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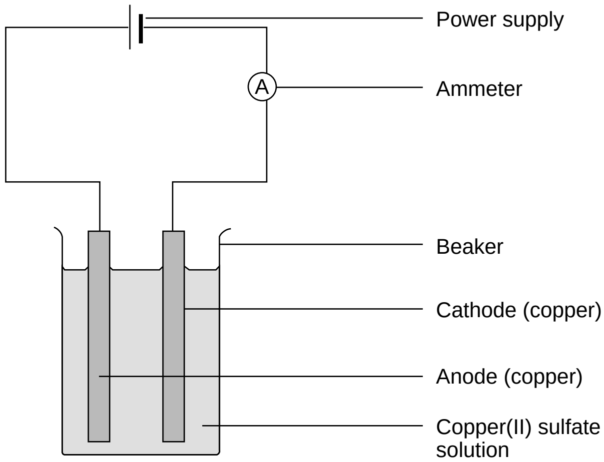
Quantitative electrolysis

Introduction

When electrolysis is done on a commercial scale it is important to know how much current is required and for how long. This experiment relates the amount of metal removed from an electrode to the electric current and the time the current flows.



What to record

- The masses of the electrodes before electrolysis (identify the electrodes by writing on them).
- The masses of the electrodes after electrolysis.
- The current flowing.
- The time the current flows.

What to do

1. Clean the electrodes with emery paper (avoid inhaling any dust).
2. Weigh the anode.
3. Immerse the electrodes to a depth of 3–4 cm in the solution of copper(II) sulfate.
4. Allow about 0.4 A to pass for about 30 min.
5. Remove the anode, wash carefully in water and dry gently with a paper towel.
6. Reweigh the anode.

Safety

Wear eye protection.

Questions

1. Calculate the number of moles of copper that have been removed from the anode.(Mass lost in g / 63.5)
2. Calculate the charge that has flowed through the circuit using the relationship charge (in Coulombs) = current (in amps) x time (in seconds).
3. Using the answers to questions 1 and 2, calculate the number of Coulombs required to remove one mole of copper.
4. 193,000 (2 x 96,500) Coulombs is required to remove one mole of copper. The difference between this and the answer to question 3 is due to errors in the experiment. What are the main sources of error in this experiment?

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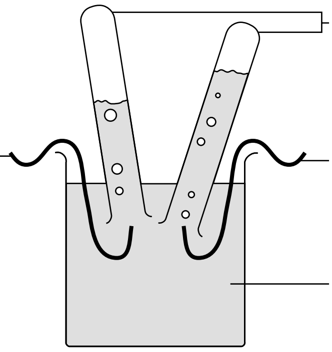
The electrolysis of solutions

Introduction

When electricity passes through molten compounds, like sodium chloride, the ions move towards the electrode of opposite charge. Sodium chloride gives sodium metal and chlorine gas. This experiment illustrates what happens when the system is made more complicated because water is present. Electricity is passed through various solutions and the products are identified.



What to record

Solution	Product at the anode	Product at the cathode

What to do

1. Set up the apparatus as shown.
2. Switch on and observe what happens.
3. Try to identify the gases produced (if any).

Safety

Wear eye protection

The gases produced may be flammable, oxidising, and toxic. Take care not to inhale them. Do not let the current flow for very long. Some of the solutions are toxic.

Questions

1. What type of element is formed at the negative electrode?
2. What type of element is formed at the positive electrode?
3. Your table of results should show some products, which could not come from the compound itself that was electrolysed. Where could these other products have come from?
4. Write a general rule for the products formed at
   (*a*) the cathode
   (*b*) the anode.

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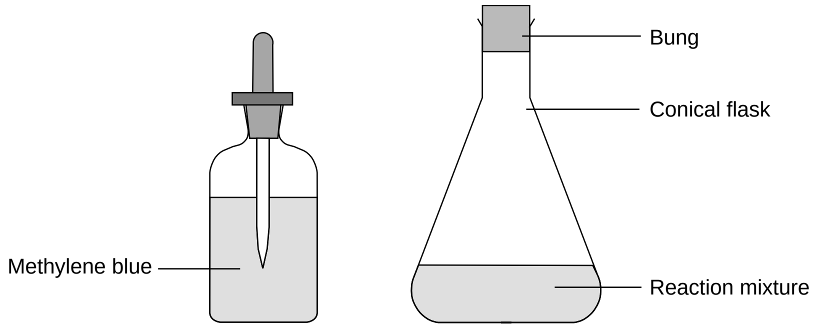
An oxidation and reduction reaction

Introduction

A conical flask contains a colourless solution. When shaken, a blue colour forms. After a few seconds, the blue colour fades and the solution again becomes colourless. The process can be repeated. It is an oxidation followed by a reduction process



What to do

1. Put some water in the conical flask. Put in the stopper. Shake vigorously to check for leaks. If there are none, pour the water away and proceed.
2. Put 100 cm^3 of potassium hydroxide solution into a conical flask.
3. Add 3.3 g dextrose.
4. Add 3–4 drops of methylene blue indicator.
5. Put a stopper on the flask.
6. Shake vigorously.
7. When the solution clears, repeat the process.
8. It is necessary periodically to remove the stopper.

Safety

Wear eye protection.

Questions

1. Why is it necessary to periodically remove the stopper?

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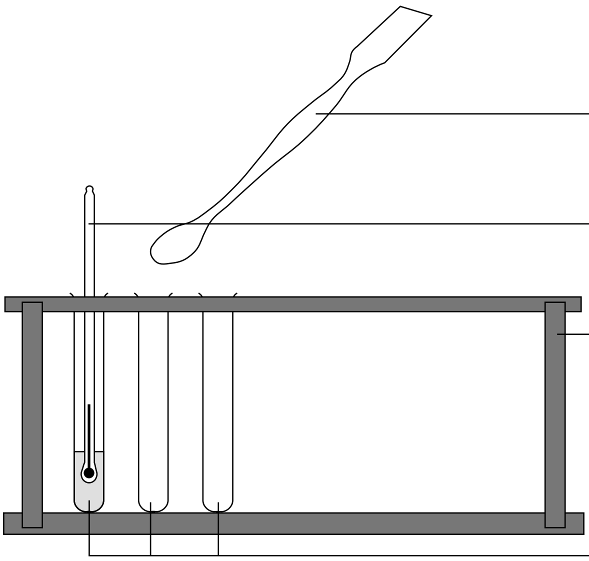
Heats of reaction (exothermic or endothermic reactions)

Introduction

Instant hot and cold packs are available for use in first aid. This experiment illustrates the types of chemical reaction that occur in these packs.



What to record

What was done and any changes in temperature from the starting temperature of your reaction. A table may be useful.

Initial solution	Temperature of solution/°C	Solid added	Final temperature of mixture/°C	Temperature change	Type of reaction

What to do

Experiment 1.

1. Put 2 cm^3 of water in a test-tube.
2. Record the temperature of the water.
3. Add a spatula measure of anhydrous (white) copper (II) sulfate.
4. Carefully stir, using the thermometer, and record the temperature again.

Experiment 2.

1. In a dry test-tube mix one spatula measure of citric acid and one spatula measure of sodium hydrogencarbonate.
2. Put 2 cm^3 of water in another test tube.

3. Record the temperature of the water.
4. Add the mixture to the water.
5. Watch what happens and take the temperature of the solution.

Experiment 3.

1. Put about 5 cm^3 of copper(II) sulfate solution in a test-tube.
2. Record the temperature.
3. Add a spatula measure of powdered zinc.
4. Record the new temperature.

Safety

Wear eye protection.

Anhydrous copper(II) sulfate is harmful.

Zinc powder is flammable.

Questions

1. Which reactions are exothermic and which are endothermic?
2. Write word and symbol equations for Experiment 3.
3. Which two substances could be put in a cold pack?
4. Golfers need a hand warmer to keep their hands warm on a cold day. Which chemicals could be put in these warmers?

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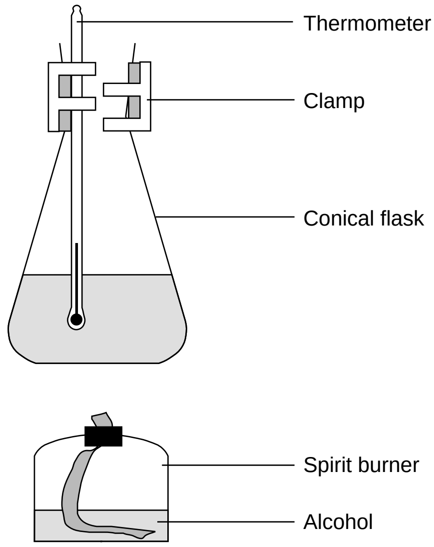
Comparing the heat energy produced by combustion of various alcohols

Introduction

The combustion of alcohol produces energy. This experiment compares the amount of heat produced by the combustion of various alcohols.



What to record

Alcohol	Initial temp/°C	Final temp/°C	Temp change/°C	Initial mass/g	Final mass/g	Mass used/g
Methanol						
Ethanol						
Propanol						
Butanol						

What to do

1. Fill the conical flask with 100 cm^3 of water. Clamp the flask at a suitable height so that the spirit burner can be easily placed below.
2. Weigh the spirit burner (and lid) containing the alcohol and record the mass and name of the alcohol.
3. Record the initial temperature of the water using the thermometer.
4. Place the spirit burner under the conical flask and light the wick.

5. Allow the alcohol to heat the water so the temperature rises by about 40 °C.
6. Replace the cap to extinguish the flame.
7. Reweigh the spirit burner and cap and work out the mass of alcohol used.

Repeat for different alcohols. Use 100 cm^3 of new cold water each time.

Safety

Wear eye protection. Do not open the spirit burner.

Question

1. Which fuel provides the most energy per gram?

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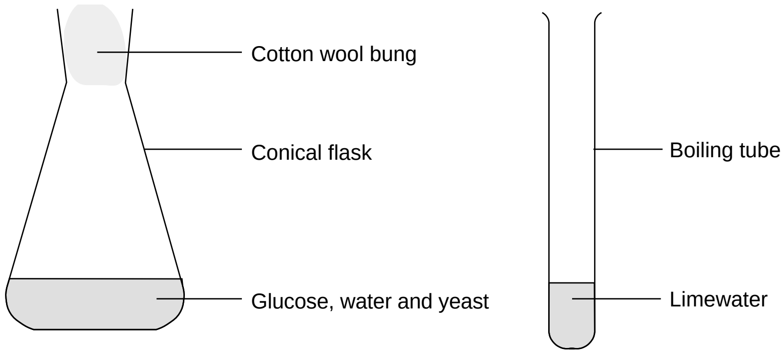
Fermentation

Introduction

Beer and wine are produced by the fermentation of glucose by yeast. In this experiment, a glucose solution is left to ferment. The resulting mixture is then tested for the presence of any fermentation products.



What to record

What was seen to happen to the limewater.

What to do

Lesson 1

1. Put 5 g of glucose in the flask and dissolve it in 50 cm^3 of warm water.
2. Add 1 g of yeast to the glucose solution and plug the top with cotton wool.
3. Wait 20 min while fermentation takes place.
4. Remove the cotton wool and pour the invisible gas from the flask into the boiling tube with limewater. Take care not to pour any of the liquid as well.
5. Gently swirl the limewater round the tube and observe what happens.

Lesson 2

1. Note the smell of the solution.

Safety

Wear eye protection. Do not taste the product.

Questions

1. What gas is present in the flask after fermentation?
2. Suggest a different method for measuring the speed of this reaction.
3. Yeast contains a chemical called zymase, which is an enzyme. Complete the word equation for fermentation.

$$\text{Glucose} \xrightarrow{\text{zymase}} \qquad\qquad + $$

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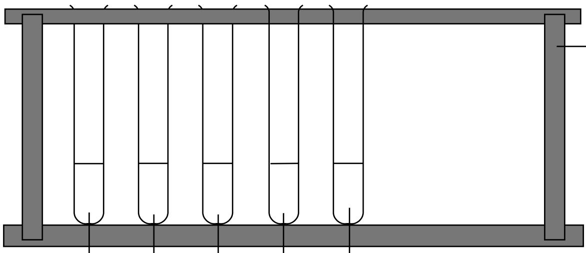
Microbes, milk and enzymes

Introduction

Microbes are responsible for the production of some foods, for example cheese and yoghurt. They are also responsible for food decay. The enzymes they contain are catalysts. This experiment shows how these microbes and enzymes effect various types of milk.



What to do

The experiment needs to be done over two lessons.

First lesson.

1. Place five test-tubes in a test-tube rack. Fill each one to a depth of about 3 cm with five different types of milk.
2. Label each type with a sticky label near the top of the test-tube.
3. Leave in a warm place for between 3-5 days.

Second lesson.

1. Fill a beaker with about 100 cm^3 of tap water and stand the test-tubes in the beaker. Heat over a Bunsen burner to about 60 °C.
2. Turn off the Bunsen burner and carefully lift the beaker off the tripod.
3. Put six drops of rezasurin indicator in each test-tube of milk, shake thoroughly with the normal side to side action.
4. Leave to stand for 15 min and note any colour change.

Key

The rezasurin indicates the number of bacteria present.

Colour	Number of bacteria	Condition of milk
Purple	None	Completely sterilised
Blue	Few	Milk still fresh
Pink	Some	Milk on the turn
Colourless	Many	Milk has gone off

Safety

Do not taste any of the milk.

Safety

Wear eye protection.

The transition metal compounds may be harmful or irritant, as may their solutions, depending on the concentration.

Ammonia vapour irritates eyes, lungs and the respiratory system

Answers

1. They are hard, dense and shiny. They are good conductors of heat and electricity. They are also malleable and ductile.
2. Transition metals react with water very slowly, if at all.
3. As well as the above they also form coloured compounds. They form compounds that can have more than one formula.

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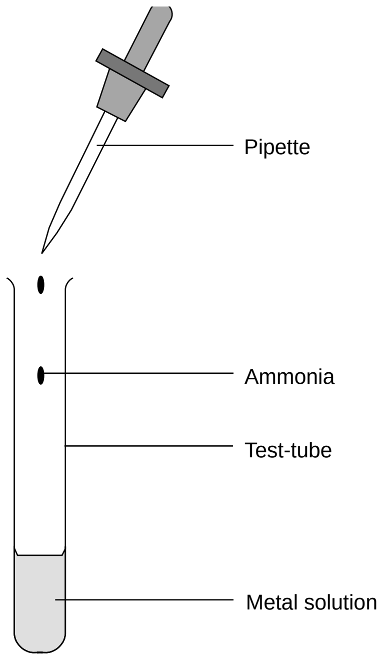
Properties of the transition metals and their compounds

Introduction

The Periodic Table allows chemists to see similarities and trends in the properties of chemical elements. This experiment illustrates some properties of the common transition elements and their compounds.



What to record

What was observed. A table may be useful.

What to do

1. Test the metal samples for hardness and ability to bend without breaking. Complicated apparatus is not needed for this! Record your answers qualitatively.
2. Find out which samples are magnetic.
3. Set up an experiment to see if the metals react with water. (This may need to be left for some time).
4. Take a small sample of a solution of copper(II) sulfate (approximately 2 cm^3), add ammonia solution to it a few drops at a time. Record your observations. Add ammonia solution until there is no further change.
5. Repeat with the other solutions of transition metal compounds.

Safety

Wear eye protection.

The transition compounds may be harmful or irritant.

Ammonia vapour irritates eyes, lungs and the respiratory system.

Questions

1. Describe the physical properties of transition metals.
2. How do transition metals react with water?
3. What properties do the compounds of transition metals have in common?

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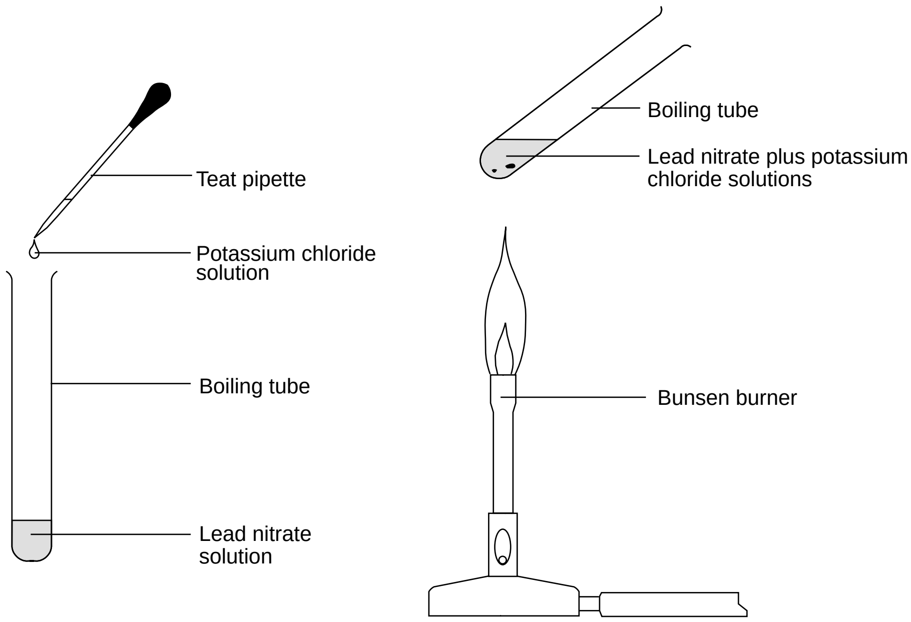
Halogen compounds

Introduction

The halogens are elements of Group 7 of the Periodic table. This experiment illustrates some of the trends and similarities within the compounds of this group.



Safety

Wear eye protection.

What to record

What was observed. The table may be used.

What to do

Test 1 Silver nitrate	**Observations**
Put a little sodium chloride solution (Cl^- ions) in a test-tube and add five drops of silver nitrate solution. Leave in the light for a few minutes.	
Put a little sodium bromide solution (Br^- ions) in a test-tube and add five drops of silver nitrate solution. Leave in the light for a few minutes.	
Put a little sodium iodide solution (I^- ions) in a test-tube and add five drops of silver nitrate solution. Leave in the light for a few minutes.	

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Test 2 Chlorine water (Toxic vapour)	Observations
Add a few drops of a solution of chlorine (**Toxic vapour**) to sodium bromide solution.	
Add a few drops of a solution of chlorine (**Toxic vapour**) to sodium iodide solution.	

Test 3 Lead nitrate (Toxic)		Observations
Put approximately 4 cm^3 of lead nitrate solution (**Toxic**) into a boiling tube, then add five drops of potassium chloride solution to a boiling tube and heat till it boils.	Place all three tubes in a beaker of cold water to cool.	
Put approximately 4 cm^3 of lead nitrate solution (**Toxic**) into a boiling tube, then add five drops of potassium bromide solution to the boiling tube and heat till it boils.		
Put about 4 cm^3 of lead nitrate solution (**Toxic**) into a boiling tube, then add five drops of potassium iodide solution to a boiling tube and heat till it boils.		

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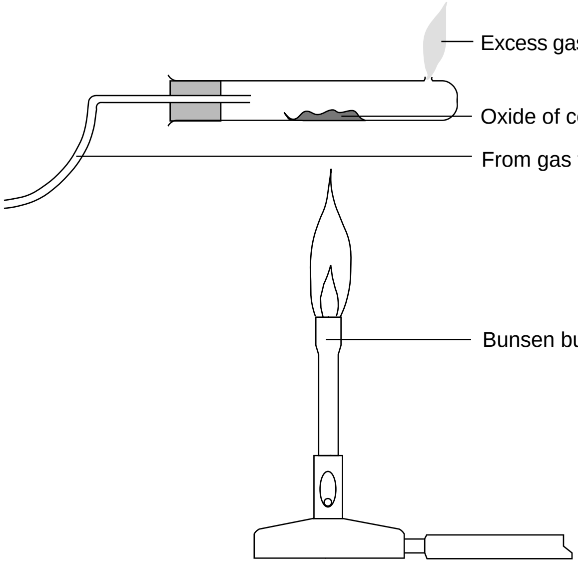
Finding the formula of an oxide of copper

Introduction

The chemical formula gives the types of atom in the substance. It also gives the relative number of each type. From the mass of each element in a sample, the number of moles can be calculated. The lowest whole number ratio provides the simplest chemical formula.



What to record

- Weight of test-tube + bung.
- Weight of test-tube + bung + copper(II) oxide.
- Weight of test-tube + bung + copper.

What to do

1. Weigh the test-tube + bung.
2. Place two spatulas of dry black copper(II) oxide in the centre of the tube. Try to spread it out.
3. Weigh the tube + bung + copper(II) oxide.
4. Assemble the apparatus as shown in the diagram.
5. Pass a gentle stream of gas through the tube without lighting it. This will flush out the air. After a few seconds set light to the gas and adjust the height of the flame coming out of the test tube to about 3 cm. Keep your head well back.
6. Heat the copper(II) oxide strongly and move the flame slowly to and fro. Continue to heat for five min after the solid has turned a brownish pink colour.
7. Stop heating the tube but keep the gas flowing through the test-tube and burning at the end. This prevents re-oxidation of the copper.
8. Let the test-tube cool, turn off the gas and reweigh the tube + bung + copper.

Safety

Wear eye protection

Copper(II) oxide is harmful.

Questions

1. What is the mass of copper(II) oxide used?
2. What is the mass of copper formed?
3. What is the mass of oxygen lost?
4. How many moles of copper were formed?
5. How many moles of oxygen were combined with this number of moles of copper?
6. What is the simplest whole number ratio of moles of copper to moles of oxygen?
7. What is the formula of copper(II) oxide?