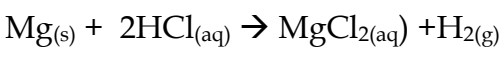
Stoichiometry-Activity 2, KEY

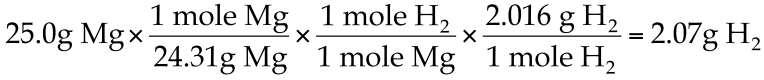
Exercises:

1. Magnesium (Mg) reacts with hydrochloric acid (HCl) to produce magnesium chloride ($MgCl_2$) and hydrogen gas (H_2).
   a. Write the balanced equation for this reaction.



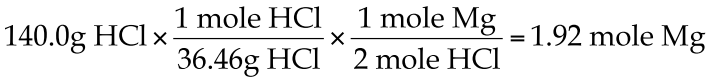
$$Mg_{(s)} + 2HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$$

   b. If you start with 25.0 g of magnesium, how many grams of hydrogen gas will form?



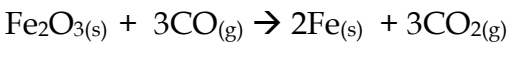
$$25.0\text{g Mg} \times \frac{1\text{ mole Mg}}{24.31\text{g Mg}} \times \frac{1\text{ mole H}_2}{1\text{ mole Mg}} \times \frac{2.016\text{ g H}_2}{1\text{ mole H}_2} = 2.07\text{g H}_2$$

   c. If you start with 140.0 g of hydrochloric acid, how many moles of magnesium will react?



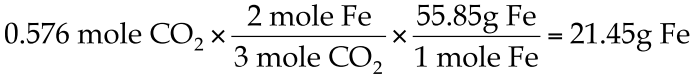
$$140.0\text{g HCl} \times \frac{1\text{ mole HCl}}{36.46\text{g HCl}} \times \frac{1\text{ mole Mg}}{2\text{ mole HCl}} = 1.92\text{ mole Mg}$$

2. Ferric oxide (Fe_2O_3) plus carbon monoxide (CO) gas yields iron metal (Fe) and carbon dioxide (CO_2) gas
   a. Write the balanced equation for this reaction.



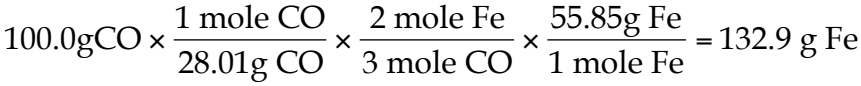
$$Fe_2O_{3(s)} + 3CO_{(g)} \rightarrow 2Fe_{(s)} + 3CO_{2(g)}$$

   b. How many grams of Fe are made if 0.576 moles of CO_2 are produced?



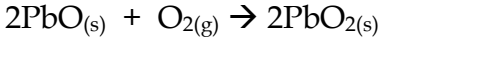
$$0.576\text{ mole CO}_2 \times \frac{2\text{ mole Fe}}{3\text{ mole CO}_2} \times \frac{55.85\text{g Fe}}{1\text{ mole Fe}} = 21.45\text{g Fe}$$

   c. 100.0 g CO reacted with excess ferric oxide. How many grams of Fe was produced?



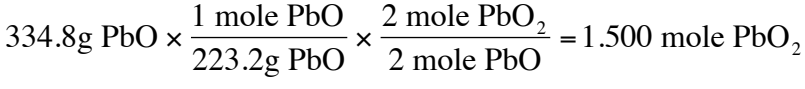
$$100.0\text{gCO} \times \frac{1\text{ mole CO}}{28.01\text{g CO}} \times \frac{2\text{ mole Fe}}{3\text{ mole CO}} \times \frac{55.85\text{g Fe}}{1\text{ mole Fe}} = 132.9\text{ g Fe}$$

3. Lead(II) oxide (PbO) and oxygen gas (O_2) react to form lead(IV) oxide (PbO_2)
   a. Write the balanced equation for this reaction.



$$2PbO_{(s)} + O_{2(g)} \rightarrow 2PbO_{2(s)}$$

   b. How many moles of lead(IV) oxide will be formed from 334.8 g of PbO ?



$$334.8\text{g PbO} \times \frac{1\text{ mole PbO}}{223.2\text{g PbO}} \times \frac{2\text{ mole PbO}_2}{2\text{ mole PbO}} = 1.500\text{ mole PbO}_2$$

4. Nitrogen gas (N_2) and hydrogen gas (H_2) combine to form ammonia (NH_3) gas.
   a. Write the balanced equation for this reaction.

$N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$

   b. In the above reaction, how many g of ammonia will be produced from 7.2 g of hydrogen gas?

$$7.2\text{g } H_2 \times \frac{1 \text{ mole } H_2}{2.016\text{g } H_2} \times \frac{2 \text{ mole } NH_3}{3 \text{ mole } H_2} \times \frac{17.03\text{g } NH_3}{1 \text{ mole } NH_3} = 41\text{g } NH_3$$

   c. How many grams of nitrogen are needed to produce 460 g of ammonia?

$$460\text{g } NH_3 \times \frac{1 \text{ mole } NH_3}{17.03\text{g } NH_3} \times \frac{1 \text{ mole } N_2}{2 \text{ mole } NH_3} \times \frac{28.02\text{g } N_2}{1 \text{ mole } N_2} = 380\text{g } N_2$$

5. Pentane (C_5H_{12}) combusts in O_2 to form CO_2 and H_2O.
   a. Write the balanced equation for this reaction.

$C_5H_{12\,(l)} + 8O_{2(g)} \rightarrow 5CO_{2(g)} + 6H_2O_{(g)}$

   b. How many grams of carbon dioxide form from 320.0 g of pentane?

$$320.0\text{g } C_5H_{12} \times \frac{1 \text{ mole } C_5H_{12}}{72.15\text{g } C_5H_{12}} \times \frac{5 \text{ mole } CO_2}{1 \text{ mole } C_5H_{12}} \times \frac{44.01\text{g } CO_2}{1 \text{ mole } CO_2} = 976.0\text{g } CO_2$$

   c. How many grams of water are produced if 200.0 g of CO_2 are produced?

$$200.0\text{g } CO_2 \times \frac{1\text{mole } CO_2}{44.01\text{g } CO_2} \times \frac{6 \text{ mole } H_2O}{5 \text{ mole } CO_2} \times \frac{18.02\text{g } H_2O}{1 \text{ mole } H_2O} = 98.27\text{g } H_2O$$

   d. You start with 150.0 g of pentane. How many grams of H_2O will you make?

$$150.0\text{g } C_5H_{12} \times \frac{1 \text{ mole } C_5H_{12}}{72.15\text{g } C_5H_{12}} \times \frac{6 \text{ mole } H_2O}{1 \text{ mole } C_5H_{12}} \times \frac{18.02\text{g } H_2O}{1 \text{ mole } H_2O} = 224.8\text{g } H_2O$$

6. In the process of photosynthesis, carbon dioxide (CO_2) and water (H_2O) are transformed using the energy from sunlight into sucrose ($C_{12}O_{11}H_{22}$) and O_2.
   a. Write the balanced equation for this reaction.

$12\ CO_{2(g)} + 11\ H_2O_{(g)} \rightarrow C_{12}O_{11}H_{22(s)} + 12O_{2(g)}$

   b. How many grams of carbon dioxide are required to produce a sugar cube that has a mass of 4.00 grams?

$$4.00\text{g } C_{12}O_{11}H_{22} \times \frac{1 \text{ mole } C_{12}O_{11}H_{22}}{342.30\text{g } C_{12}O_{11}H_{22}} \times \frac{12 \text{ mole } CO_2}{1 \text{ mole } C_{12}O_{11}H_{22}} \times \frac{44.01\text{g } CO_2}{1 \text{ mole } CO_2} = 6.17\text{g } CO_2$$