Moles, calculations in gaseous and solution and acids and bases

Moles and calculations

Objectives

All

Define relative molecular mass and relative formula mass

Most

Describe Avogadro's constant and the terms moles and molar mass

Some

Explain how to use moles and molar mass in calculations

Relative molecular mass (M_r)

When we are referring to a compound we add up the relative atomic masses to give the relative molecular mass, M_r.

Definition: M_r is the mass of a molecule of a particular compound, relative to 1/12 the mass of an atom of carbon 12

Worked example

$H_2O = (2x1) + 16 = 18$

$CH_4 = 12 + (4x1) = 16$

Where crystals are concerned the M_r may also include water of crystallisation.

Calculating M_r

Calculate the M_r of;

1. $CuSO_4$
2. $PbNO_3$
3. $Na_2CO_3.10H_2O$

Relative formula mass

Ionic compounds consist of metal and non-metal ions rather than molecules

e.g. NaCl is made up of Na^+ and Cl^- ions in a lattice.

It would not be correct to use the term relative molecular mass as an NaCl molecule does not exist.

To be absolutely correct we use **relative formula mass** for ionic compounds. (Although in practice Mr is often used for ionic compounds as well).

Relative formula mass

Calculate the relative formula mass of;

- $MgCl_2$
- KBr
- $CaCl_2$
- NaF
- Fe_2O_3
- Na_2O

The Mole

- 1 mole is the amount of substance which contains as many particles as there are atoms in exactly 12 grams of ^{12}C.
- **This value is 6.022×10^{23} particles.**
- For an element it is the **A_r in grams**
- For a compound it is the **M_r in grams**

Molar Mass

This is defined as **the mass of 1 mole of a substance**. It has the units **$gmol^{-1}$**.

When the number of moles equals 1 then this number is also equal to;

- Relative atomic mass (A_r) **or**
- Relative molecular mass (M_r).

Molar mass example

Water molecules have M_r = 18.

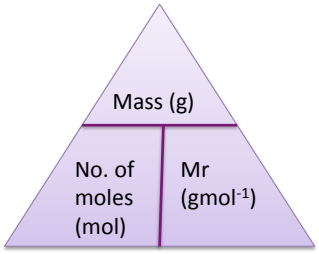
therefore 1 mole of water has a mass of 18 grams.

The molar mass of water = 18 $gmol^{-1}$

Calculating number of moles

Number of moles (mol) = $\frac{\text{mass (g)}}{\text{molar mass } (gmol^{-1})}$

This equation can be rearranged to calculate mass or molar mass as well as number of moles.



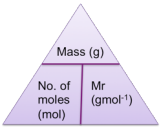
Worked Example

- How many moles of Ca are there in 120g of Ca?

A_r Ca = 40, therefore molar mass Ca = 40 $gmol^{-1}$

number of moles = $\frac{120}{40}$

= 3.0 mol



(c) In the sixteenth century, a large deposit of graphite was discovered in the Lake District.

People at the time thought that the graphite was a form of lead.

Nowadays, graphite is used in pencils but it is still referred to as 'pencil lead'.

A student decided to investigate the number of carbon atoms in a 'pencil lead'. He found that the mass of the 'pencil lead' was 0.321 g.

(i) Calculate the amount, in mol, of carbon atoms in the student's pencil lead.

Assume that the 'pencil lead' is pure graphite.

answer = ... mol **[1]**

(ii) Using the Avogadro constant, N_A, calculate the number of carbon atoms in the student's 'pencil lead'.

number of carbon atoms = ... **[1]**

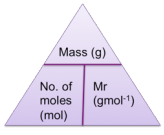
Mark scheme

c	i	0.0268 **OR** 0.027 **OR** 0.02675 mol ✓	1	**NO OTHER ACCEPTABLE ANSWER**
	ii	1.61×10^{22} ✓	1	**ALLOW** 1.6×10^{22} up to calculator value **ALLOW** **ECF** answer to **(i)** × 6.02×10^{23} **ALLOW** any value for N_A in the range: $6.0 \times 10^{23} - 6.1 \times 10^{23}$

AfL – using whiteboards

Calculate the **amount in moles** in the following;

1. 32.1 grams of sulfur atoms
2. 50.0 grams of $CaCO_3$
3. 6.35 grams of copper atoms
4. 400 grams of NaOH
5. 69g of Pb
6. 5.30g of Na_2CO_3



Calculating masses

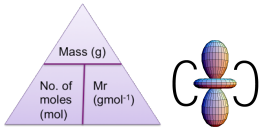
Worked example

What mass of NaCl contains 10 moles of NaCl particles?

M_r NaCl = 23 + 35.5 = 58.5 $gmol^{-1}$

Mass = moles x M_r

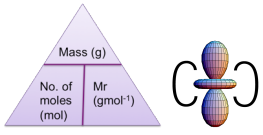
Mass = 10 x 58.5 = 585 grams



AfL – using whiteboards

Calculate the mass of

1. 0.013 moles of Cl_2
2. 2.00 moles of SO_3
3. 0.25 moles S_8
4. 0.15 moles of $MgSO_4.7H_2O$



Past paper question

(b) A student knew that calcium hydroxide could be made by adding calcium to water.

The student added 0.00131 mol of calcium to a beaker containing about 100 cm^3 of water.
A reaction took place as shown by the equation below.
All the calcium hydroxide formed was soluble.

$$Ca(s) + 2H_2O(l) \rightarrow Ca(OH)_2(aq) + H_2(g)$$

(i) Calculate the mass of calcium that the student added.

mass of calcium = ... g **[1]**

Mark scheme

(b)	**(i)**	0.00131 × 40.1 = 0.0525 g **OR** 5.25 × 10^{-2} ✓	1	**ALLOW** 0.053 **OR** 0.05253 **OR** 0.052531 g **IGNORE** 0.05 **if correct answer seen in working** **DO NOT ALLOW** 0.052 **OR** 0.0524

(c) Epsom salts can be used as bath salts to help relieve aches and pains.

Epsom salts are crystals of hydrated magnesium sulfate, $MgSO_4 \bullet xH_2O$.

A sample of Epsom salts was heated to remove the water. 1.57 g of water was removed leaving behind 1.51 g of anhydrous $MgSO_4$.

(i) Calculate the amount, in mol, of anhydrous $MgSO_4$ formed.

amount = ... mol **[2]**

(ii) Calculate the amount, in mol, of H_2O removed.

amount = ... mol **[1]**

(iii) Calculate the value of ***x*** in $MgSO_4 \bullet xH_2O$.

x = ... **[1]**

Mark scheme

(c)	(i)	$M(MgSO_4)$ = 120.4 OR 120 (g mol^{-1}) ✓ mol $MgSO_4$ = $\frac{1.51}{120.4}$ = *0.0125 mol* ✓	2	**ALLOW** 0.013 up to calculator value of 0.012541528 correctly rounded (from M = 120.4 g mol^{-1}) **ALLOW** 0.013 up to calculator value of 0.012583333 correctly rounded (from M = 120 g mol^{-1}) **ALLOW** ecf from incorrect M i.e. 1.51 ÷ M
	(ii)	$\frac{1.57}{18.0}$ = 0.0872(2) (mol) ✓	1	**ALLOW** 0.09 up to calculator value of 0.08722222
	(iii)	***x*** = 7 ✓	1	**ALLOW** ecf i.e. answer to (ii) ÷ answer to (i) **ALLOW** correctly calculated answer from 1 significant figure up to calculator value, ie, ***x*** does not have to be a whole number. Likely response = 6.95 ✓

Concentrations and solutions

Objectives

Must

Recall the molar volume of gases at STP and RTP

Should

Carry out calculations involving gas volumes, concentrations of solutions, volumes of solution and moles

Could

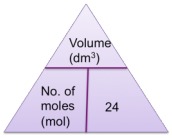
Apply these calculations to titrations

Starter

Draw all arrangements of the formulae below;

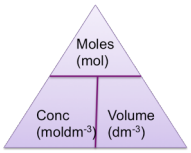
Gas phase

Number of moles = $\frac{\text{volume (in dm}^3\text{)}}{24}$



Liquid phase

Moles = concentration x volume



Theory – moles of gas

Molar volume – This is the volume per mole of gas molecules.

When quoting the molar volume it is important to **give the temperature** as this effects the volume the gas occupies.

At Standard Temperature (273K) and Pressure (STP) this value is **22.4 dm³**

At Room Temperature (298K) and Pressure (RTP) this value is **24 dm³**

What is 24 dm^3?

- This is about the size of a beach ball
- It is interesting that the molar volume is the same for every gas.

1 MOLE HYDROGEN

1 MOLE NITROGEN

1 MOLE OXYGEN

Questions – finding moles

Use the formula from the starter to find the number of moles of molecules in the following gaseous volumes;

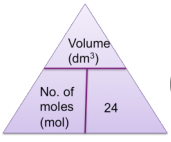
a) 240 cm^3 of Helium

b) 480 cm^3 of carbon dioxide CO_2

c) 480 dm^3 of sulfur dioxide SO_2

d) 1200 cm^3 of methane CH_4

e) 1.2 cm^3 of propane C_3H_8



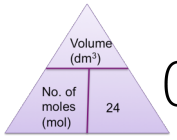
Answers

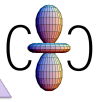
a) Moles = (240/1000)/24 = 0.010 mol
b) 0.020 mol
c) 20 mol
d) 0.050 mol
e) 0.000050 mol **or** 5.0 x 10^{-5} mol

Questions – finding volumes

What is the volume occupied by each of the following gases;

a) 4.0g of hydrogen molecules H_2
b) 3.2g of methane CH_4
c) 0.00048g of ozone O_3
d) 17.6kg of carbon dioxide CO_2
e) 6.8 tonnes of ammonia NH_3





Answers

Moles = $\frac{\text{mass}}{\text{Mr}}$ moles = $\frac{\text{volume}}{\text{24 (RTP)}}$

a) Moles of H_2 molecules = 4.0g/2 = 2 mol
volume = moles x 24 = 2 x 24 = **48 dm^3**

b) 4.8 dm^3

c) 0.24 cm^3

d) 9600 dm^3

e) 9,600,000 dm^3

AfL

1. Find the number of moles of molecules in 96 cm^3 of uranium (VI) fluoride. Show your working
2. What is the volume occupied by 4.0g of Argon atoms

Answers

1. 0.0040 mol
2. 2.4 dm^3

Group 2 elements and compounds show periodic trends. One trend is shown by the effect of heat upon Group 2 carbonates.

A student carried out an experiment to find out the volume of carbon dioxide obtained by heating a weighed sample of magnesium carbonate.

The student placed a 1.47 g sample of $MgCO_3$ into a test-tube and heated it until there was no further change in mass.

The following reaction took place.

$$MgCO_3(s) \longrightarrow MgO(s) + CO_2(g)$$

(i) What type of reaction is this?

..... **[1]**

(ii) What volume of CO_2, in dm^3, would have been given off when measured at room temperature and pressure?

The molar mass of $MgCO_3$ = 84.3 g mol^{-1}

answer = ...dm^3 **[2]**

Mark scheme

i	**Thermal** decomposition ✓	1	**DO NOT ALLOW** just 'decomposition' or 'thermodecomposition'
ii	1.47 = 0.0174 mol of $MgCO_3$ ✓ 84.3 $0.0174 \times 24.0 = 0.418\ dm^3$ **OR** (Calculator value × 24.0) = 0.419 dm^3 ✓	2	**ALLOW** mol of $MgCO_3$ as calculator value of 0.017437722 or correct rounding to 2 sig figs or more **DO NOT ALLOW** 0.0175 (this has taken M_r of $MgCO_3$ as 84) **ALLOW**, for 2nd mark **calculated moles of $MgCO_3$** × 24(.0) as calculator value or correct rounding to 2 sig figs or more [e.g. 0.017 × 24(.0) = 0.408] **DO NOT ALLOW** 84.3 or 1.47 × 24(.0) as no mole calculation has been done **ALLOW** two marks for correct answer with no working shown

A student heats 5.29 g of $Sr(NO_3)_2$ and collects the gas at room temperature and pressure, RTP.

$$2Sr(NO_3)_2(s) \rightarrow 2SrO(s) + 4NO_2(g) + O_2(g)$$

Calculate the volume of gas, in dm^3, obtained by the student at RTP.

Molar mass of $Sr(NO_3)_2 = 211.6\ g\ mol^{-1}$.

answer = ... dm^3 **[3]**

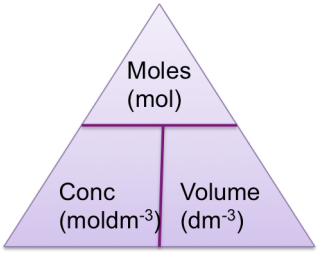
Mark scheme

Calculates correctly: Mol of $Sr(NO_3)_2 = \frac{5.29}{211.6} = 0.0250$ ✓ Calculates correctly: Mol of gas = 5/2 × 0.0250 = 0.0625 ✓ Calculates correctly: Volume of gas = 24.0 × 0.0625 = 1.50 dm^3 ✓	3	**ALLOW** 0.025 **ALLOW** ECF for first answer × 2.5 as calculator value or correct rounding to 2 significant figures or more but ignore trailing zeroes **ALLOW** ECF for second answer × 24(.0) as calculator value or correct rounding to 2 significant figures or more but ignore trailing zeroes **DO NOT ALLOW** ECF of first answer × 24(.0) (which gives 0.6(0) dm^3) as this has not measured the volume of any gas, simply 0.0250 mol of solid $Sr(NO_3)_2$ converted into a gas i.e. This answer would give **one** mark **ALLOW** 1.5 dm^3 **ALLOW** ECF producing correct volume of NO_2 only i.e. 1.2(0) dm^3 would give **two** marks **OR** **ALLOW** ECF producing correct volume of O_2 only i.e. 0.3(0) dm^3 would give **two** marks

Theory – concentration of solutions

When the volume of a solution and the number of moles are known , the concentration can be calculated using the equation;

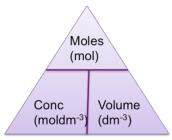
Moles = concentration ($moldm^{-3}$) x volume (dm^3)



Questions

Calculate the number of moles present in each of the following;

a) 25.0 cm^3 of 0.1 $moldm^{-3}$ hydrochloric acid
b) 1.5 dm^3 of 2.5 $moldm^{-3}$ sodium hydroxide
c) 3.0 cm^3 of 2.0 $moldm^{-3}$ sulfuric acid
d) 20.0cm^3 of 0.17 $moldm^{-3}$ barium hydroxide
e) 11.2cm^3 of 0.5 $moldm^{-3}$ sodium carbonate solution



Answers

a) 25.0/1000 x 0.1 mol = 0.0025 mol
b) 3.75 mol
c) 0.006 mol
d) 0.0034 mol
e) 0.0056 mol

Calcium carbonate, $CaCO_3$, reacts with hydrochloric acid as shown in the equation below.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

(a) 7.50×10^{-3} mol $CaCO_3$ reacts with 0.200 mol dm^{-3} HCl.

(i) Calculate the volume, in cm^3, of 0.200 mol dm^{-3} HCl required to react with 7.50×10^{-3} mol $CaCO_3$.

answer = ... cm^3 **[2]**

(ii) Calculate the volume, in cm^3, of CO_2 formed at room temperature and pressure.

answer = ... cm^3 **[1]**

Mark scheme

(a)	**(i)**	mol HCl = 1.50×10^{-2} ✓ volume HCl(aq) = 75.0 ✓	**2**	**ALLOW** answers to 2 significant figures **ALLOW** ecf from wrong number of moles i.e. $\frac{\text{moles of HCl} \times 1000}{0.200}$ **ALLOW** one mark for 37.5 (from incorrect 1:1 ratio)
	(ii)	180 ✓	**1**	No other acceptable answer

2 Sodium tartrate and copper(II) nitrate are both salts.

(a) Sodium tartrate is a salt of tartaric acid. The formula of tartaric acid can be represented as H_xA. In this formula, x is the number of H^+ ions that can be replaced by metal ions to form salts.

A student carries out a titration to find the value of x in the formula of tartaric acid, H_xA.
In the titration, 25.00 cm^3 of 0.0500 mol dm^{-3} tartaric acid, H_xA, exactly reacts with 12.50 cm^3 of 0.200 mol dm^{-3} sodium hydroxide, NaOH. A solution of sodium tartrate is produced.

(i) Calculate the amount, in mol, of H_xA used.

amount = ... mol **[1]**

(ii) Calculate the amount, in mol, of NaOH used.

amount = ... mol **[1]**

(iii) Deduce the value for x in the formula of tartaric acid, H_xA.

x = ... **[1]**

Mark scheme

2	(a)	(i)	mol of H_xA = $\frac{25.00 \times 0.0500}{1000}$ = 1.25×10^{-3} **OR** 0.00125 mol ✓	1	**ALLOW** 0.0013 **OR** 1.3×10^{-3} **ALLOW** correct answer only without working
		(ii)	mol of NaOH = $\frac{12.50 \times 0.200}{1000}$ = $2.5(0) \times 10^{-3}$ **OR** 0.0025(0) mol ✓	1	**ALLOW** correct answer without working
		(iii)	Answer **2a(ii)** rounded to nearest whole number ✓ Answer **2a(i)** If **2a(i)** and **2a(ii)** are correct this will be $x = \frac{2.50 \times 10^{-3} \text{ mol}}{1.25 \times 10^{-3} \text{ mol}} = 2$ **OR** H_2A	1	**ALLOW** answer without working if answers to **2a(i) AND 2a(ii)** are seen **DO NOT ALLOW** responses without seeing answers in **2a(i) AND 2a(ii)**

A student carries out a titration to find the concentration of some sulfuric acid.

The student finds that 25.00 cm^3 of 0.0880 mol dm^{-3} aqueous sodium hydroxide, NaOH, is neutralised by 17.60 cm^3 of dilute sulfuric acid, H_2SO_4.

$$H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

(i) Calculate the amount, in moles, of NaOH used.

answer = ... mol **[1]**

(ii) Determine the amount, in moles, of H_2SO_4 used.

answer = ... mol **[1]**

(iii) Calculate the concentration, in mol dm^{-3}, of the sulfuric acid.

answer = ... mol dm^{-3} **[1]**

Mark scheme

(i)	Calculates correctly $\frac{0.0880 \times 25.0}{1000} = 2.20 \times 10^{-3}$ mol **OR** 0.00220 mol ✓	**1**	**ALLOW** 0.0022 **OR** 2.2×10^{-3} mol
(ii)	Calculates correctly $\frac{0.00220}{2} = 1.10 \times 10^{-3}$ mol **OR** 0.00110 mol ✓	**1**	**ALLOW** 0.0011 **OR** 1.1×10^{-3} mol **ALLOW** ECF for answer **(i)**/2 as calculator value or correct rounding to 2 significant figures or more but ignore trailing zeroes
(iii)	$\frac{0.00110 \times 1000}{17.60} = 0.0625$ mol dm^{-3} **OR** 6.25×10^{-2} mol dm^{-3} ✓	**1**	**ALLOW** 0.063 **OR** 6.3×10^{-2} mol dm^{-3} **ALLOW** ECF for answer **(ii)** × 1000/17.60 **OR** ECF from **(i)** for answer **(i)**/2 × 1000/17.60 as calculator value or correct rounding to 2 significant figures or more but ignore trailing zeroes

Acids and bases

Objectives

Must

Identify acids, bases and alkalis and give the formula of some common examples.

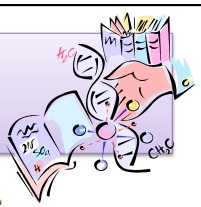
Could

Define the terms acid, base and alkali.

Should

Construct balanced symbol equations for the dissolving of acid, bases and alkalis in water and neutralisation reactions.

Theory - Acids



Definition of an acid → **A proton donor**.

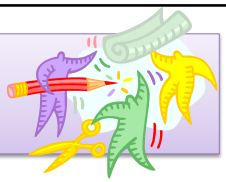
When an acid is added to water, it releases H+ ions (protons) into the solution;

E.g. $HNO_3 \rightarrow H^+ + NO_3^-$

$H_2SO_4 \rightarrow 2H^+ + SO_4^{2-}$

The H^+ ion is responsible for all acid reactions that take place and is responsible for the pH of the solution.

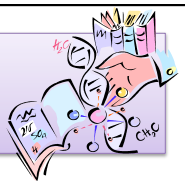
Activity



Learn the **definition of an acid** and the following formulae;

1. Sulfuric acid - H_2SO_4
2. Nitric acid - HNO_3
3. Hydrochloric acid - HCl
4. Phosphoric (V) acid - H_3PO_4
5. Ethanoic acid - CH_3COOH

Theory - Bases

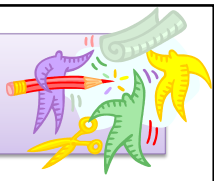


Definition of a base → **A proton acceptor**

Common bases are metal oxides and metal hydroxides. Ammonia and amines are also bases. Alkalis are soluble bases.

Bases neutralise acids and have a pH higher than 7.

Activity



Learn the definition of a base (and an alkali) and the following formulae;

1. Sodium hydroxide - NaOH
2. Calcium hydroxide - $Ca(OH)_2$
3. Magnesium oxide - MgO
4. Ammonia - NH_3
5. Potassium hydroxide - KOH

AfL

Quick test on formulae;

1. Ammonia
2. Potassium hydroxide
3. Sulfuric acid
4. Magnesium oxide
5. Calcium hydroxide
6. Nitric acid

AfL - answers

Quick test on formulae;

1. Ammonia - NH_3
2. Potassium hydroxide – KOH
3. Sulfuric acid – H_2SO_4
4. Magnesium oxide – MgO
5. Calcium hydroxide – $Ca(OH)_2$
6. Nitric acid – HNO_3

Theory

Reactions of acids and bases **produce water** and are often called **neutralisation reactions** as the pH of the products are neutral.

As well as water a **salt** is formed in the reaction when the H^+ ion of an acid is replaced by a metal ion or NH_4^+.

Neutralisation reactions

E.g. Sodium hydroxide reacting with hydrochloric acid;

$NaOH + HCl \rightarrow NaCl + H_2O$

Looking at the formation of the 2 products individually;

$Na^+ + Cl^- \rightarrow NaCl$

Here the H^+ attached to the Cl^- ion is replaced by Na^+ (a metal ion)

$OH^- + H^+ \rightarrow H_2O$

This type of reaction can occur between acids and bases, alkalis and carbonates (carbon dioxide is also produced).

Past paper question

Calcium oxide reacts with water and with nitric acid.

State the formula of the calcium compound formed when:

(i) calcium oxide reacts with water, ... **[1]**

(ii) calcium oxide reacts with nitric acid. ..... **[1]**

Mark scheme

(i)	$Ca(OH)_2$ ✓	1	**IGNORE** charges, even if wrong
(ii)	$Ca(NO_3)_2$ ✓	1	**IGNORE** charges, even if wrong

Ammonium compounds such as ammonium sulfate, $(NH_4)_2SO_4$, can be used as fertilisers.

(i) Write a balanced equation to show how ammonium sulfate could be formed by the reaction between aqueous ammonia and sulfuric acid.

..... **[1]**

(ii) Ammonium sulfate is an example of a salt formed when an acid is neutralised by a base.

Explain what is meant by the term *salt*.

.....

..... **[1]**

(iii) Why is ammonia acting as a base in this neutralisation?

.....

..... **[1]**

(iv) What is the relative formula mass of $(NH_4)_2SO_4$?

Give your answer to **one** decimal place.

..... **[1]**

Mark scheme

i	$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$ ✓	**1**	**ALLOW** $2NH_4OH + H_2SO_4 \rightarrow (NH_4)_2SO_4 + 2H_2O$ **ALLOW** $NH_3 + H^+ \rightarrow NH_4^+$ **ALLOW** any correct multiple **IGNORE** state symbols
ii	when the H^+ in an acid is replaced by a metal ion **OR** an ammonium ion **OR** a + ion ✓	**1**	**ALLOW** H for H^+; **ALLOW** 'metal' for 'metal ion **i.e.:** H in an acid can be replaced by a metal
iii	accepts a proton **OR** accepts H^+ ✓	**1**	**ALLOW** donates a lone pair **ALLOW** removes H^+ **ALLOW** forms OH^- ions
iv	132.1 ✓	**1**	**IGNORE** units **NO OTHER ACCEPTABLE ANSWER**

4

2 Chemicals called 'acids' have been known throughout history. The word acid comes from the Latin 'acidus' meaning sour. Dilute sulfuric acid, H_2SO_4, is a common laboratory acid.

(a) (i) State the formulae of two ions released when sulfuric acid is in aqueous solution.

..... [2]

(ii) A student adds a sample of solid potassium carbonate, K_2CO_3, to an excess of dilute sulfuric acid.

Describe what the student would **see** and write the equation for the reaction which takes place.

.....

.....

.....

.....

..... [3]

Mark scheme

2	a	i	Any **two** from ✓✓ H^+ SO_4^{2-} HSO_4^-	2 max	**DO NOT ALLOW** OH^- **IGNORE** state symbols Charge is essential **ALLOW** H_3O^+ for H^+ and SO_4^{-2} for SO_4^{2-} One answer incorrect = 1 mark max Two answers incorrect = 0 marks
		ii	Effervescence **OR** fizzing **OR** bubbling **OR** gas produced ✓ K_2CO_3 dissolves **OR** disappears **OR** colourless solution is formed ✓ $H_2SO_4 + K_2CO_3 \rightarrow K_2SO_4 + CO_2 + H_2O$ ✓	3	**DO NOT ALLOW** 'carbon dioxide produced' without 'gas' **DO NOT ALLOW** incorrectly named gas produced **DO NOT ALLOW** 'precipitate forms' = CON **ALLOW** 'it' for K_2CO_3 **DO NOT ALLOW** mark for 'dissolves' from state symbols in equation **DO NOT ALLOW** 'potassium' **IGNORE** state symbols **ALLOW** ionic equation

2 A student carries out experiments using acids, bases and salts.

(a) Calcium nitrate, $Ca(NO_3)_2$, is an example of a salt.

The student prepares a solution of calcium nitrate by reacting dilute nitric acid, HNO_3, with the base calcium hydroxide, $Ca(OH)_2$.

(i) Why is calcium nitrate an example of a salt?

.....

..... **[1]**

(ii) Write the equation for the reaction between dilute nitric acid and calcium hydroxide. Include state symbols.

..... **[2]**

(iii) Explain how the hydroxide ion in aqueous calcium hydroxide acts as a base when it neutralises dilute nitric acid.

.....

.....

..... **[1]**

Mark scheme

2	(a)	(i)	The H^+ ion in an (nitric) acid has been replaced by a metal ion **OR** by a Ca^{2+} ion ✓	1	**DO NOT ALLOW** it has been produced by the reaction of an acid and a base as this is stated in the question. **IGNORE** references to replacement by NH_4^+ ions or positive ions. **ALLOW** H **OR** Hydrogen for H^+; **DO NOT ALLOW** Hydrogen atoms **ALLOW** Ca **OR** Calcium for Ca^{2+}. **DO NOT ALLOW** Calcium atoms **ALLOW** 'metal' for 'metal ion
		(ii)	$2HNO_3(aq) + Ca(OH)_2(aq) \rightarrow Ca(NO_3)_2(aq) + 2H_2O(l)$ Formulae ✓ Balance **AND** states ✓	2	**ALLOW** multiples **ALLOW** (aq) **OR** (s) for $Ca(OH)_2$
		(iii)	Accepts a **proton OR** accepts H^+ ✓	1	**ALLOW** $H^+ + OH^- \rightarrow H_2O$ **ALLOW** OH^- reacts with H^+ **OR** OH^- takes H^+ **ALLOW** OH^- 'attracts' H^+ if 'to form water' is seen **DO NOT ALLOW** OH^- neutralises H^+ ('neutralises' is in the question)