

Chapter 1

1. —

2. —

3. —

4. a. $v = d/t$, where v = speed, d = distance, t = time

Given $t = 2\text{h}, 15\text{ min}$

$$= \frac{2 \times 60 + 15}{60} \text{ h}$$

$$\text{Time} = \frac{135}{60} \text{ h} = 2.25\text{h}$$

$$V = \frac{d}{t} = \frac{60.5 \text{ mi}}{2.25} \text{ h} = 26.889 \text{ mph}$$

b. Speed in km/h

$$V = \frac{d}{t} = \frac{135}{60} = 60.5 \text{ mi} \times \frac{1.609 \text{ km}}{1 \text{ mi}} \times \frac{1}{2.25 \text{ h}}$$

$$V = 43.264 \text{ km/h}$$

5. a. $\text{mph} = (0.6)(160 \text{ km/h}) = \mathbf{96 \text{ mph}}$

b. $\text{km/h} = (1.7)(70 \text{ mph}) = \mathbf{119 \text{ km/h}}$

$$6. \quad 100 \text{ yd} \left[\frac{3 \text{ ft}}{1 \text{ yd}} \right] \left[\frac{1 \text{ mi}}{5280 \text{ ft}} \right] = 0.0568 \text{ mi}$$

$$\frac{80 \text{ mi}}{\text{h}} \left[\frac{1 \text{ h}}{60 \text{ min}} \right] \left[\frac{1 \text{ min}}{60 \text{ s}} \right] = 0.222 \text{ mi/s}$$

$$t = \frac{d}{v} = \frac{0.0568 \text{ mi}}{0.222 \text{ mi/s}} = 2.5586 \text{ s}$$

$$t = 2.56 \text{ s}$$

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

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

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

8. —

9. —
10. —
11. MKS, CGS, $^{\circ}\text{C} = \frac{5}{9} (^{\circ}\text{F} - 32) = \frac{5}{9} (68 - 32) = \frac{5}{9} (36) = \mathbf{20^{\circ}}$
SI: $\text{K} = 273.15 + ^{\circ}\text{C} = 273.15 + 20 = \mathbf{293.15}$
12. $4000 \text{ J} \times \frac{0.7378 \text{ ft-lb}}{1 \text{ J}} = 2951.2 \text{ ft-lbs}$
13. a. $70.8 \cancel{\text{ kg}} \left[\frac{2.2 \text{ lbs}}{\cancel{\text{ kg}}} \right] = \mathbf{155.76 \text{ lbs}}$
b. $145 \cancel{\text{ lbs}} \left[\frac{1 \text{ kg}}{2.2 \cancel{\text{ lbs}}} \right] = \mathbf{65.91 \text{ kg}}$
c. $6 \cancel{\text{ ft}} \left[\frac{12 \cancel{\text{ in.}}}{\cancel{\text{ ft}}} \right] \left[\frac{2.54 \text{ cm}}{1 \cancel{\text{ in.}}} \right] = \mathbf{182.88 \text{ cm}}$
d. $179.9 \cancel{\text{ cm}} \left[\frac{1 \cancel{\text{ in.}}}{2.54 \cancel{\text{ cm}}} \right] \left[\frac{1 \text{ ft}}{12 \cancel{\text{ in.}}} \right] = \mathbf{5.9 \text{ ft} = 5 \text{ ft } 10.8 \text{ in.}}$
14. a. $^{\circ}\text{F} = 2(^{\circ}\text{C}) + 30^{\circ} = 40^{\circ} + 30^{\circ} = \mathbf{70^{\circ}}$
b. $^{\circ}\text{F} = \frac{9}{5} (^{\circ}\text{C}) + 32^{\circ} = \frac{9}{5} (20^{\circ}) + 32^{\circ} = \mathbf{68^{\circ}}$
c. very close
d. $30^{\circ}\text{C} \rightarrow \mathbf{90^{\circ}\text{F}}$ vs. $\mathbf{86^{\circ}\text{F}}$
 $5^{\circ}\text{C} \rightarrow \mathbf{40^{\circ}\text{F}}$ vs $\mathbf{41^{\circ}\text{F}}$
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. $\mathbf{10^4}$ b. $\mathbf{10^6}$ c. $\mathbf{10^3}$ d. $\mathbf{10^{-3}}$
e. $\mathbf{10^0}$ f. $\mathbf{10^{-1}}$

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. $4.3 \times 10^3 + 43.0 \times 10^3 = 47.3 \times 10^3 = 4.73 \times 10^4$
 b. $8.0 \times 10^4 + 46.0 \times 10^4 = 54.0 \times 10^4 = 5.40 \times 10^5$
 c. $600 \times 10^{-6} + 6 \times 10^{-6} = 606 \times 10^{-6} = 6.06 \times 10^{-4}$
 d. $2.6 \times 10^3 + 0.06 \times 10^3 - 0.5 \times 10^3 = 2.16 \times 10^3 = 2160$
21. a. $(1000)(10000) = (10^3)(10^4) = 10^7$
 b. $(0.001)(100) = (1 \times 10^{-3})(10^2) = 10^{-1}$
 c. $(10^2)(10^7) = 10^9$
 d. $(100)(0.000001) = (10^2)(10^{-6}) = 10^{-4}$
 e. $(10^{-8})(10^7) = 10^{-1} = 1 \times 10^{-1}$
 f. $(10^4)(10^{-10})(10^{26}) = 1 \times 10^{20}$
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. $\frac{4 \times 10^3}{8 \times 10^{-5}} = 0.5 \times 10^8 = 5.0 \times 10^7$
 b. $\frac{6 \times 10^{-3}}{6 \times 10^6} = \frac{6}{6} \times 10^{-9} = 1 \times 10^{-9}$
 c. $\frac{44 \times 10^{-5}}{5 \times 10^{-5}} = \frac{44}{5} \times 10^0 = 8.8$
 d. $\frac{88 \times 10^{18}}{8 \times 10^{-8}} = \frac{88}{8} \times 10^{26} = 1.1 \times 10^{27}$
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. $(400^2) = (4 \times 10^2)^2 = 16 \times 10^4$
 b. $(6 \times 10^{-4})^2 = 1296 \times 10^{-16} = 12.96 \times 10^{-14}$
 c. $(5 \times 10^{-3})(3 \times 10^{-4})^2 = (5 \times 10^{-3})(9 \times 10^{-8}) = 45 \times 10^{-11}$
 d. $((2 \times 10^{-4})(0.8 \times 10^5)(0.0005 \times 10^6))^3$
 $= ((2 \times 10^{-4})(8 \times 10^4)(5 \times 10^2))^3$
 $= (80 \times 10^2)^3 = (8 \times 10^3)^3$
 $= ((8)^3 \times 10^3)^3 = 512 \times 10^9 = 5.12 \times 10^{11}$

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

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

28. Scientific: a. $\mathbf{2.05 \times 10^1}$
b. $\mathbf{5.04 \times 10^4}$
c. $\mathbf{6.74 \times 10^{-4}}$
d. $\mathbf{4.60 \times 10^{-2}}$

Engineering: a. $\mathbf{20.46 \times 10^0}$
b. $\mathbf{50.42 \times 10^3}$
c. $\mathbf{674.00 \times 10^{-6}}$
d. $\mathbf{46.00 \times 10^{-3}}$

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

Engineering: a. $\mathbf{50.0 \times 10^{-3}}$
b. $\mathbf{0.045 \times 10^3}$
c. $\mathbf{31.25 \times 10^{-3}}$
d. $\mathbf{3.142 \times 10^0}$

30. Scientific Notation

a. 3.2×10^{-3}

b. $(7 \times 10^7)(4 \times 10^1) = 2.8 \times 10^8$

c. $\frac{(2 \times 10^4)(6 \times 10^7)}{(5 \times 10^4)} = \left(\frac{12}{5}\right) 10^7 = 2.4 \times 10^7$

d. $(6.2)^2 \times (10^8) \times (82 \times 10^{-3}) = (38.44)(82)(4.02) \times 10^8 = 1.267 \times 10^{12}$

Engineering Notation:

a. 3.20×10^3

b. $280.0 \times 10^6 = 0.028 \times 10^9$

c. 24.0×10^6

d. 1.267×10^{12}

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

+2
-3

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

-3
+3

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

-2 +3 +3
+2 -3 -3

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

+4 -3 -3
-4 +3 +3

32. a. $0.06 \times 10^0 \text{ s} = 60 \times 10^{-3} \text{ s} = 60 \text{ ms}$

b. $4000 \times 10^{-6} \text{ s} = 4 \times 10^{-3} \text{ s} = 4 \text{ ms}$

c. $0.08 \times 10^{-3} \text{ s} = 80 \times 10^{-5} = 80 \mu\text{s}$

d. $6400 \times 10^{-12} \text{ s} = 0.0064 \times 10^{-6} \text{ s} = 0.0064 \mu\text{s}$

e. $100 \times 10^{-3} \text{ m} = 1 \times 10^{-3} \text{ m} = 1 \text{ km}$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$38. \quad d = 15 \text{ km} \left[\frac{1000 \text{ m}}{1 \text{ km}} \right] \left[\frac{39.37 \text{ in.}}{1 \text{ m}} \right] \left[\frac{1 \text{ ft}}{12 \text{ in.}} \right] \left[\frac{1 \text{ mi}}{5280 \text{ ft}} \right]$$

$$= 9.321 \text{ mi} \cong 9.32055$$

$$V = \frac{1 \text{ mi}}{8.5 \text{ min}}, t = \frac{d}{v} = \frac{9.321 \text{ mi}}{\frac{1 \text{ mi}}{8.5 \text{ min}}} = 79.2285 \text{ min} \cong 79.23 \text{ min}$$

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

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

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

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

$$41. \quad d = vt = \left[800 \frac{\text{cm}}{\text{s}} \right] [0.048 \text{ h}] \left[\frac{60 \text{ min}}{1 \text{ h}} \right] \left[\frac{60 \text{ s}}{1 \text{ min}} \right] \left[\frac{1 \text{ m}}{100 \text{ cm}} \right]$$

$$= 1382.4 \text{ m}$$

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

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

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

$$\frac{\text{min}}{\text{mile}} = \frac{10.22 \text{ min}}{0.228 \text{ miles}} = \mathbf{44.82 \text{ min/mile}}$$

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

$$v = \frac{d}{t} \Rightarrow t = \frac{d}{v} = \frac{1204 \text{ ft}}{1056 \frac{\text{ft}}{\text{min}}} = \mathbf{1.14 \text{ minutes}}$$

45.

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

b

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

c

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

d

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

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

$$\sqrt{400/(6^2 + 10/5)} = 7.071$$

52

$$205 \times 10^{-6}$$

53

$$1.20 \times 10^{12}$$

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. $Q_1 = Q_2 = Q; F_1 = \frac{k Q^2}{r^2} \Rightarrow Q^2 = \frac{F_1 r^2}{k}; F_2 = \frac{k Q^2}{(2r)^2} = \frac{k}{2r^2} \left[\frac{F_1 r^2}{k} \right] \text{ and } F_2 = \frac{r^2}{(2r)^2} F_1 = \frac{F_1}{4} \text{ Ans.}$

$$6. \quad F = \frac{kQ_1Q_2}{r^2} = r = \sqrt{\frac{kQ_1Q_2}{r^2}} \Rightarrow r = \sqrt{\frac{(9 \times 10^9)(30 \times 10^{-6})^2}{(4.5 \times 10^4)}} = 0.01342 \text{ m} = 13.42 \text{ mm}$$

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

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

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

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

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

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

$$8. \quad V = \frac{W}{Q} = \frac{3.4 \text{ J}}{12 \mu\text{C}} = 283.33 \text{ kV}$$

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

$$10. \quad Q = \frac{W}{V} = \frac{400 \mu\text{J}}{40 \text{ mC}} = 10 \text{ mC}$$

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

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

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

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

$$14. \quad I = \frac{Q}{t} = \frac{600 \text{ C}}{(4)(60 \text{ s})} = 2.50 \text{ A}$$

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

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

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

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

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

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

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

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

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

$$21. \quad 0.92 \times 10^{16} \cancel{\text{electrons}} \left(\frac{1 \cancel{\text{C}}}{6.242 \times 10^{18} \cancel{\text{electrons}}} \right) = 1.474 \text{ mC}$$

$$I = \frac{Q}{t} = \frac{1.474 \text{ mC}}{50 \text{ ms}} = 29.48 \text{ mA}$$

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

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

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

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

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

(a) > (b)

$$23. \quad Q = It = (300 \times 10^{-3} \text{ A}) \times (40 \text{ s}) = 12 \text{ C}$$

$$V = \frac{W}{Q} = \frac{60 \text{ J}}{12 \text{ C}} = 5.0 \text{ V}$$

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

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

$$25. \quad Q = \frac{W}{V} = \frac{0.8}{24 \text{ V}} = 0.0333 \text{ C}$$

$$I = \frac{Q}{t} = \frac{0.0333 \text{ C}}{6 \times 10^{-3} \text{ s}} = 5.55 \text{ A}$$

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

$$27. \quad \text{Ah rating} = \text{current} \times \text{hours} = (0.64\text{A})(80\text{h}) = 51.2 \text{ Ah.}$$

$$28. \quad t(\text{hours}) = \frac{\text{Ah rating}}{I} = \frac{72\text{Ah}}{1.80\text{A}} = 40\text{h}$$

$$29. \quad \begin{aligned} 45 \text{ Ah (for 1 h): } W_1 &= VQ = V \cdot I \cdot t \\ &= (12\text{V}) (45\text{A}) (1\text{h}) \left[\frac{60\text{min}}{1\text{h}} \right] \left[\frac{60\text{s}}{1\text{min}} \right] \\ &= 1.944 \times 10^6 \text{ J} \\ 75 \text{ Ah (for 1 h): } W_2 &= VQ = V \cdot I \cdot t \\ &= (12\text{V}) (75\text{A}) (1\text{h}) \left[\frac{60\text{min}}{1\text{h}} \right] \left[\frac{60\text{s}}{1\text{min}} \right] \\ &= 3.240 \times 10^6 \text{ J} \end{aligned}$$

Ratio $\frac{W_2}{W_1} = 1.67$ or 67% more energy available with 75Ah rating for 60s discharge:

$$45\text{Ah} = It = I \left[\frac{60\text{s}}{60\text{s}} \right] \left[\frac{1\text{h}}{60\text{min}} \right] = I (16.67 \times 10^{-3} \text{ h})$$

$$\text{And } I = \frac{45\text{Ah}}{16.67 \times 10^{-3} \text{ h}} = 2700\text{A}$$

$$75\text{Ah} = It = I \left[\frac{60\text{s}}{60\text{s}} \right] \left[\frac{1\text{h}}{60\text{min}} \right] = I (16.67 \times 10^{-3} \text{ h})$$

$$\text{And } I = 4500\text{A} = \frac{75\text{Ah}}{16.67 \times 10^{-3} \text{ h}} = 4500\text{A}$$

$\frac{I_2}{I_1} = 1.67$ or 67% more starting current available at 75Ah.

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

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

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

$$33. \quad I = \frac{4\text{Ah}}{8.0\text{h}} = 500 \text{ mA;}$$

$$Q = It = (500\text{mA}) (8\text{h}) \left[\frac{60\text{min}}{1\text{h}} \right] \left[\frac{60\text{s}}{1\text{min}} \right] = 41.40 \text{ kC}$$

$$\text{Energy} = W = QV = (41.4\text{kC})(12\text{V}) = 172.8\text{kJ}$$

$$34. \quad -$$

$$35. \quad -$$

$$36. \quad -$$

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

38. —

39. —

40. —

41. —