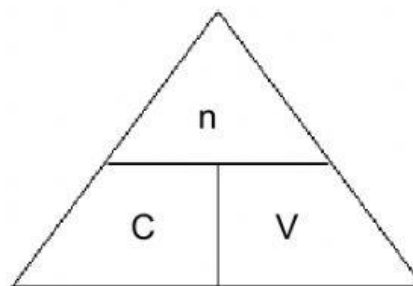
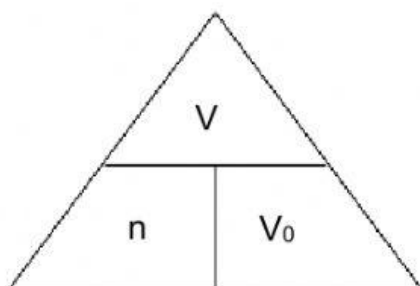
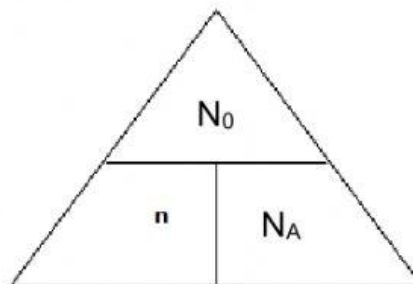
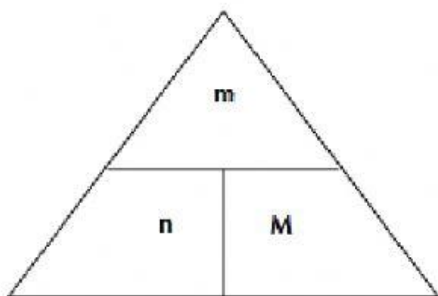


Mole – Part 6

We have now learnt all 4 formulae that we will make use of for mole calculations. These can be represented by the 4 triangles which you should have written into your notes:



(**These formulae will be given in the data sheet in an exam, but the triangles will not.)

We are now going to learn how to use these calculations in chemical reactions. You will need to be confident in balancing equations for this section!

Stoichiometry:

- A chemical equation is a chemical balance sheet for a chemical reaction
- The relationship of how the substances react (ratios) is known as **stoichiometry**
- The numbers in front of the substances are known as the **stoichiometric coefficients**
- These give the proportions in which the substances react and the proportions of products formed

Stoichiometry is the calculation of relative quantities of reactants and products in chemical reactions.

➤ **Start with balanced equations**

Balance the following equation (use a 1 if no other number is required):



➤ **Coefficients of equation give you the mole ratio**

So **1 mole CaCO_3** will react with **2 moles HCl** to produce **1 mole of CaCl_2** , **1 mole of CO_2** and **1 mole of H_2O** . We call this the **mole ratio** because it is the ratio in which the substances will always react with each other.

We can never work with MASS ratios because the masses of reactants do not combine in fixed ratios due to the different molar mass of each substance. We must ALWAYS convert to moles before working with these ratios.

Mole ratio calculations:



This means that the ratio is:

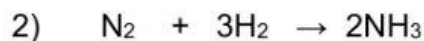
2 moles of H_2 will react with 1 mole of O_2 to produce 2 moles of H_2O

20 moles of H_2 will react with 10 moles of O_2 to produce 20 moles of H_2O

40 moles H_2 will react with 20 moles O_2 to produce 40 moles of H_2O

_____ moles of H_2 + 3 moles of $\text{O}_2 \rightarrow$ 6 moles of H_2O

8 moles of H_2 + _____ moles of $\text{O}_2 \rightarrow$ 8 moles of H_2O



1 mole of N_2 will react with 3 moles of H_2 to form 2 moles of NH_3

4 moles of N_2 + _____ moles of H_2 $\rightarrow$ _____ moles of NH_3

Exercise on mole ratio:

Use simple ratios to calculate the number of moles that will react in the following reactions.



8 moles + _____ moles $\rightarrow$ _____ moles



3 moles + _____ moles $\rightarrow$ _____ moles + 4,5 moles

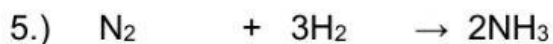
Hint: 2
decimal
places



8 moles + _____ moles $\rightarrow$ 8 moles + _____ moles



6 moles + 12 moles $\rightarrow$ _____ moles

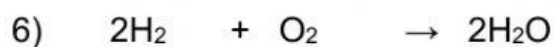


2 moles + _____ moles $\rightarrow$ _____ moles

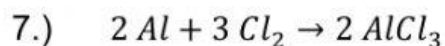
Now express this as mass NH_3 produced:

$$m(\text{NH}_3) = n \times M = \quad \text{g NH}_3$$

(using the mass/mole triangle)



_____ moles + 3 moles $\rightarrow$ _____ mol = **g**



108 g Al + chlorine $\rightarrow$ _____ g



$n(\text{Al}) = m/M = 108 / 27 = 4 \text{ mol}$

$n(\text{AlCl}_3) = n(\text{Al}) \div 2 \times 2 = 4 \text{ mol}$

$m(\text{AlCl}_3) = n \times M = 4 \times \quad = \quad \text{g}$



(you need to convert mass of Al to moles, work out the moles of AlCl_3 and then mass of AlCl_3 .)



Excess of H_2 + 16g of $\text{O}_2 \rightarrow$ _____ g of H_2O

We will follow this format every time we do a mole ratio problem:

- Balance the equation
- Coefficients of equation give you the mole ratio
- Calculate the molar mass of the reactants
- Calculate the number of moles of the given substance
- Apply the mole ratio to determine no. of moles of substance you are looking for
- Convert back to grams or volume as required

We set the calculations out in a table format – see the example below. Check each step in the procedure above and see how it ties in to the calculations in the table.

Example 1:

Calculate the mass of oxygen obtained when 29,4g potassium chlorate decomposes completely to potassium chloride:

We don't do any calculations for KCl because it was not part of the question.

	KClO_3	$\rightarrow$	KCl	$+$	O_2	
GIVEN:						
<u>Mole ratio:</u>	2		2		3	(from the balancing)
<u>Mass:</u>	29,4g					
<u>Molar mass:</u>	122,5 g.mol ⁻¹				32 g.mol ⁻¹	
<u>No. of moles:</u>	$n = m/M$					
	=	/				
	=	mol				
PRODUCE:						
<u>No. of moles:</u>					0,24 mol $\div 2 \times 3 =$	0,36 mol
<u>Mass:</u>					$m = n \times M$	
					$= 0,36 \times 32$	
					=	g

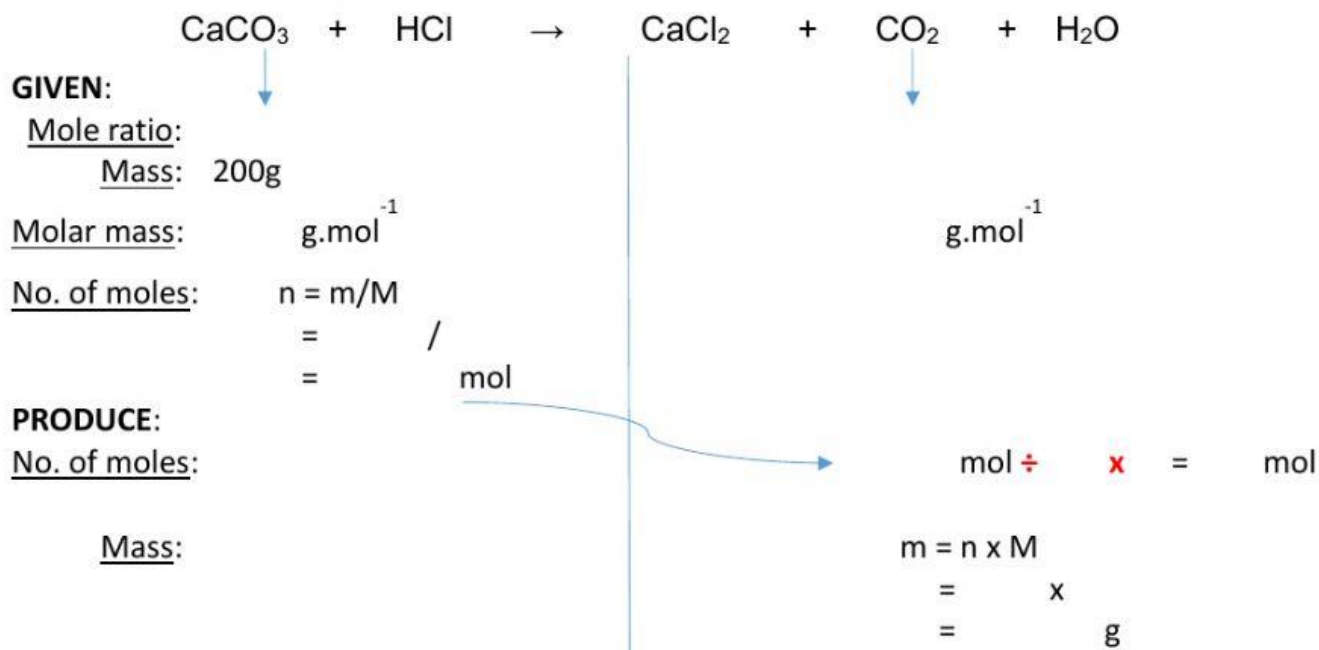
This part of the calculation is where we use the mole ratio from the balanced equation to change the number of moles reactant into the number of moles product. The values come from the coefficient in the balanced equation. Take the no. of moles of reactant, $\div$ coefficient of reactant and $\times$ coefficient of product. So $\div$ by the one you know and $\times$ by the one you are calculating.

Your answer!

Example 2:

A sample of limestone (CaCO_3) of mass 200g is treated with excess dilute hydrochloric acid (HCl). Calculate what mass of carbon dioxide should be formed.

(Step 1: Balance the equation)



Example 3:

A sample of impure limestone (CaCO_3) of mass 200g is treated with excess dilute hydrochloric acid (HCl). Calculate what volume of carbon dioxide should be formed.



GIVEN:

Mole ratio: 1

Mass: 200 g

Molar mass: 100 g.mol⁻¹

No. of moles: n = 2 mol

1

44 g.mol⁻¹

PRODUCE:

No. of moles:

mol ÷ x = mol

Volume:

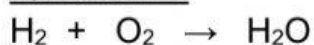
$$\begin{aligned} V &= n \times V_0 \\ &= \quad \times \\ &= \quad \text{dm}^3 \end{aligned}$$

Mole/mass ratio exercises:

Use the tabular method shown above to do the following calculations in your notebooks. (These exercises are from your printed notes.)

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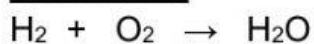
Question 7



7.1 How many moles of H₂O are formed when 5 moles of O₂ react with excess H₂

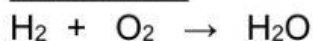
7.2 What mass of H₂O is formed when 5 moles of O₂ react with excess H₂

Question 8



8.1 What mass of H₂ is needed to react with 64g of O₂

Question 9



9.1 What volume of O_2 at STP is required to react with $11,2\text{dm}^3$ of H_2

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1. Consider the following reaction: $\text{N}_2 + 3 \text{H}_2 \rightarrow 2 \text{NH}_3$.
Determine the number of moles of ammonia which form when 2 moles of nitrogen react with sufficient hydrogen.
2. Potassium chlorate, KClO_3 , is heated to produce potassium chloride and oxygen.
Here is the unbalanced equation: $\text{KClO}_3 \rightarrow \text{KCl} + \text{O}_2$
What mass of KClO_3 should be heated to produce 24,0 g of oxygen?
3. Calculate the mass of SO_2 formed when 2,4 kg of sulphur are burned completely in oxygen.
Here is the chemical equation: $\text{S} + \text{O}_2 \rightarrow \text{SO}_2$
4. If 160 g of SO_2 reacts with sufficient O_2 , how much SO_3 will be formed?
Here is the unbalanced equation: $\text{SO}_2 + \text{O}_2 \rightarrow \text{SO}_3$

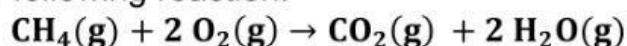
Mole/No of particles ratio exercises (pg 147)

1. Consider the following reaction: $\text{N}_2 + 3 \text{H}_2 \rightarrow 2 \text{NH}_3$.
 - a. Determine the number of moles of ammonia which form when 8 moles of nitrogen react with sufficient hydrogen.
 - b. Determine the number of moles of ammonia that are formed when $1,6 \times 10^{24}$ molecules of hydrogen react with sufficient oxygen.
2. Potassium chlorate, KClO_3 , is heated to produce potassium chloride and oxygen.

Here is the chemical equation: $KClO_3 \rightarrow KCl + O_2$

Calculate the number of molecules of oxygen produced, if 5 moles of $KClO_3$ decompose to form potassium chloride and oxygen.

Eg1 Consider the following reaction:

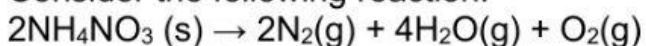


Calculate the number of molecules of water produced when 0,5 dm³ of methane is burned in O_2

Mole/Volume ratio exercise

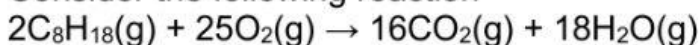
Pg 132

7.6) Consider the following reaction:



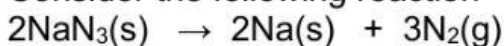
If 3 moles of NH_4NO_3 decomposes, calculate the volume of O_2 that forms at STP.

7.7) Consider the following reaction



If 342,54 g of C_8H_{18} combusts, calculate the mass of CO_2 that forms

7.8) Consider the following reaction



If 5,5 moles of NaN_3 decomposes, then calculate the mass of Na that forms