Rewarding Learning

GCSE Double Award Science Chemistry

Practical Manual

Centres are responsible for their own hazard analysis and risk assessment before beginning this practical work with pupils.

Double Award Science Chemistry Practical Manual

Content/Specification Section Page

C.1 Investigate the reactions of acids, including temperature changes that occur

Introduction

Acids react with metals, bases and carbonates to produce salts. In this practical you will record observations for these different reactions. In addition, you will record temperature changes which occur in some acid reactions, using a thermometer.

Some general observations which you may find are:

- bubbles indicating that a gas is produced
- the solid reactant disappearing and producing a solution
- a colour change for example copper(II) oxide is a black powder, and copper(II) carbonate is a – green solid which react with acid to produce a blue copper(II) solution
- the test tube may feel warm due to heat released

Safety

Wear safety glasses and if a chemical touches your skin wash it off with water.

Follow any other safety advice given by your teacher.

Experiment 1

Apparatus and Chemicals

- Boiling tube
- Boiling tube rack
- 25 cm^3 measuring cylinder
- Splint
- Bunsen burner
- Hydrochloric acid
- 2 cm strip of magnesium
- 2 cm piece of zinc
- 2 cm strip of copper

Method

1. Measure out 15 cm^3 of hydrochloric acid using a measuring cylinder and add to a boiling tube.
2. Add the magnesium strip to the boiling tube. Ensure that the magnesium is fully immersed in the acid by swirling and allow the reaction to proceed for about ten seconds.
3. Light a splint and hold the lit splint just above the mouth of the test tube containing the magnesium and acid.
4. Record all observations in the table below.
5. Repeat steps 1 and 2 using a piece of zinc. Record your observations.
6. Repeat steps 1 and 2 using a piece of copper. Record your observations.

Observations

Reaction	Observations
Hydrochloric acid + magnesium	
Hydrochloric acid + zinc	
Hydrochloric acid + copper	
Testing the gas with a lit splint	

Questions

1. In the reaction of magnesium and acid a gas is produced. Name the gas produced. Use results from your table to verify your answer.

2. Write a word equation for the reaction of zinc and hydrochloric acid.

3. Write a balanced symbol equation with state symbols for the reaction of magnesium and hydrochloric acid.

4. Write a balanced equation for the reaction occurs when the gas produced is tested with a lit splint.

5. From your results table name the least reactive metal.

Experiment 2

An acid will react with metal oxides. In this reaction, you will react sulfuric acid and copper(II) oxide.

Apparatus and Chemicals

- Kettle
- 250 cm^3 beaker
- 100 cm^3 beaker
- 25 cm^3 measuring cylinder
- Spatula
- Glass rod
- Heatproof mat
- Universal indicator paper
- Sulfuric acid
- Copper(II) oxide on a watch glass

Method

Record observations for steps 1, 6, and 8 in the table below.

1. Place a piece of universal indicator paper on a white tile and use a glass rod to add a drop of sulfuric acid onto the piece of universal indicator paper. Record the colour and pH.
2. Using a measuring cylinder, measure out 25 cm^3 of sulfuric acid into the small beaker.
3. Using hot water from a kettle, fill the 250 cm^3 beaker about ⅓ full with hot water.
4. Warm the sulfuric acid beaker by letting it rest (carefully) in the hot water bath (leave for 2 minutes).
5. Carefully remove the small beaker and add a spatula of copper(II) oxide to the acid slowly and stir with a glass rod.
6. Keep adding the copper(II) oxide, until there is some left over at the bottom of the beaker.
7. Let the beaker sit for 2 minutes to allow the black powder to settle.
8. Place a piece of universal indicator paper on a white tile and use a glass rod to add a drop of the solution from the medium beaker to the universal indicator paper. Record the colour and pH.

Test	Observation
1	
6	
8	

Questions

1. At the end of the experiment, you were asked to test the pH again – did you find that the pH is now higher? Why do you think this is?

2. Write the balanced symbol equation for the reaction between copper(II) oxide and sulfuric acid.

Experiment 3

An acid will usually release heat when it reacts.

In this experiment you are going to react an acid with an alkali and measure the temperature change during the reaction. The acid will react to produce a salt and water – no gas is produced.

Apparatus and Chemicals

- Polystyrene cup
- 250 cm^3 beaker
- Thermometer
- 25 cm^3 measuring cylinder
- Hydrochloric acid
- Sodium hydroxide solution
- Deionised water bottle

Method

1. Place the polystyrene cup into the 250 cm^3 beaker.
2. Using a measuring cylinder place 25 cm^3 of hydrochloric acid in the polystyrene cup.
3. Measure the initial temperature of the hydrochloric acid and record the result in the results table.
4. Rinse the measuring cylinder with deionised water and measure out 25 cm^3 of sodium hydroxide solution. Measure the temperature of the sodium hydroxide solution and record the result in the results table.
5. Add the sodium hydroxide solution to the acid, stir with the thermometer, measure and record the highest temperature reached during the reaction.

Initial temperature of acid /°C	Initial temperature of sodium hydroxide solution /°C	Average initial temperature /°C	Highest temperature reached /°C	Temperature change /°C

Questions

1. Why was a polystyrene cup used in this experiment?

---

2. Why was the polystyrene cup placed in a glass beaker?

---

3. Use your result to explain if this reaction is an exothermic or endothermic reaction.

---

4. Write an ionic equation for this neutralisation reaction. Include state symbols in your answer.

Experiment 4

In this reaction you will react calcium carbonate with hydrochloric acid and test the gas. Carbon dioxide gas is denser than air so it can be collected in and bubbled through the limewater.

Apparatus and Chemicals

- 25 cm^3 measuring cylinder
- 10 cm^3 measuring cylinder
- Boiling tube
- Test-tube
- Disposable pipette/dropper
- Test-tube rack
- Hydrochloric acid
- Calcium carbonate
- Limewater

Method

1. Measure 15 cm^3 of hydrochloric acid using the 25 cm^3 measuring cylinder and place into the boiling tube.
2. Measure 3 cm^3 of limewater using the 10 cm^3 measuring cylinder and place into a test-tube. Place the test-tube and boiling tube side by side in a rack.
3. Add the calcium carbonate to the acid.
4. Using the disposable pipette, collect the gas produced by opening and closing the dropper above the reaction in the boiling tube.
5. Once the gas has been collected in the disposable pipette, bubble the gas through the limewater and record your observations.

Observations

_____

_____

_____

Questions

1. Write a balanced symbol equation for the reaction between the calcium carbonate and hydrochloric acid.

_____

2. Write the equation for the reaction of carbon dioxide with limewater. Include state symbols.

_____

C.2 Identifying the ions in an ionic compound using flame tests

Introduction

Ionic compounds contain positive ions and negative ions. Positive ions are called cations. In this experiment, you will carry out flame tests to identify the positive ions present in ionic compounds.

Some positive ions produce an intense colour in a Bunsen burner flame which can be used to identify them.

Apparatus and materials

- Sodium chloride
- Calcium chloride
- Lithium chloride
- Potassium chloride
- Copper(II) chloride
- X and Y (unknown compounds)
- Concentrated hydrochloric acid
- Heatproof mat
- Nichrome wire

Safety

Follow safety advice given by teacher.

Method

1. Take a piece of nichrome wire with a loop at one end.
2. Dip the loop in the concentrated hydrochloric acid and place in the blue flame of the Bunsen burner.
3. Repeat until the flame is no longer coloured, and the wire is clean i.e. impurities are removed.
4. Dip the clean nichrome wire in concentrated hydrochloric acid and then into the solid ionic compound.
5. Place the compound in the blue Bunsen burner flame and record the flame colour obtained.
6. Repeat for all the solid ionic compounds available, cleaning the wire loop each time.
7. Repeat the test for the unknown compounds labelled X and Y and identify the metal ions which they contain.

Table of Results

Compound	Flame colour	Cation present
Calcium chloride		
Copper(II) chloride		
Lithium chloride		
Potassium chloride		
Sodium chloride		
X		
Y		

C.3 Investigate the reactivity of metals

Introduction

Displacement reactions can be used to determine the reactivity of different metals. A displacement reaction is one in which a more reactive metal takes the place of a less reactive metal in a compound. In this practical a metal will be added to a solution of a different metal salt. If a reaction occurs the metal added is more reactive than the metal in solution. To determine if a reaction occurs you can note observations or measure the temperature change.

Apparatus and Chemicals

- Boiling tube rack
- Boiling tubes
- Copper(II) sulfate solution
- Magnesium sulfate solution
- Zinc sulfate solution
- Iron(II) sulfate solution
- Copper
- Zinc
- Iron
- Magnesium
- Stopclock

Safety

Wear safety goggles and follow the safety advice given by your teacher.

Method

1. Measure out 15cm^3 of copper(II) sulfate solution, zinc sulfate solution and iron (II) sulfate solution using a measuring cylinder and place each sample in a different boiling tube.
2. Add a piece of magnesium to each test tube.
3. Leave for 3 minutes.
4. Place a tick in the correct place in table 1 if a reaction occurred. Record all observations in table 2.
5. Repeat steps 1 – 4 using copper(II) sulfate solution, magnesium sulfate solution and iron(II) sulfate solution and zinc metal.
6. Repeat steps 1 – 4 using copper(II) sulfate solution, magnesium sulfate solution and zinc sulfate solution and iron metal.
7. Repeat step 1 – 4 zinc sulfate solution, magnesium sulfate solution and iron(II) sulfate solution and copper metal.

Results

Table 1

	Copper	Magnesium	Iron	Zinc
Copper(II) sulfate		✓		
Magnesium sulfate				
Iron(II) sulfate				
Zinc sulfate				

Table 2: Observations

	Copper	Magnesium	Iron	Zinc
Copper(II) sulfate				
Magnesium sulfate				
Iron(II) sulfate				
Zinc sulfate				

Questions

1. Use the results of your experiment to place the four metals in order from most to least reactive.

2. Explain why a reaction occurred between magnesium and copper(II) sulfate.

3. Write a balanced symbol equation for the reaction between magnesium and copper(II) sulfate.

4. Write an ionic equation for the reaction between magnesium and copper(II) sulfate.

5. Explain what happens to the magnesium, in terms of electrons, in this reaction.

6. Describe how you could practically determine the reactivity of magnesium compared to copper, zinc and iron, using the apparatus and chemicals given in this practical and a thermometer.

C.4 Investigate how changing a variable changes the rate of reaction

Introduction

Rate of a reaction is a measure of the speed of a chemical reaction and can be calculated from a time using the expression rate = $\frac{1}{\text{time}}$

The time may be for the rection to finish, as in this experiment, and can be determined by timing from the start of the reaction until there is no more fizzing and the solid reactant disappears.

Different variables such as temperature, concentration and surface area can change the rate of reaction. In this experiment you will investigate the effect of changing the concentration of hydrochloric acid on the rate of the reaction between magnesium and hydrochloric acid. The controlled variables, which need to be kept the same in the experiment include the volume of solution, the same mass and particle size of magnesium and the same temperature.

Safety

Wear safety glasses.

Follow safety advice given by your teacher.

Apparatus and Chemicals

- Hydrochloric acid
- 10 × 3 cm strips of magnesium
- 100 cm^3 beaker
- 250 cm^3 beaker
- Deionised water bottle
- 2 × measuring cylinders (25 cm^3 and 10 cm^3)
- Stop clock

Method 1

1. Using the measuring cylinder, measure out 25 cm^3 of hydrochloric acid and add to the small beaker.
2. Drop the piece of magnesium ribbon into the beaker and start the stopclock, swirl once to ensure the magnesium is fully coated in the acid.
3. Stop the stopclock when all the magnesium disappears. Record the time in seconds in the results table.
4. Repeat the experiment to ensure reliability and average the results.
5. Repeat steps 2 – 4 using a total of five different volumes of acid and deionised water to ensure different concentrations of acid. Use the most appropriate size of measuring cylinder and for each measurement and rinse with deionised water between uses.
6. Calculate the rate and record your results in the table.

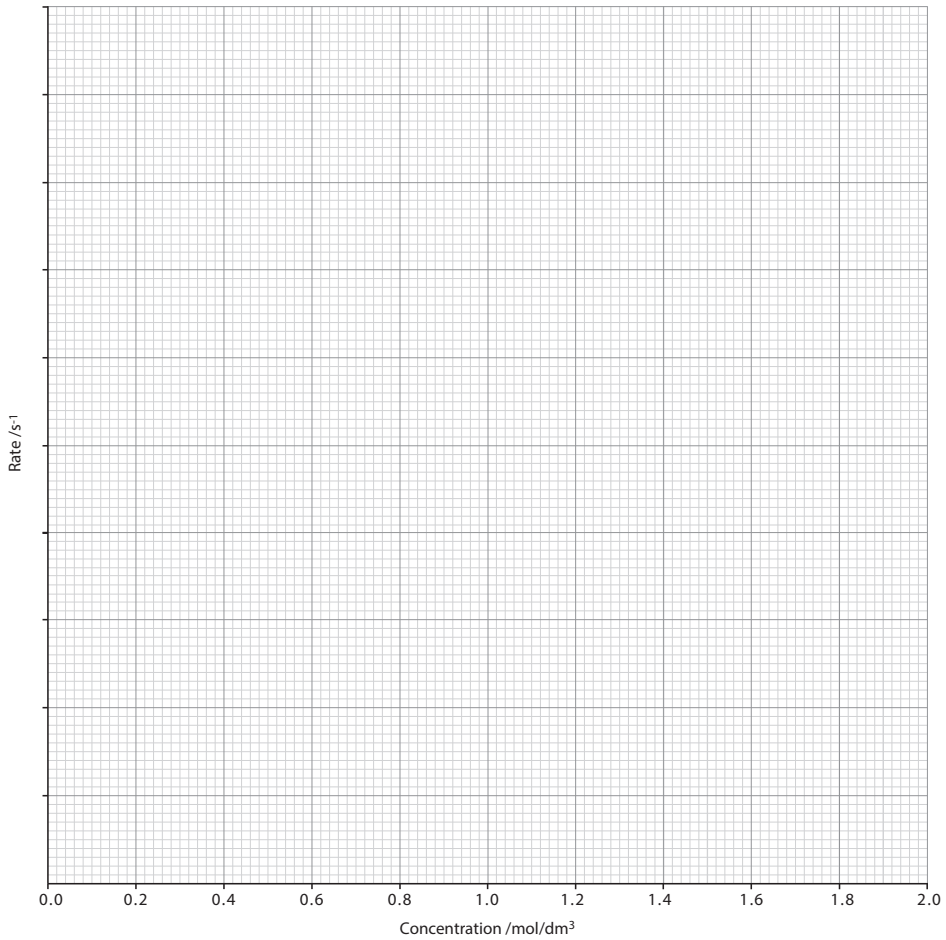
Volume of hydrochloric acid /cm^3	Volume of deionised water /cm^3	Concentration of hydrochloric acid /mol/dm^3	Time taken for magnesium to disappear /s	Repeat time taken for magnesium to disappear /s	Average time /s	Rate /s^{-1}
25	0	2.0				
10	5	1.6				
15	10	1.2				
10	15	0.8				
5	20	0.4				

Questions

1. State the trend in your results.

_____

2. Plot a graph of rate against concentration on the axes below. State the trend shown by the graph.



Trend: _____

C.5 Determine the mass of water present in hydrated crystals

Introduction

Hydrated crystals contain water of crystallisation. **Water of crystallisation** is water which is chemically bonded into the crystal structure. When heated, hydrated crystals lose their water of crystallisation and become anhydrous. **Anhydrous** solids do not contain water of crystallisation and are powdery.

To determine the mass of water of crystallisation present in hydrated crystals the crystals can be heated gently to constant mass. To heat to constant mass:

– weigh the crystals and container

– heat for a few minutes, allow to cool then weigh

– repeat the heating and weighing until the mass does not change

An evaporating basin is most often used to heat the hydrated crystals, however for small masses a crucible may be used.

In this experiment you will determine the mass of water present in hydrated iron(II) sulfate crystals.

Apparatus and chemicals

- Hydrated iron(II) sulfate $FeSO_4.xH_2O$
- Spatula
- Bunsen burner, tripod and gauze
- Heatproof mat
- Evaporating basin
- Tongs
- Electronic balance
- Stopclock

Safety

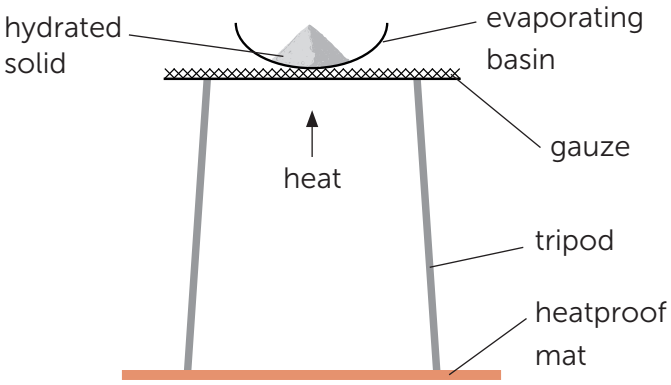
Wear safety goggles as the solid may spit when being heated.

Gentle heating should be carried out to reduce risk of spitting. Strong heating could cause $FeSO_4$ to decompose into iron(III) oxide and sulfur dioxide, so heat gently and use a well-ventilated lab.

Allow hot apparatus to cool before touching it, to reduce the risk of burns.

Iron(II) sulfate has a caution hazard symbol on the bottle. Wash hands if it touches your skin.

Diagram



Method

1. Weigh an evaporating basin and record this mass value in your results table to 2 decimal places.
2. Keep the evaporating basin on the balance and add between 1.50 g and 1.70 g of hydrated iron(II) sulfate crystals.
3. Record the mass of the evaporating basin and the crystals in your results table.
4. Place the evaporating basin containing the crystals on the gauze and heat gently for two minutes. You should heat gently to avoid decomposition and the formation of brown iron(III) oxide.
5. Allow to cool and reweigh the evaporating basin and its contents. Record the mass in your results table.
6. Heat the evaporating basin and its contents for a further two minutes, allow to cool, reweigh and record the mass in your results table.
7. Repeat step 6 until the mass readings are the same. You will now have heated to constant mass and all the water of crystallisation has been removed.

Results table

	Mass /g
Mass of evaporating basin	
Mass of evaporating basin and contents before heating	
Mass of evaporating basin and contents after heating for 2 minutes	
Mass of evaporating basin and contents after heating for 4 minutes	
Mass of evaporating basin and contents after heating for 6 minutes	
Mass of evaporating basin and contents after heating for 8 minutes	

Observations

Questions

1. Describe and explain what your results show.

2. Use your results to calculate:
   (a) The mass of hydrated iron(II) sulfate used.

   (b) The mass of anhydrous iron(II) sulfate produced.

   (c) The mass of water present in the hydrated iron(II) sulfate crystals.

   (d) Calculate the relative formula mass (RFM or M_r) of anhydrous $FeSO_4$.

   (e) Calculate the number of moles of anhydrous $FeSO_4$ produced.

   (f) Calculate the number of moles of water of crystallisation present in the hydrated iron(II) sulfate.

   (g) Use your results to parts (e) and (f) to determine the value of x in the formula $FeSO_4.xH_2O$. **(Higher only)**.

3. The formula of hydrated iron(II) sulfate is $FeSO_4.7H_2O$. Suggest why a value obtained in this experiment would be:
   (a) Higher than 7.

   (b) Lower than 7.

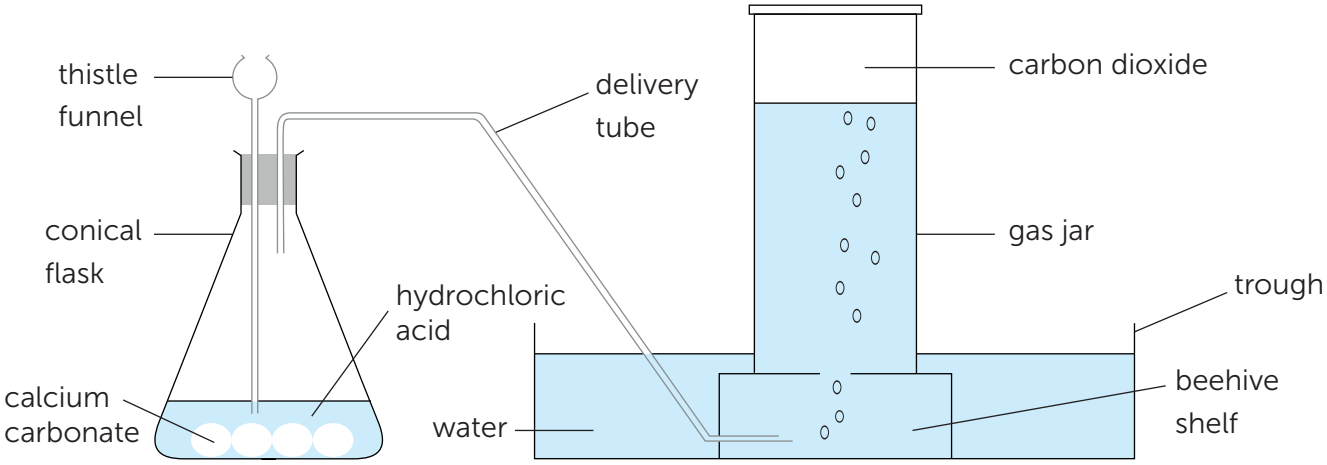
C.6 Investigate the preparation, properties, tests and reactions of the gases hydrogen, oxygen and carbon dioxide

Introduction

Hydrogen, oxygen and carbon dioxide can be prepared, on large scale in the laboratory using the apparatus below. These gases are insoluble or have a low solubility in water so they can be collected over water. As the gas is produced the water is displaced and the level in the gas jar moves down so it is easy to see when the gas jar is full of the prepared gas.

In this practical you will prepare some gas jars of carbon dioxide using this apparatus and carry out some tests on the gas. You will also prepare test tubes of oxygen and hydrogen and test for the gases.

Carbon dioxide



Apparatus and Chemicals

- Apparatus shown in the diagram above
- Calcium carbonate
- Hydrochloric acid
- Wooden splint
- Limewater
- Universal indicator solution

Safety

Wear safety glasses and follow any other safety instructions given by your teacher.

Method

1. Place 3 g of calcium carbonate into the conical flask and set up the apparatus as shown in the diagram.
2. Have three gas jars filled with water and inverted in trough of water.
3. Slowly pour 50 cm^3 of hydrochloric acid into the thistle funnel, wait 5 seconds and then carefully place the first water filled gas jar on the beehive over the end of the delivery tube.
4. Allow the gas jar to fill with gas, leave the gas jar in the water to retain the gas and replace it with another water filled gas jar.
5. Repeat step 4 until three gas jars of gas have been collected. Remove each gas jars from the water as required for the following tests.

Test 1

To the first gas jar insert a lit splint – record your observations.

Test 2

To the second gas jar add 1 cm^3 of limewater, stopper and shake – record your observations.

Test 3

To the third gas jar add 5 drops of universal indicator and shake – record your observations. Add a little deionised water if no change observed and shake again.

Questions

1. Underline the correct answer in each of the following statements.
   Carbon dioxide is:

- able/not able to support combustion
- acidic/basic
- able to react with limewater to produce a soluble/insoluble product

2. Use your experimental results to explain each of your answers to question 1.

3. Name the two substances used to produce carbon dioxide in the laboratory and write a balanced symbol equation for the reaction which occurs.

Hydrogen

Apparatus and chemicals

- Hydrochloric acid
- Zinc
- Wooden splint
- Test tube
- Test tube rack
- Measuring cylinder
- Bunsen burner

Method

1. Measure out 10 cm^3 of hydrochloric acid and place in a test tube.
2. Add a piece of zinc. Wait ten seconds and test the gas by holding a lit split above the level of the liquid in the test tube.
3. Record your observations in the table below.

Appearance of hydrochloric acid	
Appearance of zinc	
Observations during the reaction	
Observations with a lit split	

Questions

1. Name the two chemicals used to prepare hydrogen on a large scale in the laboratory and write a balanced symbol equation for the reaction which occurs.

_____

_____

2. Write a balanced symbol equation for the reaction which occurs during the test for hydrogen.

_____

Oxygen

Apparatus and chemicals

- Manganese(IV) oxide
- Hydrogen peroxide solution
- Wooden Splint
- Spatula
- Test tube
- Test tube rack
- 10 cm^3 measuring cylinder
- Bunsen burner

Method

1. Measure out 10 cm^3 of hydrogen peroxide and place in a test tube.
2. Add half a spatula of manganese(IV) oxide. Wait ten seconds and test the gas by holding a glowing split above the level of the liquid in the test tube.
3. Record your observations in the table below.

Appearance of hydrogen peroxide solution	
Appearance of manganese(IV) oxide	
Observations during the reaction	
Observations with a glowing split	

Questions

1. You may have noticed tiny bubbles in the hydrogen peroxide solution in the test tube at the start of the experiment. Explain why these bubbles are present.

2. State the purpose of the manganese(IV) oxide.

3. Name the two chemicals used to prepare oxygen on a large scale in the laboratory and write a balanced symbol equation for the reaction which occurs.

COUNCIL FOR THE **CURRICULUM, EXAMINATIONS** AND **ASSESSMENT**
29 Clarendon Road, Clarendon Dock, Belfast BT1 3BG
Tel: +44(0)28 9026 1200 Email: info@ccea.org.uk
Web: www.ccea.org.uk

Rewarding Learning