Topic: Chemical Calculation notes	Date: 28/06/2011

Calculations from equations [Reacting masses]

From the previous lesson, do you remember what does a chemical reaction tells us?

Give an example of an equation below:

_____

Below shows the procedures on how to calculate the reacting masses through some examples:

Example 1

Calculate the mass of water produced from the complete combustion of 0.25 mol of methane.

Solution

Step 1 Write the **balanced equation**.

$\_\_CH_4\ (g) + \_\_O_2\ (g) \rightarrow \_\_CO_2\ (g) + \_\_H_2O\ (l)$

Step 2 From the equation, find the **ratio of the number of moles** of H_2O to the number of moles of CH_4.

$$\frac{\text{No. of moles of } H_2O \text{ produced}}{\text{No. of moles of } CH_4 \text{ reacted}} = \frac{2}{1}$$

Step 3 **Use the ratio to find the number of moles** of H_2O produced when 0.25 moles of CH_4 is burnt.

No. of moles of H_2O = _____ X No.of moles of CH_4

= _____ X _____

= _____ mol.

Step 4 Multiply the no. of moles by the molar mass of H_2O to **obtain the mass** of H_2O in grams.

Mass of H_2O in grams = No. of moles x molar mass of H_2O

= _____ x _____

= _____ g.

Example 2

To obtain iron, iron (III) oxide reacts with carbon monoxide according to the equation:

$$Fe_2O_3\ (s) + 3CO(g) \rightarrow 2Fe(l) + 3CO_2(g)$$

What mass of iron is produced from 40 g of iron (III) oxide?

Solution

Step 1 Write the **balanced equation** [Check the equation if it is already balanced or not].

__ Fe_2O_3 + __ CO(g) → __ Fe(l) + __ CO_2(g)

Step 2 From the equation, find the **ratio of the number of moles** of Fe to the number of moles of Fe_2O_3.

$$\frac{\text{No. of moles of Fe}}{\text{No. of moles of } Fe_2O_3 \text{ reacted}} = \frac{2}{1}$$

*Step 2.5** **Change** the **mass** of Fe_2O_3 **into moles** of Fe_2O_3.

Molar mass of Fe_2O_3 = (_____) + (_____) = _____ g.

$$\text{No. of moles of } Fe_2O_3 = \frac{\text{Mass of } Fe_2O_3}{\text{Molar mass of } Fe_2O_3}$$

= _____

= _____ mol.

Step 3 **<u>Use the ratio to find the number of moles</u>** of Fe produced.

No. of moles of Fe = _____ x no. of moles of Fe_2O_3

= _____ x _____ = _____ mol.

Step 4 **<u>Obtain the mass</u>** of Fe produced.

Mass of Fe = No. of moles x Molar mass of Fe

= _____ x _____ = _____ g.

Exercise 1

Common salt sodium chloride is prepared by reacting sodium with chlorine. What mass of sodium chloride is produced from 1.42 g of chlorine?

Q: How about procedures for calculating volume of gases produced/used in a reaction? Do you think the procedure will be similar?

Example 1

Magnesium reacts with hydrochloric acid according to the equation:

$$Mg\ (s) + 2HCl\ (aq) \rightarrow McCl_2\ (aq) + H_2\ (g)$$

Calculate the volume of hydrogen gas, measured at room conditions, produced from the reaction 0f 14.6g of hydrochloric acid.

Solution

Step 1 Write the **balanced equation.** [Check the equation if it is already balanced or not].

__ Mg (s) + __ HCl (aq) → __ $McCl_2$ (aq) + __ H_2 (g)

Step 2 From the equation, find the **ratio of the number of moles** of H_2 to the number of moles of HCl.

$$\frac{\text{No. of moles of } H_2}{\text{No. of moles of HCl}} = \frac{1}{2}$$

*Step 2.5** **Change** the **mass** of HCl **into moles**.

$$\text{No. of moles of HCl} = \frac{\text{Mass of HCl (g)}}{\text{Molar mass (g) / Mr}}$$

= _____

= _____ mol.

Step 3 **Use the ratio to find the number of moles** of H_2 produced when 0.4 mol of HCl reacts.

No. of moles of H_2 = _____ x no. of moles of HCl

= _____ x _____ = _____ mol.

Step 4 Multiply the number of moles of H_2 gas by the molar gas volume. This gives the volume of H_2 gas produced.

Vol. of H_2 gas = no. of moles x molar gas volume

= _____ x _____ = _____ dm^3.

Example 2

Lead (IV) oxide, PbO_2, decomposes when heated strongly. The equation for the reaction is:

$$2PbO_2\ (s) \rightarrow 2PbO\ (s) + O_2\ (g)$$

Calculate the mass of lead (IV) oxide that decomposes to produce 1.2dm^3 of oxygen, measured at room conditions.

Solution

Step 1 Write the **balanced equation**.

__ PbO_2 (s) → __PbO (s) + __ O_2 (g)

Step 2 From the equation, find the **ratio of the number of moles** of PbO_2 to O_2.

$$\frac{\text{No. of moles of } PbO_2}{\text{No. of moles of } O_2} = \frac{2}{1}$$

*Step 2.5** **Change the volume** of O_2 gas **into moles** of O_2 gas.

$$\text{No. of moles of } O_2 \text{ gas} = \frac{\text{Vol. of } O_2 \text{ gas}}{\text{Molar gas volume}}$$

= _____

= _____ mol.

Step 3 **Use the ratio to find the number of moles** of PbO_2 when 0.05 mol of O_2 produced.

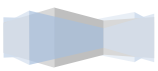
No. of moles of PbO_2 = _____ x no. of moles of O_2

= _____ x _____ = _____ mol.

Step 4 Multiply the number of moles of PbO_2 by the molar mass to **obtain the mass** in grams.

Mass of PbO_2 = no. of moles x molar mass of PbO_2 (g)

= _____ x _____ = _____ g.



Exercise 2

Ethanol, C_2H_5OH is mixed with petrol to form gasohol – a fuel for motor vehicles. On complete combustion, it produces carbon dioxide and water only. What volume of oxygen, measured at r.t.p., is needed for complete combustion of 23.0 g of ethanol?

Exercise 3

Propane, C_3H_8, burns in excess oxygen to produce carbon dioxide and water.

a) How many moles of oxygen are required to burn 3 moles of propane?
b) How many grams of water are produced from the complete combustion of 3.00g of propane?

Limiting reagents/reactants

- It is the chemical that is completly consumed in a reaction.
- The reaction stops as soon as the limiting reactant is totally consumed.
- The limiting reactant limits the amount of products formed.
- Check for limiting reactant when the quantities of **two** (or **more**) reactants are given.

Example 1:

In the Haber process, ammonia is manufactured from nitrogen and hydrogen. A mixture of 5 moles of nitrogen and 10 moles of hydrogen were allowed to react according to the following equation:

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$$

a) Which substance is the limiting reagent?
b) How many moles of ammonia are formed in this reaction?

Example 2

The contact process is used to manufacture sulphuric acid. In this process 3.50 moles of sulphur dioxide were allowed to react with 1.10 moles of oxygen to form sulphur trioxide.

a) Write a balanced equation fro the reaction between aluminium and chlorine.
b) What is the limiting reactant?
c) How many grams of sulphur trioxide are formed?