

Chapter 1

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3. —

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

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

$$5. \quad \begin{aligned} \text{a.} \quad & \text{mph} = (0.6)(160 \text{ km/h}) = \mathbf{96 \text{ mph}} \\ \text{b.} \quad & \text{km/h} = (1.7)(70 \text{ mph}) = \mathbf{119 \text{ km/h}} \end{aligned}$$

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

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

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

$$7. \quad \begin{aligned} \text{a.} \quad & \frac{95 \cancel{\text{mi}}}{\cancel{\text{hr}}} \left[\frac{5,280 \text{ ft}}{1 \cancel{\text{mi}}} \right] \left[\frac{1 \cancel{\text{h}}}{60 \cancel{\text{min}}} \right] \left[\frac{1 \cancel{\text{min}}}{60 \text{ s}} \right] = \mathbf{139.33 \text{ ft/s}} \end{aligned}$$

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

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

8. —

9. —

10. —

$$11. \quad \begin{aligned} \text{MKS, CGS, } ^\circ\text{C} &= \frac{5}{9} (^{\circ}\text{F} - 32) = \frac{5}{9} (68 - 32) = \frac{5}{9} (36) = \mathbf{20^\circ} \\ \text{SI: } K &= 273.15 + ^\circ\text{C} = 273.15 + 20 = \mathbf{293.15} \end{aligned}$$

$$12. \quad 1000 \cancel{\text{J}} \left[\frac{0.7378 \text{ ft} \cdot \text{lb}}{1 \cancel{\text{J}}} \right] = \mathbf{737.8 \text{ ft} \cdot \text{lbs}}$$

13. a. $70.8 \cancel{\text{kg}} \left[\frac{2.2 \text{ lbs}}{\cancel{\text{kg}}} \right] = 155.76 \text{ lbs}$
 b. $145 \cancel{\text{lbs}} \left[\frac{1 \text{ kg}}{2.2 \cancel{\text{lbs}}} \right] = 65.91 \text{ kg}$
 c. $6 \cancel{\text{ft}} \left[\frac{12 \cancel{\text{in.}}}{\cancel{\text{ft}}} \right] \left[\frac{2.54 \text{ cm}}{1 \cancel{\text{in.}}} \right] = 182.88 \text{ cm}$
 d. $179.9 \cancel{\text{cm}} \left[\frac{1 \cancel{\text{in.}}}{2.54 \cancel{\text{cm}}} \right] \left[\frac{1 \text{ ft}}{12 \cancel{\text{in.}}} \right] = 5.9 \text{ ft} = 5 \text{ ft } 10.8 \text{ in.}$
14. a. $^{\circ}\text{F} = 2(^{\circ}\text{C}) + 30^{\circ} = 40^{\circ} + 30^{\circ} = 70^{\circ}$
 b. $^{\circ}\text{F} = \frac{9}{5}(^{\circ}\text{C}) + 32^{\circ} = \frac{9}{5}(20^{\circ}) + 32^{\circ} = 68^{\circ}$
 c. very close
 d. $30^{\circ}\text{C} \rightarrow 90^{\circ}\text{F}$ vs. 86°F
 $5^{\circ}\text{C} \rightarrow 40^{\circ}\text{F}$ vs. 41°F
15. a. **14.6** b. **56.0**
 c. **1,046.1** d. $\frac{1}{16} = 0.0625 = \mathbf{0.1}$
 e. $3.14159 = \mathbf{3.1}$
16. a. **14.60** b. **56.04**
 c. **1,046.06** d. $\frac{1}{16} = 0.0625 = \mathbf{0.06}$
 e. $3.14159 = \mathbf{3.14}$
17. a. **14.603** b. **56.042**
 c. **1,046.060** d. $\frac{1}{16} = 0.0625 = \mathbf{0.063}$
 e. $3.14159 = \mathbf{3.142}$
18. a. 10^4 b. 10^6 c. 10^3 d. 10^{-3}
 e. 10^0 f. 10^{-1}
19. a. 15×10^3 b. 5×10^{-3} c. 2.4×10^6 d. 60×10^3
 e. 4.02×10^{-4} f. 2×10^{-10}
20. a. $4.2 \times 10^3 + 48.0 \times 10^3 = 52.2 \times 10^3 = \mathbf{5.22 \times 10^4}$
 b. $90 \times 10^3 + 360 \times 10^3 = 450 \times 10^3 = \mathbf{4.50 \times 10^5}$
 c. $50 \times 10^{-5} - 6 \times 10^{-5} = 44 \times 10^{-5} = \mathbf{4.40 \times 10^{-4}}$
 d. $1.2 \times 10^3 + 0.05 \times 10^3 - 0.4 \times 10^3 = 0.85 \times 10^3 = \mathbf{850}$

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. $\frac{(3 \times 10^2)^2(10^2)}{3 \times 10^4} = (9 \times 10^4)(10^2)/(3 \times 10^4) = (9 \times 10^6)/(3 \times 10^4) = 3 \times 10^2 = \mathbf{300}$
 b. $\frac{(4 \times 10^4)^2}{(20)^3} = \frac{16 \times 10^8}{8 \times 10^3} = \mathbf{2 \times 10^5}$
 c. $\frac{(6 \times 10^4)^2}{(2 \times 10^{-2})^2} = \frac{36 \times 10^8}{4 \times 10^{-4}} = \mathbf{9.0 \times 10^{12}}$
 d. $\frac{(27 \times 10^{-6})^{1/3}}{2 \times 10^5} = \frac{3 \times 10^{-2}}{2 \times 10^5} = 1.5 \times 10^{-7} = \mathbf{150.0 \times 10^{-9}}$
 e. $\frac{(4 \times 10^3)^2(3 \times 10^2)}{2 \times 10^{-4}} = \frac{(16 \times 10^6)(3 \times 10^2)}{2 \times 10^{-4}} = \frac{48 \times 10^8}{2 \times 10^{-4}} = \mathbf{24.0 \times 10^{12}}$
 f. $(16 \times 10^{-6})^{1/2}(10^5)^5(2 \times 10^{-2}) = (4 \times 10^{-3})(10^{25})(2 \times 10^{-2}) = 8 \times 10^{20} = \mathbf{800.0 \times 10^{18}}$

$$\begin{aligned} \text{g. } & \frac{[3 \times 10^{-3}]^3 [0.60 \times 10^2]^2 [2 \times 10^2](8 \times 10^{-4})^{1/2}}{(7 \times 10^{-5})^2} \\ &= \frac{(27 \times 10^{-9})(2.56 \times 10^4)(16 \times 10^{-2})^{1/2}}{49 \times 10^{-10}} \\ &= \frac{(69.12 \times 10^{-5})(4 \times 10^{-1})}{49 \times 10^{-10}} = \frac{276.48 \times 10^{-6}}{49 \times 10^{-10}} \\ &= 5.64 \times 10^4 = \mathbf{56.40 \times 10^3} \end{aligned}$$

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. $1/32 = 0.03125 = \mathbf{3.125 \times 10^{-2}}$
 - d. $3.14159 = \mathbf{3.142 \times 10^0}$

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

- 30.
- a. $(6)(4) \times (10^{-3})(10^4) = 24 \times 10^1 = \mathbf{240}$
 - b. $(70)(0.02) \times (10^5)(10^3) = 4.4 \times 10^8 = \mathbf{440 \times 10^6}$
 - c. $(0.001)(600) \times (10^7)(10^4) = 0.6 \times 10^{11}$
 $\frac{0.6 \times 10^{11}}{4 \times 10^3} = \left[\frac{0.6}{4} \right] \times \left[\frac{10^{11}}{10^3} \right] = 0.15 \times 10^8 = \mathbf{150 \times 10^6}$
 - d. $(5.2)^2 \times (10^4)^2 = 27.04 \times 10^8$
 $\frac{27.04 \times 10^8}{2.02 \times 10^3} = 13.39 \times 10^5 = \mathbf{1.34 \times 10^6}$

31. a. $6 \times 10^4 = \underline{0.06} \times 10^{+6} = \mathbf{0.06 \times 10^{+6}}$
 (Curved arrows: $6 \times 10^4 \xrightarrow{+2} 0.06 \times 10^{+6}$ and $6 \times 10^4 \xrightarrow{-3} 0.06 \times 10^{+6}$)
- b. $0.4 \times 10^{-3} = \underline{400} \times 10^{-6} = \mathbf{400 \times 10^{-6}}$
 (Curved arrows: $0.4 \times 10^{-3} \xrightarrow{-3} 400 \times 10^{-6}$ and $0.4 \times 10^{-3} \xrightarrow{+3} 400 \times 10^{-6}$)
- c. $50 \times 10^5 = \underline{5000} \times 10^3 = \underline{5} \times 10^6 = \underline{0.005} \times 10^9 = \mathbf{0.005 \times 10^9}$
 (Curved arrows: $50 \times 10^5 \xrightarrow{-2} 5000 \times 10^3$, $50 \times 10^5 \xrightarrow{+2} 5000 \times 10^3$, $5000 \times 10^3 \xrightarrow{-3} 5 \times 10^6$, $5000 \times 10^3 \xrightarrow{+3} 5 \times 10^6$, $5 \times 10^6 \xrightarrow{-3} 0.005 \times 10^9$, $5 \times 10^6 \xrightarrow{+3} 0.005 \times 10^9$)
- d. $12 \times 10^{-7} = \underline{0.0012} \times 10^{-3} = \underline{1.2} \times 10^{-6} = \underline{1200} \times 10^{-9} = \mathbf{1200 \times 10^{-9}}$
 (Curved arrows: $12 \times 10^{-7} \xrightarrow{+4} 0.0012 \times 10^{-3}$, $12 \times 10^{-7} \xrightarrow{-4} 0.0012 \times 10^{-3}$, $0.0012 \times 10^{-3} \xrightarrow{+3} 1.2 \times 10^{-6}$, $0.0012 \times 10^{-3} \xrightarrow{-3} 1.2 \times 10^{-6}$, $1.2 \times 10^{-6} \xrightarrow{+3} 1200 \times 10^{-9}$, $1.2 \times 10^{-6} \xrightarrow{-3} 1200 \times 10^{-9}$)
32. a. $0.05 \times 10^0 \text{ s} = \underline{50} \times 10^{-3} \text{ s} = \mathbf{50 \text{ ms}}$
 (Curved arrows: $0.05 \times 10^0 \text{ s} \xrightarrow{-3} 50 \times 10^{-3} \text{ s}$ and $0.05 \times 10^0 \text{ s} \xrightarrow{+3} 50 \times 10^{-3} \text{ s}$)
- b. $2000 \times 10^{-6} \text{ s} = \underline{2} \times 10^{-3} \text{ s} = \mathbf{2 \text{ ms}}$
 (Curved arrows: $2000 \times 10^{-6} \text{ s} \xrightarrow{+3} 2 \times 10^{-3} \text{ s}$ and $2000 \times 10^{-6} \text{ s} \xrightarrow{-3} 2 \times 10^{-3} \text{ s}$)
- c. $0.04 \times 10^{-3} \text{ s} = \underline{40} \times 10^{-6} \text{ s} = \mathbf{40 \mu\text{s}}$
 (Curved arrows: $0.04 \times 10^{-3} \text{ s} \xrightarrow{-3} 40 \times 10^{-6} \text{ s}$ and $0.04 \times 10^{-3} \text{ s} \xrightarrow{+3} 40 \times 10^{-6} \text{ s}$)
- d. $8400 \times 10^{-12} \text{ s} \Rightarrow \underline{0.0084} \times 10^{-6} \text{ s} = \mathbf{0.0084 \mu\text{s}}$
 (Curved arrows: $8400 \times 10^{-12} \text{ s} \xrightarrow{+6} 0.0084 \times 10^{-6} \text{ s}$ and $8400 \times 10^{-12} \text{ s} \xrightarrow{-6} 0.0084 \times 10^{-6} \text{ s}$)

$$\begin{array}{c} +3 \\ \text{increase by 3} \\ \downarrow \\ 10^0 \\ \uparrow \\ 10^{-3} \end{array}$$

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

-3

33. a. $1.5 \cancel{\text{ min}} \left[\frac{60 \text{ s}}{1 \cancel{\text{ min}}} \right] = \mathbf{90 \text{ s}}$

b. $2 \times 10^{-2} \cancel{\text{ h}} \left[\frac{60 \cancel{\text{ min}}}{1 \cancel{\text{ h}}} \right] \left[\frac{60 \text{ s}}{1 \cancel{\text{ min}}} \right] = \mathbf{72 \text{ s}}$

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

d. $0.16 \cancel{\text{ m}} \left[\frac{1 \text{ mm}}{10^{-3} \cancel{\text{ m}}} \right] = 0.16 \times 10^3 \text{ mm} = \mathbf{160 \text{ mm}}$

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

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

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

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

c. $12 \times 10^{-3} \cancel{\text{ m}} \left[\frac{1 \mu\text{m}}{10^{-6} \cancel{\text{ m}}} \right] = 12 \times 10^{-3} \times 10^6 \mu\text{m} = \mathbf{12 \times 10^3 \mu\text{m}}$

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

35. a. $100 \cancel{\text{ }\mu\text{m}} \left[\frac{1 \text{ m}}{39.37 \cancel{\text{ }\mu\text{m}}} \right] = \mathbf{2.54 \text{ m}}$

b. $4 \cancel{\text{ }\mu\text{m}} \left[\frac{2 \cancel{\text{ }\mu\text{m}}}{1 \cancel{\text{ }\mu\text{m}}} \right] \left[\frac{1 \text{ m}}{39.37 \cancel{\text{ }\mu\text{m}}} \right] = \mathbf{1.22 \text{ m}}$

$$c. \quad 6 \cancel{\text{N}} \left[\frac{4.45 \cancel{\text{N}}}{1 \cancel{\text{N}}} \right] = \mathbf{26.7 \text{ N}}$$

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

$$e. \quad 150,000 \cancel{\text{cm}} \left[\frac{1 \cancel{\text{in.}}}{2.54 \cancel{\text{cm}}} \right] \left[\frac{1 \text{ ft}}{12 \cancel{\text{in.}}} \right] = \mathbf{4921.26 \text{ ft}}$$

$$f. \quad 0.002 \cancel{\text{mi}} \left[\frac{5280 \cancel{\text{ft}}}{1 \cancel{\text{mi}}} \right] \left[\frac{12 \cancel{\text{in.}}}{1 \cancel{\text{ft}}} \right] \left[\frac{1 \text{ m}}{39.37 \cancel{\text{in.}}} \right] = \mathbf{3.22 \text{ m}}$$

$$36. \quad \mathbf{5280 \text{ ft}}, \quad 5280 \cancel{\text{ft}} \left[\frac{1 \cancel{\text{yd}}}{3 \cancel{\text{ft}}} \right] = \mathbf{1760 \text{ yds}}$$

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

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

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

$$v = \frac{1 \text{ mi}}{6.5 \text{ min}}, \quad t = \frac{d}{v} = \frac{6.214 \cancel{\text{mi}}}{\frac{1 \cancel{\text{mi}}}{6.5 \text{ min}}} = \mathbf{40.39 \text{ min}}$$

$$39. \quad 100 \cancel{\text{yds}} \left[\frac{3 \cancel{\text{ft}}}{1 \cancel{\text{yd}}} \right] \left[\frac{12 \text{ in.}}{1 \cancel{\text{ft}}} \right] = 3600 \text{ in} \Rightarrow \mathbf{3600 \text{ quarters}}$$

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

$$70 \text{ mph:} \quad t = \frac{d}{v} = \frac{500 \text{ mi}}{70 \text{ mph}} = 7.14 \text{ h} = \mathbf{7 \text{ h: } 8.4 \text{ min}}$$

$$\text{difference} = \mathbf{1 \text{ h: } 11.4 \text{ min}}$$

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

42. $d = 86 \cancel{\text{stories}} \left[\frac{14 \cancel{\text{ft}}}{\cancel{\text{story}}} \right] \left[\frac{1 \cancel{\text{step}}}{\frac{9}{12} \cancel{\text{ft}}} \right] = 1605 \text{ steps}$
 $v = \frac{d}{t} \Rightarrow t = \frac{d}{v} = \frac{1605 \text{ steps}}{2 \frac{\text{steps}}{\text{second}}} = 802.5 \cancel{\text{seconds}} \left[\frac{1 \cancel{\text{minute}}}{60 \cancel{\text{seconds}}} \right] = \mathbf{13.38 \text{ minutes}}$
43. $d = (86 \cancel{\text{stories}}) \left[\frac{14 \cancel{\text{ft}}}{\cancel{\text{story}}} \right] = 1204 \cancel{\text{ft}} \left[\frac{1 \cancel{\text{mile}}}{5,280 \cancel{\text{ft}}} \right] = 0.228 \text{ miles}$
 $\frac{\text{min}}{\text{mile}} = \frac{10.22 \text{ min}}{0.228 \text{ miles}} = \mathbf{44.82 \text{ min/mile}}$
44. $\frac{5 \text{ min}}{\text{mile}} \Rightarrow \frac{1 \cancel{\text{mile}}}{5 \text{ min}} \left[\frac{5,280 \cancel{\text{ft}}}{1 \cancel{\text{mile}}} \right] = \frac{1056 \cancel{\text{ft}}}{\text{minute}}$, distance = $86 \cancel{\text{stories}} \left[\frac{14 \cancel{\text{ft}}}{\cancel{\text{story}}} \right] = 1204 \text{ ft}$
 $v = \frac{d}{t} \Rightarrow t = \frac{d}{v} = \frac{1204 \cancel{\text{ft}}}{1056 \frac{\cancel{\text{ft}}}{\text{min}}} = \mathbf{1.14 \text{ minutes}}$
45. a. $5 \cancel{\text{J}} \left[\frac{1 \cancel{\text{Btu}}}{1054.35 \cancel{\text{J}}} \right] = \mathbf{4.74 \times 10^{-3} \text{ Btu}}$
- b. $24 \cancel{\text{ounces}} \left[\frac{1 \cancel{\text{gallon}}}{128 \cancel{\text{ounces}}} \right] \left[\frac{1 \cancel{\text{m}^3}}{264.172 \cancel{\text{gallons}}} \right] = \mathbf{7.1 \times 10^{-4} \text{ m}^3}$
- c. $1.4 \cancel{\text{days}} \left[\frac{86,400 \cancel{\text{s}}}{1 \cancel{\text{day}}} \right] = \mathbf{1.21 \times 10^5 \text{ s}}$
- d. $1 \cancel{\text{m}^3} \left[\frac{264.172 \cancel{\text{gallons}}}{1 \cancel{\text{m}^3}} \right] \left[\frac{8 \cancel{\text{pints}}}{1 \cancel{\text{gallon}}} \right] = \mathbf{2113.38 \text{ pints}}$
46. $6(4 \times 2 + 8) = \mathbf{96}$
47. $(42 + 6/5)/3 = \mathbf{14.4}$
48. $\sqrt{5^2 + \left(\frac{2}{3}\right)^2} = \mathbf{5.044}$
49. MODE = DEGREES: $\cos 21.87^\circ = \mathbf{0.928}$
50. MODE = DEGREES: $\tan^{-1}(3/4) = \mathbf{36.87^\circ}$
51. $\sqrt{400/(6^2 + 10/5)} = \mathbf{7.071}$

52. 205×10^{-6}

53. 1.20×10^{12}

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

Chapter 2

1. —

2. a. $F = k \frac{Q_1 Q_2}{r^2} = \frac{(9 \times 10^9)(1 \text{ C})(2 \text{ C})}{(1 \text{ m})^2} = \mathbf{18 \times 10^9 \text{ N}}$

b. $F = k \frac{Q_1 Q_2}{r^2} = \frac{(9 \times 10^9)(1 \text{ C})(2 \text{ C})}{(3 \text{ m})^2} = \mathbf{2 \times 10^9 \text{ N}}$

c. $F = k \frac{Q_1 Q_2}{r^2} = \frac{(9 \times 10^9)(1 \text{ C})(2 \text{ C})}{(10 \text{ m})^2} = \mathbf{0.18 \times 10^9 \text{ N}}$

d. Exponentially, $\frac{r_3}{r_1} = \frac{10 \text{ m}}{1 \text{ m}} = \mathbf{10}$ while $\frac{F_1}{F_2} = \frac{18 \times 10^9 \text{ N}}{0.18 \times 10^9 \text{ N}} = \mathbf{100}$

3. a. $r = 1 \text{ ft}$:

$$1 \cancel{\text{ft}} \left[\frac{12 \cancel{\text{in.}}}{1 \cancel{\text{ft}}} \right] \left[\frac{1 \text{ m}}{39.37 \cancel{\text{in.}}} \right] = 0.305 \text{ m}$$

$$F = \frac{k Q_1 Q_2}{r^2} = \frac{(9 \times 10^9)(8 \times 10^{-6} \text{ C})(40 \times 10^{-6} \text{ C})}{(0.305 \text{ m})^2} = \frac{2880 \times 10^{-3}}{93 \times 10^{-3}} = \mathbf{30.97 \text{ N}}$$

b. $r = 10 \text{ ft}$:

$$10 \cancel{\text{ft}} \left[\frac{12 \cancel{\text{in.}}}{1 \cancel{\text{ft}}} \right] \left[\frac{1 \text{ m}}{39.37 \cancel{\text{in.}}} \right] = 3.05 \text{ m}$$

$$F = \frac{k Q_1 Q_2}{r^2} = \frac{2880 \times 10^{-3}}{(3.05 \text{ m})^2} = \frac{2880 \times 10^{-3}}{9.30} = \mathbf{0.31 \text{ N}}$$

c. $r = 100 \text{ yds}$:

$$100 \cancel{\text{yds}} \left[\frac{3 \cancel{\text{ft}}}{1 \cancel{\text{yd}}} \right] \left[\frac{12 \cancel{\text{in.}}}{1 \cancel{\text{ft}}} \right] \left[\frac{1 \text{ m}}{39.37 \cancel{\text{in.}}} \right] = 91.4 \text{ m}$$

$$F = \frac{k Q_1 Q_2}{r^2} = \frac{2880 \times 10^{-3}}{(91.4 \text{ m})^2} = \frac{2880 \times 10^{-3}}{8.35 \times 10^3} = \mathbf{345 \mu\text{N}}$$

4. —

5. $Q_1 = Q_2 = Q$; $F_1 = \frac{k Q^2}{r_1^2} \Rightarrow Q^2 = \frac{F_1 r_1^2}{k}$; $F_2 = \frac{k Q^2}{r_2^2} = \frac{k}{r_2^2} \left[\frac{F_1 r_1^2}{k} \right]$ and $F_2 = \frac{r_1^2}{r_2^2} F_1$

$$6. \quad F = \frac{kQ_1Q_2}{r^2} \Rightarrow r = \sqrt{\frac{kQ_1Q_2}{F}} = \sqrt{\frac{(9 \times 10^9)(20 \times 10^{-6})^2}{3.6 \times 10^4}} = \mathbf{10 \text{ mm}}$$

$$7. \quad F = \frac{kQ_1Q_2}{r^2} \Rightarrow 1.8 = \frac{kQ_1Q_2}{(2 \text{ m})^2} \Rightarrow kQ_1Q_2 = 4(1.8) = 7.2$$

$$a. \quad F = \frac{kQ_1Q_2}{r^2} = \frac{7.2}{(10)^2} = \mathbf{72 \text{ mN}}$$

$$b. \quad Q_1/Q_2 = 1/2 \Rightarrow Q_2 = 2Q_1$$

$$7.2 = kQ_1Q_2 = (9 \times 10^9)(Q_1)(2Q_1) = 9 \times 10^9 (2Q_1^2)$$

$$\frac{7.2}{18 \times 10^9} = Q_1^2 \Rightarrow Q_1 = \sqrt{\frac{7.2}{18 \times 10^9}} = \mathbf{20 \mu C}$$

$$Q_2 = 2Q_1 = 2(2 \times 10^{-5} \text{ C}) = \mathbf{40 \mu C}$$

$$8. \quad V = \frac{W}{Q} = \frac{1.2 \text{ J}}{20 \text{ mC}} = \mathbf{120 \text{ V}}$$

$$9. \quad W = VQ = (60 \text{ V})(8 \text{ mC}) = \mathbf{0.48 \text{ J}}$$

$$10. \quad Q = \frac{W}{V} = \frac{200 \mu\text{J}}{20 \text{ mV}} = \mathbf{10 \text{ mC}}$$

$$11. \quad Q = \frac{W}{V} = \frac{620 \text{ mJ}}{9 \text{ V}} = \mathbf{68.9 \text{ mC}}$$

$$12. \quad a. \quad W = QV = (1 \times 10^{12} \text{ electrons})(40 \text{ V}) = \mathbf{40 \times 10^{12} \text{ eV}}$$

$$b. \quad 40 \times 10^{12} \text{ eV} \left[\frac{1 \text{ C}}{6.242 \times 10^{18} \text{ electrons}} \right] = \mathbf{6.41 \mu J}$$

$$13. \quad I = \frac{Q}{t} = \frac{96 \text{ mC}}{8.4 \text{ s}} = \mathbf{11.43 \text{ mA}}$$

$$14. \quad I = \frac{Q}{t} = \frac{312 \text{ C}}{(2)(60 \text{ s})} = \mathbf{2.60 \text{ A}}$$

$$15. \quad Q = It = (40 \text{ mA})(1.2)(60 \text{ s}) = \mathbf{2.88 \text{ C}}$$

$$16. \quad Q = It = (250 \text{ mA})(1.2)(60 \text{ s}) = \mathbf{18.0 \text{ C}}$$

$$17. \quad t = \frac{Q}{I} = \frac{6 \text{ mC}}{2 \text{ mA}} = \mathbf{3 \text{ s}}$$

$$18. \quad 21.847 \times 10^{18} \cancel{\text{electrons}} \left[\frac{1 \text{ C}}{6.242 \times 10^{18} \cancel{\text{electrons}}} \right] = 3.5 \text{ C}$$

$$I = \frac{Q}{t} = \frac{3.5 \text{ C}}{12 \text{ s}} = 0.29 \text{ A}$$

$$19. \quad 5 \text{ min} = (5)(60 \text{ s}) = 300 \text{ s}$$

$$Q = It = (4 \text{ mA})(300 \text{ s}) = 1.2 \text{ C}$$

$$1.2 \cancel{\text{C}} \left[\frac{6.242 \times 10^{18} \cancel{\text{electrons}}}{1 \cancel{\text{C}}} \right] = 7.49 \times 10^{18} \text{ electrons}$$

$$20. \quad I = \frac{Q}{t} = \frac{86 \text{ C}}{(1.2)(60 \text{ s})} = 1.194 \text{ A} > 1 \text{ A (yes)}$$

$$21. \quad 0.84 \times 10^{16} \cancel{\text{electrons}} \left[\frac{1 \text{ C}}{6.242 \times 10^{18} \cancel{\text{electrons}}} \right] = 1.346 \text{ mC}$$

$$I = \frac{Q}{t} = \frac{1.346 \text{ mC}}{60 \text{ ms}} = 22.43 \text{ mA}$$

$$22. \quad \text{a.} \quad Q = It = (2 \text{ mA})(0.01 \mu\text{s}) = 2 \times 10^{-11} \text{ C}$$

$$2 \times 10^{-11} \cancel{\text{C}} \left[\frac{6.242 \times 10^{18} \cancel{\text{electrons}}}{1 \cancel{\text{C}}} \right] \left[\frac{1 \cancel{\text{¢}}}{\cancel{\text{electron}}} \right]$$

$$= 1.25 \times 10^8 \cancel{\text{¢}} = \$1.25 \times 10^6 = 1.25 \text{ million}$$

$$\text{b.} \quad Q = It = (100 \mu\text{A})(1.5 \text{ ns}) = 1.5 \times 10^{-13} \text{ C}$$

$$1.5 \times 10^{-13} \cancel{\text{C}} \left[\frac{6.242 \times 10^{18} \cancel{\text{electrons}}}{1 \cancel{\text{C}}} \right] \left[\frac{\$1}{\cancel{\text{electron}}} \right] = 0.94 \text{ million}$$

(a) > (b)

$$23. \quad Q = It = (200 \times 10^{-3} \text{ A})(30 \text{ s}) = 6 \text{ C}$$

$$V = \frac{W}{Q} = \frac{40 \text{ J}}{6 \text{ C}} = 6.67 \text{ V}$$

$$24. \quad Q = It = \left[\frac{420 \text{ C}}{\cancel{\text{min}}} \right] (0.5 \cancel{\text{min}}) = 210 \text{ C}$$

$$V = \frac{W}{Q} = \frac{742 \text{ J}}{210 \text{ C}} = 3.53 \text{ V}$$

$$25. \quad Q = \frac{W}{V} = \frac{0.4 \text{ J}}{12 \text{ V}} = 33.33 \text{ mC}$$

$$I = \frac{Q}{t} = \frac{33.33 \text{ mC}}{5 \times 10^{-3} \text{ s}} = 6.67 \text{ A}$$

$$26. \quad I = \frac{\text{Ah rating}}{t(\text{hours})} = \frac{180 \text{ Ah}}{40 \text{ h}} = \mathbf{4.5 \text{ A}}$$

$$27. \quad \text{Ah} = (0.8 \text{ A})(75 \text{ h}) = \mathbf{60.0 \text{ Ah}}$$

$$28. \quad t(\text{hours}) = \frac{\text{Ah rating}}{I} = \frac{80 \text{ Ah}}{1.28 \text{ A}} = \mathbf{62.5 \text{ h}}$$

$$29. \quad 40 \text{ Ah (for 1 h): } W_1 = VQ = V \cdot I \cdot t = (12 \text{ V})(40 \text{ A}) \left(1 \cancel{\text{h}} \left[\frac{60 \cancel{\text{min}}}{1 \cancel{\text{h}}} \right] \left[\frac{60 \text{ s}}{1 \cancel{\text{min}}} \right] \right) = 1.728 \times 10^6 \text{ J}$$

$$60 \text{ Ah (for 1 h): } W_2 = (12 \text{ V})(60 \text{ A}) \left(1 \cancel{\text{h}} \left[\frac{60 \cancel{\text{min}}}{1 \cancel{\text{h}}} \right] \left[\frac{60 \text{ s}}{1 \cancel{\text{min}}} \right] \right) = 2.592 \times 10^6 \text{ J}$$

Ratio $W_2/W_1 = 1.5$ or 50% more energy available with 60 Ah rating.

$$\text{For 60 s discharge: } 40 \text{ Ah} = It = I \left[60 \cancel{\text{s}} \left[\frac{1 \cancel{\text{min}}}{60 \cancel{\text{s}}} \right] \left[\frac{1 \text{ h}}{60 \cancel{\text{min}}} \right] \right] = I(16.67 \times 10^{-3} \text{ h})$$

$$\text{and } I = \frac{40 \text{ Ah}}{16.67 \times 10^{-3} \text{ h}} = \mathbf{2400 \text{ A}}$$

$$60 \text{ Ah} = It = I \left[60 \cancel{\text{s}} \left[\frac{1 \cancel{\text{min}}}{60 \cancel{\text{s}}} \right] \left[\frac{1 \text{ h}}{60 \cancel{\text{min}}} \right] \right] = I(16.67 \times 10^{-3} \text{ h})$$

$$\text{and } I = \frac{60 \text{ Ah}}{16.67 \times 10^{-3} \text{ h}} = \mathbf{3600 \text{ A}}$$

$I_2/I_1 = 1.5$ or 50 % more starting current available at 60 Ah

$$30. \quad 0.75(18 \text{ Ah}) = 13.5 \text{ Ah} \Rightarrow \cong \mathbf{250 \text{ mA}}$$

$$31. \quad (18 \text{ Ah} - 15.5 \text{ Ah})/18 \text{ Ah} \times 100\% = \mathbf{13.89\%}$$

$$32. \quad \text{At 100 mA, discharge time} \cong 120 \text{ h; At 25 mA, discharge time} \cong 425 \text{ h;} \\ \cong \mathbf{300 \text{ h more at 25 mA}}$$

$$33. \quad I = \frac{3 \text{ Ah}}{6.0 \text{ h}} = 500 \text{ mA}$$

$$Q = It = (500 \text{ mA})(6 \cancel{\text{h}} \left[\frac{60 \cancel{\text{min}}}{1 \cancel{\text{h}}} \right] \left[\frac{60 \text{ s}}{1 \cancel{\text{min}}} \right]) = 10.80 \text{ kC}$$

$$W = QV = (10.8 \text{ kC})(12 \text{ V}) \cong \mathbf{129.6 \text{ kJ}}$$

$$34. \quad -$$

$$35. \quad -$$

$$36. \quad -$$

$$\begin{aligned}
 37. \quad & \text{a.} \quad 0.5 \mu\text{m} \left[\frac{2.54 \text{ cm}}{1 \mu\text{m}} \right] = 1.27 \text{ cm} \\
 & \quad 1.27 \text{ cm} \left[\frac{30 \text{ kV}}{\text{cm}} \right] = \mathbf{38.1 \text{ kV}} \\
 & \quad \text{b.} \quad 1.27 \text{ cm} \left[\frac{270 \text{ kV}}{\text{cm}} \right] = \mathbf{342.9 \text{ kV}} \\
 & \quad \text{c.} \quad 342.9 \text{ kV} : 38.1 \text{ kV} = \mathbf{9:1}
 \end{aligned}$$

38. —

39. —

40. —

41. —