THE PERIODIC TABLE

Introduction

Is the arrangement of elements in order of increasing atomic number in horizontal rows of such length that elements of similar chemical properties fall directly beneath one another in a vertical column.

The vertical columns are called groups and the horizontal rows are called periods.

The original form of the Periodic Table was first put forward by Mendeleeff in 1869 when he arranged the known elements in order of their relative atomic masses. However two anomalies occurred in the table.

Moseley in 1913 arranged the elements in order of increasing atomic number and this made elements of similar chemical properties to be grouped together. This Periodic Table was referred to as the modern periodic table.

The modern Periodic Table has a law known as the modern periodic law. It states that the chemical properties of an element are a periodic function of the atomic number.

The modern Periodic Table

The elements in the table fall in to 8 vertical columns (groups) numbered from I-VIII and 7 horizontal rows (periods) which are numbered 1-7. Those periods containing 8 elements or less are known as short periods and the others having more than 8 elements as long periods.

Part of the modern Periodic Table showing the first 20 elements.

	I	II		III	IV	V	VI	VII	VIII
1	$_{1}H$								$_{2}He$
2	$_{3}Li$	$_{4}Be$		$_{5}B$	$_{6}C$	$_{7}N$	$_{8}O$	$_{9}F$	$_{10}Ne$
3	$_{11}Na$	$_{12}Mg$		$_{13}Al$	$_{14}Si$	$_{15}P$	$_{16}S$	$_{17}Cl$	$_{18}Ar$
4	$_{19}K$	$_{20}Ca$							

The right side of the table contains non-metals and the left side of the table contains metals. There is a diagonal boundary between metals and non-metals. The elements along the boundary have both metallic and non-metallic properties. They are referred to as semi-metals or metalloids e.g. boron and silicon.
The elements that lie between calcium and gallium are referred to as transition elements e.g. copper, manganese and iron.
The outstanding characteristics of transition metals are:

a) Ability to form coloured compounds.
b) Having variable valence.
c) Ability to form complexes.
d) Having catalytic property.

How to determine the group and period of an element

1. The group to which an element belongs in the Periodic Table is determined by the number of electron in its outermost or valence shell.

Examples

a) Sodium has electronic configuration 2,8,1 therefore it belongs to group I because it has a single electron in the outermost shell or energy level.
b) Magnesium has electronic structure 2,8,2 therefore it is in group II because it has two valence electrons or two electrons in the outermost energy level.
c) Oxygen has electronic configuration 2,6 therefore it is in group VI because it has six valence electrons.

Exercise

1. Determine the group to which the following elements belong:
a) Nitrogen.
b) Chlorine
c) Aluminum.
d) Neon.

Note: The group of an element must be written in Roman numeral.

2. The period to which an element belongs in the Periodic Table is determined by the number of principal quantum shell in its atom.

Examples

a) Boron has electronic structure 2:3 meaning it has 2 principal quantum shells. Therefore it belongs to period 2
b) Calcium has electronic configuration 2,8,8,2 meaning it has 4 principal quantum shells. Therefore it is in period 4.
c) Phosphorus has electronic configuration 2:8:5 meaning it has 3 principal quantum shells. Therefore it belongs to period 3

Exercise

1. Determine the period to which the following elements belong:
a) Lithium.
b) Potassium.
c) Argon.

Properties of a group

a) Elements of a group have similar chemical properties.
b) Elements of a group have the same number of electron in their outermost shell.
c) Atomic size of elements in a group increases down the group.
d) Atomic number of elements in a group increases down the group.
e) Atomic radius of elements in a group increases down the group.
f) The group number of the elements in a group corresponds to the number of valence electron.
g) Effective nuclear charge of elements in a group reduces down the group.
h) Atomic mass of elements in a group increases down the group.
i) Elements in a group have common valence.

Properties of a period

a) Elements in a period have the same number of principal quantum shell.
b) The period number of elements in a period corresponds to the number of principal quantum shell.
c) Generally the atomic size of elements in a period decreases across the period from left to right.
d) Generally atomic radius of elements in a period decreases across the period from left to right.
e) Atomic number of elements in a period increases across the period from left to right.
f) Effective nuclear charge of elements in a period increases across the period from left to right.
g) Generally the atomic mass of elements in a period increases across the period from left to right.
h) Generally elements in a period differ in their chemical properties.
i) Generally elements in a period have different valence.

Reactivity of elements in Periodic Table

▪ Reactivity of metals increases down the group and decreases across the period from left to right.
▪ Reactivity of non-metals decreases down the group and increases across the period from left to right.

Position of hydrogen

Hydrogen is placed in both group 1 and 7 of the Periodic Table. Thus it is considered in group I because it has a single valence electron and forms a stable ion with charge of +1 i.e. H^+. It is placed in group VII because it reacts like group VII elements by gaining an electron to form an ion with charge of -1 i.e. H^- .

Group 1 elements (Alkali metals)

They have the following characteristics:

- They are highly electropositive and therefore the most reactive metals. Reactivity increases down the group.
- Generally they react with other elements to form ionic compounds which are readily soluble in water.
- They have a fixed valence of 1.
- They have low melting and boiling points.
- They have the largest atomic radius in any given period.

Group II elements (Alkaline earth metals)

They have the following characteristics:

- They have fixed a valence of 2.
- They are less electropositive than the corresponding group I elements and therefore are less reactive than the corresponding group I elements.
- They have higher melting and boiling points than the corresponding group I elements.
- They have smaller atomic radii than the corresponding group I elements.
- They are denser than the corresponding group I elements.

Group VII elements (Halogens)

There are referred to as halogens because they form salts readily. Hence the word halogen means “salt maker”. They have the following characteristics:

- They exist as diatomic molecules.
- They are non-metals.
- They have a fixed valence of 1.
- They are highly electronegative and therefore the most reactive non-metals. Reactivity decreases down the group.
- Their melting and boiling points increase with increase in atomic number.

Group VIII elements (Noble gases)

They are also referred to as group O elements or inert gases and have the following characteristics:

- They are monatomic gases.
- They have fully filled outer most shell.
- They hardly react with any substance because of their stable electronic configuration.

Sample Questions.

1. Electronic configuration of an element W is 2,8,6
(a) To which group of the Periodic Table does W belong? Give reason for the answer.
(b) To which group of the Periodic Table does W belong? Give reason for the answer.
(c) With a reason, suggest whether W is a metal or non-metal.
(d) Write the formula of the most common ion of W.

2. Use part of the Periodic Table below to answer the questions that follow. The letters are not the usual symbols of elements.

I							VIII
P	II	III	IV	V	VI	VII	
Q	R				S	T	
U						V	W

(a) Which of the elements is the:
(i) Least reactive?
(ii) Most reactive metal?
(iii) Most reactive non-metal?
(b) Which atom has the largest atom?
(c) What is the valence of element T?
(d) Write the formula of the oxide of element R.
(e) What type of oxide is formed by element S?

3. Part of Periodic Table showing the positions of elements A B C D E and F. The letters are not the usual symbols of elements.

I							VIII
	II	III	IV	V	VI	VII	
A							
B	C		D		E	F	

(a) State the type of bonding in the compound formed between:
(i) C and F
(ii) D and E
(b) (i) Which of the elements A and B reacts vigorously with cold water?
(ii) Write an equation for the reaction.
(c) Write the formula of ion formed from:
(i) C
(ii) F
(d) Which of the atoms B, C, D, E and F has the largest atomic radius?