Nat 5: Unit 1 Chemical Changes and Structure

Key Area: Formulae and Reacting Quantities

Lesson 18: Calculations Using the Mole and Balanced Equations

Learning Outcomes

By the end of the lesson you should …

1. Recognise that mathematical skills will be helpful in Chemistry.
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.
2. Understand how to calculate mass of substance required or produced in a chemical reaction.

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 **lesson 17**

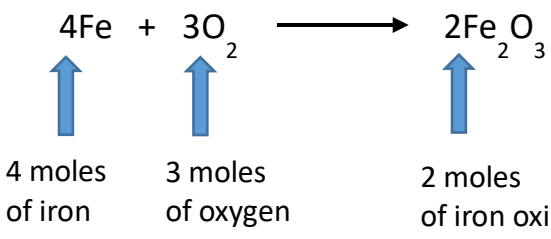
You may wish to have a copy of the data booklet handy for this lesson.
Download from the SQA website - ChemistryDataBookletSQPN5.pdf (sqa.org.uk)

Information from Balanced Equations

You will have seen and balanced many chemical equations by placing numbers into the equations. However you probably haven't thought what the numbers tell you?

The numbers are actually the number of moles of each substance.

e.g.



The above are known as mole ratios, from the equation we can see that:

4 moles of Iron will **react** with 3 moles of Oxygen to **produce** 2 moles of Iron oxide

A balanced equation will always tell you:

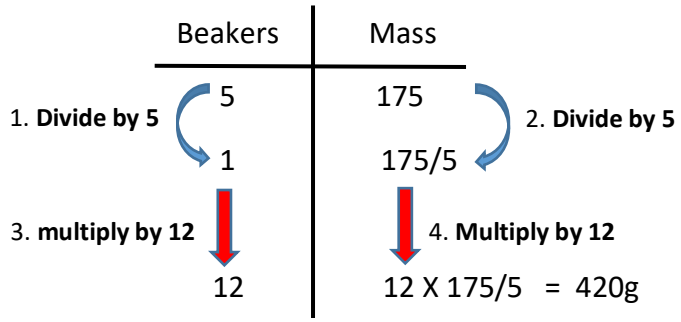
a. The number of moles of reactants required, (which we now know how to convert to mass).
b. The number of moles of product produced, (which we now know how to convert to mass).

Calculations Using Balanced Equations

This lesson will involve you using your maths skills that you have learned with regards to simple proportion.

Example

If 5 beakers weigh 175g, what will be the mass of 12 beakers?



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

You are now going to use your proportion skills together with your mole triangle knowledge to calculate mass of a reactant required or product produced in a chemical reaction.

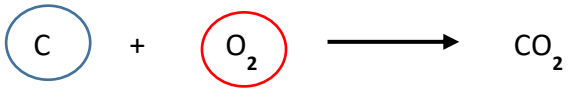
It is important to try and master these calculations as they are used in Nat5, Higher and Advanced Higher applying the same set of rules.

The following steps should be learned and followed when attempting the various types of calculation that you are going to attempt.

Rules

1. Read question carefully and underline/circle the **2 chemicals** involved in the calculation.
2. Create a calculation table with the 2 chemicals as headings. (Note: the chemical the question is about goes on the **right hand side** of the table)
3. Write down **mole ratios** of the 2 chemicals exactly from the balanced equation.
4. If the question uses mass then **convert the number of moles to mass**.
5. Use **simple proportion** to complete the calculation.

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

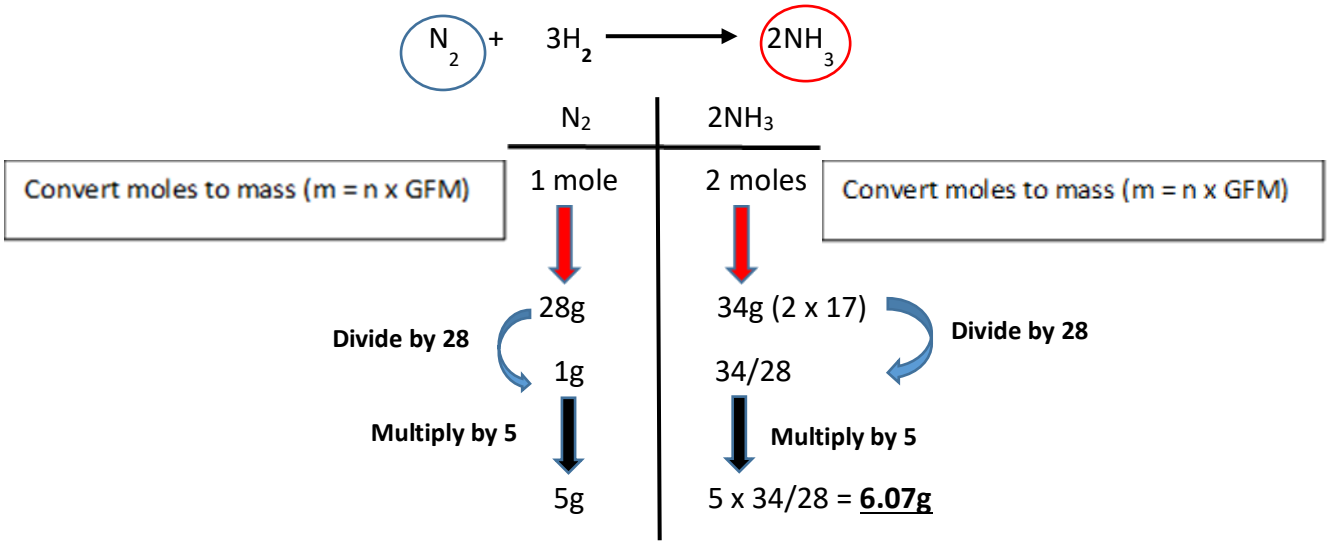


Have been asked about O_2, therefore goes on the right hand side of table

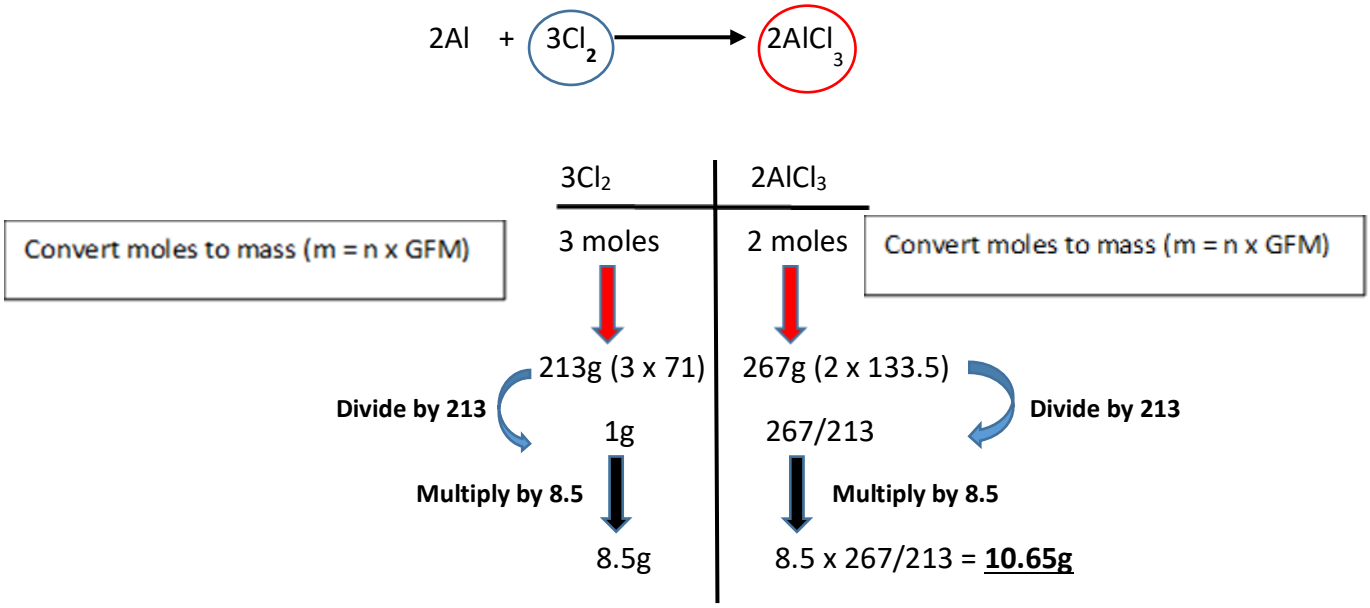
	C	O_2	
Convert moles to mass (m = n x GFM)	1 mole	1 mole	Convert moles to mass (m = n x GFM)
	12g	32g	
Divide by 12	1g	32/12	Divide by 12
Multiply by 2.4	2.4g	2.4 x 32/12 = **6.4g**	Multiply by 2.4

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

Example 2 What mass of **nitrogen hydride** is produced when 5 g of **nitrogen** reacts with excess hydrogen?



Example 3 What mass of **aluminium chloride** would be produced from 8.5g of **chlorine**?



Try the next 2 examples on into your jotter. (you don't have to show all the arrows and explanations) However make sure you follow each step very carefully. This is the hardest type of calculation you have come across so far in Nat 5, so take your time with you notes in front of you. You can check your answers and working at the end of this document.

Example 4 What mass of hydrogen would be produced when 0.49g of zinc reacted with sulphuric acid?

$$Zn + H_2SO_4 \text{ ----> } ZnSO_4 + H_2$$

Example 5 What mass of magnesium oxide would be produced when 15.5g of magnesium reacts with excess carbon dioxide?

$$2Mg + CO_2 \text{ ----> } 2MgO + C$$

Practice Makes Perfect

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

Self Check 14

1. What mass of oxygen is needed to react with 34g of carbon given that the equation for the reaction is

$$C + O_2 \text{ ---> } CO_2$$

2. Magnesium reacts with carbon dioxide according to the equation

$$2Mg + CO_2 \text{ ----> } 2MgO + C$$

What mass of magnesium oxide would be produced from 50g of magnesium?

3. Aluminium reacts with sulfuric acid according to the equation

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

What mass of hydrogen would be produced when 25g of aluminium reacted with excess sulfuric acid?

4. Methane burns in oxygen according to the equation

$$CH_4 + 2O_2 \text{ ----------> } CO_2 + 2H_2O$$

What mass of oxygen will be needed to react with 4g of methane?

5. Magnesium reacts with copper (II) sulphate solution according to the equation

$$Mg + CuSO_4 \text{ ----------> } MgSO_4 + Cu$$

What mass of copper (II) sulphate will react with 10g of magnesium?

6. When magnesium carbonate is heated strongly it decomposes to produce magnesium oxide and carbon dioxide according to the following equation:

$$MgCO_3 \text{ ----> } MgO + CO_2$$

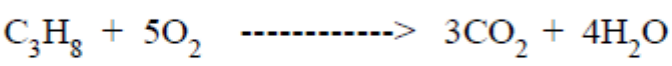
What mass of carbon dioxide will be produced from 8·45g of magnesium carbonate.

7. When hydrogen is burned in air it burns to form water according to the equation:

$$H_2 + 1/2\ O_2 \text{ ----> } H_2O$$

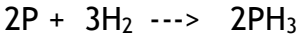
What mass of water will be produced when 68g of oxygen reacts?

8. Propane burns in excess oxygen according to the equation

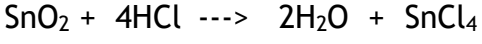


What mass of oxygen will be needed to react with 26.4 g of propane?

9. What mass of phosphorous hydride will be produced when 40g of hydrogen reacts with excess phosphorous?



10. What mass of water will be produced when 95g of hydrochloric acid reacts with excess tin oxide?



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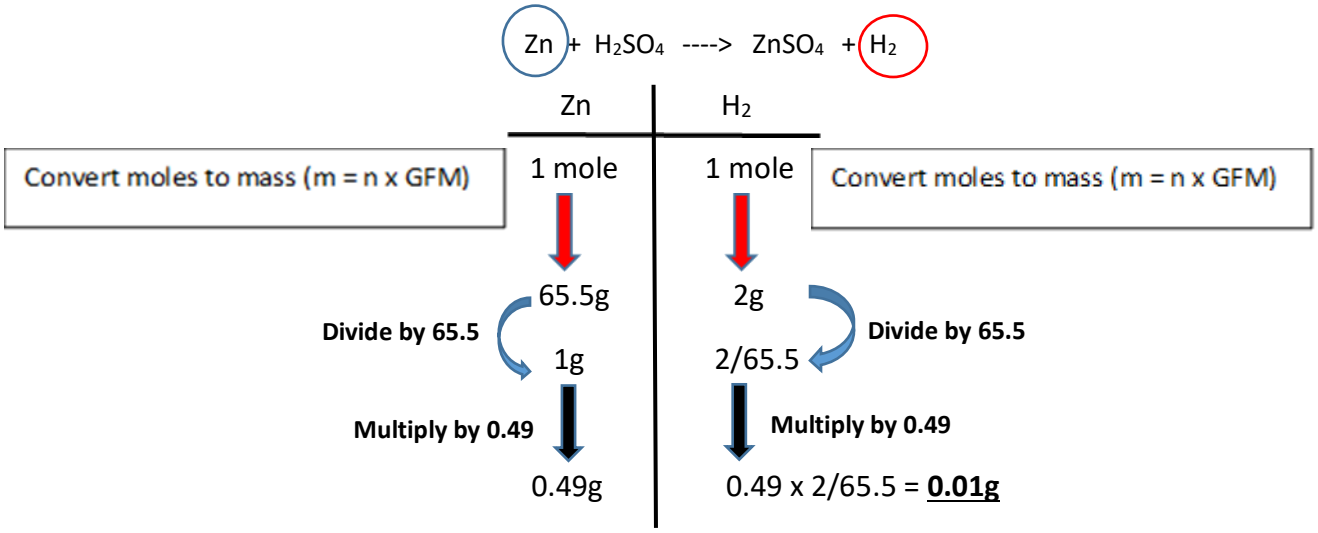

Example 5 What mass of magnesium oxide would be produced when 15.5g of magnesium reacts with excess carbon dioxide?