1.4 s
34.  $\frac{h}{v_i}$
35. a) B, C, D  
b) A  
c) 5 m/s, 0 m/s, -10 m/s  
d) 9.1 m/s  
e) 0 m/s  
g) 30 m
36. a) 1 m/s<sup>2</sup>, 2 m/s<sup>2</sup>, -2.0 m/s<sup>2</sup>  
c) 73 m
37. a) 0-5 s  
b) 5-10 s  
d) 5 s  
e) -10 m/s<sup>2</sup>
38. a) Curly: 0 m/s<sup>2</sup>, Larry: 2.5 m/s<sup>2</sup>,  
Moe: 5.0 m/s<sup>2</sup>  
b) Curly: 100 m, Larry: 20 m,  
Moe: 40 m  
c) Moe
44. 16.4g
45.  $6.2 \times 10^4$  N
40. 0.25 s
47. 3.4 m/s<sup>2</sup>
48. 4.7 N, -4.7 N
49. 9800 N

50. a) 39.2 m/s<sup>2</sup>  
b)  $6.1 \times 10^3$  N,  $2.9 \times 10^3$  N
51. -3.1 N
52. 68 cm
53.  $4.2 \times 10^3$  N
54.  $6.0 \times 10^{-6}$  N,  $2.0 \times 10^{-11}$  m/s<sup>2</sup>
55. -19.6 m/s<sup>2</sup>
56.  $6.16 \times 10^{17}$  N
57. 894 N

## Chapter 2

14. a) 8.6 km [N] + 23 km [E]  
b) 8.7 N [S] + 5 N [E]  
c) 21 m/s<sup>2</sup> [S] + 21 m/s<sup>2</sup> [W]  
d) 42 kg·m/s [N] + 2.2 kg·m/s [W]
15. a) 7.7m  
b) 6.4 m
16.  $a_x = 3.3$  m/s<sup>2</sup>,  $a_y = -2.3$  m/s<sup>2</sup>
17. 4.9 km [W12°N]
18. 22 m/s, 63° to horizontal
19. 83 cm [S49°W]
20. 56 m/s [N15°W]
21. 33 m/s<sup>2</sup> [N2°W]
22. a) 0.44 h  
b) 0.22 km  
c) 1.9 km/h [N16°E]
23. a) [N16°W]  
b) 1.7 km/h [N]  
c) 0.46 h
24. 83 m
25. [E7.7°N]
26. [N38°E]
27. a) toward stern:  $v = 0.5$  m/s [S];  
toward port:  $v = 0.5$  m/s [W]  
b) toward stern:  $v = 2.3$  m/s [N];  
toward port:  $v = 2.8$  m/s [N10°W]
28. a) 4.8 m  
b) 1.2 s  
c) 6.4 m/s [E51°N]
29. a) [W37°N]  
b) 3.3 s  
c) 3.0 m/s [N]
30. 4.2 m
31. a) 19.6 m  
b) 28 m/s, 44.4° below horizontal
32. 95 m
33. a) 0.52 s  
b) At tourist's feet  
c) 26 m

34. 59 m
36. 36 m/s, 45° above horizontal
37. a) 32 N [N72°E]  
b) 51 N [S49°W]  
c) 22 N [S42°E]
38. a) 106 N [S8.5°E]  
b) 0
39. 1.4 m/s<sup>2</sup>
40. 229 m/s [N26°E]
41. a)  $4.9 \times 10^2$  N  
b) 6.4 m/s
42. 0.68 m
43. 9.6 kg
44. 19°
45. a) 4.9 m/s<sup>2</sup>  
b) 0.14 m/s<sup>2</sup>  
c) 53 s
47. 57 m
48. 17 s
49. a) 4.9m/s<sup>2</sup>, 98 N  
b) 3.9 m/s<sup>2</sup> [right]; 137 N, 176 N  
c) 12 m/s<sup>2</sup> [right], 84 N
50. 3.8 m/s<sup>2</sup>
51. 0.80
52. 2.4 s
54. a) 78 m/s<sup>2</sup>
55.  $6.0 \times 10^{-3}$  m/s<sup>2</sup>
56. 21 m/s
57. 19 m/s
58. 9.9 m/s
59. a) 4.9 N  
b) 9.7 N
60. 49 N, 9.4 N
61. a)  $5.9 \times 10^3$  N  
b) 95 m
62. a)  $2.0 \times 10^{30}$  kg  
b)  $\rho_s = \frac{1}{4}\rho_E$

## Chapter 3

21. 196N
22. 17 N
23. 566 N
24. 128 kg
25.  $5.01 \times 10^3$  N,  $1.04 \times 10^3$  N
26. a) 617.4 N  
b) 2.4 m
27.  $3.56 \times 10^3$  N
28. 1.1 kg
29. 75 N [left]

31. a) 0.5 m from  $m_1$ , 1.5 m from  $m_2$   
b) 39.2 N
32.  $F_1 = 1.1 \times 10^3$  N [down],  
 $F_2 = 1.6 \times 10^3$  N [up]
33. 0.75 m [right], 1.25 m [up]
34. 1.25 m
35.  $3.3 \times 10^2$  kg
36. 0.95 m from centre on  
17.0-kg side
37. 29.4 N, 39.2 N
38. Front legs:  $1.05 \times 10^2$  N each,  
back legs:  $4.4 \times 10^1$  N each
39. a) 196 N [up]  
b) 34.2 N [out horizontally]
40.  $2.7 \times 10^2$  N
41. a)  $3.1 \times 10^2$  N  
b) 1.2 m
42.  $7.8 \times 10^2$  N [up]
43. 0.29 m
44.  $1.9 \times 10^3$  N [up],  
 $2.5 \times 10^3$  N [down]
45. 0.75 N, 0.25 N
46.  $9.5 \times 10^2$  N
47.  $26^\circ$
48. 1.73 m
49. 5.2 cm ( $21.8^\circ$ )
50.  $26.6^\circ$
51.  $1.6 \times 10^3$  N/m
52.  $1.88 \times 10^4$  N/m
53. 25.4 kg
54. a)  $7.5 \times 10^2$  N  
b)  $1.7 \times 10^{-2}$  m
55. a)  $9.8 \times 10^{-8}$   
b)  $2.0 \times 10^{-7}$  m  
c)  $1.7 \times 10^6$  kg
56.  $8.32 \times 10^4$  N
57.  $3.95 \times 10^7$  N/m
58.  $7.1 \times 10^8$  N·m
59. a)  $2.5 \times 10^{-2}$  m  
b)  $3.01 \times 10^{-4}$
60. a) Stress:  $6.67 \times 10^5$  N/m<sup>2</sup>,  
strain:  $6.67 \times 10^{-5}$   
b)  $2.0 \times 10^{-4}$  m
61. 22.000 0775 m
25. a) 1.86 s  
b) 14.7 N  
c) 27.3 kg·m/s
26. a) 66.5 kg·m/s  
b) 66.5 kg·m/s
27. 9 kg·m/s
30. a)  $7.5 \times 10^2$  kg·m/s  
b)  $3.7 \times 10^{-2}$  s
31. a)  $-5.3 \times 10^5$  N  
b)  $-2.7 \times 10^4$  N
32. a)  $1.1 \times 10^1$  kg·m/s  
b)  $-1.3 \times 10^7$  m/s<sup>2</sup>  
c)  $-3.9 \times 10^5$  N  
d)  $2.8 \times 10^{-5}$  s  
e)  $-1.1 \times 10^1$  kg·m/s
33. b)  $6.0 \times 10^7$  N·s
34. 24.75 N·s [forward]
35.  $1.4 \times 10^3$  N·s
36.  $5.6 \times 10^3$  m/s
37. 2.5 m/s [S]
38. 4.8 m/s
39. 1.5 m/s
40. 0.33 m/s
41. 0 m/s
42.  $4.8 \times 10^4$  kg
44.  $4.4 \times 10^6$  m/s
45.  $\frac{3}{7}v$
46.  $2 \times 10^3$  s
47. b) 763 kg·m/s [E $24.7^\circ$ N]
48. 17 m/s [N $1.4^\circ$ W]
49. 35 m/s [E]
50.  $6.7 \times 10^{-25}$  kg,  $1.7 \times 10^7$  m/s  
[S $32^\circ$ W]
51.  $3.3^\circ$
52.  $1.058 \times 10^3$  kg
53. 5.63 m/s [U $40^\circ$ R]
54. 7.7 m/s [R $20^\circ$ U]
55. a)  $v_{1o} = 23$  mm/s,  $v_{2o} = 0$ ,  
 $v_{1f} = v_{2f} = 23$  mm/s  
b)  $v_{1o} = 23$  mm/s [E],  $v_{2o} = 0$ ,  
 $v_{1f} = 23$  mm/s [E $45^\circ$ S],  
 $v_{2f} = 23$  mm/s [E $45^\circ$ N]  
c)  $p_{To} = 0.0069$  N·s [E],  
 $p_{Tf} = 0.0098$  N·s [E]  
d)  $p_{1oh} = +0.0069$  N·s,  
 $p_{1ov} = 0$ ,  $p_{2oh} = 0$ ,  $p_{2ov} = 0$ ,  
 $p_{1fh} = p_{2fh} = p_{2fv} = +0.0049$  N·s,  
 $p_{1fv} = -0.0049$  N·s  
e) 0.0098 N·s [E]
56. 24.1 m/s [S $26.6^\circ$ W]
57. a) 15 000 kg  
b) 133 m away from the  
larger mass
59. 0.0069 N·s [E], 0.0098 N·s [E]

## Chapter 5

11. a)  $2.0 \times 10^4$  J  
b) 46 J  
c)  $2.7 \times 10^{-18}$  J
12. a)  $2.7 \times 10^3$  J  
b)  $2.5 \times 10^3$  J  
c)  $9.1 \times 10^2$  J
13. 18 m,  $36^\circ$
14.  $1.4 \times 10^8$  J
15. 2100 J
16. 0 J
18. a)  $3.4 \times 10^2$  N  
b)  $5.8 \times 10^2$  N  
c)  $1.2 \times 10^2$  N
19.  $5.4 \times 10^4$  J
20. a)  $8.5 \times 10^2$  J  
c) 3.8 m/s
21. a)  $2.3 \times 10^3$  J  
b)  $3.9 \times 10^{-4}$  J  
c)  $5.8 \times 10^6$  J
22.  $1.4 \times 10^2$  kg
23.  $3.0 \times 10^4$  m/s
24.  $2.9 \times 10^4$  J
26. 14%
27. a)  $-2.8 \times 10^5$  N  
b)  $2.8 \times 10^5$  N
28. 1 m, 50 J, 8 m/s; 2 m, 225 J,  
17 m/s; 3 m, 425 J, 24 m/s
29. 55 N·s
30. a) 5 m/s  
b) 12.5 J  
d) 4.2 N
31. a) 38 J  
b) 1.5 J  
c)  $9.2 \times 10^5$  J  
d) 0 J
32. a)  $4.5 \times 10^2$  kg  
b)  $1.5 \times 10^4$  J
33. 7.6 m/s
34. 20 cm
35. 4
36. a) A, F  
b) 38 m/s  
c) 19 m/s  
d)  $1.4 \times 10^5$  N
37. 17 m
38. 5.8 cm
39. 1.7 m
40.  $1.1 \times 10^3$  m
41.  $5.3 \times 10^2$  N/m
42. a) 50 J  
b)  $1.4 \times 10^2$  J
43. 2.7 m/s
44.  $1.8 \times 10^4$  N/m

## Chapter 4

16.  $9.0 \times 10^5$  kg·m/s
17.  $7.5 \times 10^{-2}$  kg·m/s
18.  $6.3 \times 10^{-1}$  kg·m/s
19. 165.6 kg (glider)
20.  $6.0 \times 10^{26}$  m/s
23. 15 m/s
24. a)  $1.2 \times 10^3$  kg·m/s  
b)  $1.2 \times 10^3$  kg·m/s

45. 34 m/s  
 46. a) 0.77 m/s  
     b) 30 cm  
 47. 1.1 m/s  
 48.  $6.0 \times 10^2$  N  
 49.  $1.4 \times 10^3$  N/m  
 50.  $2.3 \times 10^2$  m  
 51.  $1.7 \times 10^7$  J, 4.8 kWh  
 52. a)  $4.3 \times 10^4$  W  
     b) 58 hp  
 54. a)  $1.6 \times 10^5$  W  
 55. 511 W  
 57. a) 2 m/s, 5 m/s  
     b) 38 J  
 58. 5.8 m/s, 26 m/s  
 59. a) 7.0 kg·m/s, 7.7 J  
     b) 1.1 m/s  
     c) 3.8 J  
 60. 0.45 m/s  
 61. 5 m/s [W], 3 m/s [E]  
 62. a) 2.5 m/s  
     b) 7.5 m/s  
 63. a) 52 m/s  
 64. a) 1.7 m/s  
     b) 70 m/s

## Chapter 6

13.  $7.9968 \times 10^{11}$  J  
 14. a) 776.4 km  
     b)  $5.75 \times 10^{10}$  J  
     c)  $1.11 \times 10^4$  m/s  
 15. a)  $1.66 \times 10^{10}$  J  
     b)  $1.66 \times 10^{10}$  J  
 16.  $1.1 \times 10^4$  m/s  
 17.  $8.92 \times 10^{-3}$  m  
 18.  $1.91 \times 10^8$  m from Earth's centre  
 19.  $5.87 \times 10^7$  J/kg  
 20. 7671 m/s, 5552 s (92.5 min)  
 21. 35 872 km  
 22.  $1.48 \times 10^{10}$  J  
 23. b)  $T \propto r^{\frac{3}{2}}$   
 24.  $-3.84 \times 10^{28}$  J  
 25.  $2.5 \times 10^4$  m/s  
 26.  $2.31 \times 10^3$  m/s  
 27. 7086 s or 1 h 58 min  
 28. a) 24 000 m/s  
     b) 3500 m/s  
 29. 2370 m/s  
 30. 0.25 Hz  
 31. 0.87 s  
 32. a) 2.93 J  
     b) 1.71 m/s  
     c) 1.27 m/s  
 33. a) 9.75 m/s<sup>2</sup>  
     b) 6.5 m/s<sup>2</sup>

34. a) 6.53 kW  
 35.  $5.7 \times 10^8$  N/m  
 36. 0.011 J  
 37.  $3.3 \times 10^{-4}$  m  
 38. a) 8.39 cm  
     b) 6.96 cm  
     c) 1.08 cm  
     d)  $3.41 \times 10^{-10}$  cm  
     e) 0 cm  
 39. 5.2 s  
 40. a) 5.2 s  
     b) i) 0.357 J  
        ii) 0.0186 J  
        iii)  $7.828 \times 10^{-10}$  J  
        iv) 0

## Chapter 7

17. a) 0.0175 rad  
     b)  $\frac{\pi}{2}$  rad  
     c) 3.84 rad  
     d) 8.01 rad  
     e) 20.9 rad  
 18. a) 96.1 rad  
     b)  $\frac{3\pi}{2}$  rad  
     c) 2.3 rad  
     d) 7.46 rad  
 19. a) 0°  
     b) 120°  
     c) 3600°  
     d)  $2.67 \times 10^{40}$   
 20. a) 0.56 cycles  
     b)  $\frac{1}{2}$  cycle  
     c) 0.14 cycles  
     d) 1.25 cycles  
 21. a) 80π m  
     b) 268π m  
     c) 86 m  
     d)  $3.9 \times 10^2$  m  
 22. a) 30π rad  
     b) 27 rad/s  
 23. 0.97 rad/s  
 24. a) 178.0 rad/s  
     b)  $1.0 \times 10^2$  rad  
 25. a) 0.0222 rad/s<sup>2</sup>  
     b) 0.406 Hz  
 26.  $-0.21$  rad/s<sup>2</sup>  
 27. a)  $-0.818$  rad/s<sup>2</sup>  
     b) 198 rad  
     c) 31.5 cycles  
     d) 11 rad/s  
 28. a)  $-0.92$  rad/s  
     b)  $-3.0 \times 10^{-3}$  rad/s  
     c) 12 rad/s  
 29. 4.3 rad/s  
 30.  $2.4 \times 10^2$  m/s<sup>2</sup>

31. a) 99.9 m/s  
     b) 0  
     c)  $1.10 \times 10^3$  rev  
     d)  $2.70 \times 10^5$  m  
 32. a)  $2.6 \times 10^2$  rad/s  
     b)  $2.1 \times 10^2$  m/s  
 33. 1.2 s  
 34. 0.93 s  
 35. a) 9.2 rad/s  
     b) 19 rad  
 36. a)  $-42$  rad/s<sup>2</sup>  
     b)  $3.5 \times 10^2$  rad  
     c)  $2.0 \times 10^{40}$   
     d) 4.5 s  
 37. a) 25 rad/s  
     b) 38 rad/s  
 38. a) 20π rad  
     b) 63 rad/s  
     c) 17 rad/s<sup>2</sup>  
 39. a) 1.4 s  
     b)  $1.5 \times 10^4$  rad/s<sup>2</sup>  
 40. 2.3 s  
 41. a) 38 rad  
     b) 7.2 rad/s  
 42.  $5.63 \times 10^6$  s  
 43. 3.56 s  
 44. c, a, b  
 45. a, b and c, e, d  
 46. 189 kg·m<sup>2</sup>  
 47. a) 0.15 kg·m<sup>2</sup>  
     b) 0.077 kg·m<sup>2</sup>  
     c) 0.088 kg·m<sup>2</sup>  
     d) 0.44 kg·m<sup>2</sup>  
 48. a) 0.010 kg·m<sup>2</sup>  
     b) 377 rad/s  
 49. 1.08 kg·m<sup>2</sup>  
 50. a) 3.0 kg·m<sup>2</sup>  
     b) 20.9 rad/s  
     c) 1.8 kg·m<sup>2</sup>  
 51.  $-4.8 \times 10^4$  J  
 52. a) 330 kg·m<sup>2</sup>  
     b)  $3.24 \times 10^2$  J  
     c) 0.945 m/s  
     d) 1.4  
 53. a)  $1.92 \times 10^{24}$  J  
     b) 1.27 m/s  
 54. a)  $1.0 \times 10^{-23}$  kg·m<sup>2</sup>  
     b)  $6.3 \times 10^3$  rad/s  
     c)  $2.0 \times 10^{-16}$  J  
 55. a)  $2.3 \times 10^{-51}$  kg·m<sup>2</sup>  
     b)  $4.6 \times 10^{16}$  rad/s  
     c)  $2.4 \times 10^{-18}$  J  
 56. a) 5.7 m/s  
     b) 29 rad/s

57. a) 4.9 m/s  
b) 25 rad/s
59. 6.4 m/s
60. a) 0.0264 kg·m<sup>2</sup>  
b) 4.0 kg·m<sup>2</sup>/s  
c) 27 kg·m<sup>2</sup>/s  
d) 71.4 rad/s<sup>2</sup>  
e) 7.7 N·m
61. a) 0.108 kg·m<sup>2</sup>  
b) 250 rad/s  
c) 27 kg·m<sup>2</sup>/s  
d) 71.4 rad/s<sup>2</sup>  
e) 7.7 N·m
62. a) 0.26 s  
b) 71 rad/s  
c) 0.11 kg·m<sup>2</sup>/s
63. a)  $1.6 \times 10^{-4}$  kg·m<sup>2</sup>  
b)  $2.2 \times 10^{-3}$  kg·m<sup>2</sup>/s
64. a) 1.7 kg·m<sup>2</sup>  
b) 22 kg·m<sup>2</sup>/s
65. 3.5 kg·m<sup>2</sup>
66. 1.56
67. increases by 4
68. a)  $5.7 \times 10^4$  rad/s  
b) 10 rad  
c)  $5.7 \times 10^4$  rad  
d)  $7.1 \times 10^2$  rotations
69. a) 5.7 rad/s  
b) 6.0 rad/s  
c) -0.96 rad/s
70. a) -9.2 rad/s  
b) -12 rad/s  
c) -6.5 rad/s  
d) 40 rad/s
71. 2.6 rad/s
73. a) 0.138 m/s<sup>2</sup>  
b) 3.99 s  
c) 0.551 m/s  
d) 184 rad/s  
e) 0.0205 J  
f) 1.43 J  
g) 1.46 J
74. a) 0.138 m/s<sup>2</sup>  
b) 1.03 s  
c) 1.14 m/s  
d) 380 rad/s  
e) 0.0880 J  
f) 6.16 J  
g) 6.24 J

## Chapter 8

34. a) 0  
b) -  
c) +  
d) 0  
e) +
35. a) -  
b) +

- c) -  
d) -
36. a) -  
b) e<sup>-</sup>
37. a) glass +, silk -
39. +
40. a) +
41.  $9.38 \times 10^{19}$
42.  $6.9 \times 10^{12}$
43.  $6.4 \times 10^{-8}$  C
44.  $-4.3 \times 10^{-11}$  C
45.  $1.5 \times 10^7$  electrons
46. a)  $\frac{1}{16}$   
b) 4 times  
c)  $\frac{1}{4}$
47.  $\frac{1}{2}r$
48.  $2.3 \times 10^{-8}$  N
49. a)  $3.00 \times 10^{-8}$  C  
b)  $4.5 \times 10^{-8}$  C
50.  $\frac{-1}{3}$
51. b) 5.1 m
52. a) 3.3 N [right]  
b) 7.4 N [right]  
c) 12 N [left]  
d) 0.29 or 0.15 m [left of left charge]
54.  $8.9 \times 10^2$  N [90° away from line connecting other charges]
55. a) 43.1 N [out from centre of square]  
b) 0 N
59.  $1.8 \times 10^5$  N/C
60.  $2.2 \times 10^{-2}$  C
61.  $3.6 \times 10^4$  N/C toward smaller charge
62. a)  $3.8 \times 10^6$  N/C [left]  
b)  $-1.86 \times 10^2$  N
63.  $3.6 \times 10^8$  N/C [left]
64.  $3.25 \times 10^5$  N/C [right]
65.  $5.1 \times 10^{11}$  N/C
66.  $1.2 \times 10^{-1}$  m [from larger charge]
67. 0 N/C
68.  $1.1 \times 10^6$  N/C [90° from line connecting other charges]
69. 6.0 J
70.  $1.2 \times 10^2$  C
71.  $2.3 \times 10^4$  V
72. 2.3 J
73.  $1.9 \times 10^5$  V
74. a) 0.18 J  
b) 0.14 J
75.  $2.5 \times 10^2$  V
76. a)  $5.0 \times 10^{-4}$  N

- b)  $5.0 \times 10^4$  J  
c)  $1.6 \times 10^{-4}$  kg
77.  $4.78 \times 10^5$  m/s
78. 1.41 times faster
79. a)  $1.1 \times 10^{16}$   
b)  $7.3 \times 10^7$  m/s
80. a)  $3.0 \times 10^{10}$  m/s<sup>2</sup>  
b)  $1.202 \times 10^{-15}$  J
81.  $1.9 \times 10^{-14}$  m
82. a) 2.5 cm  
b)  $6.0 \times 10^5$  m/s
83.  $7.80 \times 10^2$  N/C
84.  $1.81 \times 10^3$  V
85. a)  $2.04 \times 10^{-7}$  N/C  
b)  $6.1 \times 10^{-9}$  V
86.  $7.7 \times 10^2$  N/C
87.  $3 \times 10^3$  V
88.  $5.0 \times 10^{-3}$  m
89.  $2.67 \times 10^{-1}$  m
90. a)  $4.2 \times 10^{-19}$  C  
b)  $\approx 3e^-$
91. a)  $1.26 \times 10^7$  m/s  
b)  $7.26 \times 10^6$  m/s
92. a)  $4.5 \times 10^3$  N/C  
b)  $1.2 \times 10^{-4}$  N  
c)  $1.2 \times 10^{-4}$  N  
d)  $2.7 \times 10^{-8}$  C

## Chapter 9

22.  $8.1 \times 10^{-2}$  m
23.  $7.5 \times 10^{-5}$  T
24.  $4.2 \times 10^{-3}$  m
25.  $1.6 \times 10^{-4}$  T
26.  $1.8 \times 10^{-2}$  T
27. a) 0  
b)  $4.0 \times 10^{-4}$  T
28.  $2.5 \times 10^{-4}$  T
29. 24 A
30. a) 0.57 N [up]  
b) 0.57 N [down]
31. a) 4900 A
32. a)  $6.8 \times 10^{-2}$  N  
b) 2.7 N/kg
33.  $4.3 \times 10^{-3}$  m
34.  $1.4 \times 10^3$  m
36.  $1.3 \times 10^{-9}$  N
37. a)  $1.12 \times 10^{-15}$  N [toward wire]  
b) away from wire
38. a) 0  
b)  $2.36 \times 10^5$  T
39. 4750 m/s
40. 2500 V
41.  $2.44 \times 10^3$  N



42. 1.56 N [perpendicular to wire],  
0.78 N [at 30°]  
43. a)  $2.8 \times 10^{-2}$  T  
b)  $2.5 \times 10^{16}$  m/s<sup>2</sup>  
44. a)  $7.4 \times 10^6$  m/s  
b)  $4.2 \times 10^{-13}$  N  
45.  $1.5 \times 10^{-8}$  s  
46.  $8.7 \times 10^{-3}$  s  
47. a) clockwise  
b) counterclockwise  
48. a) clockwise (from top)  
b) linear (at south end)

## Chapter 10

21. a) 4 m  
b) 5 cm  
c) 8 s  
d)  $0.1 \text{ s}^{-1}$   
e) 0.4 m/s  
22. 3.125 cycles/s, 0.32 s/cycle  
23. 1.2 cycles/s, 0.83 s/cycle  
24. 0.017 s/cycle  
25. a) 2.5 Hz  
b) 0.4 s/cycle  
26. i) 1.3 Hz, 0.77 s/cycle  
ii) 0.75 Hz, 1.33 s/cycle  
iii) 5/9 Hz, 1.8 s/cycle  
27. a) 0.98 m  
b) -0.087 m  
c) -0.71 m  
d) 1 m  
30. a) 2.9 s/cycle  
b) 18 s/cycle  
c) 0.78 s/cycle  
31. a) i) 7.2 s/cycle  
ii) 44 s/cycle  
iii) 1.9 s/cycle  
b) i) 1.8 s/cycle  
ii) 11 s/cycle  
iii) 0.49 s/cycle  
32. a) 0.711 s/cycle  
b) 0.889 s/cycle  
c) 0.204 s/cycle  
33. a)  $2.3 \times 10^3$  N/m  
b)  $8.0 \times 10^2$  N  
34. a)  $4.62 \times 10^{14}$  Hz  
b)  $5.00 \times 10^{14}$  Hz  
c)  $5.17 \times 10^{14}$  Hz  
d)  $5.77 \times 10^{14}$  Hz  
e)  $6.32 \times 10^{14}$  Hz  
f)  $7.50 \times 10^{14}$  Hz  
35. a) 8.28 min (0.138 h)  
b)  $2.1 \times 10^{-2}$  min ( $3.5 \times 10^{-4}$  h)  
c)  $3.2 \times 10^2$  min (5.4 h)  
d) 5.1 min ( $8.4 \times 10^{-2}$  h)  
36.  $9.46 \times 10^{15}$  m  
37. 100 a  
38.  $5.33 \times 10^{-7}$  s  
39. 0.314 s  
40.  $8 \times 10^{14}$  Hz -  $4 \times 10^{15}$  Hz  
41.  $1.8 \times 10^7$  times  
42. a) 0.5  
b) 0.866  
c) 0.707  
d) 0.218  
e) 0.963  
f) 0  
g) 1  
43. a) 20°  
b) 40°  
c) 44.4°  
d) 19.5°  
e) 90°  
44.  $3.3 \times 10^8$  m/s  
45. 8.1°  
46. 0.98  
48. a)  $1.24 \times 10^8$  m/s  
b)  $1.97 \times 10^8$  m/s  
c)  $2.26 \times 10^8$  m/s  
d)  $2.31 \times 10^8$  m/s  
49. a) 0.413  
b) 0.658  
c) 0.752  
d) 0.769  
50.  $5.31 \times 10^{-5}$  s  
51. a) 54.9°  
b) 35.2°  
c) 54.9°  
52. 36.9°  
53. a) 37.5%  
b) 20.7%  
c) 5.85%  
56. 53°  
57. a) 53.1°  
b) 56.3°  
c) 40.9°  
d) 45.7°  
58. 1.73  
60. a) 48.5%  
b) 37.5%  
c) 5.85%  
d) 0.380%  
61. 26.6°  
62. 6.06%

## Chapter 11

26. a) 33.4°  
b) 0.662°  
27. 0.55 m

29. a) 7.14°  
b) 10.8°  
c) 21.9°  
d) 25.8°  
30. 3.12 μm  
31. 481 μm  
32. 0.23 mm  
33.  $4.76 \times 10^{11}$   
35. 2.86 μm  
36. 2.07  
37. 531 nm  
41. a) 86.8 nm  
b) 203 nm  
42. a) 218 nm  
b) 109 nm  
43. a) 1.40 m  
b) 520 nm  
c) 2.5 m  
44. a)  $1.5 \times 10^{20}$  Hz  
b) 3.2 Hz  
46. a) 3.78°  
b) 2.87°  
47. 837 nm  
48. 140 mm, 174 mm  
49. a) 6.47°  
b) 8.10°  
50. 6.95 μm  
51. a) 171 mm  
b) 143 mm  
52. 4.90°  
53. a) 6.1 mm  
b) 0.10°  
54. 450 nm  
55. 0.304°  
56. 1  
57. 27 m  
58. a) 2  
b) 2  
59. 11  
60. a) 1  
b) 1  
c) 2  
61.  $1.39 \times 10^{-20}$   
62. 500  
63. 0  
65.  $7.9 \times 10^{-20}$   
66. 49°

## Chapter 12

19. 4581.27°C  
20.  $1.07 \times 10^{-3}$  m  
21.  $2.32 \times 10^{-5}$  m, infrared  
21.  $6.36 \times 10^{18}$  photons/s  
23. 0  
25.  $8.15 \times 10^{19}$  photons/s

26. a)  $2.83 \times 10^{52}$  Hz  
 b)  $4.28 \times 10^{-19}$  J  
 28.  $2.2 \times 10^{-7}$  m  
 30. a)  $7.5 \times 10^{17}$  Hz  
 b)  $1.66 \times 10^{-24}$  N·s  
 c)  $5.53 \times 10^{-33}$  kg  
 31.  $5.02 \times 10^{-19}$  N·s  
 32.  $6.63 \times 10^{-29}$  N·s  
 33.  $4.48 \times 10^{-12}$  m  
 34.  $2.04 \times 10^{-9}$  m  
 35. increases by 202%  
 36.  $2.9 \times 10^{-34}$  m  
 37. 3371 m/s  
 38.  $1.37 \times 10^{27}$  m/s  
 39. a)  $1.73 \times 10^{-10}$  m  
 40.  $4.34 \times 10^{-7}$  m, violet  
 41. a)  $-12.75$  eV  
 b)  $-2.55$  eV  
 42.  $2.64 \times 10^{-10}$  m  
 43.  $8.22 \times 10^{-8}$  N  
 44.  $6.56 \times 10^{15}$  Hz  
 48.  $7.27 \times 10^{-7}$  m  
 49.  $1.98 \times 10^{-5}$  m/s

## Chapter 13

28. a)  $3.16 \times 10^{-18}$   
 b)  $3.3 \times 10^{-16}$   
 c)  $3.6 \times 10^{-8}$   
 d)  $7.28 \times 10^{-6}$   
 e)  $7.33 \times 10^{-3}$   
 29. a) 120 km/h  
 b) 180 km/h [W], 80 km/h [E]  
 c) Snoopy by 0.139 h  
 30. 0.60 m  
 31.  $2.83 \times 10^8$  m/s  
 32.  $6.12 \times 10^{-7}$  s  
 33.  $1.04 \times 10^2$  m  
 34.  $7.58 \times 10^{10}$  m  
 35.  $6.81 \times 10^{-12}$  s  
 36. 82.7 m  
 37.  $2.45 \times 10^8$  m/s  
 38.  $6.68 \times 10^{-8}$  s  
 39.  $9.47 \times 10^{15}$  m  
 40. 500 m  
 41.  $1.66 \times 10^8$  m/s  
 42.  $9 \times 10^8$  m  
 43.  $1.8 \times 10^8$  m/s  
 44. 0.691 ca  
 45.  $1.52 \times 10^{-3}$  m  
 46.  $7.81 \times 10^{-15}$  m  
 47.  $3.00 \times 10^{-7}$  kg  
 48.  $3.67 \times 10^{-26}$  kg  
 49.  $2.26 \times 10^{-2}$  T  
 50.  $2.6 \times 10^8$  m/s  
 51.  $3.00 \times 10^8$  m/s  
 52.  $1.42 \times 10^8$  m/s  
 53.  $2.88 \times 10^8$  m/s  
 54.  $2.99 \times 10^8$  m/s  
 55.  $2.47 \times 10^8$  m/s  
 56.  $1.50 \times 10^8$  m/s  
 57.  $3.56 \times 10^{-13}$  kg  
 58.  $1.02 \times 10^{-6}$  kg  
 59.  $\$2 \times 10^9$   
 60. 0.5c–0.9c  
 61. electron  
 62.  $2.9 \times 10^{-1}$  N·s  
 63.  $4.16 \times 10^{15}$  kg  
 64.  $2.4 \times 10^{-28}$  kg  
 65. 937.8 MV  
 66. A  
 67. 10 501 MeV  
 68. 2.999 999 96  $\times 10^8$  m/s  
 69. A

## Chapter 14

43. a) Cl  
 b) Rn  
 c) Be  
 d) U  
 e) Md  
 44. a) 17 p<sup>+</sup>, 18 n  
 b) 86 p<sup>+</sup>, 136 n  
 c) 4 p<sup>+</sup>, 5 n  
 d) 92 p<sup>+</sup>, 146 n  
 e) 101 p<sup>+</sup>, 155 n  
 45. 17 697 MeV/c<sup>2</sup>  
 46. 0.114 u  
 47. Cu, 63.55 u  
 48. 7.5 MeV/nucleon  
 49. 4/3 : 1/1  
 50. 20.55 MeV  
 51. 5.41 MeV

52.  $5.0 \times 10^{-14}$  m  
 54. 0.789 MeV  
 55. 0.546 MeV  
 56.  $5.44 \times 10^{-21}$  N·s  
 57.  $7.42 \times 10^{-16}$  J  
 58.  $5.07 \times 10^{-16}$  m  
 59. 39.7%  
 60. 0.85:1  
 61.  $0.79 \times 10^{-6}$  g  
 62. 14 d  
 63.  $5.78 \times 10^8$  a  
 64. 1507 a  
 65.  ${}^4_2\text{He}$ ,  ${}^{16}_8\text{O}$ ,  ${}^{48}_{20}\text{Ca}$ ,  ${}^{40}_{20}\text{Ca}$ ,  ${}^{78}_{28}\text{Ni}$ ,  ${}^{132}_{50}\text{Sn}$   
 66. 0.6996 MeV  
 67. 0.013 mG  
 68. 3.64  
 69. 8 alpha, 6 beta  
 70.  ${}^{232}_{90}\text{Th}$   
 71. 4.8 fm  
 72. 4.2 MeV  
 73.  $1.67 \times 10^{17}$  Bq,  $1.61 \times 10^{17}$  Bq  
 74. 5.49 MeV  
 75. 883 kg  
 76. 24.2%  
 77.  $5 \times 10^{15}$  J  
 78. 8  
 79.  $1.782 \times 10^4$  m/s  
 80.  ${}^{92}_{36}\text{Kr}$   
 81. 0.999639c  
 82.  $1.73 \times 10^{-19}$  m  
 83. 1.16 fm  
 84. 2.28 T  
 85. 8.0 GeV  
 86. 1.87 T  
 87. a) 0  
 b) 1  
 c) 0  
 d) 0  
 89.  $\bar{u}d\bar{d}$ ,  $\bar{u}d\bar{d}$   
 90. Os  
 91.  $\bar{u}d$   
 92.  $8 \times 10^{-24}$  s  
 96.  $p^2 = -2.165 \times 10^{-13}$  N<sup>2</sup>·s<sup>2</sup>  
 98. -1  
 99. 1