(i) # of atoms = 3 molecules $\times \frac{14 \text{ atoms}}{1 \text{ molecule}}$ = **42 atoms**

(j) density = $\frac{0.0149 \text{ g}}{0.00554 \text{ L}}$ = 2.690 g/L and mass of 1 mol = 2.690 $\frac{\text{g}}{\text{L}}$ x 22.4 L = **60.2 g**

(k) # of moles = 125 g $\times \frac{1 \text{ mol}}{295.2 \text{ g}}$ = **0.423 mol**

(l) molar mass = $\frac{73.1 \text{ g}}{0.546 \text{ mol}}$ = **134 g/mol**

(m) # of moles = 1.85×10^{24} molecules $\times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}}$ = **3.07 mol**

(n) volume = 0.0694 mol $\times \frac{160.1 \text{ g}}{1 \text{ mol}} \times \frac{1 \text{ mL}}{4.80 \text{ g}}$ = **2.31 mL**

(o) # of molecules = 5.00 g $\times \frac{1 \text{ mol}}{54.0 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}}$ = **5.57×10^{22} molecules**

(p) density = $\frac{0.0316 \text{ mol}}{1.167 \text{ mL}} \times \frac{100.1 \text{ g}}{1 \text{ mol}}$ = **2.71 g/mL**

(q) # of moles = 100.0 mL $\times \frac{1.58 \text{ g}}{1 \text{ mL}} \times \frac{1 \text{ mol}}{342.0 \text{ g}}$ = **0.462 mol**

(r) volume = 0.275 g $\times \frac{1 \text{ mol}}{76.6 \text{ g}} \times \frac{22.4 \text{ L}}{1 \text{ mol}}$ = **0.0804 L**

(s) volume of 1 mol = 200.6 g $\times \frac{1 \text{ mL}}{13.55 \text{ g}}$ = **14.80 mL**

44. (a) molar mass = 30.0 g

$\%\text{C} = \frac{24.0 \text{ g}}{30.0 \text{ g}} \times 100\ \% = 80.0\%$

$\%\text{H} = \frac{6.0 \text{ g}}{30.0 \text{ g}} \times 100\ \% = 20.0\%$

(b) molar mass = 126.8 g

$\%\text{Fe} = \frac{55.8 \text{ g}}{126.8 \text{ g}} \times 100\ \% = 44.0\ \%$

$\%\text{Cl} = \frac{71.0 \text{ g}}{126.8 \text{ g}} \times 100\ \% = 56.0\ \%$

(c) molar mass = 162.3 g

$\%\text{Fe} = \frac{55.8 \text{ g}}{162.3 \text{ g}} \times 100\ \% = 34.4\%$

$\%\text{Cl} = \frac{106.5 \text{ g}}{162.3 \text{ g}} \times 100\ \% = 65.6\%$

(d) molar mass = 60.0 g

$\%\text{C} = \frac{24.0 \text{ g}}{60.0 \text{ g}} \times 100\ \% = 40.0\ \%$

$\%\text{H} = \frac{4.0 \text{ g}}{60.0 \text{ g}} \times 100\ \% = 6.7\ \%$

$\%\text{O} = \frac{32.0 \text{ g}}{60.0 \text{ g}} \times 100\ \% = 53.3\ \%$

(e) molar mass = 100.1 g

$\%\text{Ca} = \frac{40.1 \text{ g}}{100.1 \text{ g}} \times 100\ \% = 40.0\%$

$\%\text{C} = \frac{12.0 \text{ g}}{100.1 \text{ g}} \times 100\ \% = 12.0\%$

$\%\text{O} = \frac{48.0 \text{ g}}{100.1 \text{ g}} \times 100\ \% = 48.0\%$

(f) molar mass = 40.0 g

$\%\text{Na} = \frac{23.0 \text{ g}}{40.0 \text{ g}} \times 100\ \% = 57.5\ \%$

$\%\text{O} = \frac{16.0 \text{ g}}{40.0 \text{ g}} \times 100\ \% = 40.0\ \%$

$\%\text{H} = \frac{1.0 \text{ g}}{40.0 \text{ g}} \times 100\ \% = 2.5\ \%$

(g) molar mass = 147.1 g

$$\%\,Ca = \frac{40.1\ g}{147.1\ g} \times 100\,\% = 27.3\,\%$$

$$\%\,Cl = \frac{71.0\ g}{147.1\ g} \times 100\,\% = 48.3\,\%$$

$$\%\,H = \frac{4.0\ g}{147.1\ g} \times 100\,\% = 2.7\,\%$$

$$\%\,O = \frac{32.0\ g}{147.1\ g} \times 100\,\% = 21.8\,\%$$

(h) molar mass = 149.0 g

$$\%\,N = \frac{42.0\ g}{149.0\ g} \times 100\,\% = 28.2\,\%$$

$$\%\,H = \frac{12.0\ g}{149.0\ g} \times 100\,\% = 8.1\,\%$$

$$\%\,P = \frac{31.0\ g}{149.0\ g} \times 100\,\% = 20.8\,\%$$

$$\%\,O = \frac{64.0\ g}{149.0\ g} \times 100\,\% = 43.0\,\%$$

(i) molar mass = 177.4 g

$$\%\,Ag = \frac{107.9\ g}{177.4\ g} \times 100\,\% = 60.8\,\%$$

$$\%\,N = \frac{28.0\ g}{177.4\ g} \times 100\,\% = 15.8\,\%$$

$$\%\,H = \frac{6.0\ g}{177.4\ g} \times 100\,\% = 3.4\,\%$$

$$\%\,Cl = \frac{35.5\ g}{177.4\ g} \times 100\,\% = 20.0\,\%$$

(j) molar mass = 328.5 g

$$\%\,C = \frac{204.0\ g}{328.5\ g} \times 100\,\% = 62.1\,\%$$

$$\%\,H = \frac{15.0\ g}{328.5\ g} \times 100\,\% = 4.6\,\%$$

$$\%\,N = \frac{42.0\ g}{328.5\ g} \times 100\,\% = 12.8\,\%$$

$$\%\,O = \frac{32.0\ g}{328.5\ g} \times 100\,\% = 9.7\,\%$$

$$\%\,Cl = \frac{35.5\ g}{328.5\ g} \times 100\,\% = 10.8\,\%$$

(k) molar mass = 346.9 g

$$\%\,Sn = \frac{118.7\ g}{346.9\ g} \times 100\,\% = 34.2\,\%$$

$$\%\,S = \frac{64.2\ g}{346.9\ g} \times 100\,\% = 18.5\,\%$$

$$\%\,O = \frac{160.0\ g}{346.9\ g} \times 100\,\% = 46.1\,\%$$

$$\%\,H = \frac{4.0\ g}{346.9\ g} \times 100\,\% = 1.2\,\%$$

(l) molar mass = 256.7 g

$$\%\,N = \frac{28.0\ g}{256.7\ g} \times 100\,\% = 10.9\,\%$$

$$\%\,H = \frac{14.0\ g}{256.7\ g} \times 100\,\% = 5.4\,\%$$

$$\%\,Sn = \frac{118.7\ g}{256.7\ g} \times 100\,\% = 46.2\,\%$$

$$\%\,O = \frac{96.0\ g}{256.7\ g} \times 100\,\% = 37.4\,\%$$

(m) molar mass = 120.0 g

$$\%\,C = \frac{24.0\ g}{120.0\ g} \times 100\,\% = 20.0\,\%$$

$$\%\,H = \frac{4.0\ g}{120.0\ g} \times 100\,\% = 3.3\,\%$$

$$\%\,N = \frac{28.0\ g}{120.0\ g} \times 100\,\% = 23.3\,\%$$

$$\%\,O = \frac{64.0\ g}{120.0\ g} \times 100\,\% = 53.3\,\%$$

(n) molar mass = 329.1 g

$$\%\,K = \frac{117.3\ g}{329.1\ g} \times 100\,\% = 35.6\,\%$$

$$\%\,Fe = \frac{55.8\ g}{329.1\ g} \times 100\,\% = 17.0\,\%$$

$$\%\,C = \frac{72.0\ g}{329.1\ g} \times 100\,\% = 21.9\,\%$$

$$\%\,N = \frac{84.0\ g}{329.1\ g} \times 100\,\% = 25.5\,\%$$

45. (a) $\%\,H_2O = \frac{36.0\ g}{147.1\ g} \times 100\,\% = 24.5\,\%$

(b) $\%\,H_2O = \frac{126.0\ g}{280.8\ g} \times 100\,\% = 44.9\,\%$

(c) $\%\,H_2O = \frac{162.0\ g}{706.2\ g} \times 100\,\% = 22.9\,\%$

(d) $\%\,H_2O = \frac{324.0\ g}{666.3\ g} \times 100\,\% = 48.6\,\%$

(e) $\%\,NH_3 = \frac{102.0\ g}{278.5\ g} \times 100\,\% = 36.6\,\%$ (f) $\%\,H_2O = \frac{18.0\ g}{278.5\ g} \times 100\,\% = 6.46\,\%$

(g) $\%\,C_2H_3O_2 = \frac{118.0\ g}{215.5\ g} \times 100\,\% = 54.8\,\%$ (h) $\%\,SO_4 = \frac{288.3\ g}{561.9\ g} \times 100\,\% = 51.3\,\%$

46. (a) $\text{moles B} = 15.9\ g \times \frac{1\ mol}{10.8g} = 1.47\ mol$ | 1
$\text{moles F} = 84.1\ g \times \frac{1\ mol}{19.0\ g} = 4.43\ mol$ | 3
and empirical formula = $\mathbf{BF_3}$

(b) $\text{moles Si} = 87.5\ g \times \frac{1\ mol}{28.1\ g} = 3.11\ mol$ | 1
$\text{moles H} = 12.5\ g \times \frac{1\ mol}{1.0\ g} = 12.5\ mol$ | 4
and empirical formula = $\mathbf{SiH_4}$

(c) $\text{moles P} = 43.7\ g \times \frac{1\ mol}{31.0\ g} = 1.41\ mol$ | 1 | 2
$\text{moles O} = 56.3\ g \times \frac{1\ mol}{16.0\ g} = 3.52\ mol$ | 2.50 | 5
and empirical formula = $\mathbf{P_2O_5}$

(d) $\text{moles I} = 77.9\ g \times \frac{1\ mol}{126.9\ g} = 0.614\ mol$ | 1 | 4
$\text{moles O} = 22.1\ g \times \frac{1\ mol}{16.0\ g} = 1.38\ mol$ | 2.25 | 9
and empirical formula = $\mathbf{I_4O_9}$

(e) $\text{moles Fe} = 77.7\ g \times \frac{1\ mol}{55.8\ g} = 1.39\ mol$ | 1
$\text{moles O} = 22.3\ g \times \frac{1\ mol}{16.0\ g} = 1.39\ mol$ | 1
and empirical formula = $\mathbf{FeO}$

(f) $\text{moles Fe} = 70.0\ g \times \frac{1\ mol}{55.8\ g} = 1.25\ mol$ | 1 | 2
$\text{moles O} = 30.0\ g \times \frac{1\ mol}{16.0\ g} = 1.875\ mol$ | 1.5 | 3
and empirical formula = $\mathbf{Fe_2O_3}$

(g) $\text{moles Fe} = 72.4\ g \times \frac{1\ mol}{55.8\ g} = 1.30\ mol$ | 1 | 3
$\text{moles O} = 27.6\ g \times \frac{1\ mol}{16.0\ g} = 1.725\ mol$ | 1.33 | 4
and empirical formula = $\mathbf{Fe_3O_4}$

(h) $\text{moles Li} = 46.3\ g \times \frac{1\ mol}{6.9\ g} = 6.71\ mol$ | 2
$\text{moles O} = 53.7\ g \times \frac{1\ mol}{16.0\ g} = 3.36\ mol$ | 1
and empirical formula = $\mathbf{Li_2O}$

(i) moles C = 24.4 g x $\frac{1\text{ mol}}{12.0\text{ g}}$ = 2.03 mol | 1 | 3

moles H = 3.39 g x $\frac{1\text{ mol}}{1.0\text{ g}}$ = 3.39 mol | 1.67 | 5 and empirical formula = $C_3H_5Cl_3$

moles Cl = 72.2 g x $\frac{1\text{ mol}}{35.5\text{ g}}$ = 2.03 mol | 1 | 3

(j) moles K = 26.6 g x $\frac{1\text{ mol}}{39.1\text{ g}}$ = 0.680 mol | 1 | 2

moles Cr = 35.4 g x $\frac{1\text{ mol}}{52.0\text{ g}}$ = 0.681 mol | 1 | 2 empirical formula = $K_2Cr_2O_7$

moles O = 38.0 g x $\frac{1\text{ mol}}{16.0\text{ g}}$ = 2.375 mol | 3.49 | 7

(k) moles Mg = 21.8 g x $\frac{1\text{ mol}}{24.3\text{ g}}$ = 0.897 mol | 1 | 2

moles P = 27.9 g x $\frac{1\text{ mol}}{31.0\text{ g}}$ = 0.900 mol | 1 | 2 and empirical formula = $Mg_2P_2O_7$

moles O = 50.3 g x $\frac{1\text{ mol}}{16.0\text{ g}}$ = 3.14 mol | 3.50 | 7

(l) moles H = 3.66 g x $\frac{1\text{ mol}}{1.0\text{ g}}$ = 3.66 mol | 3

moles P = 37.8 g x $\frac{1\text{ mol}}{31.0\text{ g}}$ = 1.22 mol | 1 and empirical formula = H_3PO_3

moles O = 58.4 g x $\frac{1\text{ mol}}{16.0\text{ g}}$ = 3.65 mol | 3

(m) moles C = 46.2 g x $\frac{1\text{ mol}}{12.0\text{ g}}$ = 3.85 mol | 1.33 | 4

moles H = 7.69 g x $\frac{1\text{ mol}}{1.0\text{ g}}$ = 7.69 mol | 2.66 | 8 and empirical formula = $C_4H_8O_3$

moles O = 46.2 g x $\frac{1\text{ mol}}{16.0\text{ g}}$ = 2.89 mol | 1 | 3

(n) moles C = 50.5 g x $\frac{1\text{ mol}}{12.0\text{ g}}$ = 4.21 mol | 1.33 | 4

moles H = 5.26 g x $\frac{1\text{ mol}}{1.0\text{ g}}$ = 5.26 mol | 1.66 | 5 and empirical formula = $C_4H_5N_3$

moles N = 44.2 g x $\frac{1\text{ mol}}{14.0\text{ g}}$ = 3.16 mol | 1 | 3

47. density = $\frac{1.59\text{ g}}{0.850\text{ L}}$ = 1.871 g/L, and mass of 1 mol = 1.871 $\frac{\text{g}}{\text{L}}$ x 22.4 L = 41.9 g

empirical mass of CH_2 = 12.0 + 2 x 1.0 = 14.0 g

N = $\frac{41.9\text{ g}}{14.0\text{ g}}$ = 2.99 . Therefore the molecular formula = 3 x (CH_2) = C_3H_6.

48. $\text{moles N} = 30.4\text{ g} \times \frac{1\text{ mol}}{14.0\text{ g}} = 2.17\text{ mol}$ | 1

$\text{moles O} = 69.6\text{ g} \times \frac{1\text{ mol}}{16.0\text{ g}} = 4.35\text{ mol}$ | 2

and empirical formula = $\mathbf{NO_2}$, empirical mass = 14.0 + 2 x 16.0 = 46.0 g

molar mass = $4.11\ \frac{\text{g}}{\text{L}} \times 22.4\text{ L} = 92.1\text{ g}$

$N = \frac{92.1\text{ g}}{46.0\text{ g}} = 2.0$. Therefore the molecular formula = 2 x (NO_2) = $\mathbf{N_2O_4}$.

49. Empirical mass of C_5H_{11} = 71.0 g

$\text{molar mass} = \frac{3.91\text{ g}}{0.0275\text{ mol}} = 142\text{ g/mol}$

$N = \frac{142\text{ g}}{71.0\text{ g}} = 2.0$. Therefore the molecular formula = 2 x (C_5H_{11}) = $\mathbf{C_{10}H_{22}}$.

50. $\text{density} = \frac{0.522\text{ g}}{0.450\text{ L}} = 1.16\text{ g/L}$, and mass of 1 mol = $1.16\ \frac{\text{g}}{\text{L}} \times 22.4\text{ L} = 26.0\text{ g}$

empirical mass = 1 x 12.0 + 1 x 1.0 = 13.0 g

$N = \frac{26.0\text{ g}}{13.0\text{ g}} = 2.0$. Therefore the molecular formula = 2 x (CH) = $\mathbf{C_2H_2}$.

51. Percentage O = 100% – 42.9% = 57.1%

$\text{moles C} = 42.9\text{ g} \times \frac{1\text{ mol}}{12.0\text{ g}} = 3.58\text{ mol}$ | 1

$\text{moles O} = 57.1\text{ g} \times \frac{1\text{ mol}}{16.0\text{ g}} = 3.57\text{ mol}$ | 1

empirical formula = CO and empirical mass = 28.0 g

$\text{molar mass} = \frac{1.68\text{ g}}{0.0600\text{ mol}} = 28.0\text{ g/mol}$

$N = \frac{28.0\text{ g}}{28.0\text{ g}} = 1$ and the molecular formula is **CO**

52. $\text{moles Si} = 33.0\text{ g} \times \frac{1\text{ mol}}{28.1\text{ g}} = 1.17\text{ mol}$ | 1

$\text{moles F} = 67.0\text{ g} \times \frac{1\text{ mol}}{19.0\text{ g}} = 3.53\text{ mol}$ | 3

empirical formula = SiF_3 and empirical mass = 85.1 g

$\text{molar mass} = 7.60\ \frac{\text{g}}{\text{L}} \times 22.4\text{ L} = 1.70 \times 10^2\text{ g}$

$N = \frac{1.70 \times 10^2\text{ g}}{85.1\text{ g}} = 2.0$ and the molecular formula = 2 x (SiF_3) = $\mathbf{Si_2F_6}$

53. $\text{moles B} = 78.3\text{ g} \times \frac{1\text{ mol}}{10.8\text{ g}} = 7.25\text{ mol}$ | 1

$\text{moles H} = 21.7\text{ g} \times \frac{1\text{ mol}}{1.0\text{ g}} = 21.7\text{ mol}$ | 3

empirical formula = BH_3 and empirical mass = 13.8 g

molar mass = 0.986 x 28.0 g = 27.6 g

$N = \frac{27.6\text{ g}}{13.8\text{ g}} = 2.0$ and the molecular formula = 2 x (BH_3) = $\mathbf{B_2H_6}$

54. empirical mass = 14.0 g

$$\text{density} = \frac{0.938\ \text{g}}{0.500\ \text{L}} = 1.876\ \text{g/L} \quad \text{and} \quad \text{mass of 1 mol} = 1.876\ \frac{\text{g}}{\text{L}} \times 22.4\ \text{L} = 42.0\ \text{g}$$

$$N = \frac{42.0\ \text{g}}{14.0\ \text{g}} = 3.0 \quad \text{and molecular formula} = 3 \times (CH_2) = \mathbf{C_3H_6}$$

55. empirical mass = 16.0 g ; molar mass = 3 x 16.0 g = 48.0 g

$$N = \frac{48.0\ \text{g}}{16.0\ \text{g}} = 3.0 \quad \text{and} \quad \text{molecular formula} = 3 \times (O) = \mathbf{O_3}$$

56. The total volume of water plus dissolved salt would be greater than 1.000 L.

57. Ask for instructions regarding disposal of the solution. There is no quick way to "save" the solution and be sure of the concentration.

58. When pouring samples from the volumetric flask, some of the samples will have different concentrations from other samples. The samples taken from the top of the flask will be less concentrated than those taken from the bottom.

59. (a) $[HCl] = \dfrac{0.26\ \text{mol}}{1.0\ \text{L}} = \mathbf{0.26\ M}$

(b) $[HNO_3] = \dfrac{2.8\ \text{mol}}{4.0\ \text{L}} = \mathbf{0.70\ M}$

(c) $[NH_4Cl] = \dfrac{0.0700\ \text{mol}}{0.0500\ \text{L}} = \mathbf{1.40\ M}$

(d) $[NaCl] = \dfrac{25.0\ \text{g}}{0.2500\ \text{L}} \times \dfrac{1\ \text{mol}}{58.5\ \text{g}} = \mathbf{1.71\ M}$

(e) $[CoBr_2 \cdot 6H_2O] = \dfrac{1.50\ \text{g}}{0.6000\ \text{L}} \times \dfrac{1\ \text{mol}}{326.7\ \text{g}} = \mathbf{0.00765\ M}$

(f) $[Cr(NO_3)_3 \cdot 9H_2O] = \dfrac{10.0\ \text{g}}{0.325\ \text{L}} \times \dfrac{1\ \text{mol}}{400.0\ \text{g}} = \mathbf{0.0769\ M}$

60. (a) $\text{moles } NH_4Cl = 3.00\ \dfrac{\text{mol}}{\text{L}} \times 1.00\ \text{L} = 3.00\ \text{mol}$

$$\text{mass } NH_4Cl = 3.00\ \text{mol} \times \frac{53.5\ \text{g}}{1\ \text{mol}} = 161\ \text{g}$$

Dissolve 161 g of NH_4Cl in less than 1.00 L of water and dilute to 1.00 L.

(b) $\text{moles } Hg(NO_3)_2 = 0.250\ \dfrac{\text{mol}}{\text{L}} \times 0.5000\ \text{L} = 0.125\ \text{mol}$

$$\text{mass } Hg(NO_3)_2 = 0.125\ \text{mol} \times \frac{324.6\ \text{g}}{1\ \text{mol}} = 40.6\ \text{g}$$

Dissolve 40.6 g of $Hg(NO_3)_2$ in less than 500 mL of water and dilute to 500.0 mL.

(c) $\text{moles } Ba(NO_3)_2 = 0.500\ \dfrac{\text{mol}}{\text{L}} \times 0.125\ \text{L} = 0.0625\ \text{mol}$

$$\text{mass } Ba(NO_3)_2 = 0.0625\ \text{mol} \times \frac{261.3\ \text{g}}{1\ \text{mol}} = 16.3\ \text{g}$$

Dissolve 16.3 g of $Ba(NO_3)_2$ in less than 125 mL of water and dilute to 125 mL.