Appendix A:

WORKING WITH NUMBERS

Significant Figures

Addition and Subtraction: When adding or subtracting numbers, your answer cannot have more significant figures after the decimal than the smallest number of significant figures after the decimal in any of the numbers used to obtain the answer.

For example: 25.678 + 3.45 + 67.2 = **96.3** Only 3 significant figures

Multiplication and Division: When multiplying or dividing numbers, your answer cannot have more total significant figures than the smallest total number of significant figures in any of the numbers used to obtain the answer.

For example: (26.4 N)(1.2 m) = **32 N·m** Only two significant figures

These rules are fairly easy to follow until you begin introducing zeros into your equations. Below are some examples using zeros.

700 has only one significant figure (the 7).
700.0 has 4 significant figures (all 4 numbers).
0.0700 has 3 significant figures (the 7 and the two zeros to the *right* of the 7).
0.007 has only 1 significant figure (the number 7).
7.007 has 4 significant figures (all 4 numbers).

Scientific notation may come in handy when working with significant figures. The number 7000, which has only 1 significant figure, can be written as 7.00×10^3 in order to be written with three significant figures.

You may also make zeros significant by placing a decimal point at the end. For example, 700 has only one significant figure while 700. has three.

Remember, these rules only apply to measured quantities. Quantities that can be counted rather than measured, such as people, coins, etc., are presumed to be an exact number and may be followed by as many zeros after the decimal as needed.

Unit Conversions

Before you solve an exercise, it is important that all units on the ends of the numbers you are using be in the same system. In this book, most quantities have been converted into the SI System (Système International), which is the standard system of units in physics.

Example: Convert 5 years into seconds.

$$(5\ \cancel{y}) \times \frac{(365\ \cancel{d})}{(1\ \cancel{y})} \times \frac{(24\ \cancel{h})}{(1\ \cancel{d})} \times \frac{(60\ \cancel{\text{min}})}{(1\ \cancel{h})} \times \frac{(60\ \text{s})}{(1\ \cancel{\text{min}})}$$

Notice that anything you are trying to eliminate in the numerator must be written in the denominator and vice versa. The units appearing in both the numerator and denominator cancel each other out, as shown by the slash marks through them.

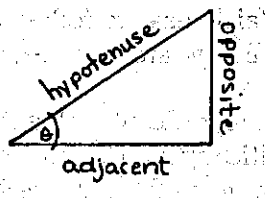
Multiplying the numerators gives: $5 \times 365 \times 24 \times 60 \times 60 = 157\ 680\ 000$

Multiplying the denominators gives: $1 \times 1 \times 1 \times 1 = 1$

Final answer: $\frac{157\ 680\ 000\ \text{s}}{1} = 157\ 680\ 000\ \text{s}$ Note: This number is not written with significant figures.

Some Simple Trigonometry Relationships

The rules of trigonometry are developed with the use of right triangles as shown in the labeled diagram. Using this diagram, you can construct trigonometric equations in the following way.



$$\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}} \qquad \cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}} \qquad \tan\theta = \frac{\text{opposite}}{\text{adjacent}}$$

Remember, you can only use the above relationships with *right* triangles. The hypotenuse of a right triangle is always the longest side.

Some Common Prefixes

Mega (M) $= 1 \times 10^6$	centi (c) $= 1 \times 10^{-2}$	micro (μ) $= 1 \times 10^{-6}$
kilo (k) $= 1 \times 10^3$	milli (m) $= 1 \times 10^{-3}$	nano (n) $= 1 \times 10^{-9}$

Appendix B:
SELECTED ANSWERS

Chapter 1

1. 884 m
3. a) 10.7 s
5. $-9.00\ m/s^2$
7. a) 2.2 m/s
9. a) 28.3 m/s
11. 0.36 s
13. 25.9 m

A1. 3.78×10^8 m
A3. a) 16.61 m/s
b) 37.16 mi/h
A5. Tortoise wins by 47 s
A7. 5 s
A9. −19 500 m
A13. a) 1.11 s
b) The same
A15. $3.9\ m/s^2$

Chapter 2

1. 145 km south
3. 50. N forward
5. 175 m/s northeast
7. 6360 km
9. Horizontal: 752 N
Vertical: 274 N
11. 40.0 m/s
13. 37° to horizontal
15. 465 m

A1. a) 1450 km south
b) 1650 km
A3. 4.1 m/s
76° east of north
A5. 14.1 m
45° north of west
A7. Horizontal: 50. N
Vertical: 42 N
A9. 4.2 m
A11. 13.4 m/s
A13. 1.2 m (does not clear)

Chapter 3

3. 4500 N
5. a) −34 000 N
7. 102 N
9. a) 78 N
11. 0.20
13. 14.5 N
15. 10 600 N
17. 1860 N
19. Culp: $1.5 \times 10^7\ N/m^2$
Vance: $1.0 \times 10^6\ N/m^2$
21. a) $.0079\ m^2$
b) 0.050 m

A1. 50. N
A3. −1400 N
A5. 100 N
A7. 0.20
A9. 17.7 N
A11. 625 N
A13. 0.080 N
A15. a) 37 500 N
b) $75\ 000\ N/m^2$

Chapter 4

1. 4.91×10^9 kg·m/s
3. a) 3750 N
b) 1.5×10^6 N
c) 400 times as great
5. 11.3 m/s
7. a) 9.0 m/s
9. 10. m/s
11. 215 m/s
13. 9.42 m/s

A1. 1470 kg·m/s
A3. 6080 N
A5. 50 000 N
A7. 1.04 m/s
A9. −0.22 m/s
A11. 17 004 m/s

Chapter 5

1. a) 1430 J
3. 4 N
5. 600 J
7. 17.4 m/s
9. 24.5 m/s
11. 7.7
13. 280 N
15. a) 6.0
b) 4.4
c) 73%

A1. 18 800 J
A3. a) 1 610 000 J
b) 53 700 W
c) 1 040 000 J
A5. 12 J
A7. a) 1.6 J
A9. 15 200 m
A11. 38
A13. 3

Chapter 6

1. 0.034 s
3. a) 1.6 m/s
5. a) 0.63 m/s
7. a) Jessica: 1.3 m/s
Julie 0.94 m/s
b) $0.15\ m/s^2$
9. 2.5 m/s
11. 1.50×10^{-15} N
13. 0.12 N·m
15. a) 17 N up
17. Anita: 384 N up
Orin: 246 N up
19. 9.74×10^{37} kg·m²
21. 5.4×10^{-8} kg·m²
23. 5.6 m/s

A1. 0.6 s
A3. 3.8 m
A5. a) 2.2 m/s
b) 35 N
A7. a) $5.9 \times 10^{-3}\ m/s^2$
b) 3.5×10^{22} N toward sun
c) 3.5×10^{22} N toward Earth
A9. Outstretched: 12 N·m
Bent: 5.6 N·m
A11. 1.5×10^{-4} kg·m2
A13. 18 m/s

Chapter 7

1. Twice as large.
3. a) 9.78×10^{-8} N
b) 1.63×10^{-8} N
5. 4.2×10^{21} m
7. $1.67 \times 10^{-9}\ m/s^2$
9. a) 9.9×10^{30} kg
b) 5.0 times
11. a) 618 000 m/s
13. a) 2.58×10^{-4} m/s

A1. 1/8100
A3. 4.1×10^{-47} N
A5. a) 1.66×10^{-3} N
A7. a) 4.9×10^{23} kg
A9. $1.33 \times 10^{-9}\ m/s^2$
A11. a) 1340 N
b) 3560 m/s

Chapter 8

1. 2 m/s
3. 28 h
5. Albert 33 y
Henry 39.6 y
7. 13.0 m
9. a) 94 450 km
11. 1.0×10^{-3} kg

A1. 15 m/s same direction
A3. 8.3 y
A5. 1390 m
A7. 10^{68} J

Chapter 9

1. a) $710.\ kg/m^3$
3. 1.76×10^{-3} kg
5. $1.3 \times 10^8\ N/m^2$
7. $5.3 \times 10^{-3}\ m^2$
9. a) 3.0×10^{-6} m
11. 4.2×10^6 Pa
13. $1330\ kg/m^3$
15. 1.61 N
17. 0.50 m
19. Decreases by $314\ m^3$
21. $0.015\ m^3$

A1. $880\ kg/m^3$

A3. Silver: 10 500 kg/m^3
Earth: 5540 kg/m^3
A5. 1.5×10^{-3} m
A7. b) 21 m
A9. a) 9.0×10^3 N
b) 10. N
A11. a) 3.03 times bigger

Chapter 10

1. 122°F
3. a) −148°C
b) −234°F
5. 437°C
7. b) 3.96×10^{-4} m^3
9. 347 000 J
11. 31.8°C
13. 9630 J
15. 3.9×10^6 J
A1. Hottest: 462°C
Coldest: −218°C
A3. 2.0×10^{-3} m
A5. 3.1×10^{-4} m^2
A7. 1990 cm^3
A9. 79.7°C
A11. 0.019 kg
A13. 1300 J

Chapter 11

1. 0.67 s
3. a) 200 N/m
5. a) 0.63 s
7. 2 s
9. a) 3.1 s
11. 0.65 m
A1. 0.0023 s
A3. 20 N/m
A5. a) 0.5441 s
A7. 6.28 s
A9. b) 0.0400 m

Chapter 12

1. 0.013 m
3. 0.4 m/s
5. 188 Hz
7. b) −5.26 m/s
9. 813 Hz
11. 0.300 m
13. 394.0 Hz
A1. 0.0085 m
A3. a) 0.688 m
A5. 40 m
A7. a) Toward: 501.5 Hz
Away: 498.5 Hz
b) 3.0 Hz
A9. 15.0 m/s
A11. 20.4 m/s
A15. 628 m/s

Chapter 13

1. 19 700 s
3. 3.80×10^{-7} m
5. 40°
7. a) −36 cm
9. 28.9°
11. 1.39
A1. 260 s
A3. 20°
A5. c) −12.0 cm
A7. a) ∞
A9. b) alcohol: 2.21×10^8 m/s
water: 2.26×10^8 m/s
A11. 20.7°
A13. a) 42.5°

Chapter 14

1. 11.1 cm
3. a) 0.0508 m
5. a) 20 times
b) 30 cm
7. 8 times
9. b) 2.7 diopters
11. 0.40 m
13. a) 8.8×10^{-4} m
15. 2.4×10^{-6} m
A1. 12.0 cm
A3. 2.4 cm
A5. 24 cm
A7. 0.17 m
A9. a) −4.0 diopters
b) 0.29 m
A11. −0.17 diopters
A13. 7130 m

Chapter 15

1. 1.3×10^{-3} N
3. 7.0×10^{-13} C
5. 10. m
7. 1.9×10^{13} N/C
9. 18×10^5 N/C to the right
11. 8800 V
13. 4.0×10^{-3} m
A1. 1.5×10^{-11} N
A3. 4.2×10^{-13} C
A5. a) 0.043 m
A7. 1.3×10^7 N/C
A9. a) 0.14 m
A11. 450 000 J
A13. 600 000 V

Chapter 16

1. 10 800 s
3. 27.5 Ω
5. 1.52 V
7. 2.0×10^4 V
9. 0.8 A
11. a) 240 V
c) 18 A
13. a) 1.5 A
b) 80 Ω
15. $8.10
17. a) 3 Ω
b) 4 A
19. Series: 10. V
Parallel: 120 V
21. a) 5 Ω
b) 85 Ω
A1. a) 15 600 s
A3. 100. Ω
A5. 5×10^{-9} A
A7. 14.17 A
A9. 1.2×10^6
A11. 0.25 A
A13. a) 3.0 Ω
b) 12 A

Chapter 17

1. 4.2×10^{-14} N
3. a) 6.0×10^{-3} T
5. a) Zero
b) 1.4×10^{-5} Wb
7. 8.4×10^{-8} V
9. a) 12 V
A1. 1.1×10^{-10} N
A3. 8.6×10^{-14} N
A5. a) 1.3×10^{-3} N
b) zero
A7. a) 1.1×10^{-5} V
A9. a) 4800 V

Chapter 18

1. 2.15 eV
3. 1040 nm
5. 150 000 m/s
7. a) 1.96 eV
b) 5.22×10^{-7} m
9. 823 nm
11. a) 657 nm Red
b) 488 nm Greenish Blue
c) 445 nm Violet
13. 1.85×10^{16} atoms
15. 1.13×10^{14} atoms
A1. 2.9×10^{20} Hz
A3. 2.42 eV
A5. 1.7×10^{-19} m
A7. Sodium: 1.68 eV Yes
Iron: 0.244 eV Yes
Gold: −0.676 eV No
A9. 7.72 eV
A11. 2.18×10^4 atoms
A13. 8.18×10^{24} atoms