REQUIRED PRACTICALS REVISION BOOKLET

CHEMISTRY

List of Required Practicals:		
1	Making Salts	
2	Neutralisation	*(Separate Sciences only)*
3	Electrolysis	
4	Temperature Changes	
5	Rates of Reaction	
6	Chromatography	
7	Identifying Ions	*(Separate Sciences only)*
8	Water Purification	

AQA
Realising potential

Making Salts

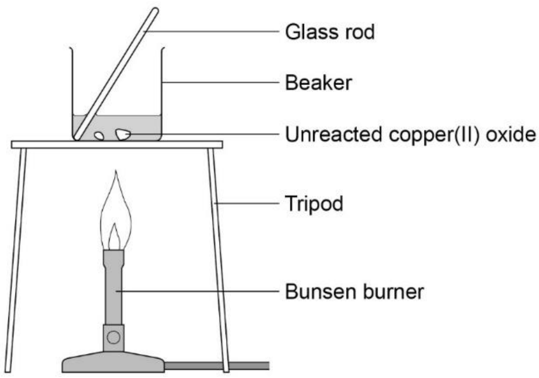
Summary	Skills
Preparation of a pure, dry sample of a soluble salt from an insoluble oxide or carbonate, using a Bunsen burner to heat dilute acid and a water bath or electric heater to evaporate the solution.	AT 2– Safe use of appropriate heating devices and techniques including use of a Bunsen burner and a water bath or electric heater. AT 3 – Use of appropriate apparatus and techniques for conducting chemical reactions, including appropriate reagents. AT 4 – Safe use of a range of equipment to purify and/or separate chemical mixtures including evaporation, filtration, crystallisation. AT 6 – Safe use and careful handling of liquids and solids, including careful mixing of reagents under controlled conditions. WS: 2.3 and 2.4

Preparation of pure dry copper sulphate crystals
You will react an acid and an insoluble base to prepare an aqueous solution of a salt. The unreacted base from the reaction will need to be filtered. You will evaporate the filtrate to leave a concentrated solution of the salt, which will crystallise as it cools and evaporates further. When dry the crystals will have a high purity.

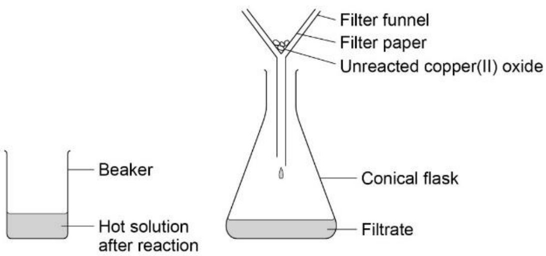
Equipment List

- 40 cm^3 1.0 M dilute sulphuric acid
- copper (II) oxide powder
- spatula
- glass rod
- 100 cm^3 beaker
- Bunsen burner
- tripod
- gauze
- heatproof mat
- filter funnel and paper
- clamp stand
- conical flask
- 250 cm^3 beaker
- evaporating basin
- crystallising dish

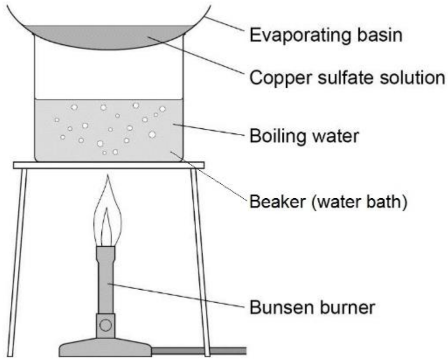
Method



1. Measure 40 cm^3 sulphuric acid into the 100 cm^3 beaker. The volume does not need to be very accurate, so you can use the graduations on the beaker.
2. Set up the tripod, gauze and heatproof mat. Heat the acid **gently** using the Bunsen burner until it is almost boiling. Turn off the Bunsen burner.
3. Use the spatula to add **small** amounts of copper (II) oxide powder. Stir with the glass rod. Continue to add copper (II) oxide if it keeps disappearing when stirred. When the copper (II) oxide disappears the solution is clear blue.
4. Stop adding the copper (II) oxide when some of it remains after stirring. Allow apparatus to cool completely.
5. Set up the filter funnel and paper over the conical flask. Use the clamp stand to hold the funnel. Filter the contents of the beaker from step **3**.
6. When filtration is complete, pour the contents of the conical flask into the evaporating basin.
7. Evaporate this gently using a water bath (250 cm^3 beaker with boiling water) on the tripod and gauze (see diagram).
8. Stop heating once crystals start to form.



9. Transfer the remaining solution to the crystallising dish. Leave this in a cool place for **at least 24 hours**.
10. Remove the crystals from the concentrated solution with a spatula. **Gently** pat the crystals dry between two pieces of filter paper. These are pure dry crystals of copper (II) sulfate.



Required Practical: Making Salts	
Key Words	Relevant Science

Required Practical: Making Salts

Summary Notes

PAST PAPER QUESTIONS: Making Salts

Question 1
Calcium nitrate solution can be made by adding solid calcium carbonate to dilute nitric acid in a beaker. The solid calcium carbonate is added until some remains at the bottom of the beaker.

(i) After this reaction the liquid in the beaker is

(1)

- ☐ **A** acidic
- ☐ **B** alkaline
- ☐ **C** neutral
- ☐ **D** pure water

(ii) Explain why the calcium carbonate is added until some solid remains at the bottom of the beaker.

(2)

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(iii) Write the balanced equation for the reaction between calcium carbonate and nitric acid to form calcium nitrate, $Ca(NO_3)_2$.

(3)

....

[6 marks]

Question Number	Answer	Additional guidance	Mark
(i)	C neutral (1)		(1)

Question Number	Answer	Mark
(ii)	An explanation that combines identification - application of knowledge (1 mark) and reasoning/justification - application of understanding (1 mark) • to react all the (nitric) acid in the solution (1) • so that the calcium nitrate solution is pure (1)	(2)

Question Number	Answer	Mark
(iii)	$CaCO_3 + 2HNO_3 \rightarrow Ca(NO_3)_2 + H_2O + CO_2$ (3) left hand side formulae (1) right hand side formulae (1) balancing correct formulae (1)	(3)

Question 2

(a) Solutions of soluble salts can react together to form an insoluble salt.
What name is given to this type of reaction?
Put a cross (☒) in the box next to your answer.

(1)

☐ **A** combustion
☐ **B** neutralisation
☐ **C** precipitation
☐ **D** separation

(b) Information about the solubility of some salts is given below.

- all nitrates are soluble
- all common carbonates are insoluble except sodium carbonate, potassium carbonate and ammonium carbonate.

Copper carbonate can be made by reacting together solutions of sodium carbonate and copper nitrate.
Complete this equation by filling in the missing state symbols.

(2)

sodium carbonate (aq) + copper nitrate (aq) → copper carbonate (..........) + sodium nitrate (..........)

(c) The symbol for a copper ion is Cu^{2+}.
The symbol for a carbonate ion is CO_3^{2-}.
Write the formula for copper carbonate.

(1)

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(d) In an experiment, solid lead iodide is produced in a mixture with a solution of a soluble salt.
Describe how a pure, dry sample of solid lead iodide can be obtained from this mixture.

(3)

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[7 marks]

Question Number	Answer	Acceptable answers	Mark
(a)	C precipitation		**(1)**

Question Number	Answer	Acceptable answers	Mark
(b)	copper carbonate (s) (1) sodium nitrate (aq)(1)		**(2)**

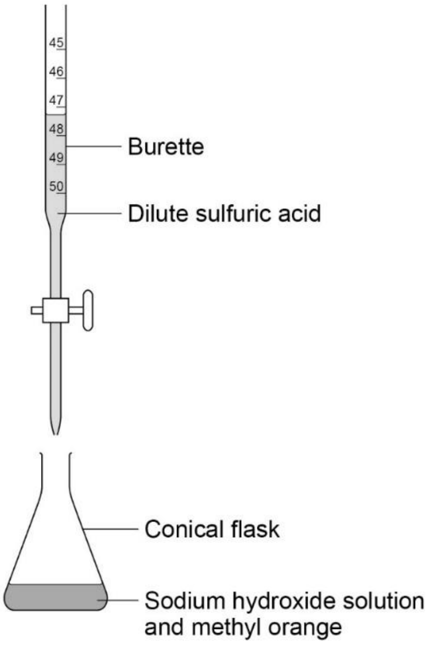
Question Number	Answer	Acceptable answers	Mark
(c)	$CuCO_3$ Ignore any 'balancing' number in front of $CuCO_3$ Ignore any working to find the formula	$Cu(CO_3)$/$Cu^{2+}CO_3^{2-}$ / $(Cu)^{2+}(CO_3)^{2-}$ / $(Cu^{2+})(CO_3^{2-})$ do not allow superscript 3 ie $CuCO^3$ do not allow $Cu(CO)_3$	**(1)**

Question Number	Answer	Acceptable answers	Mark
(d)		Maximum **2** marks if another chemical is added to the original mixture Maximum **2** marks if heat or evaporate is used on the original mixture or the filtrate	
	First mark filter/filtration/filtering (1)	description or diagram of filtering ie funnel **and** filter paper do not allow sieving/ sifting/ draining /decanting do not allow separating funnel	
	Second and third marks A description including **two** of the following		
	wash/rinse (with distilled water) (1)	pour water through solid in filter paper / clean solid with water do not allow this mark if washing is done after drying	
	any method of drying (1)	leave to dry do not allow just 'dry'	
	{lead iodide/the solid/the precipitate/the insoluble salt} is {the residue/left on the paper} (1)	do not allow other {solids/salts} left with the lead iodide	**(3)**

<u>Neutralisation</u> (Foundation Tier) (Separate Sciences only)

Summary	Skills
Determination of the reacting volumes of solutions of a strong acid and a strong alkali by titration.	AT 1- Use of appropriate apparatus to make and record a range of measurements accurately, including volume of liquids. AT 8 - The determination of concentrations of strong acids and strong alkalis. MS: 1a, 1c, 2a, 2.4 and 2.6

Investigation to find the volume of dilute sulfuric acid needed to neutralise a known volume of sodium hydroxide solution.
You will find the volume of dilute sulfuric acid needed to neutralise 25 cm^3 of sodium hydroxide solution. Observing the colour change in an acid-base indicator is used to do this.



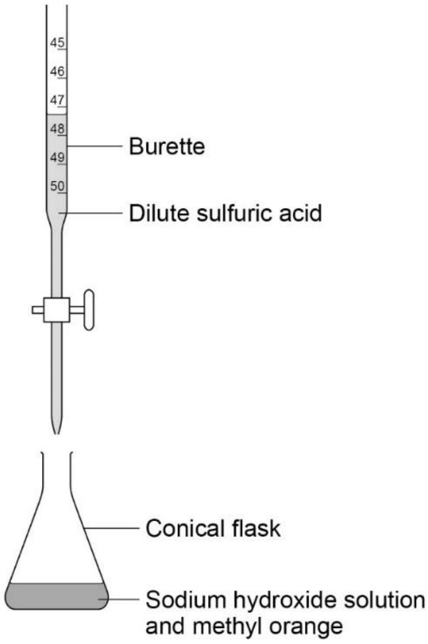
Equipment List
- 25cm^3 volumetric pipette and pipette filler
- Burette, small funnel and clamp stand
- 250cm^3 conical flask
- White tile
- Dilute sulfuric acid
- Sodium hydroxide solution
- Methyl orange indicator.

Method
1. Use the pipette and pipette filler to put exactly 25cm^3 sodium hydroxide solution into the conical flask. Your teacher will show you how to do this. Stand the flask on a white tile.
1. Clamp the burette vertically in the clamp stand about halfway up its length. There should be just enough room underneath for the conical flask and tile.
2. Close the burette tap. Use the small funnel to carefully fill the burette with dilute sulfuric acid to the 0 cm^3 line. You should do this at a low level so that you are not pouring acid from above head height. For example, put the clamp stand temporarily on a lab stool or the floor.
3. Put 5–10 drops of methyl orange indicator into the conical flask. Swirl to mix and place under the burette with the tile.
4. Carefully open the tap so that sulfuric acid flows into the flask at a drop by drop rate. Constantly swirl the flask when adding the acid. Look for a colour change from yellow to red in the indicator.
5. There will be signs that the colour change is close to being permanent. When this happens use the tap to slow the drops down. You need to be able to shut the tap immediately after a single drop of acid causes the colour to become permanently red.
6. Read the burette scale carefully and record the volume of acid you added.
7. Repeat steps **1–7** twice more and record the results in a table.
8. Calculate the mean value for the volume of acid needed to neutralise 25 cm^3 of the sodium hydroxide solution. Record this value in the final space in the table.

Neutralisation (Higher Tier) (Separate Sciences only)

Summary	Skills
Determination of the reacting volumes of solutions of a strong acid and a strong alkali by titration. *Higher Tier only:* Determination of the concentration of one of the solutions in mol/dm^3 and g/dm^3 from the reacting volumes and the known concentration of the other solution.	AT 1- Use of appropriate apparatus to make and record a range of measurements accurately, including volume of liquids. AT 8 - The determination of concentrations of strong acids and strong alkalis. MS: 1a, 1c, 2a, 2.4 and 2.6

Investigation to find the concentration of a dilute sulfuric acid solution using a sodium hydroxide solution of known concentration.
You will find the volume of dilute sulfuric acid needed to neutralise 25cm^3 of 0.5mol/dm^3 sodium hydroxide solution. Observing the colour change in an acid-base indicator is used to do this. The sulfuric acid has an unknown concentration. You also calculate the concentration of the sulfuric acid used in mol/dm^3 and g/dm^3.



Equipment List

- 25 cm^3 volumetric pipette and pipette filler
- burette
- small funnel
- clamp stand
- 250 cm^3 conical flask
- white tile
- dilute sulfuric acid of unknown concentration
- 0.1 mol/dm^3 sodium hydroxide solution
- methyl orange indicator.

Method

1. Use the pipette and pipette filler to put exactly 25cm^3 sodium hydroxide solution into the conical flask. Your teacher will show you how to do this. Stand the flask on a white tile.
2. Clamp the burette vertically in the clamp stand about halfway up its length. There should be just enough room underneath for the conical flask and tile.
3. Close the burette tap. Use the small funnel to carefully fill the burette with dilute sulfuric acid to the 0cm^3 line. You should do this at a low level so that you are not pouring acid from above head height. For example put the clamp stand temporarily on a lab stool or the floor.
4. Put 5–10 drops of methyl orange indicator into the conical flask. Swirl to mix and place under the burette with the tile.
5. Carefully open the tap so that sulfuric acid flows into the flask at a drop by drop rate. Constantly swirl the flask when adding the acid. Look for a colour change from yellow to red in the indicator.
6. There will be signs that the colour change is close to being permanent. When this happens use the tap to slow the drops down. You need be able to shut the tap immediately after a single drop of acid causes the colour to become permanently red.
7. Read the burette scale carefully and record the volume of acid you added.
8. Repeat steps **1–7** twice more and record the results in a table.
9. Calculate the mean value for the volume of acid needed to neutralise 25 cm^3 of the sodium hydroxide solution. Record this value in the final space in the table. Use your mean result to calculate the concentration of the acid in mol/dm^3 and g/dm^3 using the following calculation steps.

Calculations

Step 1:

$\boxed{\text{Concentration (mol/dm}^3\text{) = number of moles} \div \text{volume of solution (dm}^3\text{)}}$

Moles of sodium hydroxide in 25 cm^3 = concentration × volume = 0.1 mol/dm^3 × (25 ÷ 1000) dm^3

Step 2: Equation: $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$
This shows that **two** moles of sodium hydroxide neutralise **one** mole of sulfuric acid.
Moles of sulphuric acid used = (answer from step **1**) ÷ 2

Step 3: Concentration of sulfuric acid (mol/dm^3) = moles ÷ mean volume of acid
= (answer from step **2**) ÷ (mean volume from table ÷ 1000)

Step 4:

$\boxed{\text{Number of moles = mass of substance (g)} \div M_r \text{ of substance}}$

Concentration of sulfuric acid (g/dm^3) = (answer from step **3**) x M_r (H_2SO_4)

Required Practical: Neutralisation	
Key Words	Relevant Science

Required Practical: Neutralisation
Summary Notes

PAST PAPER QUESTIONS: Neutralisation

Question 1

The concentration of a solution of an alkali can be determined by titration with an acid.
25.0 cm^3 portions of the solution of the alkali are transferred into a conical flask and titrated with the acid solution, using a suitable indicator.

(i) Describe how you would measure out and transfer 25.0 cm^3 of the solution of the alkali.

(2)

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(ii) The burette readings of acid added were:

	titration 1	titration 2	titration 3
final volume / cm^3	27.20	30.10	25.35
initial volume / cm^3	2.05	5.20	0.10
volume of acid added / cm^3	25.15	24.90	25.25

The volume of acid added that should be used in the calculation is

(1)

- ☒ **A** 24.90 cm^3
- ☒ **B** 25.00 cm^3
- ☒ **C** 25.10 cm^3
- ☒ **D** 25.20 cm^3

Question Number	Answer	Acceptable answers	Mark
(i)	A description linking • **pipette** (1) • one practical point eg draw liquid up to line/ use pipette filler/ rinse first / read at eye level (1)	**ignore** burette etc for 1st mpt if using measuring cylinder/ burette allow suitable practical point eg read at eye level/ add dropwise from burette near 25 cm^3 (1) ignore as 2nd point: transfer liquid to flask / safety precautions	**(2)**

Question Number	Answer	Acceptable answers	Mark
(ii)	**D** 25.20 cm^3		**(1)**

Question 2

Titration can be used to determine the exact amount of hydrochloric acid that reacts with a given amount of sodium hydroxide solution.

$$HCl + NaOH \rightarrow NaCl + H_2O$$

(a) What type of reaction takes place when hydrochloric acid reacts with sodium hydroxide solution?

(1)

Put a cross (☒) in the box next to your answer.

☐ **A** neutralisation
☐ **B** oxidation
☐ **C** precipitation
☐ **D** reduction

(b) Suggest why universal indicator must not be used in titration experiments.

(1)

....

(c) Sodium chloride solution can be made from dilute hydrochloric acid and sodium hydroxide solution. Describe a titration experiment to find the exact volume of hydrochloric acid needed to neutralise 25.0cm^3 of sodium hydroxide solution and how you would use this result to obtain pure, dry crystals of sodium chloride.

(6)

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(d) Sodium hydroxide solution is titrated with dilute hydrochloric acid. The results of the experiment are:

volume of sodium hydroxide solution = 25.0 cm^3

volume of 0.100 mol dm^{-3} hydrochloric acid used

rough titration	= 23.1 cm^3
1st titration	= 22.6 cm^3
2nd titration	= 22.8 cm^3

(i) State the volume of hydrochloric acid that must be used to calculate the concentration of sodium hydroxide solution.

(1)

volume of hydrochloric acid =................................. cm^3

(ii) In a different experiment, 25.0cm^3 of sodium hydroxide solution reacted with 23.2cm^3 of 0.100 mol/dm^3 hydrochloric acid, HCl.

Calculate the concentration of this sodium hydroxide solution, NaOH, in mol/dm^3.

(3)

$$NaOH + HCl \rightarrow NaCl + H_2O$$

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concentration of sodium hydroxide solution = ...mol dm^3

[12 marks]

	Answer	**Acceptable answers**	**Mark**
(a)	A neutralisation		**(1)**
(b)	Any one from ▯ no sharp/clear/distinct change in colour ▯ gradual colour change ▯ there are too many different colours	ignore not as accurate/reliable allow too difficult to see when it is neutral/reaction is complete ignore speed of colour change	**(1)**

		Indicative Content	Mark
QWC	***(c)**	A description including some of the following points **titration experiment** • rinse pipette with alkali and burette with acid • measure alkali using a pipette • into suitable container e.g. flask/beaker • add a few drops of indicator / suitable named indicator (eg methyl orange/phenolphthalein) • flask on a white tile • fill burette with acid • read level/volume (of acid) in burette • add acid from burette to the flask slowly / swirl the flask • until indicator just changes colour/correct colour change for named indicator (eg methyl orange yellow to peach/orange, phenolphthalein pink to colourless)/solution is neutral • read level/volume (of acid) in burette • repeat experiment • until concordant results**salt preparation** • mix the same volume of alkali with the volume of acid determined from the first experiment but do not add indicator (or add (activated) charcoal to remove indicator, then filter) • pour solution into an evaporating basin • heat solution/leave the water to evaporate until pure salt crystals are left	**(6)**
Level	**0**	No rewardable content	
1	**1 - 2**	• a limited description of titration and/or salt preparation e.g. add hydrochloric acid to sodium hydroxide solution in a flask, then evaporate the water from solution. • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	**3 - 4**	• a simple description of titration and/or salt preparation e.g. pipette sodium hydroxide solution into flask, add indicator, place hydrochloric acid in burette, add acid to alkali until colour change. • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy	
3	**5 - 6**	• a detailed description including titration **and** salt preparation e.g. pipette sodium hydroxide solution into flask, add indicator, hydrochloric acid in burette, add acid to alkali until colour change, repeat until concordant results, evaporate water. • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors	

	Answer	Acceptable answers	Mark
(d)(i)	$\frac{22.6 + 22.8}{2}$ (1) (= 22.7)		**(1)**
(d)(ii)	marks are for the working no. moles HCl = $\frac{23.2 \times 0.1}{1000}$ (1) (= 2.32×10^{-3}) no. moles NaOH = no. moles HCl (1)	0.0928/0.093 with or without working (3) 0.09 with no working (2) common incorrect answers with working 0.108/0.1077 (2) –	**(3)**

	no. moles NaOH = no. moles HCl (1) conc NaOH = $\frac{2.32 \times 10^{-3} \times 1000}{25.0}$ (1) (= 0.0928 mol dm^{-3}) mark consequentially OR $\frac{\text{no. moles NaOH reacting}}{\text{no. moles HCl reacting}} = \frac{1}{1}$ (1) $\frac{25.0 \times \text{conc}}{23.2 \times 0.1} = \frac{1}{1}$ (1) conc NaOH = $\frac{0.1 \times 23.2}{25.0}$ (1) (= 0.0928) mol dm^{-3} OR use of $c_1v_1 = c_2v_2$ (1) 0.1 x 23.2 = conc x 25.0 (1) conc NaOH = $\frac{0.1 \times 23.2}{25.0}$ (1) (= 0.0928) mol dm^{-3}	used 1:1 ratio but 25x0.1/23.2 0.928 (2) – used 1:1 ratio but missed out 0.1	

Question 3

A titration is to be carried out to find the concentration of a solution of sodium hydroxide.
The sodium hydroxide solution is titrated with dilute sulfuric acid.
The available apparatus includes a burette, a pipette, a funnel, a conical flask and an indicator.

(a) State one safety precaution that must be taken when using sodium hydroxide solution and dilute sulfuric acid.

(1)

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....

(b) The sodium hydroxide solution is made by dissolving 4.3 g of sodium hydroxide in water and making the solution up to 250 cm^3 with water.
Calculate the concentration of the solution in g dm^{-3}.

(2)

concentration = ... g dm^{-3}

(c) Write the balanced equation for the reaction of dilute sulfuric acid, H_2SO_4, with sodium hydroxide.

(2)

....

(d) The results of titrations to determine how much of an acid is required to neutralise a given volume of an alkaline solution are shown in the table below.

	titration 1	titration 2	titration 3	titration 4
final burette reading (cm^3)	27	27.40	29.20	29.30
initial burette reading (cm^3)	0	2.10	4.00	3.50
volume of acid used (cm^3)	27	25.30	25.20	25.80

Two of the titrations in Figure 14 should **not** be used to calculate the mean volume of acid required. Identify each titration and give a reason why it should not be used in the calculation of the mean.

(2)

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[7 marks]

Question number	Answer	Mark
(a)	any **one** precaution from: • wear gloves to prevent contact with skin/safety (1) • spectacles to prevent contact with eyes (1)	**(1)**

Question number	Answer	Additional guidance	Mark
(b)	1000 cm^3 contain $\frac{4.3 \times 1000}{250}$ (1) 1 dm^3 contains 17.1 ($g\,dm^{-3}$) (1)	Award full marks for correct numerical answer without working.	**(2)**

Question number	Answer	Additional guidance	Mark
(c)	$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$ • correct formulae (1) • balancing (1)	Do not award 2 if incorrect balancing added.	**(2)**

Question number	Answer	Mark
(d)	• {titration 1/27 cm^3} should not be used because burette readings {not precise/not accurate/not read to 2 d.p.} (1) • {titration 4/25.80 cm^3} should not be used because volume of used (25.80 cm^3) not concordant with other two (1)	**(2)**

Electrolysis

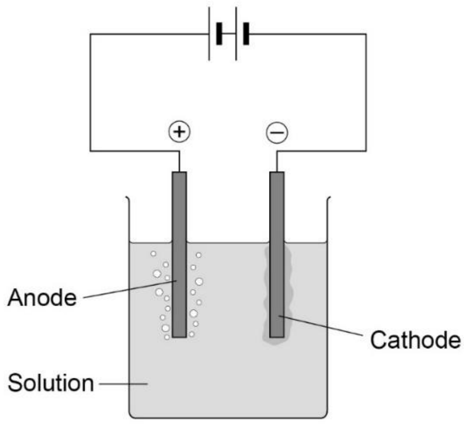
Summary	Skills
Investigate what happens when aqueous solutions are electrolysed using inert electrodes. This should be an investigation involving developing a hypothesis.	AT 3 - Use of appropriate apparatus and techniques for conducting and monitoring chemical reactions. AT 7 – Use of appropriate apparatus and techniques to draw, set up and use electrochemical cells for separation and production of elements and compounds. AT 8 - Use of appropriate qualitative reagents and techniques to analyse and identify unknown samples or products including gas tests for hydrogen, oxygen and chlorine (Chemistry only). WS: 2.1, 2.2, 2.3, 2.4 and 2.6

Investigating the elements formed at each electrode when different salt solutions are electrolysed.
You will use a low voltage power supply and carbon rod electrodes to pass a current through four different salt solutions. You will identify the element formed at the positive and negative electrode in each case.

Equipment List

- copper(II) chloride solution
- copper(II) sulfate solution
- sodium chloride solution
- sodium sulfate solution
- 100 cm^3 beaker
- petri dish lid
- two carbon rod electrodes
- two crocodile / 4 mm plug leads
- low voltage power supply
- blue litmus paper
- tweezers

Method



1. Pour copper (II) chloride solution into the beaker to about 50cm^3.
2. Add the lid and insert carbon rods through the holes. **The rods must not touch each other**. Attach crocodile leads to the rods. Connect the rods to the **D.C. terminals** of a low voltage power supply.
3. Select 4 V on the power supply and switch on.
4. Look at both electrodes. Is there bubbling at neither, one or both electrodes?
5. Use tweezers to hold a piece of blue litmus paper in the solution next to the positive electrode (the one connected to the red terminal). You will need to lift the lid temporarily to do this. Write your observations in the first blank row of the table below. What is this element?
6. After no more than five minutes, switch off the power supply. Examine the negative electrode (the one connected to the black terminal). Is there evidence of a metal coating on it? What could it be? Record your results in the table.
7. Clean the equipment carefully. Repeat steps **1–6** using solutions of copper (II) sulfate, sodium chloride and sodium sulfate.

Additional Information

- Gas produced at the positive electrode which does **not** bleach blue litmus paper, is oxygen. The amounts produced are usually too small to identify by testing.
- If a gas is produced at the negative electrode, it is hydrogen. The amounts produced are usually too small to identify by testing.

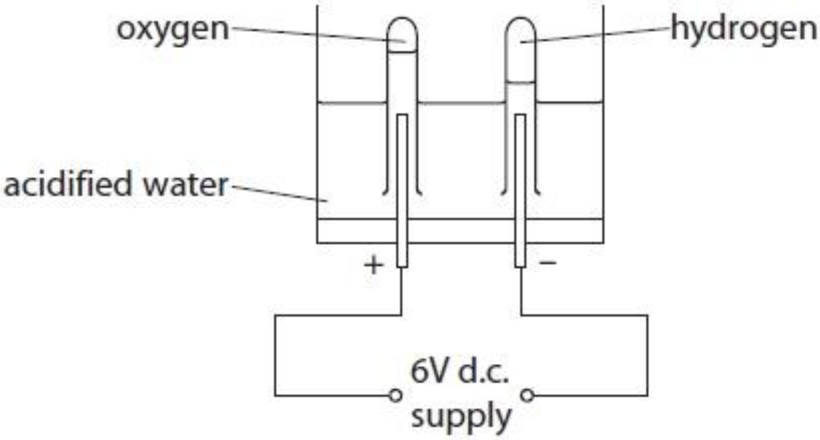
Required Practical: Electrolysis	
Key Words	Relevant Science

Required Practical: Electrolysis
Summary Notes

PAST PAPER QUESTIONS: Electrolysis

Question 1

Water, acidified with a small amount of dilute sulfuric acid, can be decomposed by electrolysis using the apparatus shown.



(i) State the form of energy used to carry out the electrolysis.

(1)

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(ii) During the electrolysis, hydrogen is formed at one of the electrodes.
Describe a test to show that this gas is hydrogen.

(2)

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[3 marks]

Question Number	Answer	Acceptable answers	Mark
(i)	electrical (energy) / electricity / direct (electric) current		**(1)**

Question Number	Answer	Acceptable answers	Mark
(ii)	A description including • {light / ignite} gas / lighted splint (1) • gas burns / (squeaky) pop (if air is present) (1)	reject glowing splint second mark conditional on first	**(2)**

Question 2

(a) Magnesium carbonate reacts with dilute nitric acid.
Give the names of the products formed in this reaction.

(2)

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(b) Zinc oxide, ZnO, reacts with dilute hydrochloric acid to form zinc chloride, $ZnCl_2$, and water.
(i) Complete the sentence by putting a cross (☒) in the box next to your answer.

This reaction is an example of:

(1)

☐ **A** combustion
☐ **B** thermal decomposition
☐ **C** neutralisation
☐ **D** oxidation

(ii) Write the balanced equation for the reaction between zinc oxide and dilute hydrochloric acid. **(3)**

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(c) Electrolysis of hydrochloric acid can produce hydrogen and chlorine.
The apparatus for the electrolysis is:

- hydrochloric acid
- two carbon rods
- a suitable container for the electrolysis reaction
- a suitable source of electricity
- test tubes

Describe how the apparatus can be used to electrolyse hydrochloric acid and how the gases produced can be tested to show that they are hydrogen and chlorine.
You may use a diagram to help your answer.

(6)

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[12 marks]

Question Number	Answer	Acceptable answers	Mark
(a)	magnesium nitrate water carbon dioxide all three correct (2) magnesium nitrate + one other correct (1)	allow correct formulae	**(2)**

Question Number	Answer	Acceptable answers	Mark
(b)(i)	C – neutralisation		**(1)**

Question Number	Answer	Acceptable answers	Mark
(b)(ii)	$ZnO + 2HCl \rightarrow ZnCl_2 + H_2O$ (3) LHS (1) RHS (1) balancing of correct formula (1)	correct multiples ignore state symbols	**(3)**

Question Number		Indicative Content	Mark
QWC	*** (c)**	A description including some of the following points experiment set up • hydrochloric acid in container • carbon rods in acid • attach rods to electrical supply • d.c. supply(or reference to positive and negative) • test tubes to collect gases test hydrogen • lighted splint • squeaky pop (with air)/burns test chlorine • (damp blue) litmus paper • (turns red then) bleaches/white	**(6)**
Level	**0**	No rewardable content	
1	**1 – 2**	• a limited description e.g. simple description/diagram of electrolysis set up OR description of test for one of the gases. • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	**3 – 4**	• a simple description e.g. a full description of electrolysis OR test for both gases OR simple description of electrolysis and the test for one of the gases. • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy	
3	**5 – 6**	• a detailed description e.g. description of electrolysis and test for both gases OR a full description of electrolysis and of one gas test. • The answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors	

Temperature Changes

Summary	Skills
Investigate the variables that affect temperature changes in reacting solutions, e.g. acid plus metals, acid plus carbonates, neutralisations, displacement of metals.	AT 1 – Use of appropriate apparatus to make and record a range of measurements accurately, including mass, temperature, and volume of liquids. AT 3 - Use of appropriate apparatus and techniques for conducting and monitoring chemical reactions. AT 5 - Making and recording of appropriate observations during chemical reactions including changes in temperature. AT 6 - Safe use and careful handling of gases, liquids and solids, including careful mixing of reagents under controlled conditions, using appropriate apparatus to explore chemical changes. MS: 1a, 2a, 2b, 4a and 4c WS: 2.1, 2.2, 2.3, 2.4, 2.6 and 2.7

Investigation of the temperature changes which take place when an acid is neutralised by an alkali.
You will monitor the temperature rise as small volumes of sodium hydroxide solution are added to dilute hydrochloric acid. The acid will be contained in an insulated cup.

Equipment List

- 2 M dilute hydrochloric acid
- 2 M sodium hydroxide solution
- expanded polystyrene cup and lid
- 250 cm^3 beaker
- 10 cm^3 measuring cylinder
- 50 cm^3 measuring cylinder
- thermometer.

Method

1. Use the 50 cm^3 measuring cylinder to put 30 cm^3 dilute hydrochloric acid into the polystyrene cup.
2. Stand the cup inside the beaker. This will make it more stable.
3. Use the thermometer to measure the temperature of the acid. Record it in a table.
4. Put 5 cm^3 sodium hydroxide solution into the 10 cm^3 measuring cylinder.
5. Pour the sodium hydroxide into the cup. Fit the lid and gently stir the solution with the thermometer through the hole. When the reading on the thermometer **stops changing**, write the temperature in the table.
6. Repeat steps **4** and **5** to add further 5 cm^3 amounts of sodium hydroxide to the cup. A total of 40 cm^3 needs to be added. The last few additions should produce a temperature fall rather than a rise.
7. Repeat steps **1–6** and record the results in the table.
8. Calculate the **mean** maximum temperature reached for each of the sodium hydroxide volumes. Record these means in the table.
9. Plot a graph with 'Mean maximum temperature in ^{o}C' on the y-axis and 'Total volume of sodium hydroxide added in cm^3' on the x-axis.
10. Draw two straight lines of best fit one through the points which are increasing and one through the points which are decreasing. Ensure the two lines are extended so they cross each other.
11. Use the graph to estimate how much sodium hydroxide solution was needed to neutralise 25cm^3 dilute hydrochloric acid.

Required Practical: Temperature Changes

Key Words	Relevant Science

Required Practical: Temperature Changes

Summary Notes

PAST PAPER QUESTIONS: Temperature Changes

Question 1
When solid ammonium chloride is added to water a colourless solution is formed.
During the process the temperature of the liquid decreases.
Describe how you would measure the change in temperature.

(2)

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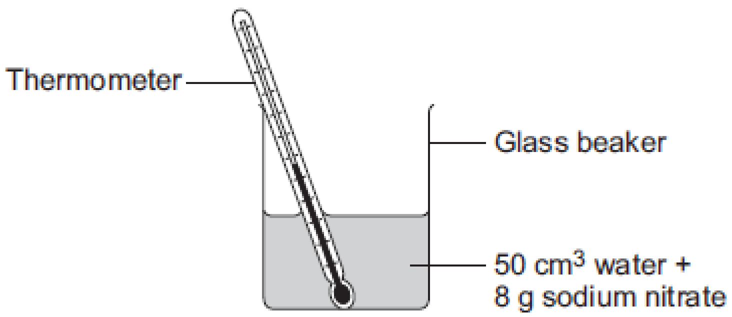
....

[2 marks]

Question number	Answer	Additional guidance	Mark
	An answer that combines the following points of application of knowledge and understanding to provide a logical description: • use a thermometer (1) • to measure initial and final temperature (1)		(2)

Question 2
This question is about temperature changes.
(a) A student investigated the temperature change when 8 g of sodium nitrate dissolves in 50 cm^3 of water.
The diagram below shows the apparatus the student used.



The student did the experiment five times.
Table 1 shows the results.

Table 1

Experiment	Decrease in temperature of water in °C
1	5.9
2	5.7
3	7.2
4	5.6
5	5.8

(i) Calculate the mean decrease in temperature.
Do not use the anomalous result in your calculation.

....

....

Mean decrease in temperature = ………………………………. °C
(2)

(ii) Suggest **one** change in the apparatus in the diagram above which would improve the accuracy of the results.
Give a reason for your answer.

....

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....

....
(2)

(b) The student investigated the temperature change when different masses of sodium carbonate were added to 50 cm^3 of water at 20 °C.
Table 2 below shows the results.

Table 2

Mass of sodium carbonate in g	**Final temperature of solution in °C**
2.0	21.5
4.0	23.0
6.0	24.5
8.0	26.0
10.0	26.6
12.0	26.6
14.0	26.6

Describe the relationship between the mass of sodium carbonate added and the final temperature of the solution.
Use values from **Table 2** in your answer.

....

....

....

....

....

....
(3)
[7 marks]

Mark Scheme

(a) (i) 5.75 **or** 5.8

*correct answer with or without working gains **2** marks*

*correct working showing addition of any four results and division by 4 gains **1** mark*

OR

*6(.04) for **1** mark*

2

(ii) use a polystyrene cup **or** lid

accept insulate the beaker

1

to prevent energy/heat gain

accept to prevent energy/heat transfer

*do **not** accept energy/heat loss*

OR

use a digital thermometer

allow use a data logger

easier to read (to 0.1°C)

1

(b) (as mass increases) the final temperature increases

1

then stays constant

1

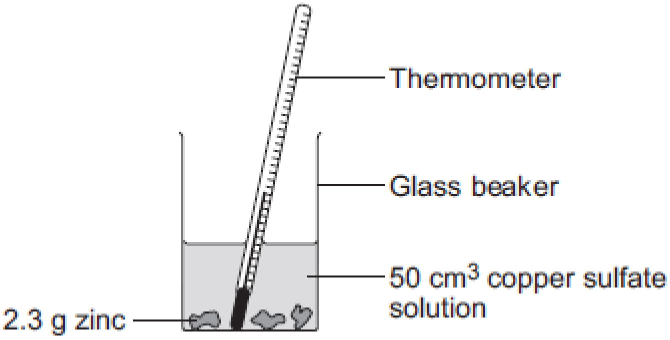
correct reference to a value above 8 g up to and including 10 g as mass when the trend changes

1

[7]

Question 3

A student investigated the temperature change when zinc reacts with copper sulfate solution.
The student used a different concentration of copper sulfate solution for each experiment.
The student used the apparatus shown below.



The student:

- measured 50 cm^3 copper sulfate solution into a glass beaker
- measured the temperature of the copper sulfate solution
- added 2.3 g zinc
- measured the highest temperature
- repeated the experiment using copper sulfate solution with different concentrations.

The equation for the reaction is:

Zn(s)	+	$CuSO_4$(aq)	$\longrightarrow$	Cu(s)	+	$ZnSO_4$(aq)
zinc	+	copper sulfate solution	$\longrightarrow$	copper	+	zinc sulfate solution

(a) The thermometer reading changes during the reaction.
Give **one** other change the student could **see** during the reaction.

....

(1)

(b) Suggest **one** improvement the student could make to the apparatus.
Give a reason why this improves the investigation.

Improvement ....

....

Reason ....

....

(2)

(c) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**
The student's results are shown in the table.

Experiment Number	**Concentration of copper sulfate in moles per dm^3**	**Increase in temperature in °C**
1	0.1	5
2	0.2	10
3	0.3	12
4	0.4	20
5	0.5	25
6	0.6	30
7	0.7	35
8	0.8	35
9	0.9	35
10	1.0	35

Describe **and** explain the trends shown in the student's results.

....

....

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....

....

(6)
[9 marks]

Mark Scheme

(a) any **one** from:

• solution becomes colourless or colour fades

• zinc becomes bronze / copper coloured

allow copper (forms) or a solid (forms)

• zinc gets smaller

allow zinc dissolves

• bubbles or fizzing.

ignore precipitate

1

(b) improvement:

use a plastic / polystyrene cup or add a lid

accept use lagging / insulation **1**

reason - must be linked

reduce / stop heat loss

OR

improvement:

use a digital thermometer

allow use a data logger

reason - must be linked

more accurate or easy to read or stores data

allow more precise or more sensitive

ignore more reliable

ignore improvements to method, eg take more readings **1**

(c) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking Guidance and apply a 'best–fit' approach to the marking.

0 marks

No relevant content

Level 1 (1−2 marks)

There is a statement about the results.

Level 2 (3−4 marks)

There are statements about the results. These statements may be linked or may include data.

Level 3 (5−6 marks)

There are statements about the results with at least one link and an attempt at an explanation.

Examples of chemistry points made in the response:

Description Statements

Concentration of copper sulfate increases

Temperature change increases

There is an anomalous result

The temperature change levels off

Reaction is exothermic

Linked Statements

Temperature change increases as concentration of copper sulfate increases

The temperature change increases, and then remains constant

After experiment 7 the temperature change remains constant

Statements including data

The trend changes at experiment 7

Experiment 3 is anomalous

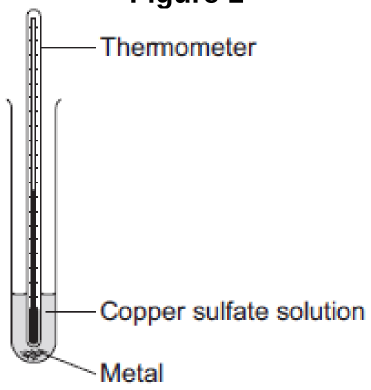
Attempted Explanation
Temperature change increases because rate increases
Temperature change levels off because the reaction is complete

Explanation
As more copper sulfate reacts, more heat energy is given off
Once copper sulfate is in excess, no further heat energy produced

6
[9]

<u>Question 4</u>
A student investigated displacement reactions of metals.
The student added different metals to copper sulfate solution and measured the temperature change.
The more reactive the metal is compared with copper, the bigger the temperature change.
The apparatus the student used is shown in **Figure 1**.

Figure 1



(a) State **three** variables that the student must control to make his investigation a fair test.

1. ....

2. ....

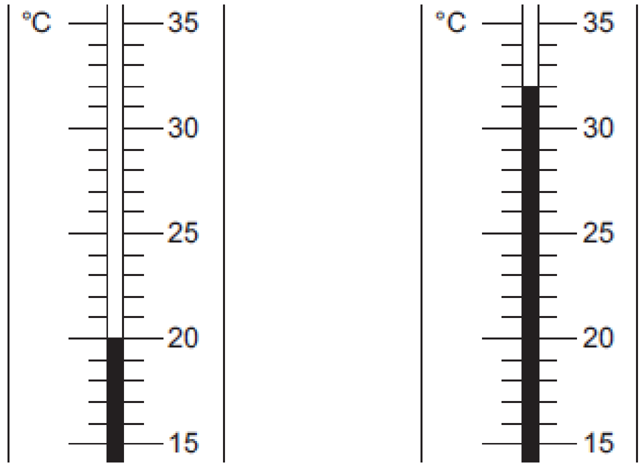
3. ....

(3)

(b) **Figure 2** shows the thermometer in one experiment before and after the student added a metal to the copper sulfate solution.

Figure 2

Before adding metal **After adding metal**



Use **Figure 2** to complete **Table 1**.

Table 1

Temperature before adding metal in °C	....
Temperature after adding metal in °C	....
Change in temperature in °C	....

(3)

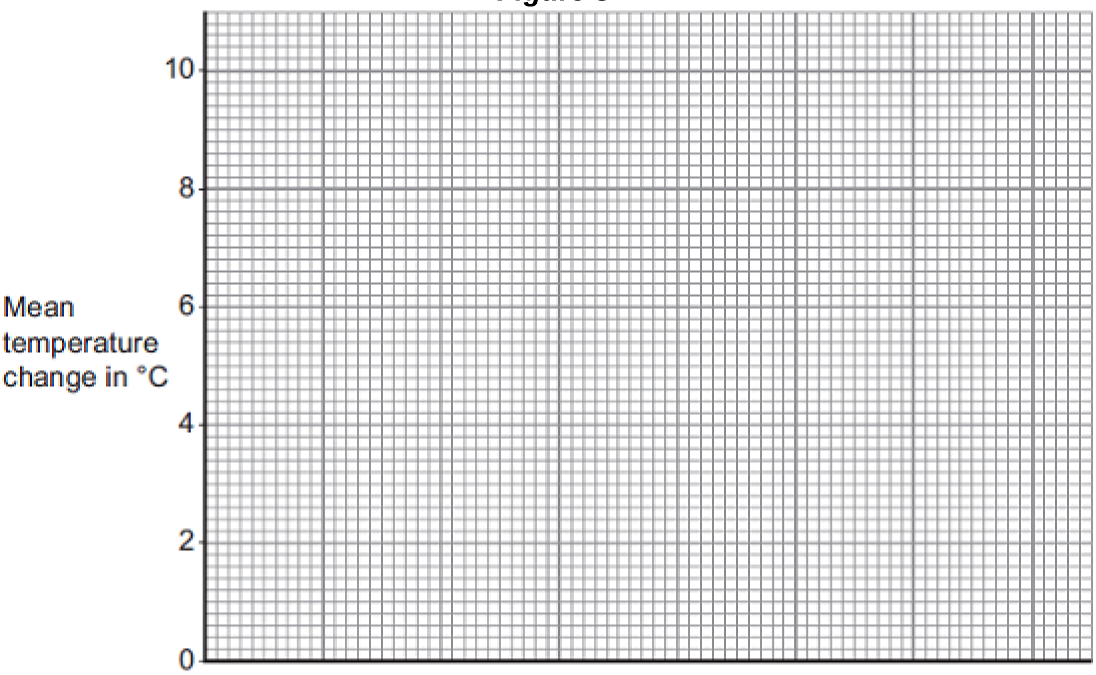
(c) The student repeated the experiment three times with each metal.
Table 2 shows the mean temperature change for each metal.

Table 2

Metal	Mean temperature change in °C
Cobalt	4.5
Gold	0.0
Magnesium	10.0
Nickel	3.0
Silver	0.0
Tin	1.5

(i) On **Figure 3**, draw a bar chart to show the results.
(ii)

Figure 3



(3)

(ii) Why is a line graph **not** a suitable way of showing the results?

....

....

(1)

(iii) Use the results to work out which metal is the most reactive.
Give a reason for your answer.
Most reactive metal ....

Reason ....

....
(2)

(iv) Explain why there was no temperature change when silver metal was added to the copper sulfate solution.

....

....

....

....
(2)

(v) It is **not** possible to put all six metals in order of reactivity using these results.
Suggest how you could change the experiment to be able to put all six metals into order of reactivity.

....

....

....

....
(2)
(Total 16 marks)

Mark Scheme

(a) any **three** from:
- concentration of (salt) solution
- volume of (salt) solution

ignore amount of solution
- **initial** temperature (of the solution)

ignore room temperature
- surface area / form of metal
- moles of metal

allow mass / amount
ignore time
ignore size of tube

3

(b) 20

1

32

1

12
allow ecf

1

(c) (i) four bars of correct height
tolerance is + / - half square
*3 correct for **1** mark*

2

bars labelled

1

(ii) *one variable* is non-continuous / categoric
accept qualitative or discrete
accept no values between the metals

1

(iii) magnesium

1

because biggest temperature change
accept gives out most energy
ignore rate of reaction
dependent on first mark

1

(iv) does not react / silver cannot displace copper

1

because silver not more reactive (than copper) **or** silver below copper in reactivity series
*do **not** accept silver is less reactive than copper sulfate*

1

(v) replace the copper sulfate
could be implied

1

with any compound of a named metal less reactive than copper
allow students to score even if use an insoluble salt

1
[16]

Rates of Reaction

Summary	Skills
Investigate how changes in concentration affect the rates of reactions by a method involving measuring the volume of a gas produced and a method involving a change in colour or turbidity. This should be an investigation involving developing a hypothesis.	AT 1 – Use of appropriate apparatus to make and record a range of measurements accurately, including mass, temperature, and volume of liquids. AT 3 - Use of appropriate apparatus and techniques for conducting and monitoring chemical reactions. AT 5 - Making and recording of appropriate observations during chemical reactions including changes in temperature. AT 6 - Safe use and careful handling of gases, liquids and solids, including careful mixing of reagents under controlled conditions, using appropriate apparatus to explore chemical changes. MS: 1a, 1c, 1d, 2a, 2b, 4a, 4b, 4c, 4d and 4e WS: 2.1, 2.2, 2.3, 2.4, 2.6 and 2.7

Investigation into how the concentration of a solution affects the rate of a chemical reaction.
There are two parts to this practical which investigate how the rate of reaction can be measured.

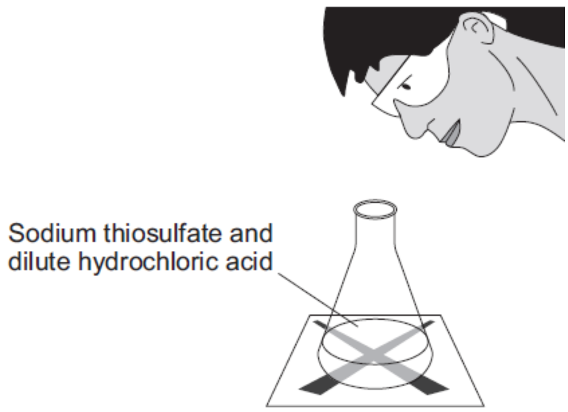
Activity 1: Observing colour change
You will react sodium thiosulfate with hydrochloric acid. You will then find out how the rate of reaction changes as the thiosulfate solution becomes more dilute.

Equipment List

- 40 g/dm^3 sodium thiosulfate solution
- 2.0 M dilute hydrochloric acid
- 10 cm^3 measuring cylinder
- 100 cm^3 measuring cylinder
- 100 cm^3 conical flask
- printed black paper cross
- stop clock.

Method

1. Use a measuring cylinder to put 10cm^3 sodium thiosulfate solution into the conical flask. Use the measuring cylinder to then add 40cm^3 water. This dilutes the sodium thiosulfate solution to a concentration of 8 g/dm^3. Put the conical flask on the black cross.
2. Put 10 cm^3 of dilute hydrochloric acid into the 10 cm^3 measuring cylinder.
3. Put this acid into the flask. At the same time swirl the flask gently and start the stopclock.
4. Look down through the top of the flask. Stop the clock when you can no longer see the cross. **Take care to avoid breathing in any sulfur dioxide fumes.**
5. Write the time it takes for the cross to disappear in the first blank column of a table. Record the time **in seconds**. You will need to multiply any minutes by 60 and then add the extra seconds.



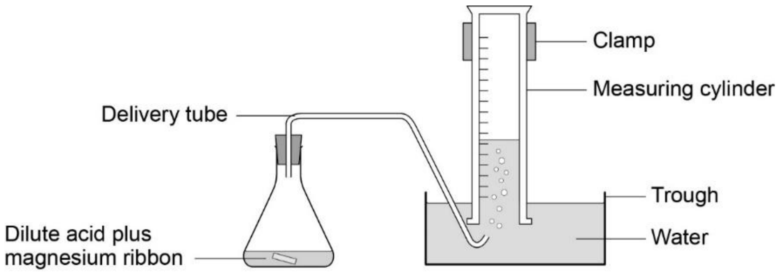
6. Repeat steps **1–5** four times, **but in step 1 use:**
   - 20 cm^3 sodium thiosulfate + 30 cm^3 water (concentration 16 g/dm^3)
   - 30 cm^3 sodium thiosulfate + 20 cm^3 water (concentration 24 g/dm^3)
   - 40 cm^3 sodium thiosulfate + 10 cm^3 water (concentration 32 g/dm^3)
   - 50 cm^3 sodium thiosulfate + no water (concentration 40 g/dm^3)
7. Then repeat the **whole investigation** (steps **1–5**) twice more. Record the results in the second and third blank columns of the table.
8. Calculate the **mean** time for each of the sodium thiosulfate concentrations. Leave out anomalous values from your calculations. Record the means in the fourth blank column.

9. Plot a graph with ‘mean time taken for cross to disappear in seconds’ on the y-axis and ‘Sodium thiosulfate concentration in g/dm^3’ on the x-axis
10. Draw a smooth curved line of best fit.

Activity 2: Measuring the volume of gas produced
You will react magnesium ribbon and hydrochloric acid. You will then find out how the rate of reaction is affected by the concentration of the acid.

Equipment List

- Safety goggles
- conical flask (100 cm^3)
- single-holed rubber bung and delivery tube to fit conical flask
- trough or plastic washing-up bowl
- two measuring cylinders (100 cm^3)
- clamp stand, boss and clamp
- stop clock
- graph paper
- magnesium ribbon cut into 3 cm lengths
- dilute hydrochloric acid, (2.0 M, and 1.0 M).



Method

1. Measure 50 cm^3 of 2.0 M hydrochloric acid using one of the measuring cylinders. Pour the acid into the 100 cm^3 conical flask.
2. Set up the apparatus as shown in the diagram. Half fill the trough or bowl with water.
3. Fill the other measuring cylinder with water. Make sure it stays filled with water when you turn it upside down.
4. When you are ready, add a 3 cm strip of magnesium ribbon to the flask, put the bung back into the flask as quickly as you can, and start the stopclock.
5. Record the volume of hydrogen gas given off at suitable intervals (eg 10 seconds) in a table. Continue timing until no more gas appears to be given off.
6. Repeat steps **1-5** using 1.0 M hydrochloric acid.
7. Plot a graph with ‘Volume of gas produced in cm^3 (for 2.0 M hydrochloric acid)’ on the y-axis and ‘Time in seconds’ on the x-axis.
8. Draw a smooth curved line of best fit
9. Plot a curve for 1.0 M hydrochloric acid on the same graph.
10. Use this graph to compare the rates of reaction of 1.0 M and 2.0 M hydrochloric acid with magnesium
11. Compare your results with the data collected in **Activity 1.**

Required Practical: Rates of Reaction	
Key Words	Relevant Science

Required Practical: Rates of Reaction
Summary Notes

PAST PAPER QUESTIONS: Rates of Reaction

<u>Question 1</u>
A student investigated the rate of reaction between magnesium ribbon and excess dilute hydrochloric acid.

The word equation for the reaction is

magnesium + hydrochloric acid → magnesium chloride + hydrogen

The total volume of hydrogen evolved was measured every 10 seconds for 120 seconds.
The graph in Figure 1 shows the results obtained by the student.

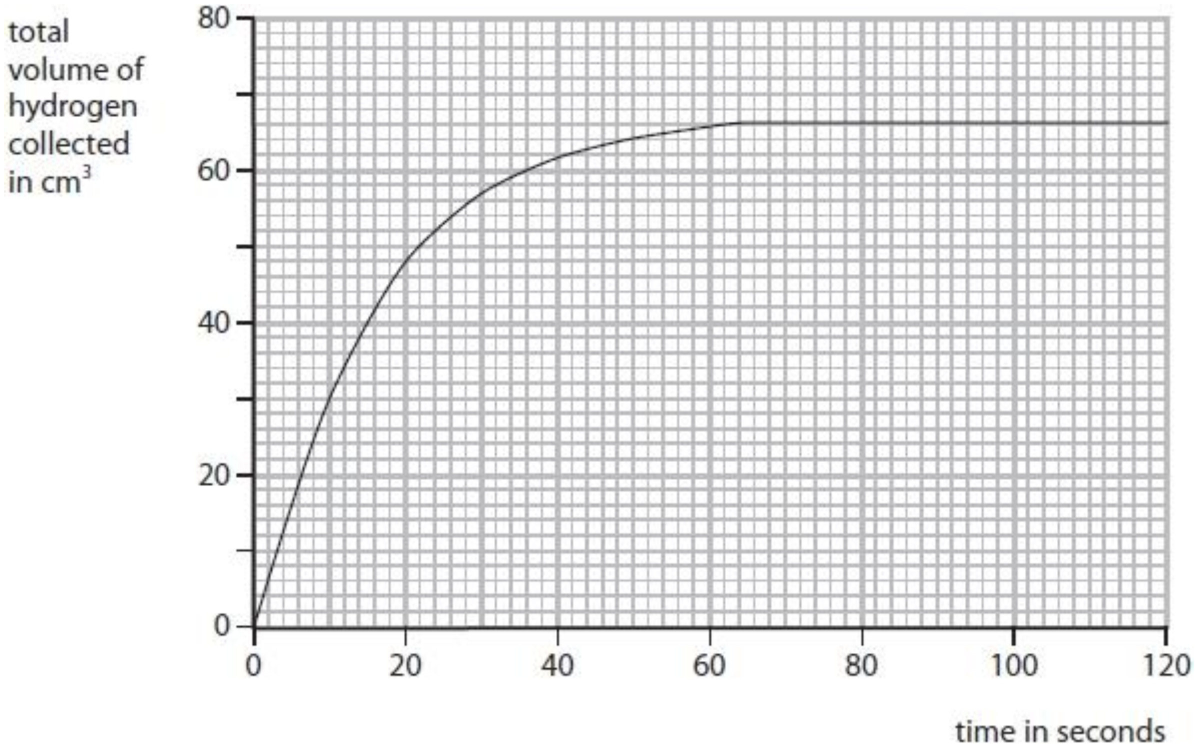


Figure 1

(i) Using the graph, give the time in seconds at which the reaction stopped.

(1)

.... s

(ii) Give the reason why the reaction stopped.

(1)

....

....

(iii) Use the graph to calculate the average rate of reaction during the first 20 seconds, in cm^3 of hydrogen produced per second.

....

....

....

average rate of reaction = ... $cm^3\ s^{-1}$

(iv) The experiment was repeated at a higher temperature, keeping all other conditions exactly the same.
This change caused the reaction to take place more quickly.
On the graph in Figure 1, sketch a line to show the results you would expect in this experiment.

(2)

(v) The rate of the reaction can be changed by adding a solid catalyst to the reaction mixture.
Which line in the table shows how the final volume of hydrogen produced and the mass of the catalyst change?

(1)

	change in final volume of hydrogen	change in mass of catalyst
☐ **A**	increases	no change
☐ **B**	no change	decreases
☐ **C**	no change	no change
☐ **D**	increases	decreases

[7 marks]

Question number	Answer	Mark
(i)	value in the range 60 - 64 (s)	(1)

Question number	Answer	Mark
(ii)	all magnesium is used up	(1)

Question number	Answer	Additional guidance	Mark
(iii)	volume of hydrogen = 48 (1) rate = $\frac{48}{20}$ (1) = or 2.4 ($cm^3\,s^{-1}$)	2.4 only (2) incorrect volume/20 1 mark only	(2)

Question number	Answer	Mark
(iv)	curved line to the left of curve (1) same final volume (which is the maximum volume) (1)	(2)

Question number	Answer	Mark
(v)	C no change, no change	(1)

Chromatography

Summary	Skills
Investigate how paper chromatography can be used to separate and tell the difference between coloured substances. Students should calculate Rf values.	AT 1 - Use of appropriate apparatus to make and record a range of measurements accurately. AT 4 – Safe use of a range of equipment to purify and/or separate chemical mixtures including chromatography. WS: 2.4 and 2.6

Investigation into the use of paper chromatography to separate and identify a mixture of food colourings.

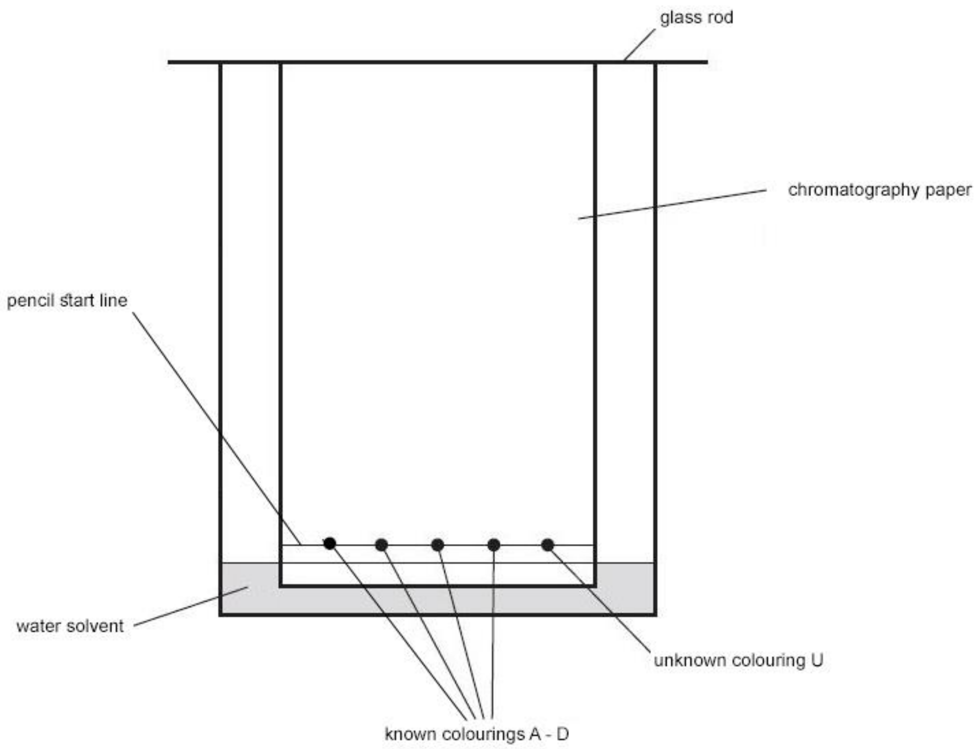
You will use paper chromatography to separate the different colours present in an unknown mixture of food colourings. You will then measure the distance travelled by each colour and the solvents to calculate R_f values.

Equipment List

- 250 cm^3 beaker
- Glass rod
- A rectangle of chromatography paper
- Four known food colourings labelled **A**-**D**
- An **unknown mixture** of food colourings labelled **U**
- Glass capillary tubes.

Method

1. Use a ruler to draw a horizontal pencil line 2 cm from a short edge of the chromatography paper. Mark five pencil spots at equal intervals across the line. Keep at least 1 cm away from each end.
2. Use a glass capillary tube to put a small spot of each of the known colourings on four of the pencil spots. Then use the glass capillary tube to put a small spot of the unknown mixture on the 5th pencil spot. Try to make sure each spot is no more than 5 mm in diameter. Label each spot **in pencil**.
3. Pour water into the beaker to a depth of **no more than 1 cm**.
4. Tape the edge of the chromatography paper to the glass rod. The paper needs to be taped at the end furthest from the spots. Rest the rod on the top edge of the beaker. The bottom edge of the paper should dip into the water. **Ensure that the pencil line is above the water surface and that the sides of the paper do not touch the beaker wall.**
5. Wait for the water solvent to travel at least three quarters of the way up the paper. Do **not** disturb the beaker during this time. Carefully remove the paper. Draw another pencil line on the dry part of the paper as close to the wet edge as possible.



6. Hang the paper up to dry thoroughly.
7. Measure the distance in mm between the two pencil lines. This is the distance travelled by the water solvent.
8. Measure and record the same distance for each food colouring in a table.
9. For each of the four known colours, measure the distance in mm from the bottom line to the centre of each spot. Write each measurement in the table.
10. Use the following equation to calculate the R_f value for each of the known colours. Write the calculated values in the table.

$$R_f = \frac{\text{distance moved by substance}}{\text{distance moved by solvent}}$$

10. Match the spots in mixture **U** with those from **A–D**. Use the colour and distance travelled to help you. Which of colourings **A–D** are in mixture **U**? Are there any other colourings in mixture **U** which do **not** match **A–D**?

Required Practical: Chromatography	
Key Words	Relevant Science

Required Practical: Chromatography

Summary Notes

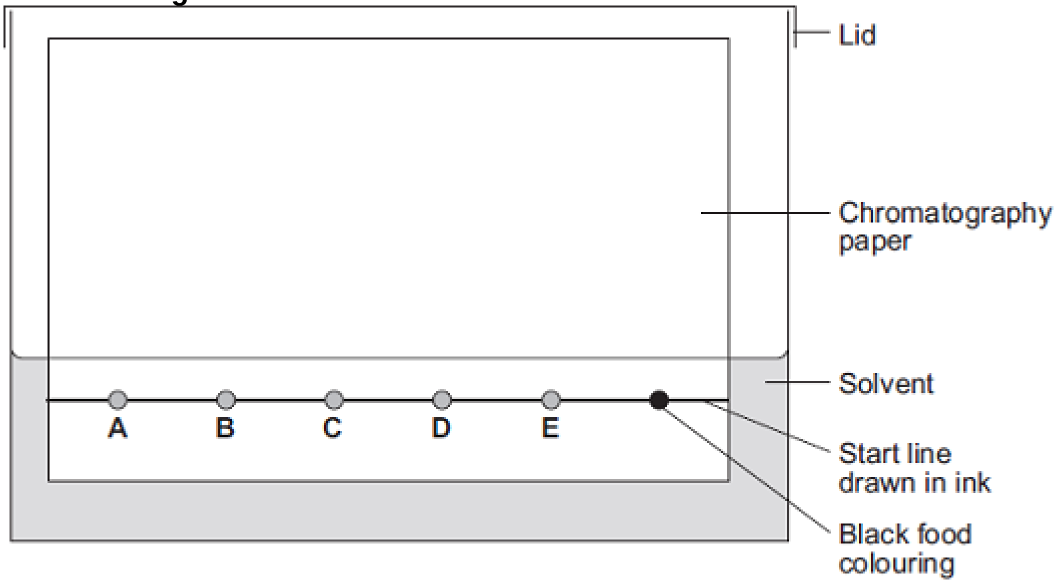
PAST PAPER QUESTIONS: Chromatography

<u>Question 1</u>
Chromatography can be used to separate components of a mixture.

(a) A student used paper chromatography to analyse a black food colouring.

The student placed spots of known food colours, **A**, **B**, **C**, **D** and **E**, and the black food colouring on a sheet of chromatography paper. The student set up the apparatus as shown in **Diagram 1**.

Diagram 1



The student made **two** errors in setting up the apparatus.
Identify the **two** errors and describe the problem each error would cause.

....

....

....

....

....

....

....

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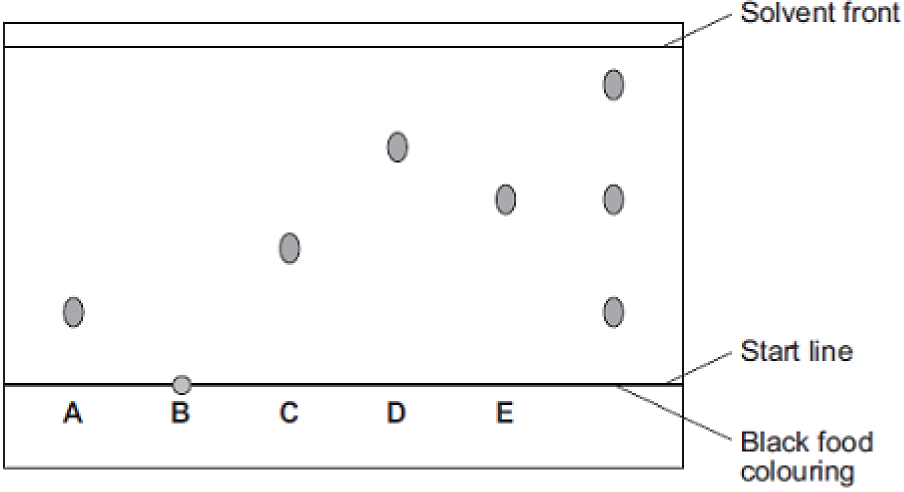
(4)

(b) A different student set up the apparatus without making any errors.
The chromatogram in **Diagram 2** shows the student's results.

Diagram 2



(i) What do the results tell you about the composition of the black food colouring?

....

....

....

(2)

(ii) Use **Diagram 2** to complete **Table 1**.

Table 1

	Distance in mm
Distance from start line to solvent front	…………………
Distance moved by food colour **C**	…………………

(2)

(iii) Use your answers in part **(b) (ii)** to calculate the R_f value for food colour **C**.

....

....

R_f value = ………………………

(1)

(c) **Table 2** gives the results of chromatography experiments that were carried out on some known food colours, using the same solvent as the students.

Table 2

Name of food colour	Distance from start line to solvent front in mm	Distance moved by food colour in mm	R_f value
Ponceau 4R	62	59	0.95
Carmoisine	74	45	0.61
Fast red	67	27	0.40
Erythrosine	58	17	0.29

Which of the food colours in **Table 2** could be food colour **C** from the chromatogram?
Give the reason for your answer.

....

....

....
(2)

(d) Two types of chromatography are gas chromatography and paper chromatography.
Give **one** advantage of gas chromatography compared with paper chromatography.

....

....
(1)
(Total 12 marks)

Mark Scheme

(a) start line drawn in ink

1

so it will run / dissolve in the solvent / split up
allow mixes with the spots

1

spots under solvent **or** solvent above spots / start line

1

so they will mix with solvent **or** wash off paper **or** colour the solvent **or** dissolve in the solvent

1

(b) (i) contains **A** and **E**

1

and one other (unknown substance)
*if no other marks awarded, an answer saying it is made up of three colours gains **1** mark*

1

(ii) 45 or 46
allow any value from 45 to 46

1

18
allow any value from 16 to 20
*award **1** mark if numbers correct but in cm*

1

(iii) 0.40
*allow ecf from **(b)(ii)***
ignore units

1

(c) fast red
*allow ecf from **(b)(iii)***

1

has same R_f value
*allow none of them, as none has the same R_f value for **2** marks*

1

(d) any **one** from:

- more accurate
- more sensitive
- uses small quantities of samples
- quicker / faster / more rapid
- can link to mass spectrometer (MS)

1
[12]

Question 2

The label shows the ingredients in a drink called Cola.

Cola
Ingredients:
Carbonated water
Sugar
Colouring
Phosphoric acid
Flavouring
Caffeine

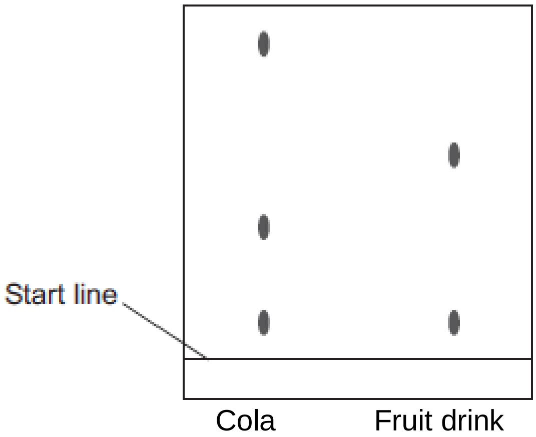
(a) (i) The pH of carbonated water is 4.5.
The pH of Cola is 2.9.
Name the ingredient on the label that lowers the pH of Cola to 2.9.

....
(1)

(ii) Which ion causes the pH to be 2.9?

....
(1)

(b) A student investigated the food colouring in Cola and in a fruit drink using paper chromatography.
The chromatogram in the figure below shows the student's results.



(i) Complete the sentence.
The start line should be drawn with a ruler and ____________________ .
Give a reason for your answer.

....

....
(2)

(ii) Suggest **three** conclusions you can make from the student's results.

....

....

....

....

....

....
(3)

(c) Caffeine can be separated from the other compounds in the drink by gas chromatography.
Why do different compounds separate in a gas chromatography column?

....

....
(1)

(d) Caffeine is a stimulant.
Large amounts of caffeine can be harmful.
(i) Only **one** of the questions in the table **can** be answered by science alone.
Tick (✓) **one** question.

Question	**Tick** (✓)
Should caffeine be an ingredient in drinks?	
Is there caffeine in a certain brand of drink?	
How much caffeine should people drink?	

(1)

(ii) Give **two** reasons why the other questions **cannot** be answered by science alone.

Reason 1..

....

Reason 2 ....

....
(2)
(Total 11 marks)

Mark Scheme
(a) (i) (phosphoric) acid
allow phosphoric
1

(ii) H^+ / hydrogen (ion)
if ion symbol given, charge must be correct
1

(b) (i) pencil **1**
so it will not run / smudge / *dissolve*
ignore pencil will not interfere with / affect the results
or
because ink would run / smudge / *dissolve*
ignore ink will interfere with / affect the results **1**
(ii) any **three** from:
*reference to spots / dots = max **2***
allow colouring for colour
- *3* colours in Cola

*allow more colours in cola **or** fewer colours in fruit drink*
- *2* colours in Fruit drink
- one of the colours is the same
- two of the colours in Cola are different
- one of the colours in Fruit drink is different

allow some of the colours in the drinks are different
- *one of the colours in Cola is the most soluble*

accept one of the colours in Cola has the highest R_f value
3

(c) different substances travel at different speeds **or** have different retention times
accept different attraction to solid
ignore properties of compounds

1

(d) (i) Is there caffeine in a certain brand of drink?

1

(ii) any **two** from:
- cannot be done by experiment
- based on opinion / *lifestyle choice*
- ethical, *social* or economic issue

accept caffeine has different effects on different people

2
[11]

Identifying Ions (Separate Sciences only)

Summary	**Skills**
Use of chemical tests to identify the ions in unknown single ionic compounds covering the ions from sections 4.8.3.1 to 4.8.3.5	AT 1 - Safe use of a Bunsen burner. AT 8 - Use of appropriate qualitative reagents and techniques to analyse and identify unknown samples or products including gas tests, flame tests, precipitation reactions. WS: 2.4 and 2.6

Identify the ions in a single ionic compound using chemical tests
You will analyse a range of known ionic compounds. The methods you will use are:

- flame testing
- addition of acids
- addition of barium chloride
- addition of silver nitrate.

You will then apply the knowledge you gain to identify the ions in an unknown compound.

Equipment List

- Bunsen burner
- test tubes and test tube rack
- teat pipette
- nichrome wire mounted in handle
- limewater
- 0.4 M dilute hydrochloric acid
- 0.1 M barium chloride solution
- 0.4 M dilute nitric acid
- 0.05 M silver nitrate solution
- Known labelled solutions: chlorides of lithium, sodium, potassium, calcium and copper
- known labelled solutions: sodium salts containing carbonate, sulfate, chloride, bromide and iodide
- salt solution labelled ‘unknown’.

Methods

Flame Tests

1. Pour around 1 cm depth of each of the **labelled chloride solution**s into five test tubes in the rack.
2. Dip the nichrome wire into the first solution. Then hold the tip of the wire in a blue Bunsen burner flame.
3. Record your observation in a table.
4. Clean the wire carefully.
5. Repeat steps **2–4** for each of the other four solutions.
6. Empty and clean the test tubes.

Carbonate test

1. Pour around 1 cm depth of each of the **labelled sodium solutions** into five test tubes in the rack.
2. Place 2 cm depth of limewater in a sixth test tube.
3. Add 1 cm depth of **dilute hydrochloric acid** to each sodium salt in turn. **Only if you see bubbles**, **quickly** use the teat pipette to transfer the gas produced to the limewater. Your teacher may show you how to do this. You will need to take several pipettes of the gas to get a change in the limewater.
4. Record your results in a separate table.
5. Empty and clean the test tubes.

Sulfate test

1. Pour around 1 cm depth of each of the **labelled sodium solutions** into five test tubes in the rack.
2. Add a few drops of **dilute hydrochloric acid** to each solution. Then add 1 cm depth of **barium chloride** solution.
3. Record your observations in the table.
4. Empty and clean the test tubes.

Halide test

1. Pour around 1 cm depth of each of the **labelled sodium solutions** into five test tubes in the rack.
2. Add a few drops of **dilute nitric acid** to each solution. Then add 1 cm depth of **silver nitrate** solution.
3. Record your observations in the table.

Unknown compound

1. Repeat the flame, carbonate, sulfate and halide tests on the unknown salt solution.
2. Use your results to identify the positive metal ion in the unknown compound, as well as the negative non-metal ion.

Required Practical: Identifying Ions	
Key Words	Relevant Science

Required Practical: Identifying Ions

Summary Notes

PAST PAPER QUESTIONS: Identifying Ions

Question 1

(a) Substance **X** is an ammonium salt.

(i) A test was carried out to find which anion is present in substance **X**.
Dilute hydrochloric acid was added to a sample of substance **X**.
There was effervescence and the gas given off turned limewater milky.

The anion present in substance **X** is:

(1)

- ☐ **A** carbonate ion, CO_3^{2-}
- ☐ **B** chloride ion, Cl^-
- ☐ **C** nitrate ion, NO_3^-
- ☐ **D** sulfate ion, SO_4^{2-}

(ii) Describe how sodium hydroxide solution can be used to show that ammonium ions are present in substance **X**.

(2)

....

....

....

(b) Aluminium ions, Al^{3+}, react with hydroxide ions in solution to give a white precipitate of aluminium hydroxide. Write the ionic equation for this reaction.

(3)

....

(c) A technician found some colourless crystals of a substance left, unlabelled, in a beaker in a laboratory.
She knew the substance was one of potassium sulfate, potassium iodide, sodium sulfate or sodium iodide.

Explain how, using chemical tests, the technician could find out if the substance left in the beaker was potassium sulfate, potassium iodide, sodium sulfate or sodium iodide.
You may include equations in your answer.

(6)

....

....

....

....

....

....

....

....

....

[12 marks]

	Answer	Acceptable answers	Mark
(a)(i)	A carbonate ion CO_3^{2-}		**(1)**
(a)(ii)	A description including warm / heat / boil (1) **gas/ammonia** turns (damp red/pink) litmus blue / (damp red/pink) litmus turns blue when held above (the mixture)(1)	maximum (1) if additional reagents added ignore any ppt allow pungent smell / smell of ammonia/wet nappies /alkaline **gas /** effect of ammonia on other named indicators /dense white fumes with conc hydrochloric acid ignore litmus turns blue in ammonium ions/sodium hydroxide/mixture do not allow gas/ammonia if blue litmus turns red/pink	**(2)**
(b)	$Al^{3+} + 3OH^- \rightarrow Al(OH)_3$ OH^- (1) $Al(OH)_3$ (1) balancing 3, conditional on correct formulae (1)	allow multiples allow HO^- (1) allow $Al(HO)_3$ (1) do not allow $Al(HO)^3$/lower case h ignore state symbols/$3Na^+$ on both sides	**(3)**

		Indicative Content	Mark
QWC	***(c)**	An explanation including some of the following points **test for cation** • flame test • if the flame is yellow/not lilac, sodium ions are present • if the flame is lilac/not yellow, potassium ions are present**test for iodide ions** • make a solution of the crystals in water • add dilute nitric acid • add silver nitrate solution • if there is a yellow precipitate, iodide ions are present • if there is no precipitate, sulfate ions are present • $Ag^+ + I^- \rightarrow AgI$OR • make a solution of the crystals in water • add chlorine water • then cyclohexane • if the cyclohexane/top layer turns purple, iodide ions were present • if there is no colour change, sulfate ions are present • $Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$**test for sulfate ions** • make a solution of the crystals in water • add dilute hydrochloric/nitric acid • add barium chloride/nitrate solution • if there is a white precipitate, sulfate ions are present • if there is no precipitate, iodide ions are present • $Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$	**(6)**
Level	**0**	No rewardable content	
1	**1 - 2**	• a limited description of test for any 1 ion e.g. flame test, yellow flame, sodium ions are present. • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	**3 - 4**	• a simple description to identify a cation and an anion e.g. if the substance is sodium sulfate, it will give a yellow flame in a flame test and a white precipitate with barium chloride solution. • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy	
3	**5 - 6**	• a detailed description to identify at least 3 ions e.g. carry out a flame test, yellow flame, sodium ions present, lilac flame, potassium ions present, add silver nitrate solution to solution of substance, yellow precipitate, iodide ion. • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors	

Water Purification

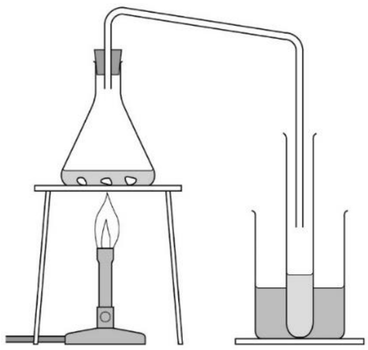
Summary	Skills
Analysis and purification of water samples from different sources, including pH, dissolved solids and distillation.	AT 2 - Safe use of appropriate heating devices and techniques including use of a Bunsen burner and a water bath or electric heater. AT 3 - Use of appropriate apparatus and techniques for the measurement of pH in different situations. AT 4 - Safe use of a range of equipment to purify and/or separate chemical mixtures including evaporation, distillation. WS: 2.3, 2.4, 2.5, 2.6 and 2.7

Distillation of salt water to produce potable water
You will test salt water for the presence of sodium and chloride ions. You will then distil the water and test the water again. If the ions have been removed the water is now safe to drink.

Equipment List

- 10 cm^3 salt water
- Bunsen burner
- tripod
- gauze
- heatproof mat
- 250 cm^3 beaker
- clamp stand
- 250 cm^3 conical flask
- delivery tube with bung
- test tubes ×2
- ice
- test tube rack
- nichrome wire
- dilute nitric acid
- silver nitrate solution

Method



1. Pour around 1 cm depth of the salt water into a test tube in the rack. Dip the nichrome wire into this solution, and then hold the tip of the wire in a blue Bunsen burner flame. Record your observation in a table. A yellow flame test confirms the presence of sodium ions.
2. Add a few drops of dilute nitric acid to this solution. Then add 1 cm depth of silver nitrate solution. Again, record your observations in the table. A white precipitate with nitric acid and sliver nitrate solution confirms the presence of chloride ions.
3. Place the remaining salt water in the conical flask. Set up the apparatus for distillation as shown in the diagram.
4. Make sure the conical flask is held on the tripod and gauze using the clamp stand. Put a mixture of ice and water in the beaker surrounding the test tube.
5. Boil the water using the Bunsen burner. Then reduce the heat so that the water boils gently. Distilled water will collect in the cooled test tube. Collect about 1cm depth of water in this way, then stop heating.
6. Repeat the tests in steps **1** and **2** again using the distilled water. Make sure that the nichrome wire and test tube have been cleaned. Again, record your results in the table.

Required Practical: Water Purification	
<u>Key Words</u>	<u>Relevant Science</u>

Required Practical: Water Purification

Summary Notes

PAST PAPER QUESTIONS: Water Purification

Question 1

Water from a lake in the UK is used to produce drinking water.

(a) What are the two main steps used to treat water from lakes?
Give a reason for each step.

Step 1 ....

Reason ....

Step 2 ....

Reason ....

(2)

(b) Explain why it is more difficult to produce drinking water from waste water than from water in lakes.

....

....

....

....

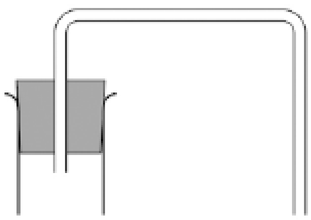
....

....

(3)

(c) Some countries make drinking water from sea water.

Complete the figure below to show how you can distil salt solution to produce and collect pure water.
Label the following:
- pure water
- salt solution



(3)

(d) How could the water be tested to show it is pure?
Give the expected result of the test for pure water.

....

....

....

....

(2)

(e) Why is producing drinking water from sea water expensive?

....

....

(1)
[11 marks]

Mark Scheme

(a) filtration

or

by passing through filter beds to remove solids

1

sterilisation to kill microbes

allow chlorine / ozone allow ultraviolet light

1

(b) water needs more / different processes

1

because it contains any **two** from:

- more organic matter
- more microbes
- toxic chemicals or detergents

2

(c) *(as part of glassware attached to bung)*

salt solution in (conical) flask

allow suitable alternative equipment, eg boiling tube

1

(at end of delivery tube)

pure water in test tube which must not be sealed

allow suitable alternative equipment, eg, beaker, condenser

1

heat source (to heat container holding salt solution)

1

*if no other mark obtained allow for **1** mark suitable equipment drawn as part of glassware attached to bung **and** at end of delivery tube*

(d) determine boiling point

1

should be at a fixed temperature 100°C

allow should be 100°C

allow if impure will boil at a temperature over 100°C

1

(e) high energy requirement

1

[11]