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(2) 500. g × $\frac{1 \text{ cork}}{1.63 g}$ = 306 corks, 307 if you round but you would have less than 307.

500. g × $\frac{1 \text{ stopper}}{4.31 g}$ = 116 stoppers

strategy: 1.00 kg corks → g of corks → # of corks. Then, # corks = # stoppers.
Then, turn # of stoppers into g of stoppers.

1.00 kg × $\frac{1000 g}{1 kg}$ × $\frac{1 \text{ corks}}{1.63 g}$ = 613.497 corks

613.497 corks = 613.497 stoppers × $\frac{4.31 g}{1 \text{ stopper}}$ = 2640 grams of stoppers

(4) We have to use the average because the atoms of an element do not all have the same mass. Each isotope has its own mass. We can use the average mass because any sample of an element in nature (more or less) has the same distribution of isotopes & thus has the same average mass per atom.

(6) (a) 10.81 amu boron × $\frac{1 \text{ atom}}{10.81 \text{ amu}}$ = 1 atoms B

(c) 19697 amu Au × $\frac{1 \text{ atoms Au}}{197.0 \text{ amu Au}}$ = 100 atoms Au

(9) 6.02×10^{23}

(11) 57.0 g F_2 × $\frac{1 \text{ mol}}{38.0 g}$ = 1.50 mol F_2 × $\frac{2 \text{ mols F atoms}}{1 \text{ mol } F_2}$ = 3.00 mol of atoms

Fluorine occurs as F_2, not F.

3.00 mol Cobalt × $\frac{58.93 g}{1 \text{ mol Co}}$ = 177 g Co

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(13) $0.50 \text{ mol O atoms} \times \frac{16.0 \text{ g}}{1 \text{ mol}} = \underline{8.00 \text{ g}}$ ← 0.5 mol O weighs more

$4 \text{ mol H atoms} \times \frac{1.01 \text{ g}}{1 \text{ mol}} = \underline{4.04} \text{ g}$

(14) (a) $26.2 \text{ g Au} \times \frac{1 \text{ mol}}{197 \text{ g}} = 0.133 \text{ mol}$

(c) $335 \text{ mg Ba} \times \frac{1 \text{ g}}{1000 \text{ mg}} \times \frac{1 \text{ mol}}{137.3 \text{ g}} = \underline{0.00244} \text{ mol}$

$2.44 \times 10^{-3} \text{ mol}$

(e) $3.05 \times 10^{-5} \, \mu\text{g Ni} \times \frac{1 \text{ g}}{10^6 \, \mu\text{g}} \times \frac{1 \text{ mol}}{58.69 \text{ g}} = \underline{5.20 \times 10^{-13}} \text{ mol}$

(15) (a) $2.00 \text{ mol Fe} \times \frac{55.85 \text{ g}}{1 \text{ mol}} = \underline{112} \text{ g Fe}$

(c) $1.23 \times 10^{-3} \text{ mol Pt} \times \frac{195.1 \text{ g}}{1 \text{ mol}} = \underline{0.240} \text{ g Pt}$

(e) $0.00102 \text{ mol Mg} \times \frac{24.31 \text{ g Mg}}{1 \text{ mol Mg}} = \underline{0.0248} \text{ g Mg}$

(16) (a) $0.00103 \text{ g} \times \frac{1 \text{ mol}}{58.93 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol}} = \underline{1.05 \times 10^{19}} \text{ atoms Co}$

(c) $2.75 \text{ g Co} \times \frac{1 \text{ mol}}{58.93 \text{ g}} = \underline{0.0467} \text{ mol Co}$

(e) $4.23 \text{ mol Co} \times \frac{58.93 \text{ g}}{1 \text{ mol}} = \underline{249} \text{ g Co}$

(18) averaging

(19) (a) $(Na \times 3) + (N \times 1) = (23 \times 3) + (14 \times 1) = 83.0 \text{ g/mol}$

(c) $NH_4Br = 14 + 4.04 + 79.9 = 97.9 \text{ g/mol}$

(e) $H_2SO_3 = 2.02 + 32.1 + 48 = 82.1 \text{ g/mol}$

(20) ⓐ $Ba^{2+}_{1}(ClO_4)^{-1}_{2}$ = $Ba(ClO_4)_2$ = (Ba × 1) + (Cl × 2) + (O × 8)

137.3 + 70.9 + 128 = 336.2 g/mol

ⓒ $Pb^{2+}\ Cl^{-1} \Rightarrow PbCl_2$ = 207.2 + 70.9 = 278.1 g/mol

ⓔ $Sn^{+4}\ Cl^{-1} \Rightarrow SnCl_4$ = 118.71 + 141.8 = 260.51 g/mol

(21) ⓐ $49.2\ mg \times \frac{1\ g}{1000\ mg} \times \frac{1\ mol}{80.06\ g} = \underline{6.15 \times 10^{-4}}\ mol\ SO_3$ 32.06 + 48 = 80.06 g/mol

ⓒ $59.1\ g \times \frac{1\ mol}{119.36\ g} = \underline{0.495}\ mol$ C + H + Cl_3 = 12 + 1 + 106.35 = 119.36

ⓔ $4.01\ g \times \frac{1\ mol}{23.949\ g} = \underline{0.167}\ mol$ LiOH 6.941 + 16 + 1.01 = 23.949

(22) ⓐ $4.26 \times 10^{-3}\ g \times \frac{1\ mol}{120\ g} = \underline{3.55 \times 10^{-5}}\ mol\ NaH_2PO_4$

$Na^{+}\ H_2PO_4^{+1}$

23
2.02
30.97
64
120

ⓒ $151\ kg \times \frac{1000\ g}{1\ kg} \times \frac{1\ mol}{55.85\ g} = \underline{2.70 \times 10^{3}}\ mol$

(23) ⓐ $1.50\ mol\ AlI_3 \times \frac{407.7\ g}{1\ mol} = \underline{612}\ g$

$Al^{+3}\ I^{-1}$ ⇓ AlI_3 → 27.0, 126.9 × 3; 407.7 g/mol

ⓒ $4.00\ mol\ C_6H_{12}O_6 \times \frac{180\ g}{1\ mol} = \underline{720.}\ g = 7.20 \times 10^{2}\ g$

(24) ⓐ $1.27 \times 10^{-3}\ mol\ CO_2 \times \frac{44.09}{1\ mol\ CO_2} = \underline{0.0559}\ g$

ⓒ $0.00451\ mol\ NH_4NO_3 \times \frac{80.04\ g}{1\ mol} = \underline{0.361}\ g$

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(25) (a) $6.37 \text{ mol } CO \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} = \underline{3.83 \times 10^{24}} \text{ molecules}$

(c) $2.62 \times 10^{-6} \text{ g } H_2O \times \frac{1 \text{ mol}}{18.0 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} = \underline{8.76 \times 10^{16}} \text{ molecules}$

(26) (a) $2.01 \text{g } Na_2SO_4 \times \frac{1 \text{ mol } Na_2SO_4}{142.1 \text{ g } Na_2SO_4} \times \frac{1 \text{ mol S atoms}}{1 \text{ mol } Na_2SO_4} = \underline{0.0141} \text{ moles}$

$(23 \times 2) + (32.1) + (64) =$

(c) $2.01 \text{g } Na_2S \times \frac{1 \text{ mol } Na_2S}{78.06 \text{ g } Na_2S} \times \frac{1 \text{ mol S}}{1 \text{ mol } Na_2S} = \underline{0.0257} \text{ mol S}$

$(23 \times 2) + 32.1 =$

(27) (a) $Na_2SO_4 = (23 \times 2) + (32.1) + (4 \times 16) = 142.1 \text{ g/mol}$

$\% Na = \frac{46}{142.1} \times 100$ $\quad \% S = \frac{32.1}{142.1} \times 100$ $\quad \% O = \frac{64}{142.1} \times 100$

$= 32.4\% \text{ Na}$ $\quad = 22.6\% \text{ S}$ $\quad = 45.0\% \text{ O}$

(c) $Na_2S = (23 \times 2) + 32.1 = 78.1 \text{ g/mol}$

$\% Na = \frac{46}{78.1} \times 100 = 58.9\%$ $\quad \% S = \frac{32.1}{78.1} \times 100 = 41.1\%$

(e) $K_3PO_4 = (39.1 \times 3) + 31 + 64 = 212.3$

$\% K = \frac{117.3}{212.3} \times 100$ $\quad \% P = \frac{31}{212.3} \times 100$ $\quad \% O = \frac{64}{212.3} \times 100$

$= 55.3\% \text{ K}$ $\quad = 14.6\% \text{ P}$ $\quad = 30.1\% \text{ O}$

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(27) (g) $KH_2PO_4 = 39.1 + 2.02 + 31.0 + 64 = 136.12$

$\%K = \frac{39.1}{136.12} \times 100$ | $\%H = \frac{2.02}{136.12} \times 100$ | $\%P = \frac{31}{136.12} \times 100$ | $\%O = \frac{64}{136.12}$

$\%K = 28.7\%$ | $\%H = 1.48\%$ | $\%P = 22.8\%$ | $\%O = 47.0\%$

(28) (a) $\%Cu = \frac{63.55}{223.35} \times 100 = 28.5\%\ Cu$

(c) $\%Fe = \frac{55.85}{126.75} \times 100 = 44.0\%\ Fe$

(e) $\%Co = \frac{58.93}{312.73} \times 100 = 18.8\%\ Co$

(g) $\%Sn = \frac{118.71}{150.71} \times 100 = 78.8\%$

(29) (a) $\%C = \frac{(6 \times 12)}{(6 \times 12) + (10 \times 1.01) + (4 \times 16)} \times 100 = 49.3\%\ C$

(c) $\%C = \frac{(8 \times 12)}{(8 \times 12) + (10 \times 1.01) + (4 \times 14) + (2 \times 16)} \times 100 = 49.5\%\ C$

(e) $\%C = \frac{(6 \times 12)}{(6 \times 12) + (11 \times 1.01) + (16) + 1.01} \times 100 = \frac{72}{100.12} \times 100 = 71.9\%\ C$

(30) $NH_4^+ Cl^-$ = ammonium chloride

(a) $\frac{\text{mass of } NH_4^+}{\text{total mass}} \times 100 = \frac{18.04}{53.49} \times 100 = 33.7\%$ ammonium

(c) $AuCl_3 \Rightarrow \%Au^{3+} = \frac{196.97}{(196.97) + (3 \times 35.45)} \times 100 = 64.9\%$ gold

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(32) empirical formula: simplest whole-number ratio of atoms
molecular formula: actual # of atoms of each element in a compound

(33) (a) $Na_2O_2 \Rightarrow NaO$
(b) $C_{12}H_{12}N_2O_3 \Rightarrow$ same; you can't divide all of the subscripts by any integer but one ("1")

(34) (a) yes, they both have E.F. of CH
(c) yes, they both have E.F. of NO_2

(36) Ca = 2.514g
Calcium oxide = 2.514g + 1.004g ← mass of oxygen

$2.514g\ Ca \times \frac{1\ mol\ Ca}{40.1\ g\ Ca} = 0.0627\ mol\ Ca$

$1.004g\ O \times \frac{1\ mol\ O}{16.0g\ O} = 0.0628\ mol\ O$

$Ca_{.0627}O_{.0628}$

$\frac{Ca}{O} = \frac{1}{1} \Rightarrow$ **CaO**

(37) Assume 100g:

$58.84\ g\ Ba \times \frac{1\ mol\ Ba}{137.38\ g\ Ba} = 0.4283\ mol\ Ba$

$13.74g\ S \times \frac{1\ mol\ S}{32.07\ gS} = 0.4284\ mol\ S$

$27.43g\ O \times \frac{1\ mol\ O}{16.0\ gO} = 1.714\ mol\ O$

$Ba_{0.4283}S_{0.4284}O_{1.714}$

$\frac{Ba}{S} = \frac{1}{1}$ $\frac{O}{Ba} = \frac{1.714}{0.4283} = \frac{4}{1}$

$Ba_1S_1O_4 \rightarrow$ **$BaSO_4$**

(39) 55.06% Co ⇒ total mass = 100%

%S = 100 − 55.06 = 44.94%S

$55.06g\ Co \times \frac{1\ mol\ Co}{58.93\ g\ Co} = 0.9343\ mol\ Co$

$44.94g\ S \times \frac{1\ mol\ S}{32.07\ gS} = 1.401\ mol\ S$

$Co_{0.9343}S_{1.401} \Rightarrow \frac{S}{Co} = \frac{1.401}{0.9343} = 1.5 = \frac{3}{2}$

Co_2S_3

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(41) 10.0 g Cu, 2.52 g O

$10.0\,g\,Cu \times \frac{1\,mol}{63.55\,g} = 0.1574\,mol\,Cu$

$2.52\,g\,O \times \frac{1\,mol}{16.00\,g} = 0.1575\,mol\,O$

$Cu_{0.1574}O_{0.1574}$ ⇓ **CuO**

(43) (a) $83.12\,g\,Na \times \frac{1\,mol}{23\,g} = 3.614\,mol\,Na$

$16.88\,g\,N \times \frac{1\,mol}{14\,g} = 1.206\,mol\,N$

$Na_{3.614}N_{1.206}$

$\frac{Na}{N} = \frac{3.614}{1.206} = \frac{3}{1}$

Na_3N = compound #1

(b) $35.36\,g\,Na \times \frac{1\,mol}{23\,g} = 1.537\,mol\,Na$

$64.64\,g\,N \times \frac{1\,mol}{14\,g} = 4.617\,mol\,N$

$Na_{1.537}N_{4.617}$

$\frac{N}{Na} = \frac{4.617}{1.537} = \frac{3}{1}$

NaN_3 = compound #2

(45) Poorly-worded & contradictory question, don't you think? Let's try again: "what other piece of information do we need in order to determine the molecular formula if the empirical formula is known?" Answer: the molar mass.

(48) $CH_4O = 12 + 4 + 16 = 32$ $\frac{192}{32} = 6$ **$C_6H_{24}O_6$**

(50) $65.45\,g\,C \times \frac{1\,mol}{12\,g} = 5.45\,mol\,C$

$5.492\,g\,H \times \frac{1\,mol\,H}{1.01\,g\,H} = 5.44\,mol\,H$

$29.06\,g\,O \times \frac{1\,mol\,O}{16\,g\,O} = 1.82\,mol\,O$

$\frac{5.45}{1.82} = \frac{C}{O} = \frac{3}{1}$

$C_3H_3O_1$ $36 + 3 + 16 = 55$ $\frac{110}{55} = 2$

$C_6H_6O_2$