

# AQA Chemistry GCSE

## Topic 3: Quantitative Chemistry

### Flashcards

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# What is the law of conservation of mass?



# What is the law of conservation of mass?

The law of conservation of mass states that no atoms are lost or made during a chemical reaction so the mass of the products equals the mass of the reactants.



Write a balanced equation  
of magnesium reacting with  
hydrochloric acid.



Write a balanced equation of magnesium reacting with hydrochloric acid.



# Define relative atomic mass and relative formula mass.



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RAM - average mass of atoms in an element taking into account masses and abundance of its isotopes, relative to  $^{12}\text{C}$ .

RFM - sum of RAM's of all atoms in the formula.



# What is the relative formula mass of:





## What is the relative formula mass of:

$\text{CaF}_2$  - ( $A_r$  values: Ca = 40, F = 19)

$$40 + 19 + 19 = 78$$

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$\text{C}_2\text{H}_{12}\text{O}_6$  - ( $A_r$  values: C = 12, H = 1, O = 16)

$$(12 \times 6) + (1 \times 12) + (16 \times 6) = 180$$



The following reaction occurs in a test tube under a Bunsen Burner:



The carbon dioxide and water escape from the test tube.

Use the equation to explain why.



Use equation to explain why carbon dioxide and water escape from the test tube.

They are both gases



The experiment was repeated three times. Calculate the mean mass of magnesium produced and suggest how you could increase the precision of the results.

	Experiment		
	1	2	3
Mass of magnesium oxide used in g	4.0	4.0	4.0
Mass of magnesium produced in g	3.3	3.5	3.2



Calculate the mean of magnesium produced and suggest how you could increase the precision of the results

$$(3.3 + 3.5 + 3.2) / 3 = 3.3$$

Measure to more decimal places **or** use a more sensitive balance / apparatus



# What is Avogadro's constant?

Higher tier only



# What is Avogadro's constant?

The number of atoms, molecules or ions in a mole of a given substance.  
The value of the constant is  $6.02 \times 10^{23}$ .

**Higher tier only**



What is the formula that links mass, molecular mass and moles together

Higher tier only





What is the formula that links mass, molecular mass and moles together

$$\text{Mass} = M_r \times \text{Moles}$$

Higher tier only



What is the mass of:  
20 moles of calcium  
carbonate,  $\text{CaCO}_3$

Higher tier only



What is the mass of 20 moles of calcium carbonate,  $\text{CaCO}_3$

Mass = Mr x Moles

Mr = 100

$100 \times 20 = 2000 \text{ g}$

Higher tier only



Calculate the amount of carbon dioxide in moles in 0.32 g of carbon dioxide.

Relative atomic masses ( $A_r$ ): carbon = 12, oxygen = 16

Higher tier only



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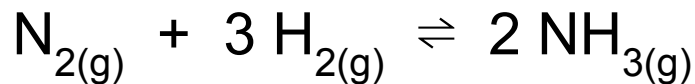
Moles = Mass / Mr

$$0.32 / 44 = \mathbf{0.007}$$

Higher tier only



Nitrogen and hydrogen form ammonia shown by the following equation:



Calculate the mass of nitrogen needed to form 6.8 tonnes of ammonia.

Relative atomic masses ( $A_r$ ): H = 1; N = 14

Higher tier only



Calculate the mass of nitrogen needed to form 6.8 tonnes of ammonia

Step 1 - Work out the number of number of moles of ammonia (Mr of ammonia = 17)

$$6800000 / 17 = 400000 \text{ moles of ammonia}$$

Step 2 - Use the balanced equation and number of moles of ammonia to work out the number of moles of nitrogen

The ratio of nitrogen to ammonia is 1:2

Therefore the number of moles of nitrogen is  $400000/2 = 200000$

Step 3 - Work out the mass of nitrogen (Mr of  $N_2$  is 28)

$$200000 \times 28 = 5600000 \text{ g} = 5.6 \text{ tonnes.}$$

**Higher tier only**



State what we mean by a limiting reactant in a chemical reaction

Higher tier only





## State what we mean by a limiting reactant in a chemical reaction

In a chemical reaction involving two reactants, it is common to use an excess of one of the reactants to ensure that all of the other reactant is used. The reactant that is completely used up is called the limiting reactant because it limits the amount of products.

Higher tier only



Hydrogen peroxide decomposes in water to form water and oxygen. How many grams of oxygen gas will be given off from 40.8 g of hydrogen peroxide?

Higher tier only



## How much oxygen will be given off from 40.8 g of hydrogen peroxide?

Step 1: Write the balanced equation  $2 \text{H}_2\text{O}_{2(l)} \rightarrow 2 \text{H}_2\text{O} + \text{O}_{2(g)}$  Mr of  $\text{H}_2\text{O}_2 = 34$

Step 2: Number of moles in 40.8 g :  $40.8/34 = 1.2$  moles

Ratio in the balanced equation of  $\text{H}_2\text{O}_2 : \text{O}_2 = 2:1$

Step 3 :Therefore number of moles of  $\text{O}_2 = 0.6$  moles

Step 4: Mass of oxygen =  $0.6 \times 32$  (Mr of  $\text{O}_2$ ) = **19.2**

**Higher tier only**



Write down the two formulae that link concentration, mass and volume together.



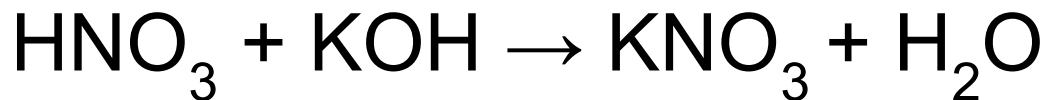
Write down the two formulae that link concentration, mole/mass and volume together.

$$\text{Concentration (g per dm}^3\text{)} = \text{Mass (g)}/\text{Volume (dm}^3\text{)}$$

$$\text{Concentration (mol per dm}^3\text{)} = \text{nr of moles}/\text{volume (dm}^3\text{)}$$



31.0 cm<sup>3</sup> of potassium hydroxide solution neutralised 25.0 cm<sup>3</sup> of 2.0 mol dm<sup>-3</sup> nitric acid.



Calculate the concentration of the potassium hydroxide solution in mol dm<sup>-3</sup>

Higher tier only



# Calculate the concentration of the potassium hydroxide solution in $\text{mol dm}^{-3}$

Step 1: Calculate the moles of  $\text{HNO}_3$  used = Concentration x volume

$$2 \times 0.025 \text{ dm}^3 \text{ (25/1000 to convert the units)} = 0.05 \text{ moles}$$

Step 2 : Calculate the moles of KOH

Ratio is 1:1 therefore number of moles of KOH = 0.05

Step 3 : Calculate the concentration of KOH

$$\text{Volume} = \text{Moles/concentration}; 0.05 / 0.031 = 1.61$$

**Higher tier only**



What is the molar volume of a gas  
at room temperature and  
pressure?





# What is the molar volume of a gas at room temperature and pressure?

1 mole of a gas at room temperature and pressure occupies  $24 \text{ dm}^3$



# What is titration?



# What is titration?

A technique for finding the concentration of a solution by reacting a known volume of this solution with a solution of known concentration.



# How do you conduct a titration?



# How do you conduct a titration?

- a) Rinse the pipette with a solution of unknown concentration. Use the pipette to measure out the known volume of this solution.
- b) Add an indicator (a substance that changes colour at the end of titration)
- c) Rinse the burette with a solution of known concentration. Discard the liquid. Use a burette to gradually add the solution of a known concentration.
- d) When indicator changes colour (at the end point), the volume added is recorded
- e) It is important to get concordant volume results - they have to lie close to each other
- f) Suitable calculations are performed to find the concentration.



Why is it not always possible to obtain the theoretical amount of product in a chemical reaction?



Why is it not always possible to obtain the theoretical amount of product in a chemical reaction?

- The reaction may not go to completion because it is reversible.
- Some of the product may be lost when it is separated from the reaction mixture.
- Some of the reactants may react in ways different to the expected reaction (side reactions may occur).



How is the percentage yield of a product in a chemical reaction?





How is the percentage yield of a product in a chemical reaction?

$$\% \text{ Yield} = \frac{\text{Actual mass of a product}}{\text{Maximum theoretical mass of product}} \times 100\%$$



# Calculate the percentage yield from the following data

Actual Yield (g)	Predicted Yield (g)	Percentage Yield (%)
45	100	
12	50	
8	40	



Calculate the percentage yield from the following data:

Actual Yield (g)	Predicted Yield (g)	Percentage Yield (%)
45	100	45
12	50	24
8	40	20



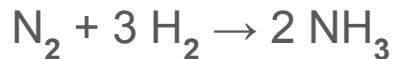
What is the % yield of  $\text{NH}_3$  if 40.5 g  $\text{NH}_3$  is produced from 20.0 mol  $\text{H}_2$  and excess  $\text{N}_2$ ?

Higher tier only



What is the % yield of  $\text{NH}_3$  if 40.5 g  $\text{NH}_3$  is produced from 20.0 mol  $\text{H}_2$  and excess  $\text{N}_2$ ?

Step 1 - Write the balanced equation



Step 2 - Calculate the theoretical amount of  $\text{NH}_3$ . Moles  $\text{NH}_3$  (ratio of  $\text{H}_2$  to  $\text{NH}_3$  is 3:2);  
of  $20/1.5 = 13.3$  moles

$$13.3 \times 17 \text{ (Mr of } \text{NH}_3) = 227$$

Step 3 - Calculate percentage yield of  $\text{NH}_3$

$$40.5/227 \times 100 = 17.8\%$$

**Higher tier only**



# What is atom economy?



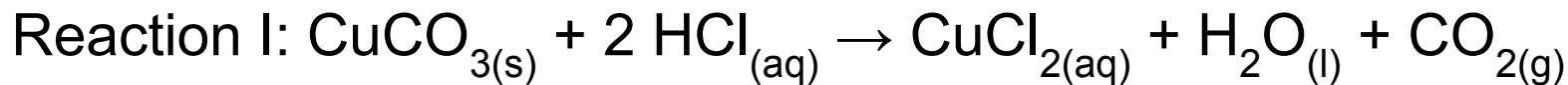
# What is atom economy?

A measure of the amount of starting materials that end up as useful products.

It is a ratio of the relative formula mass of desired product to the sum of relative formula masses of reactants.



Look at the equations for the two reactions that produce  $\text{CuCl}_2$



Reactive formula masses:  $\text{CuO} = 79.5$ ;  $\text{HCl} = 36.5$ ;  $\text{CuCl}_2 = 134.5$ ;  
 $\text{H}_2\text{O} = 18$

Which reaction has a better atom economy?





# Which reaction has a better atom economy?

Reaction II (look at the reactants):

Total formula mass of reactants = 152.5

Formula mass of  $\text{CuCl}_2$  = 134.5

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$$(134.5/152.5) \times 100\% = \mathbf{88.2\%}$$

