

# INTRODUCTION TO SUBSTANCES

## PERIODIC TABLE

The arrangement of elements in the modern periodic table is linked to the structure of their atoms. The term 'periodic' comes from the regular occurrence of certain chemical properties when the elements are arranged in order of increasing mass.

	Transition metals																	
	I II												III IV V VI VII					0
2	Li 3	Be 4											B 5	C 6	N 7	O 8	F 9	Ne 10
3	Na 11	Mg 12											Al 13	Si 14	P 15	S 16	Cl 17	Ar 18
4	K 19	Ca 20	Sc 21	Ti 22	V 23	Cr 24	Mn 25	Fe 26	Co 27	Ni 28	Cu 29	Zn 30	Ga 31	Ge 32	As 33	Se 34	Br 35	Kr 36
5	Rb 37	Sr 38	Y 39	Zr 40	Nb 41	Mo 42	Tc 43	Ru 44	Rh 45	Pd 46	Ag 47	Cd 48	In 49	Sn 50	Sb 51	Te 52	I 53	Xe 54
6	Cs 55	Ba 56	Lan than ides	Hf 72	Ta 73	W 74	Re 75	Os 76	Ir 77	Pt 78	Au 79	Hg 80	Tl 81	Pb 82	Bi 83	Po 84	At 85	Rn 86
7	Fr 87	Ra 88	Acti nides	Ku 104	Ha 105													

The Periodic Table

The elements in the periodic table are arranged in order of increasing atomic number in columns known as groups. The groups contain elements with similar chemical properties. The rows are called periods. Elements, which are metals, occur on the left and in the centre of the table. Elements, which are non-metals, occur on the right.

## METALS

Of the 92 elements that occur naturally, 81 of them are metals. Metals are generally very strong and can support very heavy loads. This is why they are used to make large structures like buildings and bridges. The metals normally used in these sorts of structures are iron and steel.

Metals have many characteristics in common:

- They are shiny, sonorous materials;
- They are mostly solids at room temperature (except mercury which is liquid);
- Many of them are hard and have high tensile strength;
- They are malleable and ductile; and
- They are good conductors of heat and electricity.

Metals can be listed in order of their reactivity. The most reactive metals, such as sodium, are never found free in nature. They are found as compounds, combined with other substances. A reactivity series is a list of metals in which the most reactive metal is placed at the top and the others follow in order of reactivity, with the least reactive at the bottom.

The Reactivity Series	
Potassium	<div style="display: flex; align-items: center; justify-content: center;"> <div style="width: 10px; height: 100%; background: linear-gradient(to bottom, yellow, orange, red, purple);"></div> <div style="margin: 0 5px;">↓</div> </div>
Sodium	
Calcium	
Magnesium	
Aluminium	
Zinc	
Iron	
Lead	
Copper	
Silver	
Gold	
	Least reactive

Iron is the most widely used metallic element. It is used in buildings, for machine bodies, for containers, for tools and utensils and lots of other everyday items. One problem with iron, however, is the fact that it rusts. Like many metals it combines with oxygen to form an oxide. The more common name for iron oxide is rust.

## ALLOYS

An alloy is a mixture of metals which may have different properties from the individual metal elements that are put together to make it. Often an alloy contains a lot of one metal, with small amounts of other metals added.

Alloy	Metals Present	Notable Property	Examples
Brass	Copper, Zinc	reflects sound	musical instruments
Stainless Steel	Iron, Chromium, Nickel	hard, does not rust	knives, forks, etc.
Bronze	Copper, Tin	very hard	machine parts
14 Carat Gold	Gold, Copper	does not corrode	jewellery

Brass is an alloy of copper and zinc. It is harder and cheaper than copper and is used for musical instruments, ornamental objects, hardware and inexpensive jewellery.

Bronze is an alloy of copper and tin. It is hard, strong and resistant to corrosion and is used mainly for outdoor sculptures.

Steel is a mixture of iron and carbon. The proportion of carbon used may range from 0.1% to 1.5%. As a result, there are various types of steel, each with different properties depending on the amount of carbon used. Steel is cheap, strong and easily shaped. It is a very important metal as it is used in the construction of bridges, buildings, ships and vehicles. Because steel is a compound that contains iron, it is susceptible to rust. This is probably its only disadvantage.

Stainless steel is an alloy of iron, chromium, nickel and carbon. Stainless steel is strong and hard, with a very high resistance to corrosion (due to the chromium). It is used for cookware, cutlery, kitchen equipment and in industrial chemical plants.

## ACIDS AND BASES

If a metal is burned in air, it forms the oxide of that metal. If this oxide is dissolved in water and the pH of this solution is tested, it has a pH of 7 or above. In other words, it is neutral or alkaline.

A non-metal treated in the same way forms an oxide which, when dissolved in water, has a pH of less than 7. This means it is acidic. This reaction is a very good way to tell if a substance is a metal or a non-metal.

Many substances can be classified as acidic or basic.

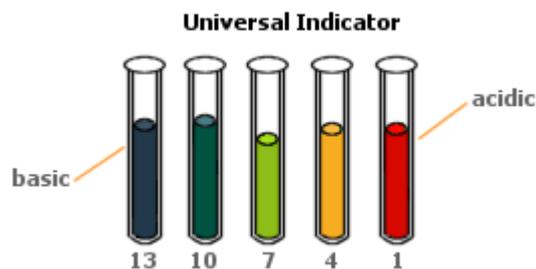
Strong acids (e.g., hydrochloric acid and sulphuric acid) and strong bases (e.g., sodium hydroxide) are highly corrosive and very dangerous. They should, therefore, be handled with great care. Weak acids and bases are very common in our everyday environment. They can even be found in the foods we consume, e.g., in vinegar, oranges and honey!

Acids are neutralised by bases. When an acid is neutralised by a base the result is a salt and water.

## INDICATORS

Some dyes have a different colour depending on whether they are in an acidic or an alkaline solution. Dyes like this are called indicators. Litmus is one example of an indicator. Acidic solutions turn litmus indicator red and alkaline solutions turn litmus indicator blue.

Universal indicator contains a mixture of dyes and goes through several different colours depending on the acidity or alkalinity of the solution.



The acidity or alkalinity of a solution can also be measured using the pH scale. This goes from 0 to 14. Acids always have a pH of less than seven on this scale while neutral substances, such as distilled water, have a pH of exactly 7 and alkalis have a pH greater than seven. The stronger the acid, the lower its pH. The stronger the base, the higher its pH.

pH	Examples
1	hydrochloric acid in stomach
2	lemon juice
3	vinegar
4	tomato juice, strong acid rain
5	soft drinking water, black coffee
6	urine, saliva
7	distilled water
8	sea water
9	baking soda
10	toothpaste
11	ammonia solution
12	washing soda
13	bleaches, oven cleaner
14	liquid drain cleaner