Chapter 1

1. –

2. –

3. –

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

Given t = 2h, 15 min

$$= \frac{2\times60+15}{60} \text{ h}$$

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

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

b. Speed in km/h

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

V = 43.264 km/h

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

6. 100 yd $\left[\frac{3ft}{1yd}\right]\left[\frac{1\ mi}{5260ft}\right]$ = 0.0568mi

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

$t = \frac{d}{v} = \frac{0.0568mi}{0.0222\ mi/s}$ = 2.5586s

t = 2.56s

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

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

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

8. –

9. –

10. –

11. MKS, CGS, °C = $\frac{5}{9}(°F - 32) = \frac{5}{9}(68 - 32) = \frac{5}{9}(36)$ = **20°**
SI: K = 273.15 + °C = 273.15 + 20 = **293.15**

12. 4000 J $\times \frac{0.7378 ft-lb}{1\ J}$ = 2951.2 ft-lbs

13. a. 70.8 ~~kg~~ $\left[\frac{2.2 \text{ lbs}}{\text{~~kg~~}}\right]$ = **155.76 lbs**

b. 145 ~~lbs~~ $\left[\frac{1 \text{ kg}}{2.2 \text{ ~~lbs~~}}\right]$ = **65.91 kg**

c. 6 ~~ft~~ $\left[\frac{12 \text{ ~~in.~~}}{\text{~~ft~~}}\right]\left[\frac{2.54 \text{ cm}}{1 \text{ ~~in.~~}}\right]$ = **182.88 cm**

d. 179.9 ~~cm~~ $\left[\frac{1 \text{ ~~in.~~}}{2.54 \text{ ~~cm~~}}\right]\left[\frac{1 \text{ ft}}{12 \text{ ~~in.~~}}\right]$ = **5.9 ft = 5 ft 10.8 in.**

14. a. °F = 2(°C) + 30° = 40° + 30° = **70°**

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

c. very close

d. 30°C → **90°F vs. 86°F**
5°C → **40°F vs 41°F**

15. a. **14.6** b. **56.0**
c. **1,046.1** d. $\frac{1}{16}$ = 0.0625 = **0.1**
e. 3.14159 = **3.1**

16. a. **14.60** b. **56.04**
c. **1,046.06** d. $\frac{1}{16}$ = 0.0625 = **0.06**
e. 3.14159 = **3.14**

17. a. **14.603** b. **56.042**
c. 1,046.060 d. $\frac{1}{16}$ = 0.0625 = **0.063**
e. 3.14159 = **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. $\mathbf{15 \times 10^3}$ b. $\mathbf{5 \times 10^{-3}}$ c. $\mathbf{2.4 \times 10^6}$ d. $\mathbf{60 \times 10^3}$

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

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. $\dfrac{(3\times10^2)^2(10^2)}{3\times10^4} = (9\times10^4)(10^2)/(3\times10^4) = (9\times10^6)/(3\times10^4) = 3\times10^2 = \mathbf{300}$

b. $\dfrac{(4\times10^4)^2}{(20)^3} = \dfrac{16\times10^8}{8\times10^3} = \mathbf{2\times10^5}$

c. $\dfrac{(6\times10^4)^2}{(2\times10^{-2})^2} = \dfrac{36\times10^8}{4\times10^{-4}} = \mathbf{9.0\times10^{12}}$

d. $\dfrac{(27\times10^{-6})^{1/3}}{2\times10^5} = \dfrac{3\times10^{-2}}{2\times10^5} = 1.5\times10^{-7} = \mathbf{150.0\times10^{-9}}$

e. $\dfrac{(4\times10^3)^2(3\times10^2)}{2\times10^{-4}} = \dfrac{(16\times10^6)(3\times10^2)}{2\times10^{-4}} = \dfrac{48\times10^8}{2\times10^{-4}} = \mathbf{24.0\times10^{12}}$

f. $(16\times10^{-6})^{1/2}(10^5)^5(2\times10^{-2}) = (4\times10^{-3})(10^{25})(2\times10^{-2}) = 8\times10^{20} = \mathbf{800.0\times10^{18}}$

g. $$\frac{\left[(3\times10^{-3})^3\right]\left[1.60\times10^2\right]^2\left[(2\times10^2)(8\times10^{-4})\right]^{1/2}}{(7\times10^{-5})^2}$$
$$= \frac{(27\times10^{-9})(2.56\times10^4)(16\times10^{-2})^{1/2}}{49\times10^{-10}}$$
$$= \frac{(69.12\times10^{-5})(4\times10^{-1})}{49\times10^{-10}} = \frac{276.48\times10^{-6}}{49\times10^{-10}}$$
$$= 5.64\times10^4 = \mathbf{56.40\times10^3}$$

28. Scientific:
a. $\mathbf{2.05\times10^1}$
b. $\mathbf{5.04\times10^4}$
c. $\mathbf{6.74\times10^{-4}}$
d. $\mathbf{4.60\times10^{-2}}$

Engineering:
a. $\mathbf{20.46\times10^0}$
b. $\mathbf{50.42\times10^3}$
c. $\mathbf{674.00\times10^{-6}}$
d. $\mathbf{46.00\times10^{-3}}$

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

Engineering:
a. $\mathbf{50.0\times10^{-3}}$
b. $\mathbf{0.045\times10^3}$
c. $\mathbf{31.25\times10^{-3}}$
d. $\mathbf{3.142\times10^0}$

30. Scientific Notation

a. 3.2×10^{-3}

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

c. $\frac{(2\times10^{4})(6\times10^{7})}{(5\times10^{4})} = \left(\frac{12}{5}\right) 10^{7} = 2.4 \times 10^{7}$

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 over; −3 under)

b. $0.4 \times 10^{-3} = \underline{400} \times 10^{-6} = \mathbf{400 \times 10^{-6}}$ (−3 over; +3 under)

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 over; +2, −3, −3 under)

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 over; −4, +3, +3 under)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

difference = **1 h: 11.4 min**

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

$= 1382.4\text{m}$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Chapter 2

1. –

2. a. $F = k\dfrac{Q_1Q_2}{r^2} = \dfrac{(9\times10^9)(1\text{ C})(2\text{ C})}{(1\text{ m})^2} = \mathbf{18\times10^9\ N}$

   b. $F = k\dfrac{Q_1Q_2}{r^2} = \dfrac{(9\times10^9)(1\text{ C})(2\text{ C})}{(3\text{ m})^2} = \mathbf{2\times10^9\ N}$

   c. $F = k\dfrac{Q_1Q_2}{r^2} = \dfrac{(9\times10^9)(1\text{ C})(2\text{ C})}{(10\text{ m})^2} = \mathbf{0.18\times10^9\ N}$

   d. Exponentially, $\dfrac{r_3}{r_1} = \dfrac{10\text{ m}}{1\text{ m}} = \mathbf{10}$ while $\dfrac{F_1}{F_2} = \dfrac{18\times10^9\text{ N}}{0.18\times10^9\text{ N}} = \mathbf{100}$

3. a. $r = 1$ ft:

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

$$F = \frac{kQ_1Q_2}{r^2} = \frac{(9\times10^9)(8\times10^{-6}\text{ C})(40\times10^{-6}\text{ C})}{(0.305\text{ m})^2} = \frac{2880\times10^{-3}}{93\times10^{-3}}$$

$$= \mathbf{30.97\ N}$$

   b. $r = 10$ ft:

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

$$F = \frac{kQ_1Q_2}{r^2} = \frac{2880\times10^{-3}}{(3.05\text{ m})^2} = \frac{2880\times10^{-3}}{9.30} = \mathbf{0.31\ N}$$

   c. $r = 100$ yds:

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

$$F = \frac{kQ_1Q_2}{r^2} = \frac{2880\times10^{-3}}{(91.4\text{ m})^2} = \frac{2880\times10^{-3}}{8.35\times10^3}$$

$$= \mathbf{345\ \mu N}$$

4. –

5. $Q_1 = Q_2 = Q;\ F_1 = \frac{kQ^2}{r^2} \Rightarrow Q^2 = \frac{F_1r^2}{k};\ F_2 = \frac{kQ^2}{(2r)^2} = \frac{k}{2r^2}\left[\frac{F_{1r^2}}{k}\right]$ and $F_2 = \frac{r^2}{(2r)^2}F_1 = \frac{F_1}{4}$ Ans.

6. $F = \frac{kQ_1Q_2}{r^2} = r = \sqrt{\frac{kQ_1Q_2}{r^2}} \Rightarrow r = \sqrt{\frac{(9\times10^9)(30\times10^{-6})^2}{(4.5\times10^4)}} = 0.01342\text{ m} = 13.42\text{ mm}$

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

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

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

   $7.2 = kQ_1Q_2 = (9\times10^9)(Q_1)(2Q_1) = 9\times10^9\left(2Q_1^2\right)$

   $\frac{7.2}{18\times10^9} = Q_1^2 \Rightarrow Q_1 = \sqrt{\frac{7.2}{18\times10^9}} = \mathbf{20\ \mu C}$

   $Q_2 = 2Q_1 = 2(2\times10^{-5}\text{ C}) = \mathbf{40\ \mu C}$

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

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

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

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

12. a. $W = QV = (1\times10^{12}\text{ electrons})(40\text{ V}) = \mathbf{40\times10^{12}\text{ eV}}$

    b. $40\times10^{12}\ \cancel{e}\text{V}\left[\frac{1\text{ C}}{6.242\times10^{18}\ \cancel{\text{electrons}}}\right] = \mathbf{6.41\ \mu J}$

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

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

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

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

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

18. 21.847×10^{18} electrons $\left[\frac{1\text{ C}}{6.242\times10^{18}\text{ electrons}}\right] = 3.5$ C

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

19. 5 min = (5)(60 s) = 300 s

$Q = It$ = (4 mA)(300 s) = 1.2 C

$1.2\text{ C}\left[\frac{6.242\times10^{18}\text{ electrons}}{1\text{ C}}\right] =$ **7.49×10^{18} electrons**

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

21. 0.92×10^{16} electrons $\left(\frac{1C}{6.242\times10^{18}\text{ electrons}}\right) = 1.474$ mC

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

22. a. $Q = It$ = (2 mA)(0.01 μs) = 2×10^{-11} C

$2 \times 10^{-11}\text{ C}\left[\frac{6.242\times10^{18}\text{ electrons}}{1\text{ C}}\right]\left[\frac{1\text{ ¢}}{\text{electron}}\right]$

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

b. $Q = It$ = (100 μA)(1.5 ns) = 1.5×10^{-13} C

$1.5 \times 10^{-13}\text{ C}\left[\frac{6.242\times10^{18}\text{ electrons}}{1\text{ C}}\right]\left[\frac{\$1}{\text{electron}}\right] =$ **0.94 million**

(a) > (b)

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

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

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

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

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

$I = \frac{Q}{t} = \frac{0.0333C}{6\times10^{-3}s} = 5.55\text{A}$

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

27. Ah rating = current × hours = (0.64A)(80h) = 51.2 Ah.

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

29. 45 Ah (for 1 h):W_1= VQ = V. I. t
$= (12\text{V})\ (45\text{A})\ (1\text{h})\left[\dfrac{60min}{1\,h}\right]\left[\dfrac{60s}{1\,min}\right]$
$= 1.944 \times 10^6$ J
75 Ah (for 1 h):W_2= VQ = V. I. t
$= (12\text{V})\ (75\text{A})\ (1\text{h})\left[\dfrac{60min}{1\,h}\right]\left[\dfrac{60s}{1\,min}\right]$
$= 3.240 \times 10^6$ J
Ratio $\dfrac{W_2}{W_1}$ = 1.67 or 67% more energy available with 75Ah rating for 60s discharge:
45Ah = $It = I[60s]\left[\dfrac{1min}{60s}\right]\left[\dfrac{1h}{60\,min}\right]$ = I $(16.67\times10^{-3}$ h)
And $I = \dfrac{45Ah}{16.67 \times 10^{-3}\ h} = 2700\text{A}$
75Ah = $It = I[60s]\left[\dfrac{1min}{60s}\right]\left[\dfrac{1h}{60\,min}\right]$ = I $(16.67\times10^{-3}$ h)
And I = 4500A $= \dfrac{75Ah}{16.67 \times 10^{-3}\ h} = 4500\text{A}$
$\dfrac{I_2}{I_1}$ = 1.67 or 67% more starting current available at 75Ah.

30. 0.75(18 Ah) = 13.5 Ah $\Rightarrow \cong$ **250 mA**

31. (18 Ah − 15.5 Ah)/18 Ah × 100% = **13.89%**

32. At 100 mA, discharge time ≅ 120 H; At 25 mA, discharge time ≅ 425 h;
≅ **300 h more at 25 mA**

33. $I = \dfrac{4Ah}{8.0h} = 500$ mA;
$Q = It$ = (500mA) (8h) $\left[\dfrac{60min}{1\,h}\right]\left[\dfrac{60s}{1\,min}\right]$ = 41.40 kC
Energy = $W = QV$ = (14.4kC)(12V) = 172.8kJ

34. –

35. –

36. –

37. a. $0.5 \text{ in}\left[\frac{2.54 \text{ cm}}{1 \text{ in}}\right] = 1.27 \text{ cm}$

$1.27 \text{ cm}\left[\frac{30 \text{ kV}}{\text{cm}}\right] = \mathbf{38.1\ kV}$

b. $1.27 \text{ cm}\left[\frac{270 \text{ kV}}{\text{cm}}\right] = \mathbf{342.9\ kV}$

c. 342.9 kV:38.1 kV = **9:1**

38. –

39. –

40. –

41. –