Chapter 1

1. –

2. –

3. –

4. $10 \, \cancel{\text{min}} \left[\dfrac{1 \, \text{h}}{60 \, \cancel{\text{min}}} \right] = \mathbf{0.167 \, h}$

   $v = \dfrac{d}{t} = \dfrac{30.5 \, \text{mi}}{1.167 \, \text{h}} = \mathbf{26.14 \, mph}$

5.   a.   mph = (0.6)(160 km/h) = **96 mph**
      b.   km/h = (1.7)(70 mph) = **119 km/h**

6. $100 \, \cancel{\text{yds}} \left[\dfrac{3 \, \cancel{\text{ft}}}{1 \, \cancel{\text{yd}}} \right] \left[\dfrac{1 \, \text{mi}}{5{,}280 \, \cancel{\text{ft}}} \right] = 0.0568 \, \text{mi}$

   $\dfrac{60 \, \text{mi}}{\cancel{\text{h}}} \left[\dfrac{1 \, \cancel{\text{h}}}{60 \, \cancel{\text{min}}} \right] \left[\dfrac{1 \, \cancel{\text{min}}}{60 \, \text{s}} \right] = 0.0167 \, \text{mi/s}$

   $t = \dfrac{d}{v} = \dfrac{0.0568 \, \text{mi}}{0.0167 \, \text{mi/s}} = \mathbf{3.40 \, s}$

7.   a. $\dfrac{95 \, \cancel{\text{mi}}}{\cancel{\text{h}}} \left[\dfrac{5{,}280 \, \text{ft}}{\cancel{\text{mi}}} \right] \left[\dfrac{1 \, \cancel{\text{h}}}{60 \, \cancel{\text{min}}} \right] \left[\dfrac{1 \, \cancel{\text{min}}}{60 \, \text{s}} \right] = \mathbf{139.33 \, ft/s}$

      b. $t = \dfrac{d}{v} = \dfrac{60 \, \text{ft}}{139.33 \, \text{ft/s}} = \mathbf{0.43 \, s}$

      c. $v = \dfrac{d}{t} = \dfrac{60 \, \cancel{\text{ft}}}{1 \, \cancel{\text{s}}} \left[\dfrac{60 \, \cancel{\text{s}}}{1 \, \cancel{\text{min}}} \right] \left[\dfrac{60 \, \cancel{\text{min}}}{1 \, \text{h}} \right] \left[\dfrac{1 \, \text{mi}}{5{,}280 \, \cancel{\text{ft}}} \right] = \mathbf{40.91 \, mph}$

8. –

9. –

10. –

11. MKS, CGS, $°C = \dfrac{5}{9}(°F - 32) = \dfrac{5}{9}(68 - 32) = \dfrac{5}{9}(36) = \mathbf{20°}$

    SI: K = 273.15 + °C = 273.15 + 20 = **293.15**

12. $1000 \, \cancel{\text{J}} \left[\dfrac{0.7378 \, \text{ft-lb}}{1 \, \cancel{\text{J}}} \right] = \mathbf{737.8 \, ft\text{-}lbs}$

13. a. $70.8 \, \cancel{kg} \left[\dfrac{2.2 \text{ lbs}}{\cancel{kg}} \right] = \textbf{155.76 lbs}$

b. $145 \, \cancel{lbs} \left[\dfrac{1 \text{ kg}}{2.2 \, \cancel{lbs}} \right] = \textbf{65.91 kg}$

c. $6 \, \cancel{ft} \left[\dfrac{12 \, \cancel{in.}}{\cancel{ft}} \right] \left[\dfrac{2.54 \text{ cm}}{1 \, \cancel{in.}} \right] = \textbf{182.88 cm}$

d. $179.9 \, \cancel{cm} \left[\dfrac{1 \, \cancel{in.}}{2.54 \, \cancel{cm}} \right] \left[\dfrac{1 \text{ ft}}{12 \, \cancel{in.}} \right] = \textbf{5.9 ft} = \textbf{5 ft 10.8 in.}$

14. a. $°F = 2(°C) + 30° = 40° + 30° = \textbf{70}°$

b. $°F = \dfrac{9}{5}(°C) + 32° = \dfrac{9}{5}(20°) + 32° = \textbf{68}°$

c. very close

d. $30°C \rightarrow \textbf{90°F vs. 86°F}$
$5°C \rightarrow \textbf{40°F vs 41°F}$

15. a. **14.6** b. **56.0**

c. **1,046.1** d. $\dfrac{1}{16} = 0.0625 = \textbf{0.1}$

e. $3.14159 = \textbf{3.1}$

16. a. **14.60** b. **56.04**

c. **1,046.06** d. $\dfrac{1}{16} = 0.0625 = \textbf{0.06}$

e. $3.14159 = \textbf{3.14}$

17. a. **14.603** b. **56.042**

c. **1,046.060** d. $\dfrac{1}{16} = 0.0625 = \textbf{0.063}$

e. $3.14159 = \textbf{3.142}$

18. a. $\textbf{10}^{\textbf{4}}$ b. $\textbf{10}^{\textbf{6}}$ c. $\textbf{10}^{\textbf{3}}$ d. $\textbf{10}^{\textbf{-3}}$

e. $\textbf{10}^{\textbf{0}}$ f. $\textbf{10}^{\textbf{-1}}$

19. a. $\textbf{15} \times \textbf{10}^{\textbf{3}}$ b. $\textbf{5} \times \textbf{10}^{\textbf{-3}}$ c. $\textbf{2.4} \times \textbf{10}^{\textbf{6}}$ d. $\textbf{60} \times \textbf{10}^{\textbf{3}}$

e. $\textbf{4.02} \times \textbf{10}^{\textbf{-4}}$ f. $\textbf{2} \times \textbf{10}^{\textbf{-10}}$

20. a. $4.2 \times 10^3 + 48.0 \times 10^3 = 52.2 \times 10^3 = \textbf{5.22} \times \textbf{10}^{\textbf{4}}$
b. $90 \times 10^3 + 360 \times 10^3 = 450 \times 10^3 = \textbf{4.50} \times \textbf{10}^{\textbf{5}}$
c. $50 \times 10^{-5} - 6 \times 10^{-5} = 44 \times 10^{-5} = \textbf{4.40} \times \textbf{10}^{\textbf{-4}}$
d. $1.2 \times 10^3 + 0.05 \times 10^3 - 0.4 \times 10^3 = 0.85 \times 10^3 = \textbf{850}$

21. a. $(10^2)(10^3) = 10^5 = \mathbf{100 \times 10^3}$
     b. $(10^{-2})(10^3) = 10^1 = \mathbf{10}$
     c. $(10^3)(10^6) = \mathbf{1 \times 10^9}$
     d. $(10^2)(10^{-5}) = \mathbf{1 \times 10^{-3}}$
     e. $(10^{-6})(10 \times 10^6) = \mathbf{10}$
     f. $(10^4)(10^{-8})(10^{28}) = \mathbf{1 \times 10^{24}}$

22. a. $(50 \times 10^3)(2 \times 10^{-3}) = 100 \times 10^0 = \mathbf{100}$
     b. $(2.2 \times 10^3)(2 \times 10^{-3}) = 4.4 \times 10^0 = \mathbf{4.40}$
     c. $(82 \times 10^{-6})(1.2 \times 10^{-6}) = \mathbf{98.40}$
     d. $(30 \times 10^{-4})(4 \times 10^{-3})(7 \times 10^8) = 840 \times 10^1 = \mathbf{8.40 \times 10^3}$

23. a. $10^2/10^4 = 10^{-2} = \mathbf{10 \times 10^{-3}}$
     b. $10^{-2}/10^3 = 10^{-5} = \mathbf{10 \times 10^{-6}}$
     c. $10^4/10^{-3} = 10^7 = \mathbf{10 \times 10^6}$
     d. $10^{-7}/10^2 = \mathbf{1.0 \times 10^{-9}}$
     e. $10^{38}/10^{-4} = \mathbf{1.0 \times 10^{42}}$
     f. $\sqrt{100}/10^{-2} = 10^1/10^{-2} = \mathbf{1 \times 10^3}$

24. a. $(2 \times 10^3)/(8 \times 10^{-5}) = 0.25 \times 10^8 = \mathbf{2.50 \times 10^7}$
     b. $(4 \times 10^{-3})/(4 \times 10^6) = 4/4 \times 10^{-9} = \mathbf{1 \times 10^{-9}}$
     c. $(22 \times 10^{-5})/(5 \times 10^{-5}) = 22/5 \times 10^0 = \mathbf{4.40}$
     d. $(78 \times 10^{18})/(4 \times 10^{-6}) = \mathbf{1.95 \times 10^{25}}$

25. a. $(10^2)^3 = \mathbf{1.0 \times 10^6}$ b. $(10^{-4})^{1/2} = \mathbf{10.0 \times 10^{-3}}$
     c. $(10^4)^8 = \mathbf{100.0 \times 10^{30}}$ d. $(10^{-7})^9 = \mathbf{1.0 \times 10^{-63}}$

26. a. $(2 \times 10^2)^2 = \mathbf{4 \times 10^4}$
     b. $(5 \times 10^{-3})^3 = \mathbf{125 \times 10^{-9}}$
     c. $(4 \times 10^{-3})(3 \times 10^{-3})^2 = (4 \times 10^{-3})(9 \times 10^4) = 36 \times 10^1 = \mathbf{360}$
     d. $((2 \times 10^{-3})(0.8 \times 10^4)(0.003 \times 10^5))^3 = (4.8 \times 10^3)^3 = (4.8)^3 \times (10^3)^3$
         $= 110.6 \times 10^9 = \mathbf{1.11 \times 10^{11}}$

27. a. $\dfrac{(3 \times 10^2)^2 (10^2)}{3 \times 10^4} = (9 \times 10^4)(10^2)/(3 \times 10^4) = (9 \times 10^6)/(3 \times 10^4) = 3 \times 10^2 = \mathbf{300}$

     b. $\dfrac{(4 \times 10^4)^2}{(20)^3} = \dfrac{16 \times 10^8}{8 \times 10^3} = \mathbf{2 \times 10^5}$

     c. $\dfrac{(6 \times 10^4)^2}{(2 \times 10^{-2})^2} = \dfrac{36 \times 10^8}{4 \times 10^{-4}} = \mathbf{9.0 \times 10^{12}}$

     d. $\dfrac{(27 \times 10^{-6})^{1/3}}{2 \times 10^5} = \dfrac{3 \times 10^{-2}}{2 \times 10^5} = 1.5 \times 10^{-7} = \mathbf{150.0 \times 10^{-9}}$

     e. $\dfrac{(4 \times 10^3)^2 (3 \times 10^2)}{2 \times 10^{-4}} = \dfrac{(16 \times 10^6)(3 \times 10^2)}{2 \times 10^{-4}} = \dfrac{48 \times 10^8}{2 \times 10^{-4}} = \mathbf{24.0 \times 10^{12}}$

     f. $(16 \times 10^{-6})^{1/2}(10^5)^5(2 \times 10^{-2}) = (4 \times 10^{-3})(10^{25})(2 \times 10^{-2}) = 8 \times 10^{20} = \mathbf{800.0 \times 10^{18}}$

g.
$$\frac{\left[3\times10^{-3})^3\right]\left[.60\times10^2\right]^2\left[2\times10^2)(8\times10^{-4})\right]^{1/2}}{(7\times10^{-5})^2}$$

$$=\frac{(27\times10^{-9})(2.56\times10^4)(16\times10^{-2})^{1/2}}{49\times10^{-10}}$$

$$=\frac{(69.12\times10^{-5})(4\times10^{-1})}{49\times10^{-10}}=\frac{276.48\times10^{-6}}{49\times10^{-10}}$$

$$=5.64\times10^4=\mathbf{56.40\times10^3}$$

28. Scientific:
   a. **2.05×10^1**
   b. **5.04×10^4**
   c. **6.74×10^{-4}**
   d. **4.60×10^{-2}**

   Engineering:
   a. **20.46×10^0**
   b. **50.42×10^3**
   c. **674.00×10^{-6}**
   d. **46.00×10^{-3}**

29. Scientific
   a. **5.0×10^{-2}**
   b. **4.5×10^1**
   c. $1/32=0.03125=\mathbf{3.125\times10^{-2}}$
   d. $3.14159=\mathbf{3.142\times10^0}$

   Engineering:
   a. **50.0×10^{-3}**
   b. **0.045×10^3**
   c. **31.25×10^{-3}**
   d. **3.142×10^0**

30. a. $(6)(4)\times(10^{-3})(10^4)=24\times10^1=\mathbf{240}$
   b. $(70)(0.02)\times(10^5)(10^3)=4.4\times10^8=\mathbf{440\times10^6}$
   c. $(0.001)(600)\times(10^7)(10^4)=0.6\times10^{11}$

   $$\frac{0.6\times10^{11}}{4\times10^3}=\left[\frac{0.6}{4}\right]\times\left[\frac{10^{11}}{10^3}\right]=0.15\times10^8=\mathbf{150\times10^6}$$

   d. $(5.2)^2\times(10^4)^2=27.04\times10^8$

   $$\frac{27.04\times10^8}{2.02\times10^3}=13.39\times10^5=\mathbf{1.34\times10^6}$$

31. a. $6 \times 10^4 = \underline{0.06} \times 10^{+6} = \mathbf{0.06 \times 10^{+6}}$

(arrow: +2 above, −3 below)

b. $0.4 \times 10^{-3} = \underline{400} \times 10^{-6} = \mathbf{400 \times 10^{-6}}$

(arrow: −3 above, +3 below)

c. $50 \times 10^5 = \underline{5000} \times 10^3 = \underline{5} \times 10^6 = \underline{0.005} \times 10^9 = \mathbf{0.005 \times 10^9}$

(arrows above: −2, +3, +3; arrows below: +2, −3, −3)

d. $12 \times 10^{-7} = \underline{0.0012} \times 10^{-3} = \underline{1.2} \times 10^{-6} = \underline{1200} \times 10^{-9} = \mathbf{1200 \times 10^9}$

(arrows above: +4, −3, −3; arrows below: −4, +3, +3)

32. a. $0.05 \times 10^0 \text{ s} = \underline{50} \times 10^{-3} \text{ s} = \mathbf{50 \ ms}$

(arrow: −3 above, +3 below)

b. $2000 \times 10^{-6} \text{ s} = \underline{2} \times 10^{-3} \text{ s} = \mathbf{2 \ ms}$

(arrow: +3 above, −3 below)

c. $0.04 \times 10^{-3} \text{ s} = \underline{40} \times 10^{-6} \text{ s} = \mathbf{40 \ \mu s}$

(arrow: −3 above, +3 below)

d. $8400 \times 10^{-12} \text{ s} \Rightarrow \underline{0.0084} \times 10^{-6} \text{ s} = \mathbf{0.0084 \ \mu s}$

(arrow: +6 above, −6 below)

$$+3$$
increase by 3

10^0

e. $\quad 100 \times 10^3 \times 10^{-3}$ m $= \underline{0.1} \times 10^3$ m $=$ **0.1 km**

$$-3$$

33. a. $\quad 1.5 \text{ min} \left[\dfrac{60 \text{ s}}{1 \text{ min}} \right] =$ **90 s**

b. $\quad 2 \times 10^{-2} \text{ h} \left[\dfrac{60 \text{ min}}{1 \text{ h}} \right] \left[\dfrac{60 \text{ s}}{1 \text{ min}} \right] =$ **72 s**

c. $\quad 0.05 \text{ s} \left[\dfrac{1 \, \mu \text{s}}{10^{-6} \text{ s}} \right] = \mathbf{0.05 \times 10^6} \, \mu\text{s} = \mathbf{50 \times 10^3} \, \mu\text{s}$

d. $\quad 0.16 \text{ m} \left[\dfrac{1 \text{ mm}}{10^{-3} \text{ m}} \right] = 0.16 \times 10^3 \text{ mm} =$ **160 mm**

e. $\quad 1.2 \times 10^{-7} \text{ s} \left[\dfrac{1 \text{ ns}}{10^{-9} \text{ s}} \right] = 1.2 \times 10^2 \text{ ns} =$ **120 ns**

f. $\quad 4 \times 10^8 \text{ s} \left[\dfrac{1 \text{ min}}{60 \text{ s}} \right] \left[\dfrac{1 \text{ h}}{60 \text{ min}} \right] \left[\dfrac{1 \text{ day}}{24 \text{ h}} \right] =$ **4629.6 days**

34. a. $\quad 80 \times 10^{-3} \text{ m} \left[\dfrac{100 \text{ cm}}{1 \text{ m}} \right] = 8000 \times 10^{-3} \text{ cm} =$ **8 cm**

b. $\quad 60 \text{ cm} \left[\dfrac{1 \text{ m}}{100 \text{ cm}} \right] \left[\dfrac{1 \text{ km}}{1000 \text{ m}} \right] = \mathbf{60 \times 10^{-5} \text{ km}}$

c. $\quad 12 \times 10^{-3} \text{ m} \left[\dfrac{1 \, \mu\text{m}}{10^{-6} \text{ m}} \right] = 12 \times 10^{-3} \times 10^{+6} \, \mu\text{m} = \mathbf{12 \times 10^3} \, \mu\text{m}$

d. $\quad 60 \text{ cm}^2 \left[\dfrac{1 \text{ m}}{100 \text{ cm}} \right] \left[\dfrac{1 \text{ m}}{100 \text{ cm}} \right] = \mathbf{60 \times 10^{-4} \text{ m}^2}$

35. a. $\quad 100 \text{ in.} \left[\dfrac{1 \text{ m}}{39.37 \text{ in.}} \right] =$ **2.54 m**

b. $\quad 4 \text{ ft} \left[\dfrac{12 \text{ in.}}{1 \text{ ft}} \right] \left[\dfrac{1 \text{ m}}{39.37 \text{ in.}} \right] =$ **1.22 m**

c. $6 \text{ lb} \left[\dfrac{4.45 \text{ N}}{1 \text{ lb}} \right] = \textbf{26.7 N}$

d. $60 \times 10^3 \text{ dynes} \left[\dfrac{1 \text{ N}}{10^5 \text{ dynes}} \right] \left[\dfrac{1 \text{ lb}}{4.45 \text{ N}} \right] = \textbf{0.13 lb}$

e. $150{,}000 \text{ cm} \left[\dfrac{1 \text{ in.}}{2.54 \text{ cm}} \right] \left[\dfrac{1 \text{ ft}}{12 \text{ in.}} \right] = \textbf{4921.26 ft}$

f. $0.002 \text{ mi} \left[\dfrac{5280 \text{ ft}}{1 \text{ mi}} \right] \left[\dfrac{12 \text{ in.}}{1 \text{ ft}} \right] \left[\dfrac{1 \text{ m}}{39.37 \text{ in.}} \right] = \textbf{3.22 m}$

36.   **5280 ft**, $5280 \text{ ft} \left[\dfrac{1 \text{ yd}}{3 \text{ ft}} \right] = \textbf{1760 yds}$

    $5280 \text{ ft} \left[\dfrac{12 \text{ in.}}{1 \text{ ft}} \right] \left[\dfrac{1 \text{ m}}{39.37 \text{ in.}} \right] = \textbf{1609.35 m, 1.61 km}$

37. $\dfrac{60 \text{ mi}}{\text{h}} \left[\dfrac{5280 \text{ ft}}{1 \text{ mi}} \right] \left[\dfrac{12 \text{ in.}}{1 \text{ ft}} \right] \left[\dfrac{1 \text{ m}}{39.37 \text{ in.}} \right] \left[\dfrac{1 \text{ h}}{60 \text{ min}} \right] \left[\dfrac{1 \text{ min}}{60 \text{ s}} \right] = \textbf{26.82 m/s}$

38. $10 \text{ km} \left[\dfrac{1000 \text{ m}}{1 \text{ km}} \right] \left[\dfrac{39.37 \text{ in.}}{1 \text{ m}} \right] \left[\dfrac{1 \text{ ft}}{12 \text{ in.}} \right] \left[\dfrac{1 \text{ mi}}{5280 \text{ ft}} \right] = 6.214 \text{ mi}$

    $v = \dfrac{1 \text{ mi}}{6.5 \text{ min}}, \; t = \dfrac{d}{v} = \dfrac{6.214 \text{ mi}}{\dfrac{1 \text{ mi}}{6.5 \text{ min}}} = \textbf{40.39 min}$

39. $100 \text{ yds} \left[\dfrac{3 \text{ ft}}{1 \text{ yd}} \right] \left[\dfrac{12 \text{ in.}}{1 \text{ ft}} \right] = 3600 \text{ in} \Rightarrow \textbf{3600 quarters}$

40.   60 mph: $t = \dfrac{d}{v} = \dfrac{500 \text{ mi}}{60 \text{ mph}} = 8.33 \text{ h} = \textbf{8 h: 19.8 min}$

    70 mph: $t = \dfrac{d}{v} = \dfrac{500 \text{ mi}}{70 \text{ mph}} = 7.14 \text{ h} = \textbf{7 h: 8.4 min}$

    difference = **1 h: 11.4 min**

41. $d = vt = \left[600 \dfrac{\text{cm}}{\text{s}} \right] [0.016 \text{ h}] \left[\dfrac{60 \text{ min}}{1 \text{ h}} \right] \left[\dfrac{60 \text{ s}}{1 \text{ min}} \right] \left[\dfrac{1 \text{ m}}{100 \text{ cm}} \right] = \textbf{345.6 m}$

42. $\quad d = 86 \text{ stories} \left[\dfrac{14 \text{ ft}}{\text{story}} \right] \left[\dfrac{1 \text{ step}}{\dfrac{9}{12} \text{ ft}} \right] = 1605 \text{ steps}$

$\quad v = \dfrac{d}{t} \Rightarrow t = \dfrac{d}{v} = \dfrac{1605 \text{ steps}}{\dfrac{2 \text{ steps}}{\text{second}}} = 802.5 \text{ seconds} \left[\dfrac{1 \text{ minute}}{60 \text{ seconds}} \right] = \textbf{13.38 minutes}$

43. $\quad d = (86 \text{ stories}) \left[\dfrac{14 \text{ ft}}{\text{story}} \right] = 1204 \text{ ft} \left[\dfrac{1 \text{ mile}}{5{,}280 \text{ ft}} \right] = 0.228 \text{ miles}$

$\quad \dfrac{\text{min}}{\text{mile}} = \dfrac{10.22 \text{ min}}{0.228 \text{ miles}} = \textbf{44.82 min/mile}$

44. $\quad \dfrac{5 \text{ min}}{\text{mile}} \Rightarrow \dfrac{1 \text{ mile}}{5 \text{ min}} \left[\dfrac{5{,}280 \text{ ft}}{1 \text{ mile}} \right] = \dfrac{1056 \text{ ft}}{\text{minute}}, \qquad \text{distance} = 86 \text{ stories} \left[\dfrac{14 \text{ ft}}{\text{story}} \right] = 1204 \text{ ft}$

$\quad v = \dfrac{d}{t} \Rightarrow t = \dfrac{d}{v} = \dfrac{1204 \text{ ft}}{1056 \dfrac{\text{ft}}{\text{min}}} = \textbf{1.14 minutes}$

45.   a. $5 \text{ J} \left[\dfrac{1 \text{ Btu}}{1054.35 \text{ J}} \right] = \mathbf{4.74 \times 10^{-3} \text{ Btu}}$

       b. $24 \text{ ounces} \left[\dfrac{1 \text{ gallon}}{128 \text{ ounces}} \right] \left[\dfrac{1 \text{ m}^3}{264.172 \text{ gallons}} \right] = \mathbf{7.1 \times 10^{-4} \text{m}^3}$

       c. $1.4 \text{ days} \left[\dfrac{86{,}400 \text{ s}}{1 \text{ day}} \right] = \mathbf{1.21 \times 10^5 \text{ s}}$

       d. $1 \text{ m}^3 \left[\dfrac{264.172 \text{ gallons}}{1 \text{ m}^3} \right] \left[\dfrac{8 \text{ pints}}{1 \text{ gallon}} \right] = \textbf{2113.38 pints}$

46. $\quad 6(4 \times 2 + 8) = \textbf{96}$

47. $\quad (42 + 6/5)/3 = \textbf{14.4}$

48. $\quad \sqrt{5^2 + \left(\dfrac{2}{3} \right)^2} = \textbf{5.044}$

49. $\quad$ MODE = DEGREES: $\cos 21.87° = \textbf{0.928}$

50. $\quad$ MODE = DEGREES: $\tan^{-1}(3/4) = \textbf{36.87°}$

51. $\quad \sqrt{\left(400/(6^2 + 10/5) \right)} = \textbf{7.071}$

52. $\mathbf{205 \times 10^{-6}}$

53. $\mathbf{1.20 \times 10^{12}}$

54. $6.667 \times 10^6 + 0.5 \times 10^6 = \mathbf{7.17 \times 10^6}$