21) fundamental steps
① making observations
② formulating a hypothesis
③ performing experiments to test hypothesis

hypothesis $\xrightarrow{\text{tested}}$ theory (model)

* Scientist continue to perform experiments to refine or replace existing theories

33. use rounding rules

a) 3.42×10^{-4}

b) 1.034×10^{4}

c) 1.7992×10^{1}

d) 3.37×10^{5}

37) a) $\frac{2.524}{3.1} + \frac{0.470}{0.623} + \frac{80.705}{0.4326} =$

$0.8148 + 0.7544 + 186.558 =$

188.1

* keep track of correct number of sig figs but round off at the end

b) $\frac{6.404 \times 2.91}{18.7 - 17.1} = \frac{18.6\underline{4}}{1.\underline{6}} = 12$

c) $(6.071 \times 10^{-5}) - (8.2 \times 10^{-6}) - (0.521 \times 10^{-4}) =$

change all numbers to same exponent

$(60.71 \times 10^{-6}) - (8.2 \times 10^{-6}) - (52.1 \times 10^{-6}) =$

$0.\underline{41} \times 10^{-6} = 4 \times 10^{-7}$

d) $\frac{(3.8 \times 10^{-12}) + (4.0 \times 10^{-13})}{(4 \times 10^{-12}) + (6.3 \times 10^{-13})} =$

$\frac{(38 \times 10^{-13}) + (4.0 \times 10^{-13})}{(4 \times 10^{-12}) + (63 \times 10^{-13})} =$

$\frac{4\underline{2} \times 10^{-13}}{6\underline{7} \times 10^{-12}} = 6.3 \times 10^{-26}$

e) $\frac{9.5 + 4.1 + 3.175}{4} = \frac{19.\underline{5}75}{4} = 4.89$

averages are exceptions, they are only as precise as the least precise number ... so 4.9

A) $\frac{8.925 - 8.905}{8.925} \times 100 = \frac{0.020}{8.925} = 0.22$

45 a)

$$1\ \text{troy lb} \times \frac{12\ \text{troy oz}}{1\ \text{troy lb}} \times \frac{20\ \text{pw}}{1\ \text{troy oz}} \times \frac{24\ \text{grains}}{1\ \text{pw}} \times \frac{0.0648\ \text{g}}{1\ \text{grain}} \times \frac{1\ \text{kg}}{1000\ \text{g}} = 0.373\ \text{kg}$$

$$1\ \text{troy lb} = 0.373\ \text{kg} \times \frac{2.205\ \text{lb}}{1\ \text{kg}} = 0.822\ \text{lb}$$

b)

$$1\ \text{troy oz}\ \frac{20\ \text{pw}}{1\ \text{troy oz}}\ \frac{24\ \text{grains}}{1\ \text{pw}}\ \frac{0.0648\ \text{g}}{1\ \text{grain}} = 31.1\ \text{g}$$

$$1\ \text{troy oz} = 31.3\ \text{g}\ \frac{1\ \text{carat}}{0.200\ \text{g}} = 156\ \text{carats}$$

c)

$$1\ \text{troy lb} = 0.373\ \text{kg}$$

$$0.373\ \text{kg}\ \frac{1000\ \text{g}}{1\ \text{kg}}\ \frac{1\ \text{cm}^3}{19.3\ \text{g}} = 19.3\ \text{cm}^3$$

53 a) $T_C = \frac{5}{9}(T_F - 32)$

$= \frac{5}{9}(-459\,^\circ F - 32) = -273\,^\circ C$

$T_K = T_C + 273 = -273 + 273 = 0\,K$

b) $T_C = \frac{5}{9}(-40.\,^\circ F - 32) = -40.\,^\circ C$

$T_K = T_C + 273 = -40.\,^\circ C + 273 = 233\,K$

c) $T_C = \frac{5}{9}(68\,^\circ F - 32) = 20.\,^\circ C$

$T_K = T_C + 273 = 20.\,^\circ C + 273 = 293\,K$

d) $T_C = \frac{5}{9}(7\times10^7\,^\circ F - 32) = 4\times10^7\,^\circ C$

$T_K = T_C + 273 = 4\times10^7\,^\circ C + 273 =$

$4\times10^7\,K$

57) $T_F = \frac{9}{5}T_C + 32$

$T_F = 2\,T_C$

substitution

$2\,T_C = \frac{9}{5}T_C + 32$

$-\frac{9}{5}T_C \quad -\frac{9}{5}T_C$

$\frac{0.2\,T_C}{0.2} = \frac{32}{0.2}$

$T_C = 160\,^\circ C$

so $T_F = 2T_C$ when $T_F = 2(160)$

$T_F = 320\,^\circ F$

59) mass: $350\,lb \frac{453.6\,g}{1\,lb} = 1.6 \times 10^5\,g$

volume: $1.2 \times 10^4\,in^3 \left(\frac{2.54\,cm}{1\,in}\right)^3 = 2.0 \times 10^5\,cm^3$

$D = \frac{m}{V} = \frac{1.6 \times 10^5\,g}{2.0 \times 10^5\,cm^3} = 0.80\,\frac{g}{cm^3}$

61) $V = \frac{4}{3}\pi r^3$

$V = \frac{4}{3}(3.14)(7.0 \times 10^5\,km \frac{1000\,m}{1\,km} \frac{100\,cm}{1\,m})^3 = 1.4 \times 10^{33}\,cm^3$

$D = \frac{m}{V} = \frac{2 \times 10^{36}\,kg \frac{1000\,g}{1\,kg}}{1.4 \times 10^{33}\,cm^3} = 1 \times 10^6\,\frac{g}{cm^3}$

65) $V = 21.6\,mL - 12.7\,mL = 8.9\,mL$

$D = \frac{m}{V} = \frac{33.4\,g}{8.9\,mL} = 3.8\,\frac{g}{mL} = 3.8\,\frac{g}{cm^3}$