Check safety in all experiments.

Leaving a sour taste

We recognise some acids by their taste. The words *sharp* or *bitter* or *sour* are used to describe the flavour of unripe fruit.

Chemists sometimes describe an acid by the way it behaves... for example, by the way it reacts with a metal.

Different acids react in much the same way with most metals. To understand why, we need to see if acids have anything in common.

Formula	Chemical name	Name *in word equations*
HCl	..... acid	..... chloride
H_2SO_4		
HNO_3		

These acids all contain the element ..... . This element can be displaced from the acid by a metal.

Magnesium reacts with dilute **hydrochloric acid**. A *word equation* for the reaction is

The *symbols equation*, including state symbols, is therefore

*Add a short length of **magnesium** ribbon to a little dilute **hydrochloric acid** in a test tube. Record ALL your observations clearly.*

.....

.....

.....

.....

Now decide how you could identify ONE of the products of this reaction. Repeat the experiment and carry out a suitable test for this product. Describe the test you perform and the results you obtain.

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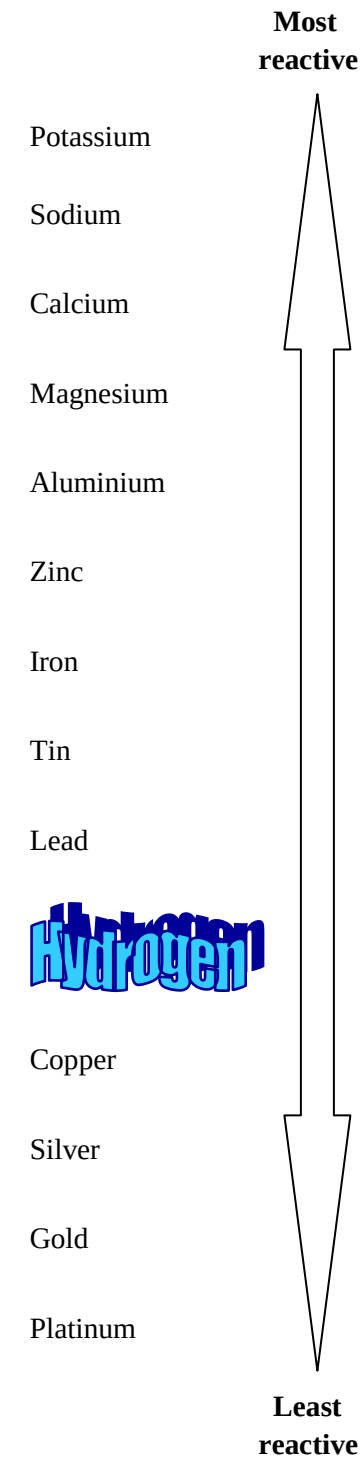
Reactivity series



Only metals *above* hydrogen in the reactivity series can displace hydrogen from an acid.

Back to basics

Acids also react with metal oxides. This time, *all* metal oxides react... not just the oxides of metals above hydrogen in the reactivity series.

Metal atoms have a tendency to release some of their electrons to non-metal atoms like oxygen. The metal atoms become positive **ions** and the non-metal atoms become negative **ions**. The ions of opposite charge attract strongly to form an ionic compound.

Complete the following table to show the formula of some common metal oxides.

Name	Formula
magnesium oxide	
sodium oxide	
aluminium oxide	
copper(II) oxide	
iron(III) oxide	

Magnesium oxide reacts with dilute **nitric acid**. A *word equation* for the reaction is

The *symbols equation*, including state symbols, is therefore

The change/s you would expect to **see** is/are .....

.....

.....

Copper(II) oxide reacts with dilute **sulfuric acid**. A *word equation* for the reaction is

The *symbols equation*, including state symbols, is therefore

The change/s you would expect to **see** is/are .....

.....

.....

*Warm a little dilute **sulfuric acid** in a beaker **gently** for a **short time**. Do **not** boil.*

*Remove from the heat and add a **very small** amount of **copper(II) oxide**. If this dissolves, add a little more.*

Common ions

Sodium	Na^+
Potassium	K^+
Magnesium	Mg^{2+}
Calcium	Ca^{2+}
Aluminium	Al^{3+}
Copper(II)	Cu^{2+}
Iron(II)	Fe^{2+}
Iron(III)	Fe^{3+}
Hydrogen	H^+
Ammonium	NH_4^{1+}
Oxide	O^{2-}
Chloride	Cl^-
Hydroxide	OH^-
Nitrate	NO_3^{1-}
Sulfate	SO_4^{2-}

The reaction of metal oxides with acids is commonly termed an acid-base reaction. A metal oxide is said to be a **base**.

Base or alkali?

Metals also form compounds called metal *hydroxides*. Metal hydroxides, like metal oxides, are bases and will react with acids.

NaOH(aq) + HCl(aq) → NaCl(aq) + ...

Potassium hydroxide reacts with dilute **sulfuric acid**. A *word equation* for the reaction is

The *symbols equation*, including state symbols, is therefore

.....KOH(aq) + ... → ..... + ...

Sodium hydroxide and potassium hydroxide in the equations above are given the state symbol (aq) because they are soluble in water. A metal hydroxide that dissolves in water forms what we call an **alkali**.

Not all metal hydroxides are soluble in water. Insoluble metal hydroxides can be formed by *precipitating* them from solution.

*Put a small volume of **iron(III) chloride** solution in a test tube and then add **sodium hydroxide** solution dropwise until no further change is seen. **Describe** all that you see.*

.....

.....

.....

.....

Word equation:

Symbols equation:

*With the help of these two equations, **explain** your observations.*

.....

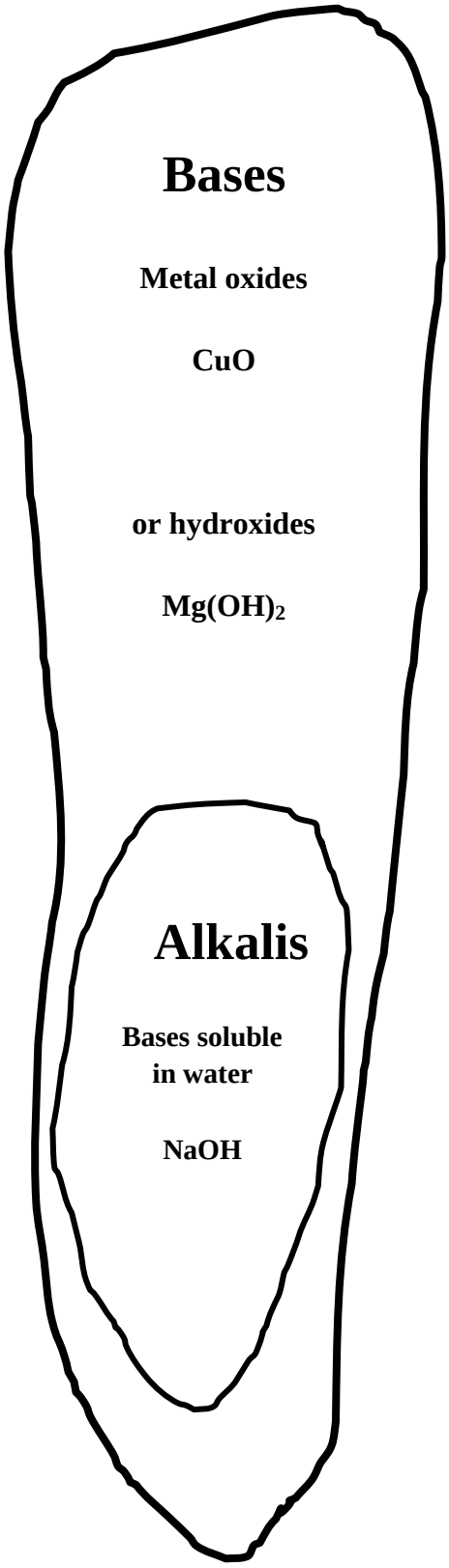
.....

.....

.....

.....

*If you wish, you can repeat the above experiment but this time add the **sodium hydroxide** solution to **iron(II) sulfate** solution.*



Odd alkali

All acids separate into their ions when they dissolve in water.

$HNO_3(aq) \rightarrow$ .....(aq) + $NO_3^{1-}(aq)$

Any acid solution will therefore contain ..... **ions**.

Alkalis also separate into ions in aqueous solution.

$NaOH(aq) \rightarrow Na^+(aq)$ + ...(aq)

Any alkali solution is a source of ..... **ions**.

When an acid and an alkali are mixed in solution, these ..... and ..... ions combine to form .....

.....(aq) + ...(aq) → .....

The reaction between the ..... ions from an acid and the ..... ions from an alkali is called **neutralisation**.

When ammonia, NH_3, dissolves in water, an H^+ ion passes from a water molecule to an ammonia molecule.

$NH_3(g) + H_2O(l) \rightarrow$ .....(aq) + ...(aq)

The solution now contains ..... ions and so ammonia solution is an ..... .

As an ..... , ammonia solution will also react with an acid.

$NH_3(aq) + HCl(aq) \rightarrow$ .....(aq) + ...(aq)

in a neutralisation reaction.

The presence of ..... ions in ammonia solution can be detected as follows.

*Put a little **magnesium sulfate** solution in a test tube and add **ammonia solution** until no further change is seen. **Describe** all that you see.*

.....

.....

.....

Explain, with the help of a symbols equation, what you see.

.....

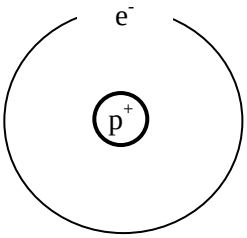
.....

.....

.....

The charge on the nitrate ion is normally written just "-" rather than "1-".

A hydrogen atom is



where

e^- = electron

p^+ = proton

A hydrogen ion, H^+, is therefore just a ..... .

An acid donates an H^+ ion to other species. We sometimes therefore refer to an acid as a ..... donor.

Definitions

An acid forms $H^+(aq)$ ions in solution *or* an acid is a ..... donor.

A base is a ..... acceptor.

An alkali forms .....(aq) ions in solution. An alkali is a ..... acceptor.

Putting some fizz into Chemistry

Acids react with metal carbonates. In these reactions, one of the products is a gas. There are *two* other products, neither of which is a gas.

Sodium carbonate reacts with dilute **hydrochloric acid**. A *word equation* for the reaction is

The *symbols equation*, including state symbols, is therefore

The changes you could expect to **see** are .....

.....

.....

*To a little dilute **hydrochloric acid** in a test tube, add a small amount of solid **sodium carbonate**. Verify that the above changes **are** seen. Carry out a simple test to confirm the formation of the expected gas. Describe the test and its result.*

.....

.....

.....

.....

*Mix a little solid **citric acid** with a small amount of solid **sodium carbonate** in a test tube. Look for indication of any reaction. Now add some **water** to the test tube. **Describe** and **explain** what you observe.*

.....

.....

.....

.....

Other carbonates react in the same way with an acid. **Ammonium carbonate** reacts with dilute **sulfuric acid**. A *word equation* for the reaction is

The *symbols equation*, including state symbols, is therefore

Calcium carbonate is

Ca^{2+} CO_3^{2-}

A gas that could be made from these symbols is

.....

This would leave us with

.....

When an acid is added to a metal carbonate, the same gas is shaken loose. The metal ..... that remains, then reacts with the acid. If the acid used is hydrochloric acid, the other two products would be

calcium .....

and

.....

Salts Chemistry Taster Session Holiday Home Study

When a metal is added to an acid, the metal displaces the hydrogen. The hydrogen in the acid is replaced by the metal.

$$Mg(s) + H_2SO_4 \rightarrow MgSO_4(aq) + H_2(g)$$

The product formed when the hydrogen in an acid is replaced by a metal is called a **SALT**. We can summarise this idea in a *general* word equation.

METAL + ACID → [ ] + [ ]

When a metal **oxide** dissolves in an acid, the hydrogen in the acid is again replaced by the metal to form a salt.

$$CuO(s) + H_2SO_4 \rightarrow CuSO_4(aq) + H_2O(l)$$

The other product of the reaction is now [ ] . The general word equation for the reaction of a metal oxide with an acid is...

METAL + ACID → [ ] + [ ]
OXIDE

The same general word equation applies to the reaction of a metal **hydroxide** with an acid,

METAL + ACID → [ ] + [ ]
HYDROXIDE

$$Cu(OH)_2(s) + H_2SO_4 \rightarrow CuSO_4(aq) + \boxed{}$$

When a metal **carbonate** dissolves in an acid, the hydrogen in the acid is still replaced by the metal to form a salt but now **two** other products are formed.

$$CaCO_3(s) + 2HCl \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

METAL + ACID → [ ] + [ ] + [ ]
CARBONATE

Complete the following equations *by adding the formulae of the products* and then **balance** them *by adding numbers, where appropriate, in front of the reactants/products:*

Mg(s)	+	H_2SO_4(aq)	⇒		+			
KOH(aq)	+	HNO_3(aq)	⇒		+			
$CaCO_3$(s)	+	HCl(aq)	⇒		+		+	
CuO(s)	+	HNO_3(aq)	⇒		+			
NH_4OH(aq)	+	H_2SO_4(aq)	⇒		+			
Na_2CO_3(s)	+	HNO_3(aq)	⇒		+		+	
Al(s)	+	HCl(aq)	⇒		+			
$MgCO_3$(s)	+	H_2SO_4(aq)	⇒		+		+	
Al_2O_3(s)	+	HBr(aq)	⇒		+			
NaOH(aq)	+	H_3PO_4(aq)	⇒		+			