Nat 5: Unit 1 Chemical Changes and Structure

Key Area: Formulae and Reacting Quantities

Lesson 21: Consolidation of Lessons 17-20; percentage by mass calculations and calculations using the mole and balanced equations.

Learning Outcomes

By the end of the lesson you should be able to…

1. Calculate percentage by mass of an element in a compound
2. Be able to calculate mole ratio of substances in balanced equations.
3. Carry out calculations using the mole triangle and proportion.

Success Criteria

You will have been successful in this lesson if you:

1. Successfully complete all self checks evaluating and correcting any errors made.

If you have any questions about the content of this lesson, you should ask your **class teacher** either through your class MS team or via email. MS Teams will be monitored throughout the week by a chemistry teacher. If you need help or clarification with either the task or the content of the lesson, just ask.

Links to Prior Knowledge:

It is essential that you have completed **lessons 18 to 20**

You may wish to have a copy of the data booklet handy for this lesson. Download from the SQA website - ChemistryDataBookletSQPN5.pdf (sqa.org.uk)

You do not have to copy (or print and stick) this lesson into your notebook as it is consolidation.

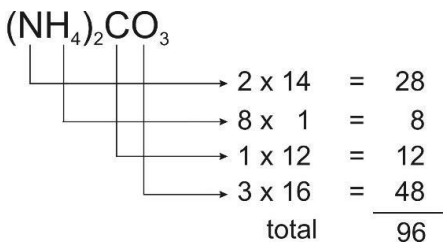
You should now understand the following types of calculation:

1. Percentage by Mass

Calculate the percentage by mass of

a. **nitrogen** in ammonium carbonate $(NH_4)_2CO_3$

Step 1: calculate the GFM



Step 2: insert values into equation

$$\%\ by\ mass = \frac{m}{GFM} \times 100$$

% by mass of **nitrogen** = $\frac{28}{96}$ x 100 = **29.17 %**

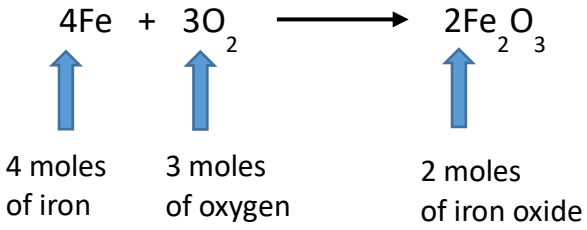
b. **oxygen** in ammonium carbonate $(NH_4)_2CO_3$

% by mass of **oxygen** = $\frac{48}{96}$ x 100 = **50 %**

2. Mole Ratios from Balanced Equations

We used the following example to introduce the idea of mole ratios.

e.g.



4 moles of Iron will **react** with 3 moles of Oxygen

4 Fe	3 O_2
4 moles	3 moles

or

4 moles of Iron will **produce** 2 moles of Iron oxide

4 Fe	2 Fe_2O_3
4 moles	2 moles

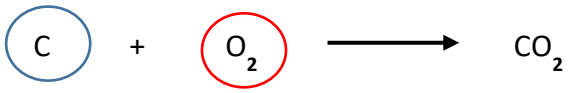
or

3 moles of Oxygen will **produce** 2 moles of Iron oxide

$3\ O_2$	$2\ Fe_2O_3$
3 moles	2 moles

3. Calculations Using Balanced Equations

Example 1 What mass of **oxygen** will react with 2.4g of **carbon**?



Have been asked about O_2, therefore goes on the right hand side of table

C	O_2
1 mole	1 mole
12g	32g
1g	32/12
2.4g	2.4 x 32/12 = **6.4g**

Convert moles to mass (m = n x GFM)

Convert moles to mass (m = n x GFM)

Divide by 12

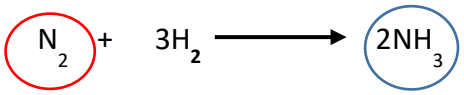
Divide by 12

Multiply by 2.4

Multiply by 2.4

Remember, whatever you do to one side of the equation you must do to the other!

Example 2 What mass of **nitrogen** is required to produce 30 g of **nitrogen hydride**?



Have been asked about nitrogen, therefore goes on the **right hand side of table**

$2NH_3$	N_2
2 moles	1 mole
34g (2 x 17)	28g
1g	28/34
30g	30 x 34/28 = **<u>24.71g</u>**

Convert moles to mass (m = n x GFM)

Convert moles to mass (m = n x GFM)

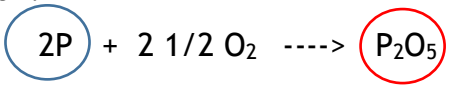
Divide by 34

Divide by 34

Multiply by 30

Multiply by 30

Example 3 Phosphorous burns in air to form phosphorous (V) oxide according to the equation:



What mass of phosphorous (V) oxide will be produced from 0.4 mol of phosphorous?

2 P	P_2O_5
2 moles	1 mole
1 mole	1/2 mole
0.4	0.4 x 1/2 = **0.2 moles**

Divide by 2

Divide by 2

Multiply by 0.4

Multiply by 0.4

Convert moles to mass (m = n x GFM)

m = 0.2 x 142 = **28.4g**

Practice makes Perfect

Once you have read and fully understand the previous information please attempt the following self checks in your jotter.

Self Check 17

Calculate the percentage by mass of the following

***a) % sodium** in sodium sulphate*	Na_2SO_4
***b) % magnesium** in magnesium nitrate*	$Mg(NO_3)_2$
***c) % aluminium** in aluminium oxide*	Al_2O_3
***d) % carbon** in glucose*	$C_6H_{12}O_6$
***e) % sulphur** in sulphuric acid*	H_2SO_4
***f) % nitrogen** in ammonium nitrate*	NH_4NO_3
***g) % calcium** in calcium hydroxide*	$Ca(OH)_2$

Self Check 18

1. What mass of carbon dioxide is produced when 160g of methane burns?

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

2. Calculate the mass of magnesium carbonate required to produce 100g of magnesium oxide.

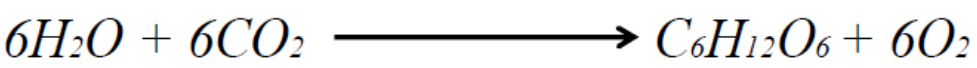
$$MgCO_3 \longrightarrow CO_2 + MgO$$

3. Silicon carbide is prepared in the following reaction

$$3C + SiO_2 \longrightarrow 2CO + SiC$$

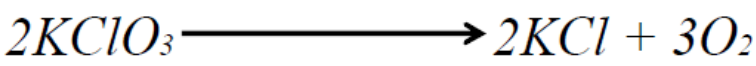
Calculate the mass of silicon carbide produced when 0.8 moles of carbon reacts.

4. The chemical reaction for photosynthesis is shown below



What mass of water is required to produce 85g of glucose ($C_6H_{12}O_6$)?

5. The chemical reaction for the decomposition of potassium chlorate ($KClO_3$) is shown below



What mass of potassium chlorate would produce 0.2 moles of oxygen gas?

6. Butane burns in air according to the equation

$$C_4H_{10} + 6^1/_2\, O_2 \text{ ----> } 4CO_2 + 5H_2O$$

What mass of carbon dioxide will be produced when butane burns in 25g of oxygen?

7. What mass of bromine is required to produce 50g of phosphorous bromide?

$$2P + 3Br_2 \text{ ---> } 2PBr_3$$

8. Aluminium reacts with sulfuric acid according to the equation

$$2Al + 3H_2SO_4 \text{ ----> } (Al)_2(SO_4)_3 + 3H_2$$

What mass of aluminium would produce 0.75 moles of hydrogen?