

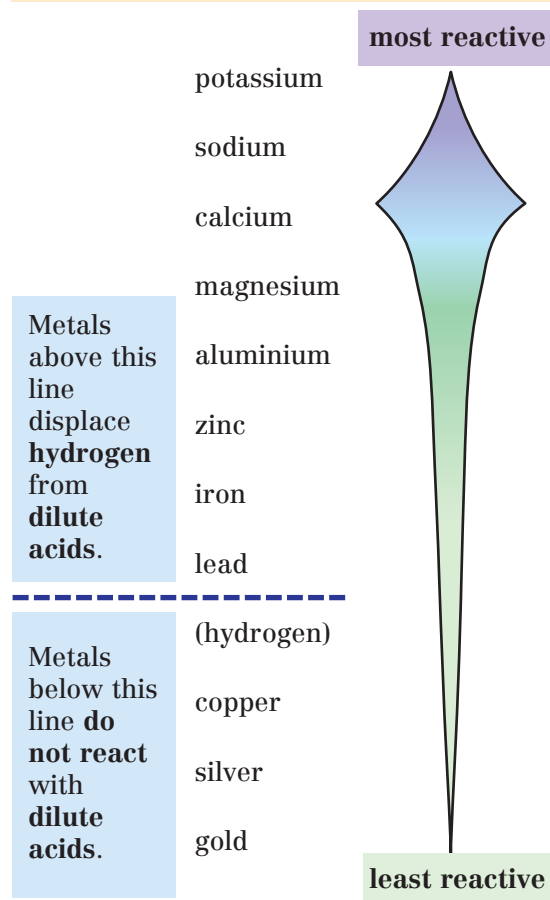


# METALS Reactivity series

Using reactions with oxygen  
reactions with water  
reactions with dilute acids  
reactions with oxides

metals can be placed in an order of reactivity or **Reactivity Series**.

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The more reactive a metal, the more stable its compounds are.

### Questions

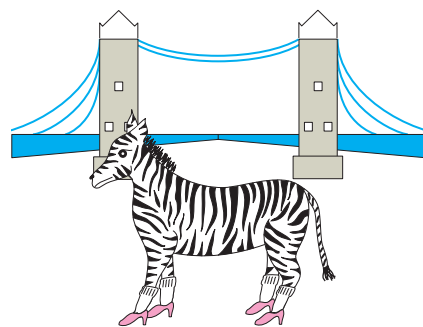
- Which metals in the series displace hydrogen from dilute acids?
- (a) Name the two most reactive elements in the series.  
(b) Would you expect them to occur naturally as elements or compounds? Give a reason for your answer.
- Which metals in the series have the most stable compounds?
- The following table describes some of the reactions of five metals. The metals are copper, iron, magnesium, sodium, and zinc. Identify each of the metals, A–E, and then place them in order of reactivity, most to least.

Metal	Reaction with oxygen	Reaction with dilute hydrochloric acid	Reaction with water
A	does not burn, but becomes coated with a black powder	no reaction	no reaction with water or steam
B	burns with a bright white light to form a white powder	vigorous reaction	reacts slowly with cold water, but more rapidly with steam
C	burns vigorously with a yellow flame to form a white powder	violent reaction	melts and fizzes to produce a colourless gas
D	does not burn easily, but when it does so, forms a black solid	slow reaction	slow reaction with steam
E	does not burn easily, but when it does so, forms a white solid when cool	quite a slow reaction unless powdered	quite a slow reaction with steam

- Give word equations for each of the reactions of B and C with oxygen, dilute hydrochloric acid, and water.
- Write out the Reactivity Series using chemical symbols instead of names.

Although hydrogen is not a metal, it is sometimes included in the Reactivity Series.

**P**ink  
**S**hoes  
**C**an  
**M**ake  
**A**  
**Z**ebra  
**I**n  
**L**ondon  
**H**ave)  
**C**lean  
**S**ocks –  
**G**ood



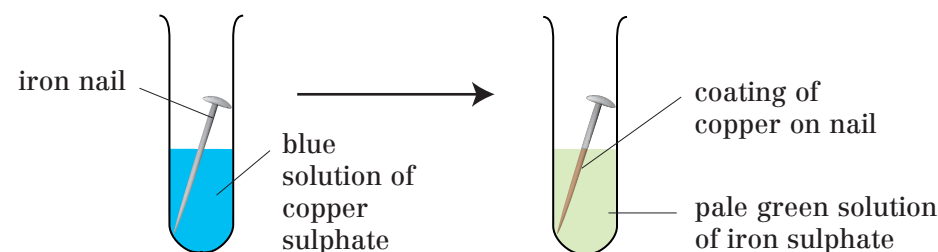
Learning a sentence like this one, or making up one of your own, can help you to remember the order of metals in the series.

# METALS Displacement reactions

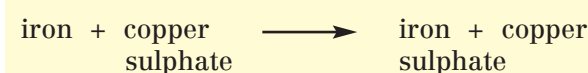
A more reactive metal will displace a less reactive metal from a solution of its salts. Reactions between metals and dilute acids are another type of displacement reaction. Many metals displace hydrogen from a dilute acid.

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### Experiment Iron and copper sulphate solution

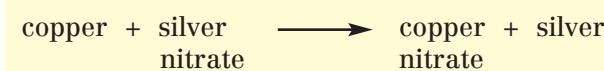
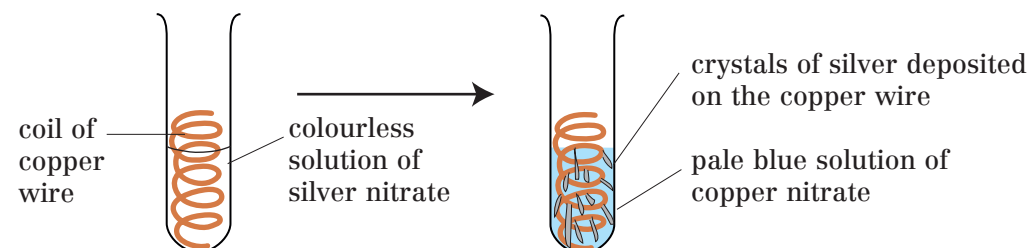


See pages 101, 102, and 103.



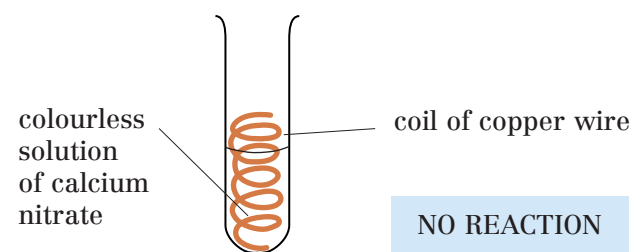
Iron displaces copper from copper sulphate solution. Iron is **more reactive** than copper.

### Experiment Copper and silver nitrate solution



Copper displaces silver from silver nitrate solution. Copper is **more reactive** than silver.

### Experiment Copper and calcium nitrate solution



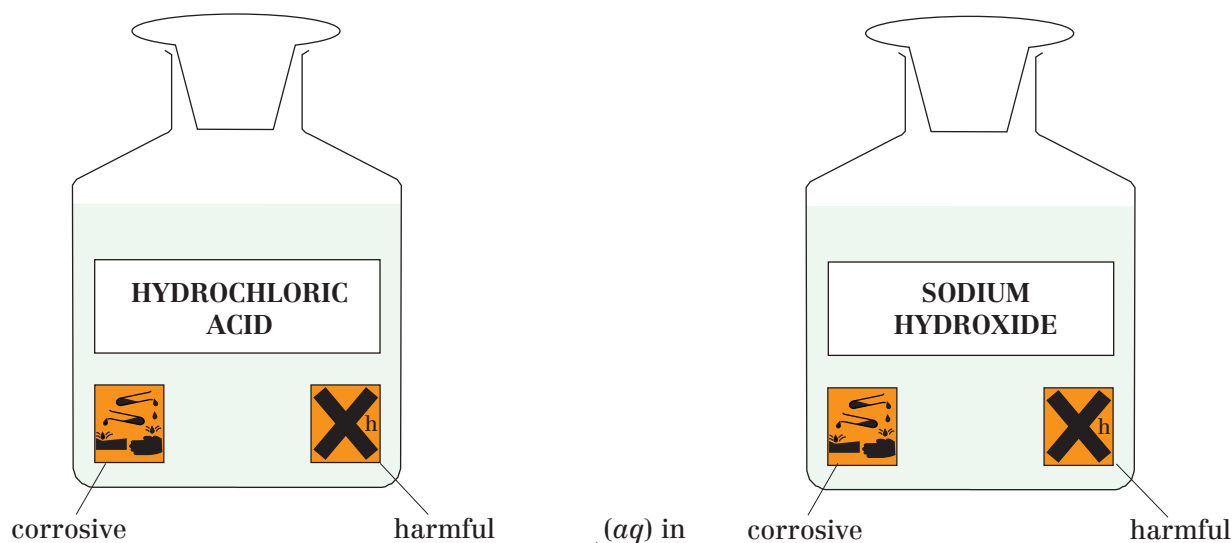
Copper does not displace calcium from calcium nitrate solution. Calcium is **more reactive** than copper.

### Questions

- When iron and copper sulphate solution react together  
(a) Which metal is displaced?  
(b) Which metal is more reactive?
- When copper and silver nitrate react together  
(a) Which metal is displaced?  
(b) Which metal is more reactive?
- Why is there no reaction when copper wire is placed in a solution of calcium nitrate?
- Will the following chemicals react together  
(a) magnesium and copper sulphate solution  
(b) copper and magnesium sulphate solution  
(c) zinc and copper nitrate solution  
(d) lead and copper nitrate solution  
In each case explain your answer. Give word equations wherever a reaction can take place.
- Why is hydrogen given off when magnesium and zinc are added to dilute acids?
- Why is there no reaction when copper is added to a dilute acid?
- Of the metals listed in the Reactivity Series only copper, silver, and gold occur naturally as elements. Suggest a reason for this.

Acidic solutions turn litmus solution red and blue litmus paper red.  
 Acids are corrosive when concentrated and can eat away skin, cloth, and metals.  
 Acidic solutions have a pH less than 7.  
 Acids are composed of hydrogen and other non-metals.

Alkaline solutions turn litmus solution blue and red litmus paper blue.  
 Alkalis are corrosive when concentrated.  
 Alkalis are soapy to the touch, and can cause burns.  
 Alkaline solutions have a pH greater than 7.



### Some common acids

hydrochloric acid,  $\text{HCl} (aq)$   
 sulphuric acid,  $\text{H}_2\text{SO}_4 (aq)$   
 nitric acid,  $\text{HNO}_3 (aq)$   
 ethanoic acid,  $\text{CH}_3\text{COOH} (aq)$   
 carbonic acid,  $\text{H}_2\text{CO}_3 (aq)$

strong acids  
 weak acids

(aq) in aqueous solution – water must be present

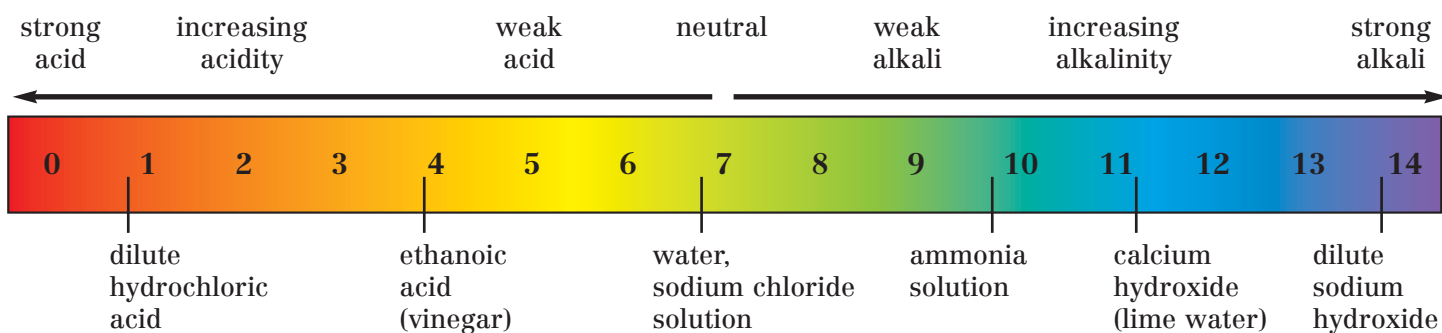
### Some common alkalis

sodium hydroxide,  $\text{NaOH} (aq)$   
 potassium hydroxide,  $\text{KOH} (aq)$   
 ammonia solution,  $\text{NH}_3 (aq)$

(aq) in aqueous solution – water must be present

The pH scale shows how acidic or alkaline a solution is. Universal indicator has a range of colours which can be matched against the pH scale.

Bases neutralise acids. Alkalis are **soluble** bases.



### Questions

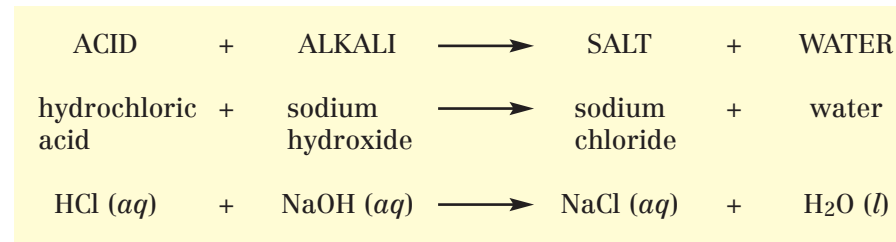
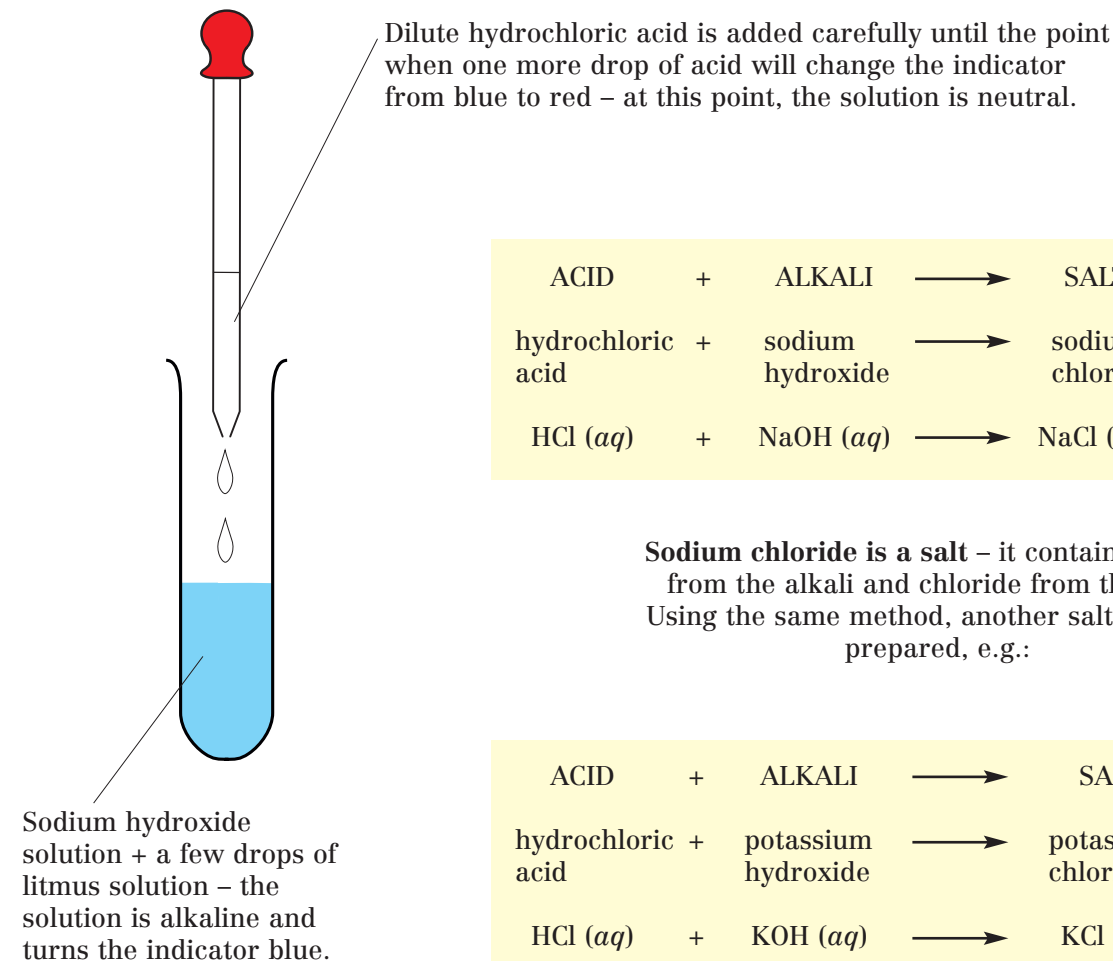
1. What are the chemical formulae of hydrochloric acid, sulphuric acid, and nitric acid?
2. Name two weak acids.
3. What are bases?
4. What are soluble bases called?
5. What colour is litmus solution in: (a) acids (b) alkalis?
6. What do the symbols and tell you about a chemical?
7. What safety precautions should be taken when working with acids and alkalis?

Neutralisation is a reaction between an **acid** and a **base** to give a **salt + water**.  
 Alkalis are **soluble** bases.

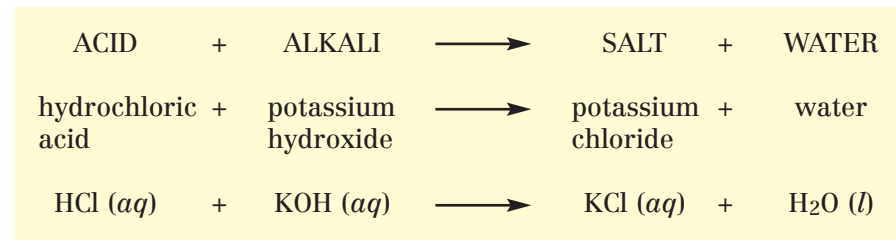
(A more detailed account of acid/alkali neutralisation is given on page 89.)

See also pages 93, 102 and 103.

### Experiment Demonstrating neutralisation



**Sodium chloride is a salt** – it contains sodium from the alkali and chloride from the acid. Using the same method, another salt could be prepared, e.g.:



**Potassium chloride is a salt** – it contains potassium from the alkali and chloride from the acid.

ACIDS	→	SALTS
hydrochloric acid	→	chlorides
sulphuric acid	→	sulphates
nitric acid	→	nitrates

### Questions

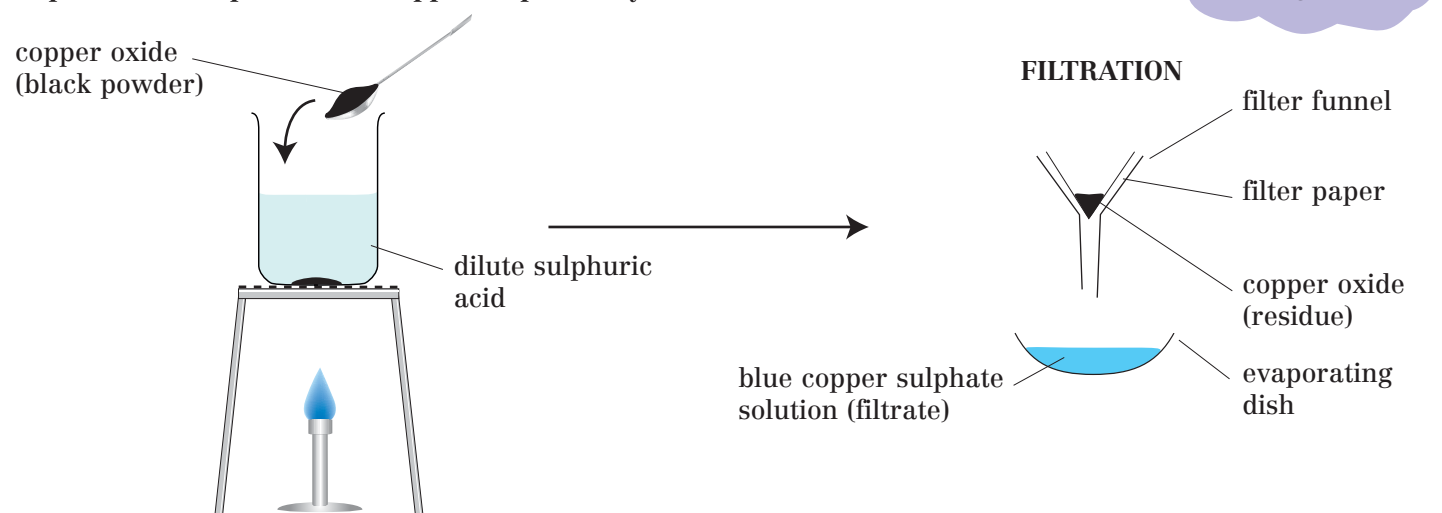
1. What does the word 'neutralisation' mean?
2. Which salts are given by: (a) hydrochloric acid (b) sulphuric acid (c) nitric acid?
3. When a salt is prepared by acid/alkali neutralisation, where does the metal in the salt come from?
4. Is sodium chloride solution acidic, alkaline or neutral?
5. Which acid and alkali would you use to prepare the following salts: (a) sodium chloride (b) potassium chloride (c) sodium sulphate (d) potassium nitrate?
6. Write word equations for the reactions in question 5.
7. What do the state symbols (aq) and (l) mean?

# ACIDS, BASES AND SALTS Neutralisation II – Acids and insoluble bases

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Acids can be neutralised by insoluble bases, e.g. copper oxide, zinc oxide. This reaction can be used to prepare salts.

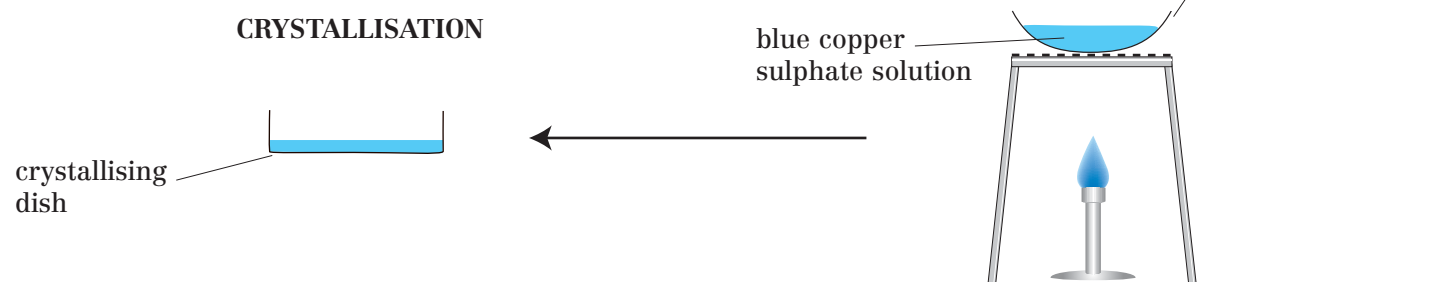
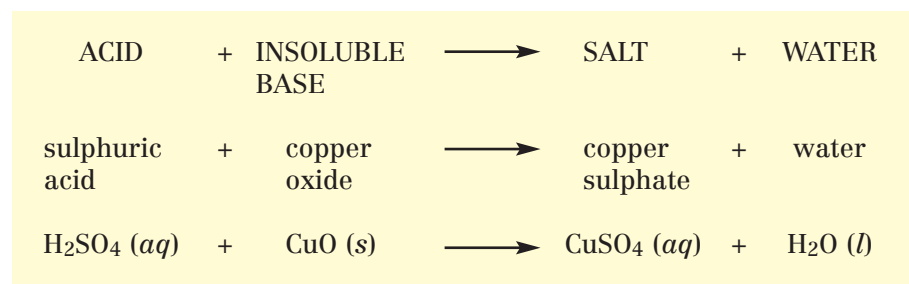
## Experiment Preparation of copper sulphate crystals



See also page 21.

Copper oxide is added until it is in excess – i.e. there is some unreacted copper oxide in the mixture. This ensures that all the acid is used up.

The copper oxide reacts with the acid to give a blue solution.



Copper sulphate solution is transferred to a crystallising dish and left in a warm place to allow crystals to form as the water evaporates from the solution.

The solution is heated to reduce the volume.

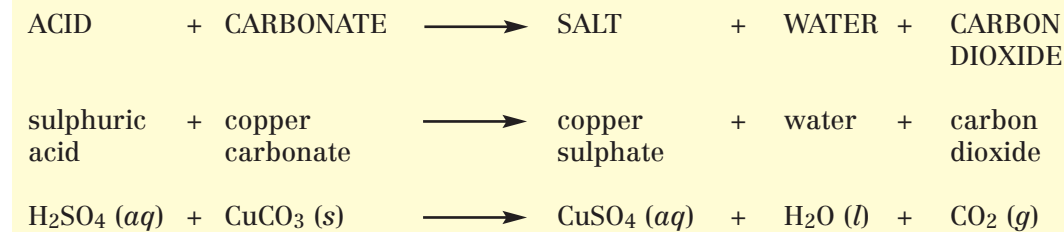
### Questions

- Why is the reaction between dilute sulphuric acid and copper oxide an example of a neutralisation reaction?
- Why must excess copper oxide be used?
- Why is the crystallising dish left in a warm place?
- Which acids and bases would be used to prepare the following salts:  
 (a) copper chloride      (b) copper nitrate  
 (c) zinc sulphate      (d) zinc chloride?
- Write word equations for each of the reactions in question 4.
- What safety precautions must be taken when carrying out this experiment?
- What does the state symbol (s) mean?

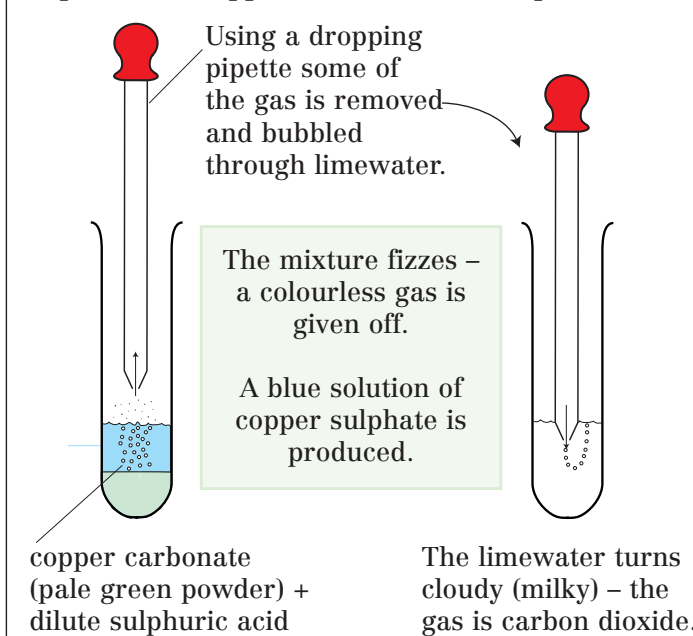
# ACIDS, BASES AND SALTS Acids and carbonates

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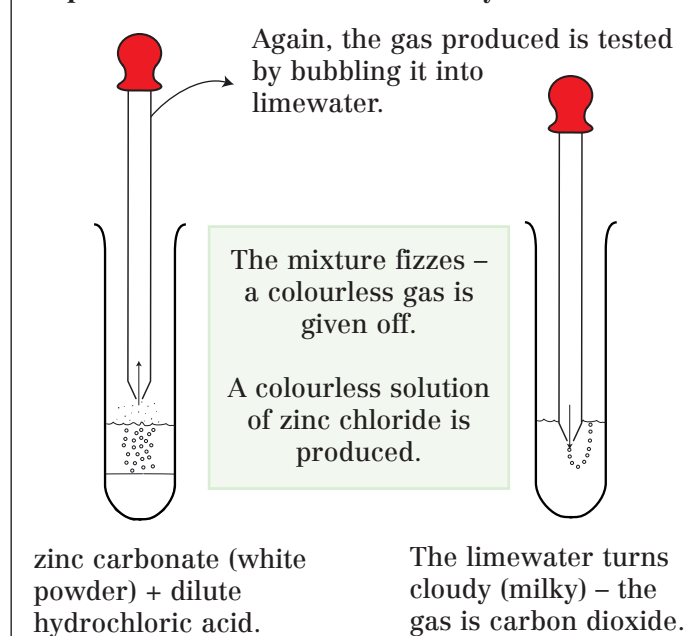
When dilute acids react with carbonates, carbon dioxide is produced.



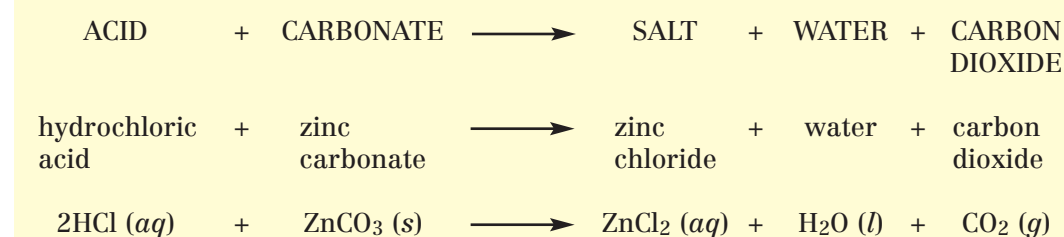
## Experiment Copper carbonate and sulphuric acid



## Experiment Zinc carbonate and hydrochloric acid



Limewater turning cloudy is the chemical test for carbon dioxide.



Production of carbon dioxide, when a dilute acid is added to a chemical, is a test for a carbonate.

### Questions

- Describe the chemical test for carbon dioxide.
- Describe the chemical test for a carbonate.
- Write word equations for the following reactions:  
 (a) magnesium carbonate + hydrochloric acid →  
 (b) sodium carbonate + sulphuric acid →  
 (c) zinc carbonate + sulphuric acid →  
 (d) potassium carbonate + sulphuric acid →  
 (e) magnesium carbonate + sulphuric acid →  
 (f) copper carbonate + nitric acid →
- What does the state symbol (g) mean?