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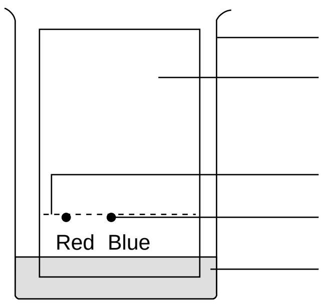
‘Smarties’ chromatography

Introduction

In this experiment dye is removed from the surface of various Smarties. A spot of each colour is put on a piece of chromatography paper and water is allowed to soak up the paper. The results show which mixtures are used to produce particular colours for the Smarties.



What to record

Record the dyes used to make each colour.

What to do

1. Draw a pencil line 1 cm from the bottom of the chromatography paper.
2. Use a clean paintbrush and clean water to remove the colour from a Smartie. Paint the colour in a small spot on to the line on the chromatography paper.
3. Clean the brush and paint the colour of another Smartie on a small spot about 2 cm from the previous spot. Repeat this until all the colours are on the paper.
4. Using the pencil write the name of each colour by the corresponding spot.
5. Roll the paper into a cylinder, hold in place with paper clips. Put the cylinder in a beaker containing 1 cm of water. Allow the water to rise up the paper.
6. When it reaches the top take the cylinder out of the water, carefully unroll it and examine it.

Safety

Do not eat in the laboratory.

Questions

1. Why do some dyes separate into different colours yet others do not?
2. Why do some dyes move further up the chromatography paper than others?
3. Look on the side of the Smarties packet for the list of coloured dyes used. Try and identify which dyes correspond to the spots on the chromatogram.

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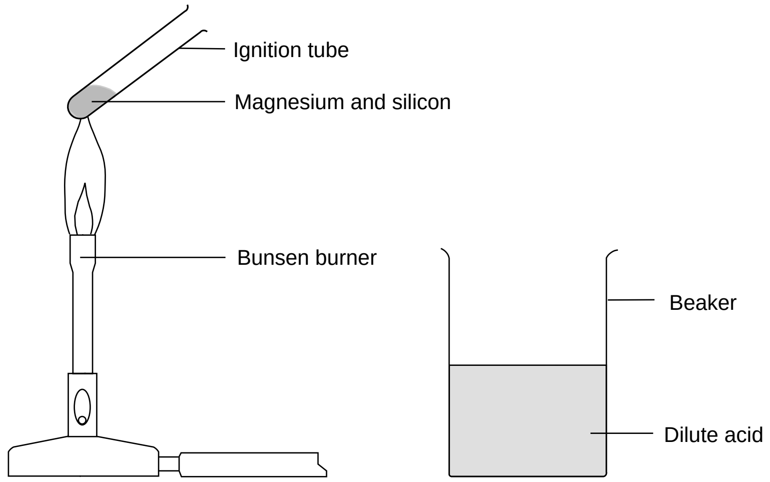
The decomposition of magnesium silicide

Introduction

This experiment illustrates a reaction with low activation energy. Magnesium reacts with silicon to produce magnesium silicide. This then decomposes in dilute acid to produce silane, which spontaneously combusts on contact with air.



What to do

1. Carefully heat equal amounts of silicon and magnesium powder (1 spatula of each) in an ignition tube (behind a safety screen).
2. Use the clamp stand base to crush the cooled tube between two sheets of paper.
3. Put 100 cm^3 of dilute hydrochloric acid into a 1 dm^3 beaker and add 800 cm^3 of tap water.
4. Put the crushed ignition tube with its contents into the dilute acid, stand back and observe. (Do not inhale the fumes, use a fume cupboard if possible, or ensure the room is well ventilated.)

Safety

Wear eye protection.

Questions

The equations for this reaction are:

$2Mg + Si \rightarrow Mg_2Si$

$Mg_2Si + 2H_2O \rightarrow SiH_4(g) + 2MgO$

$SiH_4 + 2O_2 \rightarrow SiO_2 + 2H_2O$

1. What happens when silane meets oxygen?
2. Why does methane (CH_4) not behave in the same way?

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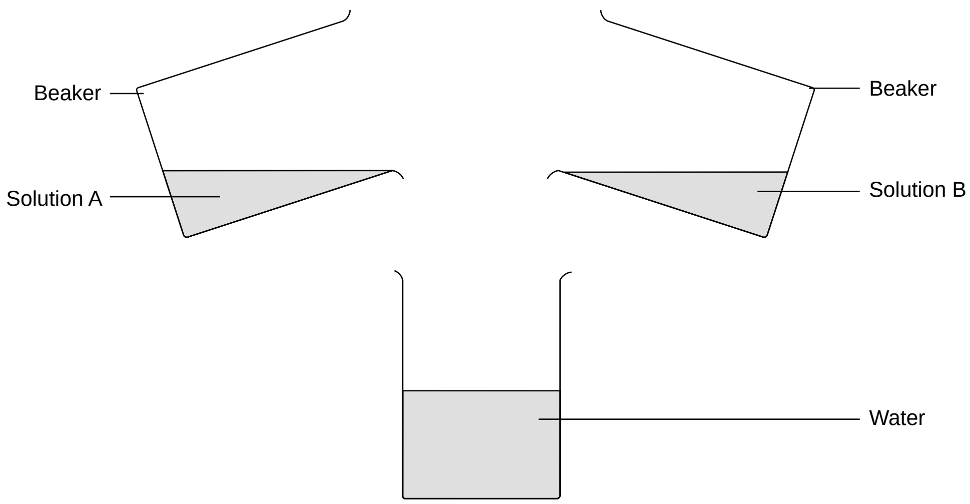
An example of chemiluminescence

Introduction

Chemiluminescence is the emission of light during a chemical reaction. In this experiment two solutions are mixed to produce chemiluminescence.



What to do

1. Collect 30 cm^3 of solution (A).
2. Collect 30 cm^3 of solution (B).
3. In a dark room: add 10 cm^3 of each of the two solutions A and B simultaneously to 50 cm^3 of water in a 100 cm^3 beaker.
4. Repeat this but add dyes such as Fluorescein or Methylene blue to the water before mixing A and B.

Safety

Wear eye protection.

Questions

1. Describe one use for chemiluminescence

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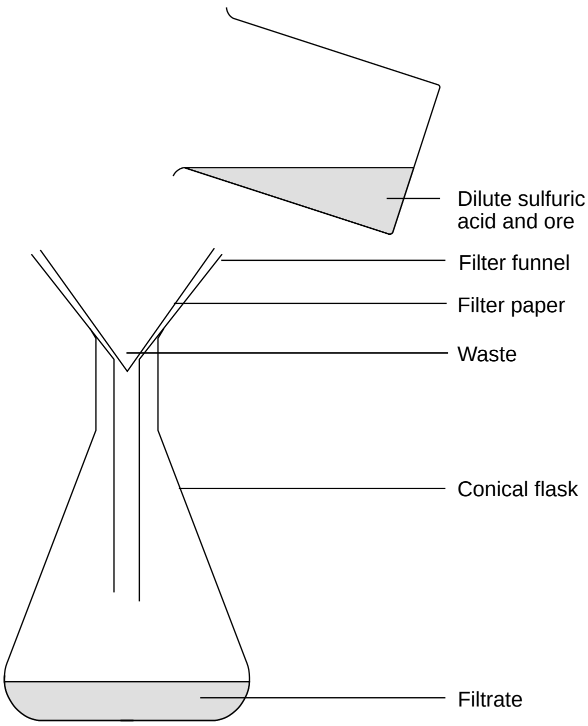
Colorimetric determination of a copper ore

Introduction

An ore is any rock from which a metal may be extracted. Ores contain a mineral of the metal together with waste material. To decide whether an ore is worth mining it is necessary to find out how much of the useful mineral it contains, and how much is waste. This experiment illustrates an example of how this might be done.



What to record

How much copper the ore is estimated to contain.

What to do

1. Weigh 10 g of the ground ore into a beaker.
2. Add 40 cm^3 of 2 mol dm^{-3} sulfuric acid in small amounts. Do not let the mixture go over the top.
3. When the reaction finishes filter the mixture into a conical flask.
4. Add deionised water until the total volume of liquid in the flask is 100 cm^3.
5. Using the laboratory copper(II) sulfate solution, prepare six tubes of diluted copper(II) sulfate, according to the following table. Ensure the solutions are well mixed.

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Tube number	1	2	3	4	5
Volume of copper(II) sulfate solution/cm^3	8	6	4	2	0
Volume of deionised water/cm^3	2	4	6	8	10

6. Pour a sample of the solution from your conical flask into another test-tube.
7. Compare the colour of your tube from part 6 with those from part 5. Which one matches the colour best?
8. Estimate the mass of copper mineral in 10 g of the ore using the following table:

Tube of best match	1	2	3	4	5
Mass of compound in 10 g of ore/g	10	7.5	5	2.5	0

Safety

Wear eye protection. Dilute sulfuric acid is corrosive. When gases are made in a reaction, a mist of fine acid spray is often produced which is dangerous to your eyes and causes irritation if inhaled.

Questions

1. Which part of the ore (copper mineral or waste) causes the blue colour of the solutions?
2. Which part of the ore (copper mineral or waste) was removed by filtration in part 3 of the experiment, and why was this done?
3. How could this experiment be adapted to check the result?

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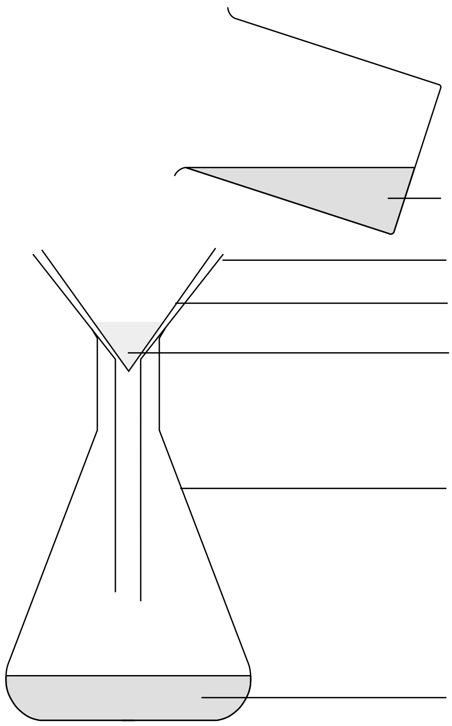
Glue from milk

Introduction

Glue can be made from the protein in milk called casein. In this experiment, polymer glue is prepared from milk. The casein is separated from milk by processes called coagulation and precipitation.



What to do

1. Place 125 cm^3 of skimmed milk into a 250 cm^3 beaker. Add approximately 25 cm^3 of ethanoic acid (or vinegar).
2. Heat gently with constant stirring until small lumps begin to form.
3. Remove from the heat and continue to stir until no more lumps form.
4. Allow the curds to settle, decant some of the liquid (whey) and filter off the remainder using the filter funnel resting on the 250 cm^3 conical flask.
5. Gently remove excess liquid from the curds using the paper towel.
6. Return the solid to the empty beaker. Add 15 cm^3 of water to the solid and stir.
7. Add about half a teaspoon of sodium hydrogen carbonate to neutralise any remaining acid. (Watch for bubbles of gas to appear then add a little more sodium hydrogen carbonate until no more bubbles appear).
8. The substance in the beaker is glue.
9. Find a way to test your glue.

Safety

Wear eye protection.

Questions

1. What is the purpose of the ethanoic acid (vinegar) in this experiment?
2. Why is sodium hydrogencarbonate added?
3. Write an equation for this reaction between ethanoic acid and sodium hydrogencarbonate.

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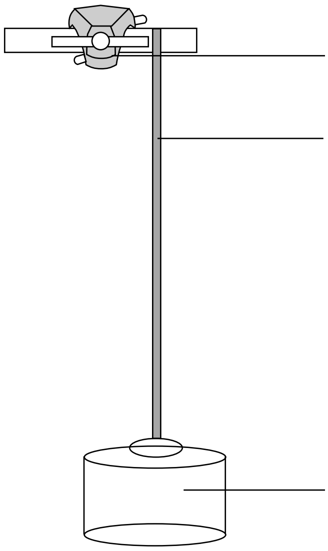
Rubber band

Introduction

This experiment involves an investigation into the effect of heat on a stretched rubber band.



What to record

What was done and what was observed.

What to do

1. Take the rubber band. Quickly stretch it and press it against your lips. Note any temperature change compared with the unstretched band.
2. Now carry out the reverse process. First stretch the rubber band and hold it in this position for a few seconds. Then quickly release the tension and press the rubber band against your lips. Compare this temperature change with the first situation.
3. Set up the apparatus as shown in the diagram. Make sure that if the rubber band breaks the weight cannot drop on toes!
4. Predict what happens if this rubber band is heated with a hair dryer. Write down your prediction. Measure the length of the stretched rubber band.
5. Now heat the rubber band using the hair dryer and observe the result. Does this observation match your prediction? Measure the new length.

Questions

1. Based on your initial testing (by placing the rubber band against your lips) decide which process is exothermic (heat given out): stretching or contracting of the rubber band?
2. The chemist Le Chatelier made the statement '… an increase in temperature tends to favour the endothermic process'. Explain in your own words how this statement and how your answer to question 1 can account for your observations when heating the rubber band.
3. Draw a number of lines to represent chains of rubber molecules showing how they might be arranged in the unstretched and stretched forms. (Hint: the lines of polymer should show less order in the unstretched form than in the stretched form.)

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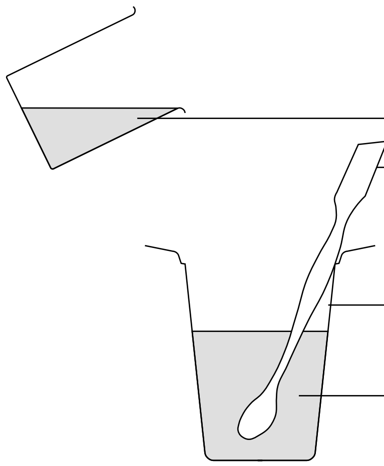
Polymer slime

Introduction

A solution of polyvinyl alcohol can be made into a gel (slime) by adding a borax solution, which creates crosslinks between chains. In this activity, some interesting properties of the slime are investigated.



What to record

Results of the tests.

What to do

1. Collect 40 cm^3 of polyvinyl alcohol solution in a disposable cup containing a spatula.
2. If desired add one drop of food colour or fluoroscein dye to the solution. Stir well.
3. Measure 10 cm^3 of borax solution and add this to the polyvinyl alcohol solution. Stir vigorously until gelling is complete.
4. Remove the slime from the cup and pat and knead it thoroughly to completely mix the contents. Roll the slime around in your hand, gently squeezing the material to remove air bubbles at the same time.

Safety

Wear eye protection.

Questions

Test the properties of your slime

1. Pull slowly – what happens?
2. Pull sharply and quickly – what happens?
3. Roll the slime into a ball and drop it on the bench – what happens?
4. Place a small bit on the bench and hit it with your hand – what happens?
5. Write your name on a piece of paper with a water based felt tip pen. Place the slime on top, press firmly, then lift up slime. What happened to the writing? To the slime? Try the same thing using a spirit-based pen. Does this show the same effect?

6. Place a small piece of your slime on a watch glass or petri dish. Add dilute hydrochloric acid dropwise, stirring well after each drop. When a change is noticed record the number of drops added and your observations.
7. Now add dilute sodium hydroxide solution dropwise to the same sample used in 6 stirring after each drop. When a change is noticed record your observations. Can the whole process be repeated with tests 6 and 7? Try it!

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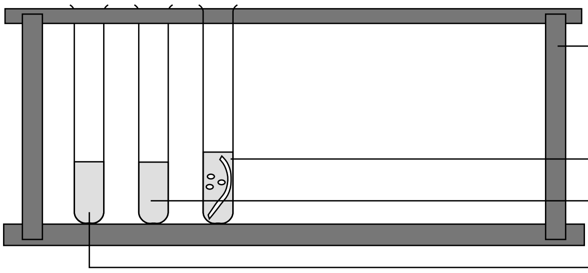
The properties of ethanoic acid

Introduction

Acids are an important group of chemicals. Organic acids are characterised by the presence of a -COOH group attached to a carbon atom. In this experiment, some typical properties of a weak organic acid are observed.



What to record

What was observed.

What to do

1. Use a small quantity (1–2 cm^3 at a time) of dilute ethanoic acid.
2. Observe the effect on full range indicator paper of adding drops of sodium carbonate solution to 2 cm^3 of dilute ethanoic acid.
3. Repeat the experiment with dilute sodium hydroxide solution.
4. Add a small piece of magnesium ribbon to the ethanoic acid. What is observed? Try to confirm the identity of the gas given off.

Safety

Wear eye protection.

Questions

1. Write equations for the reactions of hydrochloric acid (HCl) with: -
   (*a*) sodium carbonate solution (Na_2CO_3)
   (*b*) sodium hydroxide solution (NaOH)
   (*c*) magnesium ribbon (Mg).
2. The formula of ethanoic acid is written as CH_3COOH. Write similar equations for the reactions of ethanoic acid with:
   (*a*) sodium carbonate solution
   (*b*) sodium hydroxide solution
   (*c*) magnesium.

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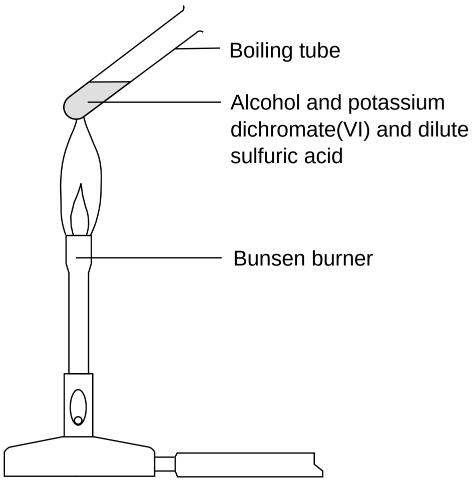
Properties of alcohols

Introduction

Alcohols are an important group of organic chemicals. The alcohol people drink is called ethanol and is produced by fermentation. Alcohols are characterised by an -OH group attached to a carbon atom.



What to record

What was observed.

What to do

1. Take a small quantity of ethanol and add the same volume of water. What is the pH of the mixture? Test the mixture with full range indicator solution. Does the water mix with the ethanol?
2. Put a small quantity of ethanol on a tin lid and ignite it with a splint. Does it burn, and if so, describe the flame.
3. Put 5 cm^3 of dilute sulfuric acid in a boiling tube. Add five drops of potassium dichromate(VI) solution. Now add two drops of ethanol and heat the mixture until it just boils. Is there any sign of a reaction? Is there any change of smell that could come from a new compound?

Safety

Ethanol is highly flammable. Potassium dichromate (VI) is toxic. Wear disposable gloves. Avoid skin contact. Wash hands after use.

Questions

1. What is the name of the process used to produce ethanol on a commercial scale?
2. The reaction of an alcohol to produce an acid is called an oxidation reaction. What is the opposite reaction called that produces an alcohol from an acid?
3. Write a chemical equation for the combustion of ethanol.

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Testing salts for anions and cations

Introduction

Chemists often have to identify the composition of unknown substances. This experiment involves identifying the cations and anions in various salt solutions.

What to record

Sample	Test performed	Result of test

What to do

1. Dissolve the unknown substance in deionised water. 5–10 cm^3 of solution may be needed.
2. Using the analysis table, test small aliquots (portions).
3. Repeat for the other unknown substances.

Safety

Wear eye protection. Some of the unknowns may be toxic or corrosive.

Questions

1. Write word and ionic equations for those reactions that give a positive result.

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Testing salts for anions and cations.

For anions: carry out the three tests A,B and C below:

Test	Anion	Test and observation
A Silver nitrate followed by ammonia solution	Chloride (Cl^-)	Add a few drops of dilute nitric acid (**Irritant**) followed by a few drops of silver nitrate solution. A white precipitate of silver chloride is formed. The precipitate is soluble in ammonia solution.
	Bromide (Br^-)	Add a few drops of dilute nitric acid (**Irritant**) followed by a few drops of silver nitrate solution. A pale yellow precipitate of silver bromide is formed. The precipitate is slightly soluble in ammonia solution.
	Iodide (I^-)	Add a few drops of dilute nitric acid followed by a few drops of silver nitrate solution. A yellow precipitate of silver iodide is formed. It is insoluble in ammonia solution.
B Barium chloride	Sulfate (SO_4^{2-})	Add a few drops of barium chloride solution (**Toxic**) followed by a few drops of dilute hydrochloric acid. A white precipitate of barium sulfate is formed.
C Hydrochloric acid	Carbonate (CO_3^{2-})	Add dilute hydrochloric acid to the solution (or add it to the solid). Bubbles of carbon dioxide are given off.

For cations: carry out the two tests D and E below:

Cation	**D Add sodium hydroxide solution (Irritant)**	**E Add ammonia solution**
Ammonium (NH_4^+(aq))	Warm carefully. Do not allow to spit. Ammonia (alkali gas) is given off	————————
Copper (Cu^{2+}(aq))	Blue (jelly-like) precipitate of $Cu(OH)_2$(s)	Blue jelly like precipitate dissolves in excess ammonia to form a deep blue solution.
Iron(II) (Fe^{2+}(aq))	Green gelatinous precipitate of $Fe(OH)_2$(s)	Green gelatinous precipitate
Iron(III), (Fe^{3+}(aq))	Rust-brown gelatinous precipitate of $Fe(OH)_3$(s)	Rust brown gelatinous precipitate
Lead(II), (Pb^{2+}(aq))	White precipitate $Pb(OH)_2$(s) dissolves in excess NaOH(aq)	White precipitate, $Pb(OH)_2$
Zinc (Zn^{2+}(aq))	White precipitate, $Zn(OH)_2$(s)	White precipitate, $Zn(OH)_2$(s) dissolves in excess NH_3(aq)
Aluminium (Al^{3+}(aq))	Colourless precipitate, $Al(OH)_3$(s)	Colourless precipitate, $Al(OH)_3$(s)

Flame tests.

1. Slightly open the air hole of the Bunsen burner.
2. Heat a piece of nichrome wire in a Bunsen flame until the flame is no longer coloured.
3. Dip the loop at the end of the wire into some water.
4. Dip the loop into an unknown salt.
5. Hold the wire in the edge of the flame.
6. Record the colour and identify the cation using the table below.

Metal	**Colour of flame**
Barium	Apple-green
Calcium	Brick-red
Copper	Green with blue streaks
Lithium	Crimson
Potassium	Lilac
Sodium	Yellow