Unit 1

Chemistry in Action

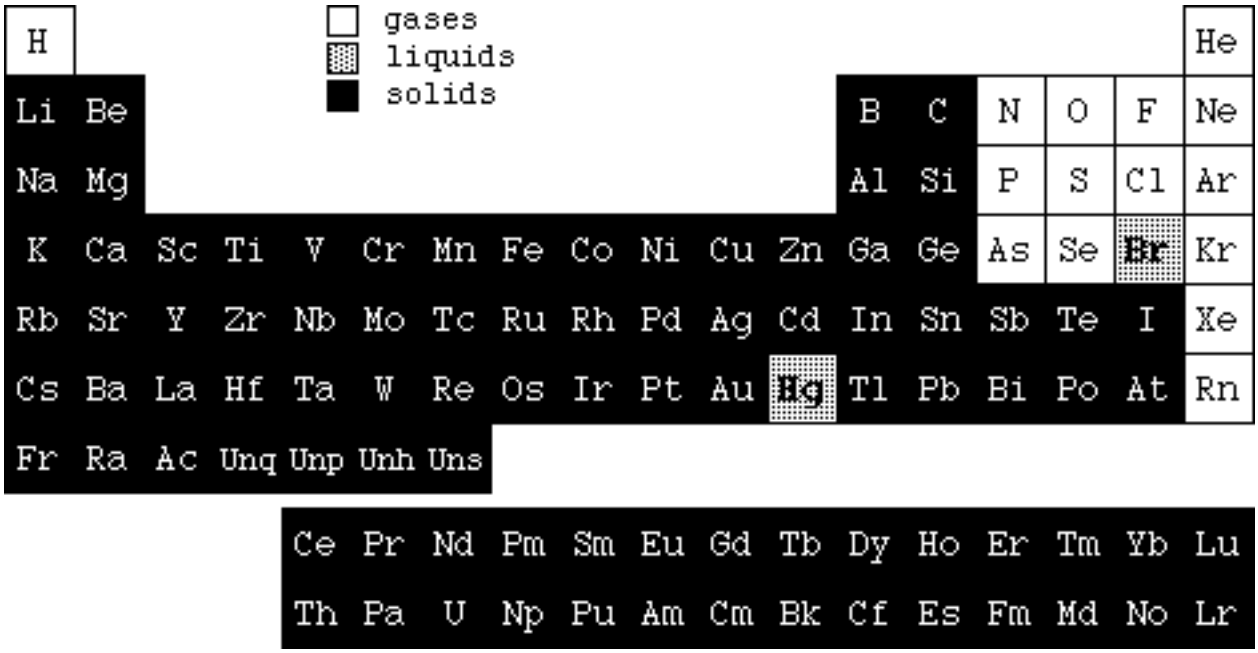
Substances

Everything in the world is made from about 100 elements.
Each element has a name and a symbol e.g.

Hydrogen	H
Oxygen	O
Nitrogen	N
Carbon	C

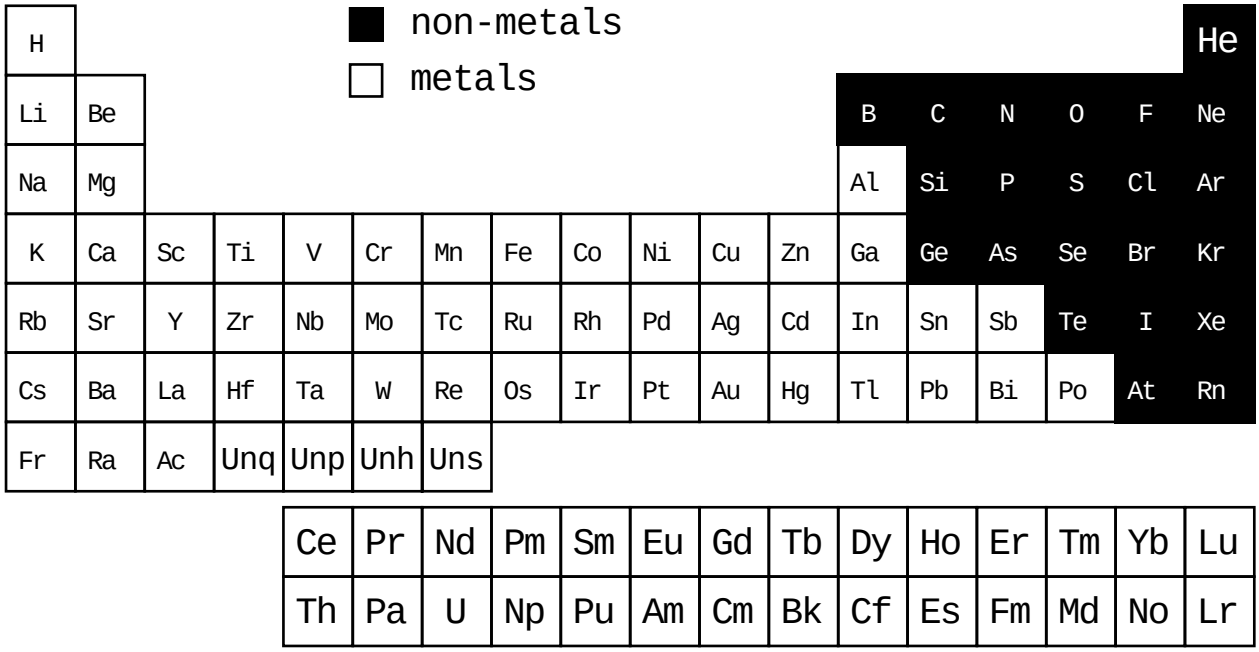
Chemists have arranged these elements in the Periodic Table.

Most of the elements are solids at room temperature.
Two are liquids - Mercury (Hg) and Bromine (Br)
Some are gases



Metals and Non-metals

Elements can be grouped or classified into metals and non-metals:



As you will see, there are more metals than non-metals !

Some elements, including Gold, Silver and Copper have been known for a long time. The most recently discovered elements have been made by scientists.

Make a database for the first 36 elements showing

- their state at room temperature (solid, liquid or gas)
- type (metal or non-metal)
- use

Here are a few to start you off:

Element	**State**	**Type**	**Use**
Iodine	Solid	Non-metal	Antiseptic
Lead	Solid	Metal	Roof lining
Helium	Gas	Non-metal	Balloons

Compounds and Mixtures

Compounds are formed when elements react together.

Your teacher will show you the reaction between Aluminium and Iodine.
The Aluminium reacts with the Iodine forming a compound called Aluminium iodide.

We can show this with a **word equation**:

Aluminium + Iodine -> Aluminium iodide

Your teacher will show you the reaction between Zinc and Sulphur.
The Zinc reacts with the Sulphur forming a compound called Zinc sulphide.

Zinc + Sulphur -> Zinc sulphide

Burn some Magnesium in air. The Magnesium reacts with the Oxygen in the air forming the compound, Magnesium oxide.

Magnesium + Oxygen -> Magnesium oxide

The above three experiments all involve hazards. There are regulations on the use of chemicals for the safety of everyone who uses chemicals at work. Each hazard is given a simple symbol which can be easily recognised:

CORROSIVE **FLAMMABLE** **HARMFUL** **IRRITANT** **TOXIC**

These hazard warning labels are attached to all appropriate chemicals. They are put on road tankers to indicate dangers in the event of spillage.

Mixtures

Mixtures occur when two or more substances come together without reacting. Air is a mixture of gases, mainly Oxygen and Nitrogen.

Push a glowing splint into a test tube containing Oxygen. The splint re-lights.

There is not enough Oxygen in air for this to work.

Solutions

A solution is formed when a substance dissolves in a liquid.

When a substance dissolves in a liquid we say that this substance is **soluble** in the liquid.

When a substance does not dissolve in a liquid we say that this substance is **insoluble** in the liquid.

Find out which of the given substances are soluble, and which are insoluble, in Water.

Sodium fluoride is dissolved in drinking water to help prevent tooth decay.

Where Lead pipes are still used in some houses, Lead compounds dissolve in the drinking water. This is harmful to health.

Liquids dissolve in liquids as well: whisky is a solution of alcohol in water.

Gases also dissolve in liquids:

- Carbon dioxide is dissolved in some drinks to make them fizzy.
- Chlorine is dissolved in drinking water to kill bacteria.

Chemical Reactions

All chemical reactions involve the formation of one or more new substances. The product usually looks different.

e.g. when Copper reacts with Oxygen, Copper oxide is formed.

This is shown by the following **word equation**:

Copper	+	Oxygen	->	Copper oxide
Shiny, brown solid		colourless gas		black solid

Sometimes gases are given off in chemical reactions.
Add some water to sherbet. Carbon dioxide gas is given off. Carbon dioxide turns Limewater milky.

Sometimes, when we mix two solutions, a solid is formed. We call this solid a **precipitate**.
Mix solutions of Sodium carbonate and Copper sulphate. A blue precipitate is formed.

Chemical reactions occur in the world around us and within us:

- Digesting food
- Burning petrol in a petrol engine
- Drying of paint
- Burning toast!
- Rusting of Iron

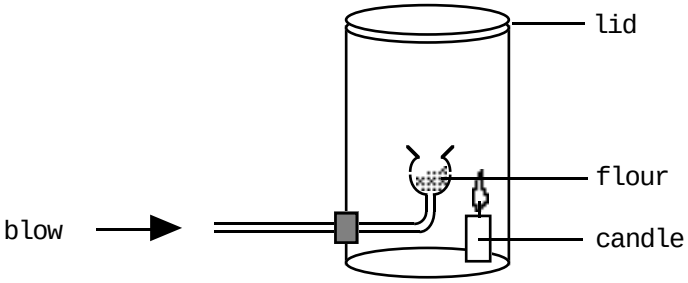
Speed of Reactions

Reactions go faster at high temperatures and when the particle size is small.

Example 1

Tiny particles of flour in the air can cause explosions in a flour mill.

Your teacher will show you this reaction:



When the flour is blown out into the can, the candle sets it on fire. Because of the small particle size it burns very quickly and gives out a lot of energy. The lid of the can blows off!

Example 2

Meat goes off and begins to smell after a few days. This is caused by chemical reactions inside the meat. If we keep the meat cold in a fridge, we can slow down decomposition and keep the meat fresh for a longer time.

Example 3

Your teacher will show you how changing the temperature and particle size affect the speed of the reaction between Magnesium and acid.

Acids and Alkalis

All solutions are either acidic, alkaline or neutral.

We can find out which, by measuring the pH.

pH is a scale of numbers from below 0 to above 14.

Neutral solutions and pure Water have a pH = **7**.

Acids have a pH **below 7**.
The lower the pH the greater the acidity.

Alkalis have a pH **above 7**.

The higher the pH the greater the alkalinity.

pH	0-2	3-6	7	8-11	12-14
	STRONG ACIDS	WEAK ACIDS	NEUTRAL SOLUTIONS	WEAK ALKALIS	STRONG ALKALIS

Strong acids and alkalis burn the skin.

Diluting acids and alkalis reduces the acidity and alkalinity and makes them less dangerous.

Measuring pH

We can measure pH using three methods:

- Universal Indicator

  This is a liquid whose colour depends on the pH

pH	0-2	3-5	6	7	8	9-12	13-14
COLOUR	RED	ORANGE	YELLOW	YELLOW/GREEN	GREEN	BLUE	PURPLE

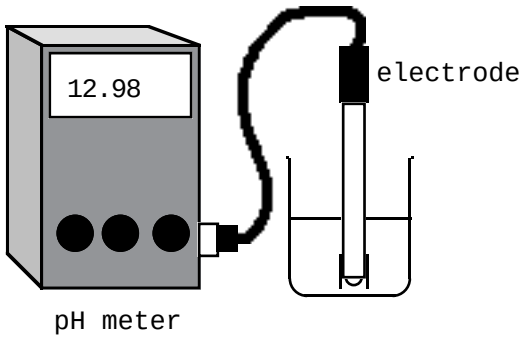
- pH Paper

  This is paper soaked in Universal Indicator and allowed to dry.

- A pH meter

  This is an instrument which measures pH.

  Just put the electrode into the solution and the pH is shown on the meter.



pH meter

What kind of solution is in the beaker in the picture above?

Some Common Acids

- Hydrochloric acid
  Used in the Chemistry laboratory and in industry

- Sulphuric acid
  Used in the Chemistry laboratory and in industry

- Nitric acid
  Used in the Chemistry laboratory and in industry

- Vinegar
  Used at home to flavour foods

- Soft drinks e.g. Lemonade and Coke

- Soda Water

Some Common Alkalis

- Sodium hydroxide
  Used in the Chemistry laboratory, in industry and at home (oven cleaners)

- Limewater
  Used in the Chemistry laboratory

- Ammonia
  Used in the Chemistry laboratory and at home (window cleaning)

- Baking Soda
  Used at home to make cakes rise.

- Dishwashing powder

- Bleach

- Soap

Neutralisation

Neutralisation is what happens when an acid cancels out an alkali to give a neutral solution, pH = 7.

The products, a salt and Water, are both neutral.

Indigestion is caused by too much acid in the stomach. We can stop it by swallowing 'Milk of Magnesia' - a weak alkali.

Add a few drops of Universal Indicator to some dilute acid in a beaker then add 'Milk of Magnesia' tablets and watch the pH **rise** up to 7.

Wasp stings are alkaline. We can reduce the pain by applying lemon juice - a weak acid.

Add a few drops of Universal Indicator to some dilute alkali in a beaker then add lemon juice and watch the pH **drop** down to 7.

Plants grow best at a pH of about 6.5. Soils which are too acidic are neutralised by applying lime - an alkali.

Shake some soil with water, filter and test the filtrate with Universal Indicator. Is it acidic, alkaline or neutral?

Pollution

Fossil fuels (coal, oil and natural gas) contain Carbon. When these fuels burn, the Carbon reacts with Oxygen forming Carbon dioxide:

Carbon + Oxygen -> Carbon dioxide

Carbon dioxide dissolves in Water forming a very, very weak and therefore harmless acid.

Fossil fuels also contain Sulphur. When Sulphur burns it reacts with Oxygen forming Sulphur dioxide:

Sulphur + Oxygen -> Sulphur dioxide

Sulphur dioxide dissolves in Water forming a strongly acidic solution. This gives rise to 'acid rain'.

In addition to Carbon dioxide and Sulphur dioxide, car exhaust contains Nitrogen dioxide produced by the reaction of Nitrogen with Oxygen around the spark plug:

Nitrogen + Oxygen -> Nitrogen dioxide

Nitrogen dioxide dissolves in Water forming a strongly acidic solution so this gas also causes acid rain.

Acid rain damages buildings made of carbonate rock e.g. Marble.

Place some marble chips in a beaker containing dilute acid and watch them dissolve!

Acid rain damages structures made of Iron or steel.

Your teacher will place some steel wool in a beaker containing dilute acid. Watch it dissolve!

Acid rain also damages soils, plant and animal life. Acidic lochs can, however, be neutralised by adding Lime - an alkali.