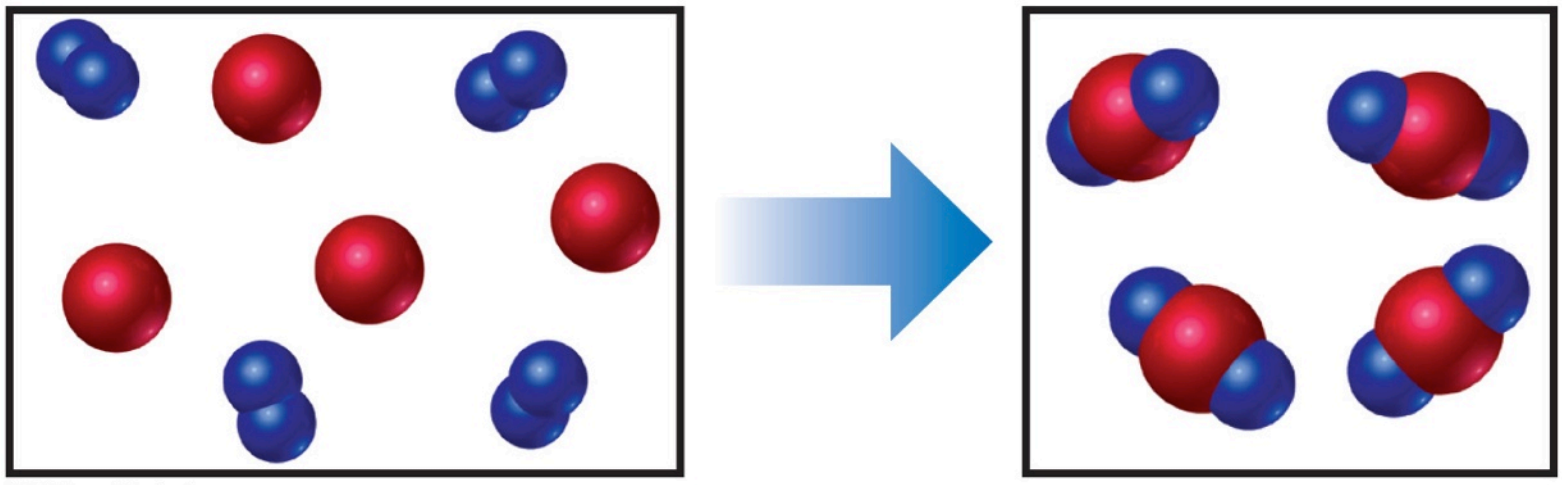

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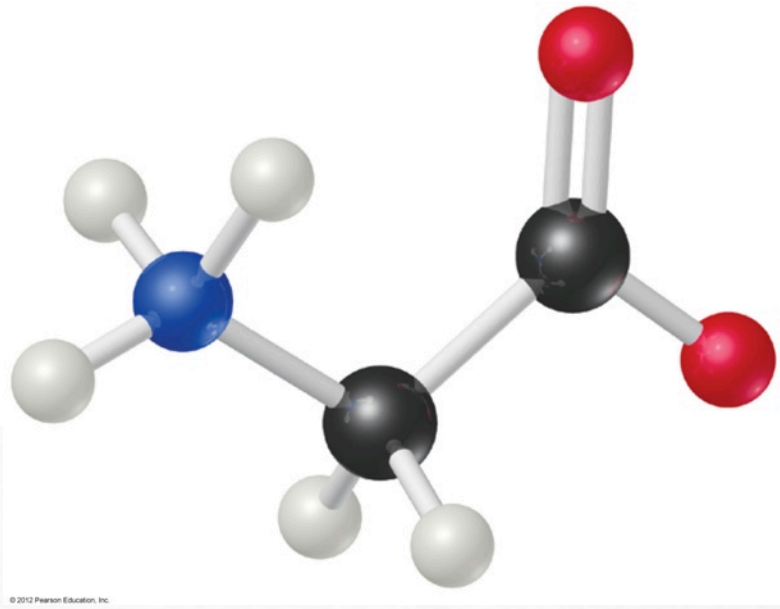
3.1 a. $A_2 + B \rightarrow A_2B$



3.5 a. $C_2H_5O_2N$

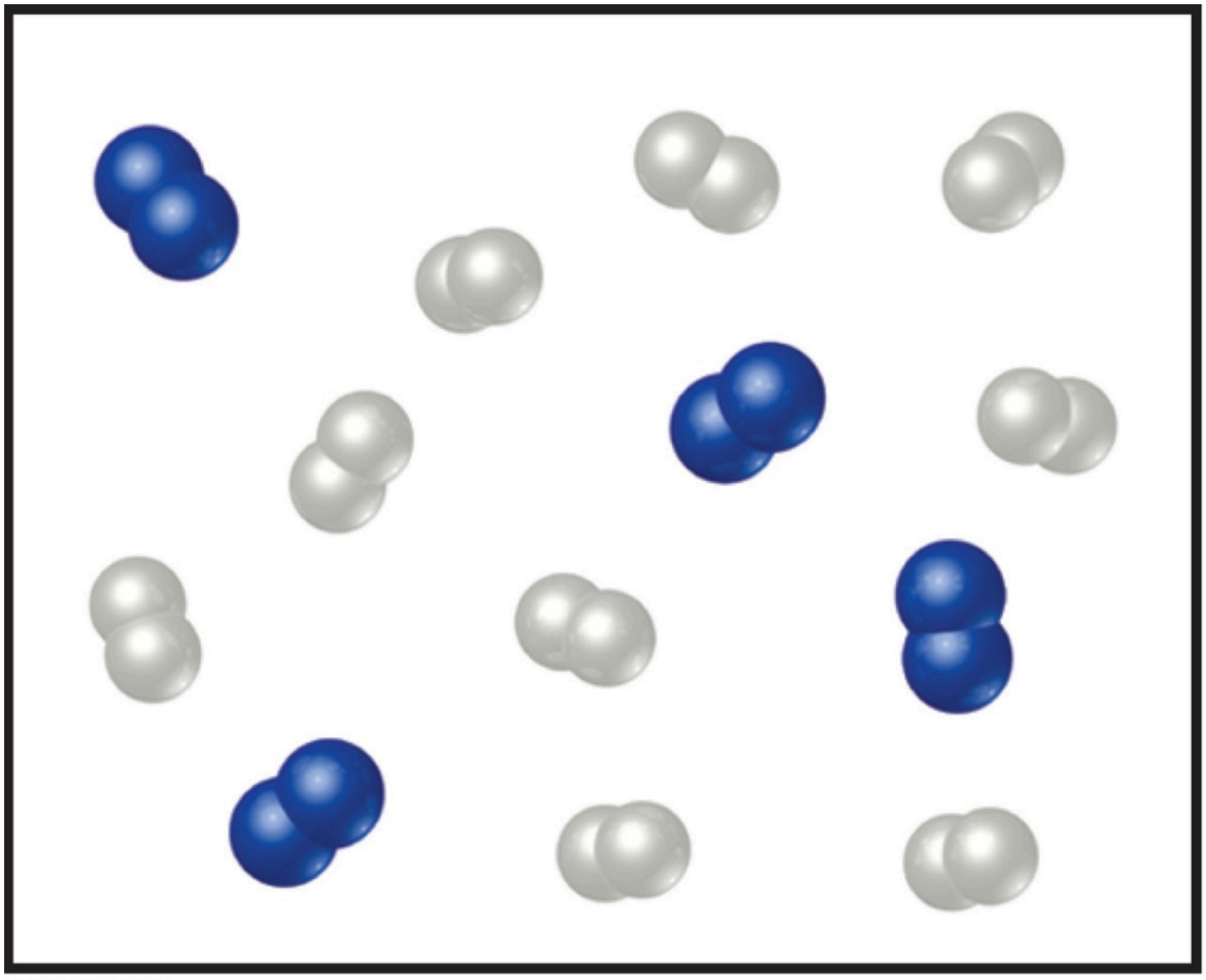
b.

(12g)	2	C
(1g)	5	H
(16g)	2	O
+ (14g)		N
75 amu		75 g/mol

c. $3\,mol\ C_2H_5O_2N \times \frac{75.0\,g}{1\,mol} =$

225.0 g $C_2H_5O_2N$

d. $\frac{14\,g\ N}{75\,g} \times 100\% = 18.7\%\ N$



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3.7 $N_2 + 3H_2 \rightarrow 2NH_3$

4 molec. N_2 $\times \dfrac{3 \text{ molec. } H_2}{1 \text{ molec. } N_2} =$ 12 molec H_2 needed

available

9 H_2 molec available — L.R.

3.9

a. Balancing chemical equations is required according to the law of conservation of mass.

b. changing the subscript changes the identity of the substance.

c. $H_2O_{(l)}$, $H_2O_{(g)}$, $NaCl_{(aq)}$, $NaCl_{(s)}$

3.11

a. $2CO + O_2 \rightarrow 2CO_2$

b. $N_2O_5 + H_2O \rightarrow 2HNO_3$

c. $CH_4 + 4Cl_2 \rightarrow CCl_4 + 4HCl$

d. $Al_4C_3 + 12H_2O \rightarrow$
$4Al(OH)_3 + 3CH_4$

e. $2C_5H_{10}O_2 + 15O_2 \rightarrow$
$10CO_2 + 10H_2O$

3.13

a. $CaC_2 + 2H_2O \rightarrow$
$Ca(OH)_2 + C_2H_2$

b. $2KClO_3 \rightarrow 2KCl + 3O_2$

c. $Zn + H_2SO_4 \rightarrow H_2 + ZnSO_4$

d. $PCl_3 + 3H_2O \rightarrow H_3PO_4 + 3HCl$

e. $3H_2S + 2Fe(OH)_3 \rightarrow$
$Fe_2S_3 + 6H_2O$

3.15 a. $2Na + Br_2 \longrightarrow 2NaBr$

sodium loses 1 electron

Bromine gain 1 electron

NaBr is an ionic compound with a high melting point

b. oxygen combines with a hydrocarbon to produce CO_2 and H_2O

$2C_6H_6 + 15O_2 \longrightarrow 12CO_2 + 6H_2O$

3.17

a. $Mg + Cl_2 \rightarrow MgCl_2$

b. $BaCO_3 \rightarrow BaO + CO_2$

c. $C_8H_8 + 10O_2 \rightarrow 8CO_2 + 4H_2O$

d. $CH_3OCH_3 + 3O_2 \rightarrow 2CO_2 + 3H_2O$

3.19 a. $2C_3H_6 + 9O_2 \rightarrow 6CO_2 + 6H_2O$

Combustion rxn.

b. $NH_4NO_3 \rightleftharpoons N_2O + 2H_2O$

Decomposition rxn.

c. $C_5H_6O + 6O_2 \rightarrow 5CO_2 + 3H_2O$

Combustion rxn.

d. $N_2 + 3H_2 \rightarrow 2NH_3$

combination rxn.

e. $K_2O + H_2O \rightarrow 2KOH$

combination rxn.

3.21 a. HNO_3

(1.0g) H
(14.00g) N
3(16.00g) O

63 g/mol HNO_3

b. $KMnO_4$

(39.1g) K
(54.9g) Mn
4(16.00g) O

158 g/mol $KMnO_4$

3.23 a. Morphine $C_{17}H_{19}NO_3$

$$\%O = \frac{3(16.00g\ O)}{285} \times 100 = 16.8\%$$

b. Codeine $C_{18}H_{21}NO_3$

$$\%O = \frac{3(16.00g\ O)}{299} \times 100 = 16.1\%$$

c. Cocaine $C_{17}H_{21}NO_4$

$$\%O = \frac{4(16.00g\ O)}{303} \times 100 = 21.1\%$$

3.27 a. 6.02×10^{23} = 1 mole

b. A mole of F.W. is equal to F.W. in grams.

3.31 $\frac{160 \text{ lbs}}{1 \text{ person}} \times \frac{0.454 \text{ kg}}{1 \text{ lbs}} \times \frac{6.02 \times 10^{23} \text{ people}}{1 \text{ mole}} = \frac{4.37 \times 10^{25} \text{ kg People}}{1 \text{ mol}}$

$\frac{4.37 \times 10^{25} \text{ kg}}{5.98 \times 10^{24} \text{ kg}}$ = 7.31 times the mass of earth.

mass of earth

3.33

a. $0.105 \text{ mol } C_{12}H_{22}O_{11} \times \frac{342 \text{ g}}{1 \text{ mol}} =$

$35.9 \text{ g } C_{12}H_{22}O_{11}$

b. $143.50 \text{ g } Zn(NO_3)_2 \times \frac{\text{mol}}{189.38 \text{ g}}$

$= 0.7578 \text{ mol } Zn(NO_3)_2$

c. $1.0 \times 10^{-6} \text{ mol } CH_3CH_2OH \times \frac{6.02 \times 10^{23} \text{ molec.}}{1 \text{ mol}}$

$= 6.02 \times 10^{17} \text{ molec. } CH_3CH_2OH$

d. $0.410 \text{ mol } NH_3 \times \frac{1 \text{ mol N}}{1 \text{ mol } NH_3} \times$

$\frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol}} = 2.46 \times 10^{23}$

atoms N

$\boxed{3.35}$

a. 2.50×10^{-3} mol $(NH_4)_3PO_4$ $\times$

$\frac{149\,g}{1\,mol}$ = 0.373 g $(NH_4)_3PO_4$

b. 0.2550 g $AlCl_3$ $\times$ $\frac{1\,mol\ AlCl_3}{133.4\,g}$

$\times$ $\frac{3\,mol\ Cl^-}{1\,mol\ AlCl_3}$ = 5.73×10^{-3} mol Cl^-

c. 7.70×10^{20} molec caffeine $\times$ $\frac{1\,mol}{6.02 \times 10^{23}\,molec}$

$\times$ $\frac{194\,g}{1\,mol\ caffeine}$ = 0.25 g caffeine

$C_8H_{10}N_4O_2$

d. $\frac{0.406\,g}{0.00105\,mol\ cholesterol}$ = 386.7 g/mol

$\boxed{3.43}$

a) $\frac{0.0130 \text{ mol C}}{0.0065} = 2$

$\frac{0.0390 \text{ mol H}}{0.0065} = 6$

$0.0065 \text{ mol O} = 1$

C_2H_6O

b) $11.66 \text{ g Fe} \times \frac{1 \text{ mol}}{55.845 \text{ g}} = 0.208 = 1 \times 2$

$5.01 \text{ g O} \times \frac{1 \text{ mol}}{16.00 \text{ g}} = \frac{0.313}{0.208} = 1.5 \times 2$

Fe_2O_3

c) $40.0 \text{ g C} \times \frac{1 \text{ mol}}{12 \text{ g}} = 3.33 = 1$

$6.7 \text{ g H} \times \frac{1 \text{ mol}}{1 \text{ g}} = \frac{6.7}{3.33} = 2$

$53.3 \text{ g O} \times \frac{1 \text{ mol}}{16 \text{ g}} = 3.33 = 1$

CH_2O

3.51

a. styrene

$$92.3\,g\,C \times \frac{1\,mol}{12\,g} = 7.7 = 1$$

$$7.7\,g\,H \times \frac{1\,mol}{1\,g} = 7.7\,mol\,H = 1$$

CH

$$\frac{104\,g}{13\,g} = 8$$

C_8H_8

b. caffeine

$$49.5\,g\,C \times \frac{1\,mol}{12\,g} = \frac{4.125}{1.03} = 4$$

$$5.15\,g\,H \times \frac{1\,mol}{1\,g} = \frac{5.15}{1.03} = 5$$

$$28.9\,g\,N \times \frac{1\,mol}{14\,g} = \frac{2.06}{1.03} = 2$$

$$16.5\,g\,O \times \frac{1\,mol}{16\,g} = 1.03 = 1$$

$C_4H_5N_2O$

$$\frac{195}{97} = 2$$

$C_8H_{10}N_4O_2$

3.53

$$\text{toluene} + O_2 \rightarrow CO_2 + H_2O$$

$$5.86\ mg\ CO_2 \times \frac{1\ g}{1000\ mg} \times \frac{12\ g\ C}{44\ g\ CO_2} \times \frac{1\ mol\ C}{12\ g} = 1.33 \times 10^{-4}\ mol\ C$$

$$1.37\ mg\ H_2O \times \frac{1\ g}{1000\ mg} \times \frac{2\ g\ H}{18\ g\ H_2O} \times \frac{1\ mol\ H}{1\ g} = 1.52 \times 10^{-4}\ mol\ H$$

$$1.33 \times 10^{-4}\ mol\ C = 1$$

$$\frac{1.52 \times 10^{-4}\ mol\ H}{1.33 \times 10^{-4}} = 1$$

CH

3.59 It is essential to balance chemical equations in order to conform to the law of conservation of mass.

3.63 a.

$$Al(OH)_3 + 3HCl \rightarrow AlCl_3 + 3H_2O$$

b. $$0.500g\ Al(OH)_3 \times \frac{1\ mol\ Al(OH)_3}{78g} \times \frac{3\ mol\ HCl}{1\ mol\ Al(OH)_3} \times \frac{36.45g}{1\ mol\ HCl} = 0.70g\ HCl$$ used

c. $$0.500g\ Al(OH)_3 \times \frac{1\ mol\ Al(OH)_3}{78g} \times \frac{1\ mol\ AlCl_3}{1\ mol\ Al(OH)_3} \times \frac{133.3g}{1\ mol} = 0.854g\ AlCl_3$$

$$0.500g\ Al(OH)_3 \times \frac{1\ mol\ Al(OH)_3}{78g} \times \frac{3\ mol\ H_2O}{1\ mol\ Al(OH)_3} \times \frac{18g}{1\ mol\ H_2O} = 0.346g\ H_2O$$

3.65 $Al_2S_3 + 6\,H_2O \rightarrow 2Al(OH)_3 + 3H_2S$

$$14.2\,g\ Al_2S_3 \times \frac{1\,mol\ Al_2S_3}{150\,g} \times \frac{2\,mol\ Al(OH)_3}{1\,mol\ Al_2S_3} \times \frac{78\,g}{1\,mol\ Al(OH)_3} = 14.78\,g\ Al(OH)_3$$

3.75 $2\,NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$

$$1.85\,mol\ NaOH \times \frac{1\,mol\ CO_2}{2\,mol\ NaOH} = 0.925\,mol\ CO_2$$

needed

$1.00\,mol\ CO_2$ – more than enough

L.R.

$$0.925\,mol\ CO_2 \times \frac{1\,mol\ Na_2CO_3}{1\,mol\ NaOH} = 0.925\,mol\ Na_2CO_3$$

produced

$1.00\,mol\ CO_2$ – $0.925\,mol\ CO_2$ = $0.075\,mol\ CO_2$ excess

given

used

3.77 $3\,NaHCO_3 + H_3C_6H_5O_7 \longrightarrow$

$3\,CO_2 + 3\,H_2O + Na_3C_6H_5O_7$

$1\,g\ NaHCO_3 \times \frac{1\,mol}{84\,g} = 1.19\times10^{-2}\,mol$

$1\,g\ H_3C_6H_5O_7 \times \frac{1\,mol}{192\,g} = \underline{5.21\times10^{-2}\,mol}$

I have

$1.19\times10^{-2}\,mol\ NaHCO_3 \times \frac{1\,mol\ H_3C_6H_5O_7}{3\,mol}$

L.R.

$= 3.97\times10^{-3}\,mol\ H_3C_6H_5O_7$

needed

b. $1.19\times10^{-2}\,mol\ NaHCO_3 \times \frac{3\,mol\ CO_2}{3\,mol}$

$\times \frac{44\,g\ CO_2}{1\,mol} = 0.524\,g\ CO_2$

c. $5.21\times10^{-3}\,mol\ H_3C_6H_5O_7 - 3.97\times10^{-3}\,mol\ H_3C_6H_5O_7$

available

used

$= 1.24\times10^{-3}\,mol\ H_3C_6H_5O_7 \times \frac{192\,g}{1\,mol} = 0.238\,g\ H_3C_6H_5O_7$

moles remaining

grams remaining

3.81

$$C_6H_6 + Br_2 \longrightarrow C_6H_5Br + HBr$$

a. $30g\ C_6H_6 \times \frac{1mol}{78g} = 0.3846mol$ — L.R.

$65g\ Br_2 \times \frac{1mol}{160g} = 0.4063\ mol$

$0.3846mol\ C_6H_6 \times \frac{1mol\ C_6H_5Br}{1mol\ C_6H_6} \times \frac{157g}{1mol} = 60.38g\ C_6H_5Br$ Theoretical

$\frac{42.3g}{60.38g} \times 100 = 70\%$ yield

Actual

Theoretical