



CHAPTER

1

PERIODIC CLASSIFICATION OF ELEMENTS

In 1661, Robert Boyle proposed the definition of an element as “any substance that cannot be decomposed into a simpler substance by a chemical reaction”. At that time, only 13 elements were known. Towards the end of the 18th century, another 11 elements have been discovered. When only a few elements were known, it was easy to study and remember their properties. But gradually with the development of science, several new elements were discovered. At present about 114 elements are known to us. Each of these elements show different properties due to different kind of atoms constituting them and they form millions of compounds. A study of the properties of these elements and their compounds individually appear to be a difficult task. So attempts were made, from time to time, to find regularities or trends in the properties of these elements such that they could be classified into a handful of groups having similar properties. The study of the properties of a typical element of a particular group enables scientist to roughly predict the properties of other elements of that group.

1.1. EARLY ATTEMPTS AT THE CLASSIFICATION OF ELEMENTS

Some elements like copper, silver and gold have characteristic lustre, malleability and ductility. Other elements like graphite (carbon), sulphur and phosphorus do not have lustre, are non-malleable and non-ductile. These important differences led Lavoisier to classify elements into two groups, **metals** and **non-metals**. However, such a grouping was too broad and unbalanced as there are only a few non-metals (about 10%) in one group and a large number of metals (90%) in the other group. Also there was no place for elements with properties resembling those of metals as well as non-metals.

1.1.1. Dobereiner's Triads

In 1803, John Dalton published a table of relative atomic weights (now called atomic masses) of elements. Attempts were then made to find a relationship between the physical and chemical properties of elements and their atomic masses. In 1829, the German Chemist Dobereiner arranged elements having similar chemical properties into **groups of three**. These groups were called **triads**. *Dobereiner found that when elements are arranged in a triad in the order of increasing atomic masses, the atomic mass of the middle element was approximately equal to the arithmetic mean of the atomic masses of the other two elements.* This is known as **Dobereiner's law of triads**. For example, the elements calcium, strontium and barium resemble one another in most of their properties. The atomic mass of strontium is almost equal to the average of the atomic masses of calcium and barium. Again, in the case of another three elements, chlorine, bromine and iodine, the atomic mass of bromine is about the average of the atomic masses of chlorine and iodine (Table 1.1)

Table 1.1 Dobereiner's triads

Elements	Atomic mass	Element	Atomic mass
Ca	40.1	Cl	35.5
Sr	87.6	Br	79.9
Ba	137.3	I	126.9

Dobereiner could identify four triads from the elements known at that time. Hence, this system of classification could not become successful because all elements could not be put into triads.

Find out which of the groups in the following table (table 1.2) form Dobereiner's triads?

Table 1.2

Group A elements	Atomic mass	Group B	Atomic mass elements
N	14.0	Li	6.9
P	31.0	Na	23.0
As	74.9	K	39.0

1.1.2. Newlands' Octaves

In 1866, John Newlands, an English scientist observed an interesting regularity. He arranged the elements in the increasing order of their atomic masses as follows (Table 1.3).

Table 1.3. Newlands' Octaves

Note of music	sa (do)	re (re)	ga (mi)	ma (fa)	pa (so)	da (la)	ni (ti)
Element	H	Li	Be	B	C	N	O
Atomic mass	1	7	9	11	12	14	16
Element	F	Na	Mg	Al	Si	P	S
Atomic mass	19	23	24	27	28	31	32
Element	Cl	K	Ca				
Atomic mass	35.5	39	40				

The properties of the eighth element were found to resemble very closely the properties of the first, wherever one starts in such a grouping. He compared this to the octaves found in musical notes. He suggested a **Law of Octaves** for the classification of elements. For example, starting from hydrogen (H) the eighth element came out to be fluorine (F). The eighth element starting from fluorine was chlorine (Cl). The properties of F and Cl were found similar. Similarly, the properties of Li, Na and K were also found similar.

At the time of Newlands only 62 elements were known. It was found that the law of octaves worked well for lighter elements only upto calcium. But it could not be applied to elements of higher atomic masses, as after calcium every eighth element did not possess properties similar to that of the first.

Let us answer these.

1. What is Dobereiner's law of triads ? Give one example.
2. A, B and C are the elements in Dobereiner's triad. If the atomic mass of A is 40 and that of C is 137, what would be the atomic mass of B ?
3. What is Newlands' Law of octaves ? Explain with an example.
4. What were the limitations of Newlands' Law of octaves ?

1.1.3. Mendeleev's Periodic Classification

The most notable contribution towards a systematic classification of elements was made by Mendeleev, a Russian chemist in 1869. He studied the physical and chemical properties of the then known 63 elements and their compounds. Among chemical properties, Mendeleev concentrated on the compounds formed by elements with oxygen and hydrogen which are very reactive and formed compounds with most elements. The formula of the oxides and hydrides formed by an element were treated as one of the basic properties of an element for its classification into groups.

He arranged such elements in the increasing order of their atomic masses. He found that elements with similar properties appeared at regular intervals. This discovery led him to formulate a Periodic Law, which states that **“the properties of elements are the periodic functions of their atomic masses”**. This means, when the elements are arranged in order of increasing atomic masses then those with similar properties are repeated at regular intervals. The Mendeleev's periodic table is given in Table 1.4

Table. 1.4. Modified Mendeleev's Periodic Table

Group	I	II	III	IV	V	VI	VII	VIII	Zero
Oxide Hydride	R_2O RH	RO RH ₂	R_2O_3 RH ₃	RO_2 RH ₄	R_2O_5 RH ₃	RO_3 RH ₃	R_2O_7 RH	RO_4	
Periods	A B	A B	A B	A B	A B	A B	A B	Transition series	Noble gases (added later)
1	H 1.008								He 4
2	Li 6.939	Be 9.012	B 10.81	C 12.011	N 14.007	O 15.999	F 18.998		Ne 20.2
3	Na 22.99	Mg 24.31	Al 29.98	Si 28.09	P 30.974	S 32.06	Cl 35.453		Ar 40
4 First series: Second series:	K 39.102 Cu 63.54	Ca 40.08 Zn 65.37	Sc 44.96 Ga 69.72	Ti 47.90 Ge 72.59	V 50.94 As 74.92	Cr 52.00 Se 78.96	Mn 54.94 Br 79.909	Fe 55.85 Co 58.93 Ni 58.71	Kr 83.3
5 First series: Second series:	Rb 85.47 Ag 107.87	Sr 87.62 Cd 112.40	Y 88.91 In 114.82	Zr 91.22 Sn 118.69	Nb 92.91 Sb 121.75	Mo 95.94 Te 127.60	Te 99 I 126.90	Ru 101.07 Rh 102.91 Pd 106.4	Xe 131.3
6 First series: Second series:	Ca 40.08 Au 196.97	Ba 137.34 Hg 200.59	La 138.91 Ti 204.37	Hf 178.49 Pb 207.19	Ta 180.95 Bi 208.98	W 183.85		Os 190.2 Ir 192.2 Pt 195.09	Rn 222

Mendeleev's Periodic Table was published in a German journal in 1872. In the formula for oxides and hydrides at the top of the columns, the letter 'R' is used to represent any of the elements in the group. For example, the hydride of carbon, CH_4 , is written as RH_4 and oxide of carbon, CO_2 , as RO_2 .

The periodic table consists of eight vertical columns called '**groups**' and six horizontal rows called '**periods**'. The eight groups are designated as I, II, III, IV, V, VI, VII and VIII. Except group VIII, each group is divided into two sub-groups as A and B. The elements which lie on left hand side of each group constitute sub-group A. These are called **normal or representative elements**. The elements which lie on right hand side of each group constitute sub-group B. These are called **transition elements**. The properties of elements within a sub-group resemble more markedly but they differ from those of the elements of the other subgroup. For example, lithium (Li), sodium (Na), potassium (K), etc of sub-group I A have close resemblance in properties but they have hardly any resemblance with those of coinage metals (Cu, Ag, and Au) of sub-group I B.

The horizontal rows or periods are numbered 1,2,3, etc.

In arranging the elements in the periodic table, Mendeleev was careful enough to group together elements with similarity in their physical and chemical properties. In doing this he had, in some cases, even to change the order of arranging the elements strictly according to their increasing atomic masses. There was provision for *including unknown elements* as well.

Why is Mendeleev's Classification Appreciated ?

By classifying elements on the basis of their atomic masses, Mendeleev brought some order in the properties exhibited by the elements and their compounds. It made the study of the elements easier. Knowing the properties of one element in a group, the properties of other elements in the group can be easily guessed.

The periodic table could predict errors in the atomic masses of some elements based on their positions in the table. For example, when the table was published the experimental value of the atomic mass of beryllium (Be) was supposed to be 13.65 and its valency, 3. So, the position of Be should have been somewhere else. But Mendeleev placed it at its appropriate position on the basis of its properties and its atomic mass corrected from 13.65 to 9.1 and valency, 2.

While arranging the elements in order of their atomic masses, however, the order had to be ignored at some places to make sure that the elements with similar properties fell in the same group. In doing so, Mendeleev left some vacant places in the table and boldly predicted the existence and properties of some undiscovered elements. For example, **scandium**, **gallium** and **germanium**, discovered later, have properties similar to **eka-boron**, **eka-aluminium** and **eka-silicon** respectively predicted by Mendeleev.

Noble gases like helium (He), neon (Ne) and argon (Ar), were not discovered at the time of Mendeleev. Therefore, there was no group of noble gases in Mendeleev's original periodic table. One of the achievements of Mendeleev's periodic table was that when these gases were discovered they could be placed in a new group called the **zero group** without disturbing the existing order.

Limitations of Mendeleev's Periodic Table

With the discovery of isotopes, the accommodation of the isotopic forms of the same element upset Mendeleev's periodic table. We have learnt that isotopes are the atoms of an element having similar chemical properties (same atomic number), but different atomic masses. If the elements are arranged according to atomic masses, the isotopes have to be placed in different groups of the periodic table. Another problem was that the atomic masses do not increase in a regular manner in going from one element to the next. So it was not possible to predict how many elements could be discovered between two elements especially when we consider the heavier elements.

Let us answer these.

- ⇒ What was Mendeleev's principle for the classification of elements ?
- ⇒ Using Mendeleev's Periodic Table, predict the formula for the oxides of the following elements :
K, C, Al, Si, Ba.
- ⇒ Besides gallium, which other elements have since been discovered that were left by Mendeleev in his Periodic Table ? (any two).
- ⇒ Give your reason why the noble gases are placed in a separate group.

1.2. Modern Periodic Table

In 1913, Henry Mosely found that the atomic number is a more fundamental property of an element than its atomic mass. This is quite convincing because the atomic number gives us the number of protons in the nucleus and also the number of electrons in an atom. This number increases by one in going from one element to the next higher element. The chemical properties of element depends on the number of electrons in its atom which in turn depends on the atomic number. So, atomic number was adopted as the basis for the classification of elements in the Modern Periodic Table. Thus the modern periodic law states that “ **the properties of elements are the periodic functions of their atomic numbers**”. When elements are arranged in order of increasing atomic number, similar elements occur in regular intervals and this leads us to the classification known as the Modern Periodic Table (Table 1.5).

The modern periodic table has 7 horizontal rows called ‘**periods**’ and 18 vertical columns called ‘**groups**’ or **families**.

Periods:

Look at the periodic table (Table 1.5). We find that the elements in the periods are as follows:

1st period contains 2 elements, H(1) and He (2). It is called very short period.

2nd period contains 8 elements, Li(3) to Ne (10). It is called short period.

3rd period contains 8 elements, Na(11) to Ar(18). It is also a short period.

4th period contains 18 elements, K(19) to Kr (36). It is called long period.

5th period contains 18 elements, Rb(37) to Xe(54). It is also a long period.

6th period contains 32 elements, Cs (55) to Ru(86). It is called very long period.

7th period now contains 25 elements, starting from Fr(87) out of a possibility of 32 elements. This period is still incomplete.

Two series of elements, 14 each, are placed at the bottom of the main periodic table. These are called **inner-transition elements**. The first series of 14 elements from atomic numbers 58 to 71 (Ce to Lu) is called **Lanthanide series**. The second series of 14 elements from atomic numbers 90 to 103 (Th to Lr) is called **Actinide Series**. They are placed separately at the bottom of the periodic table to avoid undue side-wise expansion of the table and to keep elements with similar properties in a single column.

GROUP NUMBER

Metals		Metalloids		Non-metals		GROUP NUMBER																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
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1 H Hydrogen 1.0	2 He Helium 4.0	3 Li Lithium 7	4 Be Beryllium 9	5 B Boron 10.8	6 C Carbon 12.0	7 N Nitrogen 14.0	8 O Oxygen 16.0	9 F Fluorine 19.0	10 Ne Neon 20.0											11 Na Sodium 23	12 Mg Magnesium 24.3	13 Al Aluminium 27.0	14 Si Silicon 28.1	15 P Phosphorus 31.0	16 S Sulphur 32.1	17 Cl Chlorine 35.5	18 Ar Argon 39.9																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
19 K Potassium 39.1	20 Ca Calcium 40.1	21 Sc Scandium 45.0	22 Ti Titanium 47.8	23 V Vanadium 50.9	24 Cr Chromium 52.0	25 Mn Manganese 54.9	26 Fe Iron 55.9	27 Co Cobalt 58.9	28 Ni Nickel 58.7	29 Cu Copper 63.5	30 Zn Zinc 65.4	31 Ga Gallium 69.7	32 Ge Germanium 72.6	33 As Arsenic 74.9	34 Se Selenium 79.0	35 Br Bromine 79.9	36 Kr Krypton 83.8	37 Rb Rubidium 85.5	38 Sr Strontium 87.6	39 Y Yttrium 88.9	40 Zr Zirconium 91.2	41 Nb Niobium 92.9	42 Mo Molybdenum 95.9	43 Tc Technetium (99)	44 Ru Ruthenium 101.1	45 Rh Rhodium 102.3	46 Pd Palladium 106.4	47 Ag Silver 107.9	48 Cd Cadmium 112.4	49 In Indium 114.8	50 Sn Tin 118.7	51 Sb Antimony 121.8	52 Te Tellurium 127.6	53 I Iodine 126.9	54 Xe Xenon 131.3	55 Cs Caesium 132.9	56 Ba Barium 137.3	57 La* Lanthanum 138.9	58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium (145)	62 Sm Samarium 150.4	63 Eu Europium 151.9	64 Gd Gadolinium 157.3	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	71 Lu Lutetium 174.9	72 Hf Hafnium 178.5	73 Ta Tantalum 180.9	74 W Tungsten 183.8	75 Re Rhenium 186.2	76 Os Osmium 190.2	77 Ir Iridium 192.2	78 Pt Platinum 195.1	79 Au Gold 197.0	80 Hg Mercury 200.6	81 Tl Thallium 204.4	82 Pb Lead 207.2	83 Bi Bismuth 209.0	84 Po Polonium (210)	85 At Astatine (210)	86 Rn Radon (222)	87 Fr Francium (223)	88 Ra Radium (226)	89 Ac** Actinium (227)	90 Th Thorium (232)	91 Pa Protactinium (231)	92 U Uranium (238)	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (266)	107 Bh Bohrium (264)	108 Hs Hassium (277)	109 Mt Meitnerium (268)	110 Ds Darmstadtium (271)	111 Rg Roentgenium (272)	112 Uub Ununbium (285)	113 Nh Nihonium (284)	114 Uuq Ununquadium (289)	115 Uhp Ununpentium (298)	116 Uuh Ununhexium (293)	117 Uus Ununseptium (304)	118 Uuo Ununoctium (304)	119 Uus Ununseptium (315)	120 Uuo Ununoctium (316)	121 Uuh Ununhennium (329)	122 Uuo Ununoctium (329)	123 Uuh Ununhennium (340)	124 Uuo Ununoctium (344)	125 Uuh Ununhennium (358)	126 Uuo Ununoctium (361)	127 Uuh Ununhennium (374)	128 Uuo Ununoctium (383)	129 Uuh Ununhennium (396)	130 Uuo Ununoctium (404)	131 Uuh Ununhennium (415)	132 Uuo Ununoctium (426)	133 Uuh Ununhennium (438)	134 Uuo Ununoctium (451)	135 Uuh Ununhennium (464)	136 Uuo Ununoctium (476)	137 Uuh Ununhennium (488)	138 Uuo Ununoctium (503)	139 Uuh Ununhennium (516)	140 Uuo Ununoctium (527)	141 Uuh Ununhennium (542)	142 Uuo Ununoctium (556)	143 Uuh Ununhennium (569)	144 Uuo Ununoctium (583)	145 Uuh Ununhennium (598)	146 Uuo Ununoctium (612)	147 Uuh Ununhennium (627)	148 Uuo Ununoctium (642)	149 Uuh Ununhennium (657)	150 Uuo Ununoctium (672)	151 Uuh Ununhennium (687)	152 Uuo Ununoctium (702)	153 Uuh Ununhennium (717)	154 Uuo Ununoctium (732)	155 Uuh Ununhennium (747)	156 Uuo Ununoctium (762)	157 Uuh Ununhennium (777)	158 Uuo Ununoctium (792)	159 Uuh Ununhennium (807)	160 Uuo Ununoctium (822)	161 Uuh Ununhennium (837)	162 Uuo Ununoctium (852)	163 Uuh Ununhennium (867)	164 Uuo Ununoctium (882)	165 Uuh Ununhennium (897)	166 Uuo Ununoctium (912)	167 Uuh Ununhennium (927)	168 Uuo Ununoctium (942)	169 Uuh Ununhennium (957)	170 Uuo Ununoctium (972)	171 Uuh Ununhennium (987)	172 Uuo Ununoctium (1002)	173 Uuh Ununhennium (1017)	174 Uuo Ununoctium (1032)	175 Uuh Ununhennium (1047)	176 Uuo Ununoctium (1062)	177 Uuh Ununhennium (1077)	178 Uuo Ununoctium (1092)	179 Uuh Ununhennium (1107)	180 Uuo Ununoctium (1122)	181 Uuh Ununhennium (1137)	182 Uuo Ununoctium (1152)	183 Uuh Ununhennium (1167)	184 Uuo Ununoctium (1182)	185 Uuh Ununhennium (1197)	186 Uuo Ununoctium (1212)	187 Uuh Ununhennium (1227)	188 Uuo Ununoctium (1242)	189 Uuh Ununhennium (1257)	190 Uuo Ununoctium (1272)	191 Uuh Ununhennium (1287)	192 Uuo Ununoctium (1302)	193 Uuh Ununhennium (1317)	194 Uuo Ununoctium (1332)	195 Uuh Ununhennium (1347)	196 Uuo Ununoctium (1362)	197 Uuh Ununhennium (1377)	198 Uuo Ununoctium (1392)	199 Uuh Ununhennium (1407)	200 Uuo Ununoctium (1422)	201 Uuh Ununhennium (1437)	202 Uuo Ununoctium (1452)	203 Uuh Ununhennium (1467)	204 Uuo Ununoctium (1482)	205 Uuh Ununhennium (1497)	206 Uuo Ununoctium (1512)	207 Uuh Ununhennium (1527)	208 Uuo Ununoctium (1542)	209 Uuh Ununhennium (1557)	210 Uuo Ununoctium (1572)	211 Uuh Ununhennium (1587)	212 Uuo Ununoctium (1602)	213 Uuh Ununhennium (1617)	214 Uuo Ununoctium (1632)	215 Uuh Ununhennium (1647)	216 Uuo Ununoctium (1662)	217 Uuh Ununhennium (1677)	218 Uuo Ununoctium (1692)	219 Uuh Ununhennium (1707)	220 Uuo Ununoctium (1722)	221 Uuh Ununhennium (1737)	222 Uuo Ununoctium (1752)	223 Uuh Ununhennium (1767)	224 Uuo Ununoctium (1782)	225 Uuh Ununhennium (1797)	226 Uuo Ununoctium (1812)	227 Uuh Ununhennium (1827)	228 Uuo Ununoctium (1842)	229 Uuh Ununhennium (1857)	230 Uuo Ununoctium (1872)	231 Uuh Ununhennium (1887)	232 Uuo Ununoctium (1902)	233 Uuh Ununhennium (1917)	234 Uuo Ununoctium (1932)	235 Uuh Ununhennium (1947)	236 Uuo Ununoctium (1962)	237 Uuh Ununhennium (1977)	238 Uuo Ununoctium (1992)	239 Uuh Ununhennium (2007)	240 Uuo Ununoctium (2022)	241 Uuh Ununhennium (2037)	242 Uuo Ununoctium (2052)	243 Uuh Ununhennium (2067)	244 Uuo Ununoctium (2082)	245 Uuh Ununhennium (2097)	246 Uuo Ununoctium (2112)	247 Uuh Ununhennium (2127)	248 Uuo Ununoctium (2142)	249 Uuh Ununhennium (2157)	250 Uuo Ununoctium (2172)	251 Uuh Ununhennium (2187)	252 Uuo Ununoctium (2202)	253 Uuh Ununhennium (2217)	254 Uuo Ununoctium (2232)	255 Uuh Ununhennium (2247)	256 Uuo Ununoctium (2262)	257 Uuh Ununhennium (2277)	258 Uuo Ununoctium (2292)	259 Uuh Ununhennium (2307)	260 Uuo Ununoctium (2322)	261 Uuh Ununhennium (2337)	262 Uuo Ununoctium (2352)	263 Uuh Ununhennium (2367)	264 Uuo Ununoctium (2382)	265 Uuh Ununhennium (2397)	266 Uuo Ununoctium (2412)	267 Uuh Ununhennium (2427)	268 Uuo Ununoctium (2442)	269 Uuh Ununhennium (2457)	270 Uuo Ununoctium (2472)	271 Uuh Ununhennium (2487)	272 Uuo Ununoctium (2502)	273 Uuh Ununhennium (2517)	274 Uuo Ununoctium (2532)	275 Uuh Ununhennium (2547)	276 Uuo Ununoctium (2562)	277 Uuh Ununhennium (2577)	278 Uuo Ununoctium (2592)	279 Uuh Ununhennium (2607)	280 Uuo Ununoctium (2622)	281 Uuh Ununhennium (2637)	282 Uuo Ununoctium (2652)	283 Uuh Ununhennium (2667)	284 Uuo Ununoctium (2682)	285 Uuh Ununhennium (2697)	286 Uuo Ununoctium (2712)	287 Uuh Ununhennium (2727)	288 Uuo Ununoctium (2742)	289 Uuh Ununhennium (2757)	290 Uuo Ununoctium (2772)	291 Uuh Ununhennium (2787)	292 Uuo Ununoctium (2802)	293 Uuh Ununhennium (2817)	294 Uuo Ununoctium (2832)	295 Uuh Ununhennium (2847)	296 Uuo Ununoctium (2862)	297 Uuh Ununhennium (2877)	298 Uuo Ununoctium (2892)	299 Uuh Ununhennium (2907)	300 Uuo Ununoctium (2922)	301 Uuh Ununhennium (2937)	302 Uuo Ununoctium (2952)	303 Uuh Ununhennium (2967)	304 Uuo Ununoctium (2982)	305 Uuh Ununhennium (2997)	306 Uuo Ununoctium (3012)	307 Uuh Ununhennium (3027)	308 Uuo Ununoctium (3042)	309 Uuh Ununhennium (3057)	310 Uuo Ununoctium (3072)	311 Uuh Ununhennium (3087)	312 Uuo Ununoctium (3102)	313 Uuh Ununhennium (3117)	314 Uuo Ununoctium (3132)	315 Uuh Ununhennium (3147)	316 Uuo Ununoctium (3162)	317 Uuh Ununhennium (3177)	318 Uuo Ununoctium (3192)	319 Uuh Ununhennium (3207)	320 Uuo Ununoctium (3222)	321 Uuh Ununhennium (3237)	322 Uuo Ununoctium (3252)	323 Uuh Ununhennium (3267)	324 Uuo Ununoctium (3282)	325 Uuh Ununhennium (3297)	326 Uuo Ununoctium (3312)	327 Uuh Ununhennium (3327)	328 Uuo Ununoctium (3342)	329 Uuh Ununhennium (3357)	330 Uuo Ununoctium (3372)	331 Uuh Ununhennium (3387)	332 Uuo Ununoctium (3402)	333 Uuh Ununhennium (3417)	334 Uuo Ununoctium (3432)	335 Uuh Ununhennium (3447)	336 Uuo Ununoctium (3462)	337 Uuh Ununhennium (3477)	338 Uuo Ununoctium (3492)	339 Uuh Ununhennium (3507)	340 Uuo Ununoctium (3522)	341 Uuh Ununhennium (3537)	342 Uuo Ununoctium (3552)	343 Uuh Ununhennium (3567)	344 Uuo Ununoctium (3582)	345 Uuh Ununhennium (3597)	346 Uuo Ununoctium (3612)	347 Uuh Ununhennium (3627)	348 Uuo Ununoctium (3642)	349 Uuh Ununhennium (3657)	350 Uuo Ununoctium (3672)	351 Uuh Ununhennium (3687)	352 Uuo Ununoctium (3702)	353 Uuh Ununhennium (3717)	354 Uuo Ununoctium (3732)	355 Uuh Ununhennium (3747)	356 Uuo Ununoctium (3762)	357 Uuh Ununhennium (3777)	358 Uuo Ununoctium (3792)	359 Uuh Ununhennium (3807)	360 Uuo Ununoctium (3822)	361 Uuh Ununhennium (3837)	362 Uuo Ununoctium (3852)	363 Uuh Ununhennium (3867)	364 Uuo Ununoctium (3882)	365 Uuh Ununhennium (3897)	366 Uuo Ununoctium (3912)	367 Uuh Ununhennium (3927)	368 Uuo Ununoctium (3942)	369 Uuh Ununhennium (3957)	370 Uuo Ununoctium (3972)	371 Uuh Ununhennium (3987)	372 Uuo Ununoctium (4002)	373 Uuh Ununhennium (4017)	374 Uuo Ununoctium (4032)	375 Uuh Ununhennium (4047)	376 Uuo Ununoctium (4062)	377 Uuh Ununhennium (4077)	378 Uuo Ununoctium (4092)	379 Uuh Ununhennium (4107)	380 Uuo Ununoctium (4122)	381 Uuh Ununhennium (4137)	382 Uuo Ununoctium (4152)	383 Uuh Ununhennium (4167)	384 Uuo Ununoctium (4182)	385 Uuh Ununhennium (4197)	386 Uuo Ununoctium (4212)	387 Uuh Ununhennium (4227)	388 Uuo Ununoctium (4242)	389 Uuh Ununhennium (4257)	390 Uuo Ununoctium (4272)	391 Uuh Ununhennium (4287)	392 Uuo Ununoctium (4302)	393 Uuh Ununhennium (4317)	394 Uuo Ununoctium (4332)	395 Uuh Ununhennium (4347)	396 Uuo Ununoctium (4362)	397 Uuh Ununhennium (4377)	398 Uuo Ununoctium (4392)	399 Uuh Ununhennium (4407)	400 Uuo Ununoctium (4422)	401 Uuh Ununhennium (4437)	402 Uuo Ununoctium (4452)	403 Uuh Ununhennium (4467)	404 Uuo Ununoctium (4482)	405 Uuh Ununhennium (4497)	406 Uuo Ununoctium (4512)	407 Uuh Ununhennium (4527)	408 Uuo Ununoctium (4542)	409 Uuh Ununhennium (4557)	410 Uuo Ununoctium (4572)	411 Uuh Ununhennium (4587)	412 Uuo Ununoctium (4602)	413 Uuh Ununhennium (4617)	414 Uuo Ununoctium (4632)	415 Uuh Ununhennium (4647)	416 Uuo Ununoctium (4662)	417 Uuh Ununhennium (4677)	418 Uuo Ununoctium (4692)	419 Uuh Ununhennium (4707)	420 Uuo Ununoctium (4722)	421 Uuh Ununhennium (4737)	422 Uuo Ununoctium (4752)	423 Uuh Ununhennium (4767)	424 Uuo Ununoctium (4782)	425 Uuh Ununhennium (4797)	426 Uuo Ununoctium (4812)	427 Uuh Ununhennium (4827)	428 Uuo Ununoctium (4842)	429 Uuh Ununhennium (4857)	430 Uuo Ununoctium (4872)	431 Uuh Ununhennium (4887)	432 Uuo Ununoctium (4902)	433 Uuh Ununhennium (4917)	434 Uuo Ununoctium (4932)	435 Uuh Ununhennium (4947)	436 Uuo Ununoctium (4962)	437 Uuh Ununhennium (4977)	438 Uuo Ununoctium (4992)	439 Uuh Ununhennium (5007)	440 Uuo Ununoctium (5022)	441 Uuh Ununhennium (5037)	442 Uuo Ununoctium (5052)	443 Uuh Ununhennium (5067)	444 Uuo Ununoctium (5082)	445 Uuh Ununhennium (5097)	446 Uuo Ununoctium (5112)	447 Uuh Ununhennium (5127)	448 Uuo Ununoctium (5142)	449 Uuh Ununhennium (5157)	450 Uuo Ununoctium (5172)	451 Uuh Ununhennium (5187)	452 Uuo Ununoctium (5202)	453 Uuh Ununhennium (5217)	454 Uuo Ununoctium (5232)	455 Uuh Ununhennium (5247)	456 Uuo Ununoctium (5262)	457 Uuh Ununhennium (5277)	458 Uuo Ununoctium (5292)	459 Uuh Ununhennium (5307)	460 Uuo Ununoctium (5322)	461 Uuh Ununhennium (5337)	462 Uuo Ununoctium (5352)	463 Uuh Ununhennium (5367)	464 Uuo Ununoctium (5382)	465 Uuh Ununhennium (5397)	466 Uuo Ununoctium (5412)	467 Uuh Ununhennium (5427)	468 Uuo Ununoctium (5442)	469 Uuh Ununhennium (5457)	470 Uuo Ununoctium (5472)	471 Uuh Ununhennium (5487)	472 Uuo Ununoctium (5502)	473 Uuh Ununhennium (5517)	474 Uuo Ununoctium (5532)	475 Uuh Ununhennium (5547)	476 Uuo Ununoctium (5562)	477 Uuh Ununhennium (5577)	478 Uuo Ununoctium (5592)	479 Uuh Ununhennium (5607)	480 Uuo Ununoctium (5622)	481 Uuh Ununhennium (5637)	482 Uuo Ununoctium (5652)	483 Uuh Ununhennium (5667)	484 Uuo Ununoctium (5682)	485 Uuh Ununhennium (5697)	486 Uuo Ununoctium (5712)	487 Uuh Ununhennium (5727)	488 Uuo Ununoctium (5742)	489 Uuh Ununhennium (5757)	490 Uuo Ununoctium (5772)	491 Uuh Ununhennium (5787)	492 Uuo Ununoctium (5802)	493 Uuh Ununhennium (5817)	494 Uuo Ununoctium (5832)	495 Uuh Ununhennium (5847)	496 Uuo Ununoctium (5862)	497 Uuh Ununhennium (5877)	498 Uuo Ununoctium (5892)	499 Uuh Ununhennium (5907)	500 Uuo

Lanthanides

Actinides

58	Ce Cerium	59	Pr Praseodymium	60	Nd Neodymium	61	Pm Promethium	62	Sm Samarium	63	Eu Europium	64	Gd Gadolinium	65	Tb Terbium	66	Dy Dysprosium	67	Ho Holmium	68	Er Erbium	69	Tm Thulium	70	Yb Ytterbium	71	Lu Lutetium
141.1		140.1		144.2		145		150.4		152.0		157.3		158.9		162.5		162.9		167.3		168.9		173.0			
232.0		231		238.1		237		242		243		247		245		251		254		253		256		254			
232.0		231		238.1		237		242		243		247		245		251		254		253		256		254			
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232.0		231		238.1		237		242		243		247		245		251		254		253		256		254			
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232.0		231		238.1		237		242		243		247		245		251		254		253		256		254			
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232.0		231		238.1		237		242		243		247		245		251		254		253		256		254			
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232.0		231		238.1		237		242		243		247		245		251		254		253		256		254			
232.0		231		238.1		237		242		243		247		245		251		254		253		256		254			
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232.0		231		238.1		237		242		243		247		245		251		254		253		256		254			
232.0		231		238.1		237		242		243		247		245		251		254		253		256		254			
232.0		231		238.1		237		242		243		247		245		251		254		253		256		254			
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232.0		231		238.1		237		242		243		247		245		251		254		253		256		254			
232.0		231		238.1		237		242		243		247		245		251		254		253		256		254			
232.0		231		238.1		237		242		243		247		245		251		254		253		256		254			
232.0		231		238.1		237		242		243		247		245		251		254		253		256		254			
232.0		231		238.1		237		242		243		247		245		251		254		253		256		254			
232.0		231		238.1		237		242		243		247		245		251		254		253							

Groups : The 18 vertical columns (groups or families) are numbered from 1 to 18. Group 18 is also known as **zero group** which consists of noble gases. Elements of the groups 1,2 and 13 to 18 are called **normal** or **representative elements** while those of groups 3 to 12 are called **transition elements**. At present we shall study only the first twenty elements of the eight groups (groups 1, 2 and 13 to 18) of the normal or representative elements.

Activity 1.1.

- ☞ Look at the periodic table. Find out the elements present in Group 1 of the table.
- ☞ Write down electronic configuration of the first four elements of the group.
- ☞ What similarity do you find in their electronic configurations ?
- ☞ How many valence electrons are present in these elements ?
- ☞ Repeat the above activities with those elements of group 2 and 17 elements.
- ☞ Compare your results with Table 1.6

Table 1.6. Electronic configuration of some elements of group 1,2 and 17

Group-1 elements	Atomic no.	Electronic configuration K, L, M, N,	Group-2 elements	Atomic no.	Electronic configuration K, L, M, N,	Group-17 elements	Atomic no.	Electronic configuration K, L, M, N
H	1	1						
Li	3	2, 1	Be	4	2, 2	F	9	2, 7
Na	11	2, 8, 1	Mg	12	2, 8, 2	Cl	17	2, 8, 7
K	19	2, 8, 8, 1	Ca	20	2, 8, 8, 2			

We find that the elements of group 1 have the same number of valence electrons i.e. 1, and those of group 2 and 17 have 2 and 7 valence electrons respectively.

Similarly, you will find that elements present in any one group have the same number of valence electrons. Hence, we can say that groups in the periodic table signify identical outer shell electronic configuration. On the other hand, the number of shells increases as we go down the group.

The electronic configuration of the first twenty elements in the Periodic Table are shown in Table 1.7.

Table 1.7. Electronic configuration of first twenty elements in the Periodic Table

Period	Group1	GROUP NUMBER						Group 18	
1st period	H 1	2	13	14	15	16	17	2 He 2	
2nd period	3 Li 2,1	4 Be 2,2	5 B 2,3	6 C 2,4	7 N 2,5	8 O 2,6	9 F 2,7	10 Ne 2,8	
3rd period	11 Na 2,8,1	12 Mg 2,8,2	13 Al 2,8,3	14 Si 2,8,4	15 P 2,8,5	16 S 2,8,6	17 Cl 2,8,7	18 Ar 2,8,8	
4th period	19 K 2,8,8,1	20 Ca 2,8,8,2							
Valence Electrons →		1	2	3	4	5	6	7	8

The chart shows the arrangement of first twenty elements in the periodic table on the basis of their electronic configuration. The numbers given above the symbols of the elements are atomic numbers while the numbers given below the symbols are electronic configurations.

The atomic number of Hydrogen and Helium are 1 and 2 respectively. They have 1 and 2 electrons respectively in the K-shell. The atomic number of Lithium is 3, its electronic configuration is 2, 1. Thus Lithium has 1 electron in its outermost shell. With the increase in atomic number, the number of electrons in the outermost shell increases from 1 (in Li) to 8 (in Ne). When the atomic number is 11 (in Na), the electronic configuration is 2, 8, 1. Thus Li and Na have the same number of electrons in the outermost shell (they belong to group 1). They also have similar properties. Thus with the repetition of electronic configuration, the properties of elements are also repeated. In the same way, the group 17 elements having 7 electrons in their outermost shell show similar chemical properties.

Activity 1.2

- ☞ Find out the elements present in the 2nd and 3rd period of the periodic table.
- ☞ Write down their electronic configuration.

- ☞ Do these elements contain the same number of valence electrons ?
- ☞ Do they contain the same number of shells ?

We have observed that the elements in a period do not have the same number of valence electrons as we move from left to right, though they contain the same number of shells. Or we can say that atoms of different elements with the same number of occupied shells are placed in the same period. H and He belong to the first period, since the electrons in the atoms are filled in K shell. Na, Mg, Al, Si, P, S, Cl and Ar belong to the third period as the electrons of these elements are filled in K, L and M shells.

The progression of 2, 8, 8, 18, 18, 32, 32 elements in the seven periods are in accordance with the electronic configuration of elements. We have already learnt in class IX that the maximum number of electrons that can be accommodated in any shell is given by the formula, $2n^2$ where 'n' is the number of the given shell. For example,

K – shell : $2 \times (1)^2 = 2$, hence first period has two elements, i.e., H and He.

L – shell : $2 \times (2)^2 = 8$, hence second period has eight elements, from Li to Ne.

M – shell : $2 \times (3)^2 = 18$, but the outermost shell cannot have more than 8 electrons. Therefore, third period also has eight elements from Na to Ar.

The maximum number of elements which can be accommodated in 4th, 5th, 6th and 7th period are 18, 18, 32 and 32 respectively. You will learn about these in higher classes.

The position of an element in the periodic table tells us about its chemical reactivity. As you have learnt, the valence electrons determine the chemical characteristic of the element. Differences in electronic arrangement results in variation of the properties of the elements. In other words, elements having similar electronic configuration of the valence shell have similar chemical properties. On arranging the elements in the increasing order of their atomic numbers, the elements with the same valence electrons appear at regular intervals. Hence, the chemical properties of elements show similarities.

1.3. TRENDS ON THE BASIS OF MODERN PERIODIC TABLE

From the study of the modern periodic table, we find that there is a regular periodic repetition of the electronic configuration of elements as the atomic number increases. Consequently, in some properties of elements there is a periodic trend or the rhythmic behaviour of the atoms as a function of the atomic number.

1.3.1. Valency

We have learnt that the combining capacity or the valency of an element is determined by the number of valence electrons present in the outermost shell of its atom.

Activity 1.3.

- ☞ Write down the electronic configuration of sodium (atomic number 11), magnesium (at. no. 12) and oxygen (at. no. 8). What are their valence electrons? What are their valencies?
- ☞ Similarly, find out the valencies of the first twenty elements.
- ☞ Find out how does the valency vary in a period on going from left to right ?
- ☞ How does the valency vary in a group?

We find that on moving from left to right in a period, the number of valence electrons in elements increases from 1 to 8 (Table 1.8). In the first period, the increase is from 1 to 2.

Table 1.8 Valency of the Elements of 2nd and 3rd period

Elements of 2nd period								
Elements	Li	Be	B	C	N	O	F	Ne
Atomic number	3	4	5	6	7	8	9	10
Electronic configuration.	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8
Valence electrons	1	2	3	4	5	6	7	8
Valency	1	2	3	4	3	2	1	0

Elements of 3rd period

Elements	Na	Mg	Al	Si	P	S	Cl	Ar
Atomic number	11	12	13	14	16	16	17	18
Electronic Configuration	2,8,1	2,8,2	2,8,3	2,8,4	2,8,5	2,8,6	2,8,7	2,8,8
Valence electrons	1	2	3	4	5	6	7	8
Valency	1	2	3	4	3	2	1	0

*Let us recall what we have learnt in class IX, that atoms of elements having a completely filled outermost shell i.e. 8 electrons show little chemical activity. An outermost shell, which has eight electrons was said to possess an octet in the outermost shell. In other words, the valency of the atoms having octet in their valence shells are zero. These elements are known as inert or noble **gas elements**. They are all gases and belong to group 18 of the periodic table. Of these inert elements, helium atom has two electrons in its outermost shell i.e. K-shell for which it represents full or stable structure.*

The combining capacity (valency) of the atoms of an element is the tendency to react or form molecules with other atoms of the same or different elements. It was thus explained as the tendency to attain a fully filled outermost shell or stable structure, i.e. octet of electrons in the outermost shell (except Helium structure which has two electrons in its outermost shell i.e. K-shell).

The number of electrons gained, lost or shared, so as to make the octet of electrons in the outermost shell, gives us directly the valency of the element. In other words, in a period, the valency of an element is either equal to the number of electrons in the valence shell or eight minus the number of electrons in the valence shell.

Thus, we find that on moving left to right in each of the short periods, the valency of elements increases from 1 to 4 and then decreases to 0 (zero).

The elements in a given group of the periodic table have the same valence electron (s). Hence, in a group, the elements have the same valency (Table 1.9)

Table 1. 9 . Valency of elements

Group I Elements				Group 17 Elements			
Symbol	At.no.	Electronic configuration	Valency	Symbol	At.no.	Electronic configuration	Valency
Li	3	2,1	1	F	9	2,7	1
Na	11	2,8,1	1	Cl	17	2,8,7	1
K	19	2, 8, 8, 1	1	Br	35	2,8, 18, 7	1

1.3.2. Atomic Size

The term atomic size refers to the radius of an atom. It may be visualised as the distance between the centre of the nucleus and the outermost shell of an isolated atom. The atomic radius is generally expressed in ‘picometre’ units whose symbol is ‘pm’.

$$1 \text{ picometre} = 10^{-12} \text{ m.}$$

$$\text{or } 1 \text{ pm} = 10^{-12} \text{ m.}$$

The atomic radii of hydrogen and helium are 37 pm and 93 pm respectively.

The following table (Table 1.10) gives the atomic radii of the second and third period elements.

Table 1.10. Atomic radii of 2nd and 3rd period elements in picometres (pm)

Elements	Li	Be	B	C	N	O	F	Ne
2nd period	Li	Be	B	C	N	O	F	Ne
Atomic radius(pm)	123	90	80	77	75	74	72	112
3rd period	Na	Mg	Al	Si	P	S	Cl	Ar
Atomic radius (pm)	186	160	143	118	110	104	99	154

It is observed that the *atomic radius decreases in moving from left to right along a period for normal elements*. The elements of the groups 1, 2, and 13 to 18 are called normal or representative elements. In a period, the atomic number increases from left to right. This means that the number of protons (positive charges of nucleus) and electrons in the atoms increases. The electrons are added to the same shell while the charge on the nucleus increases steadily. The increase in nuclear charge tends to pull the electrons closer to the nucleus and reduces the size of the atom. The atomic radii of noble gases (group 18 elements) have comparatively larger atomic radii than their preceding groups. This is due to the increase of electronic repulsions between completely filled outer shells.

How does atomic radius vary as we go down a group ? Table 1.11 gives the atomic radii of group 1 and group 17 elements.

Table 1.11 Increase in atomic radii in a group

Group 1 Elements	Atomic radius (pm)	Group 17 Elements	Atomic radius (pm)
Li	123	F	72
Na	186	Cl	99
K	231	Br	114
Rb	244	I	133
Cs	262		

We can see that the atomic size increases down the group. This is because electrons are added to new shells as we go down the group. This increases the distance between the outermost electrons and the nucleus so that the atomic radius increases in spite of the increase in nuclear charge.

1.3.3. Metallic and non-metallic character

Activity 1.4

- ☞ Examine the elements of the second and the third period. Which of them are metals and which are non-metals ?
- ☞ On which side of the periodic table do you find the metals ?
- ☞ On which side of the periodic table do you find the non-metals ?

We can see that metals like lithium, sodium, magnesium etc. are found towards the left-hand side of the periodic table while the non metals like oxygen, sulphur, chlorine etc. are found on the right hand side. Towards the middle, we find boron and silicon, which are classified as semi-metals or metalloids because they exhibit some properties of both metals and non -metals.

Thus, we find that **on moving from left to right in a period, the metallic character of elements decreases i.e, it changes from metallic nature to metalloid, then to non-metallic and finally the last element in a period is inert in nature (Table 1.12).**

Table 1. 12. Metallic and non-metallic character of elements in 2nd & 3rd period

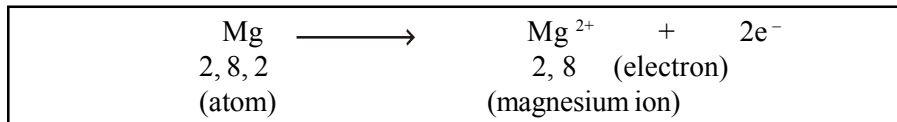
Elements of 2nd Period	Li	Be	B	C	N	O	F	Ne
Metallic/non-metallic character	metal	metal	meta- lloid	non metal	non metal	non metal	non metal	Noble gas
Elements of 3rd period	Na	Mg	Al	Si	P	S	Cl	Ar
Character	metal	metal	metal	meta- lloid	non metal	non metal	non metal	Noble gas

————→ ***Metallic or Electropositive character decreases*** —————→

In the modern periodic table, a zig-zag line separate metals from non-metals. The borderline elements -boron, silicon, germanium, arsenic, antimony, tellurium and polonium are intermediate in properties and are called **semi-metals** or **metalloids**. We shall learn in the next chapter that metals lose electrons and form positive ions, so metals are electropositive in nature. The tendency of an element to lose electrons, and form positive ions (cation) is called **electropositive character**. Since metals have such a tendency, the electropositive character is also known as the **metallic character**.

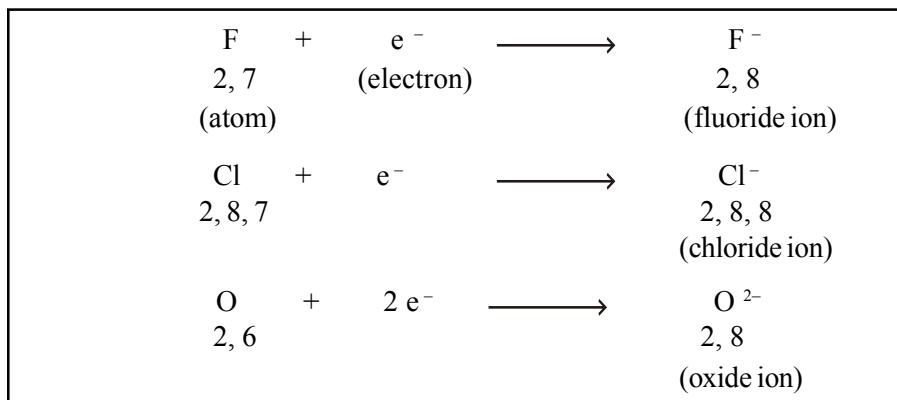
Thus, metals like Na, K and Mg are electropositive, because they have high tendency to lose electrons.

Na 2, 8, 1 (atom)	————→	Na ⁺ + e ⁻ 2, 8 (electron) (sodium ion)
K 2, 8, 8, 1 (atom)	————→	K ⁺ + e ⁻ 2, 8, 8 (electron) (potassium ion)



The valency of Na and K is 1 and that of Mg is 2.

On the other hand, non-metals accept electrons and form negative ions, so non-metals are called electronegative elements. The tendency of an element to accept electrons to form an anion is called **electronegative character** or **non-metallic character**. For example, the elements fluorine (F), Chlorine (Cl) and Oxygen (O) are electronegative in nature, because they have high tendency to gain electrons.



As we move from left to right in a period, the effective nuclear charge (positive charge on nucleus) increases due to gradual increase in the number of protons. Due to this, the valence electrons are pulled in more strongly by the nucleus and the tendency to lose electrons will decrease. Down the group, the effective nuclear charge experienced by valence electrons is decreasing because the outermost electrons are farther away from the nucleus due to the addition of new shells. Therefore, these can be lost easily. Hence **metallic character (or electropositive nature) decreases across a period and increases down a group**. *The reverse will be the trend in electronegative character of the elements.*

1.3.4. Nature of Oxides of the elements

We know that oxides of metals are basic and that of non-metals are acidic in general. With the knowledge of the trends in metallic and non-metallic properties of elements in the periodic table, can you predict the nature of the oxides formed by the elements ?

As one moves from left to right in a period, the basic nature of the oxides gradually decreases and acidic nature of the oxides gradually increases. For example, in the third period of the periodic table, sodium oxide is highly basic and magnesium oxide is comparatively less basic. The aluminium and silicon oxides are amphoteric while phosphorous oxides are acidic. Sulphur oxides are more acidic whereas chlorine oxides are highly acidic in nature (Table 1.12).

Table 1.13. Nature of oxides of third period Elements

Elements of 3rd period	Na	Mg	Al	Si	P	S	Cl	Ar
Oxides	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_2, SO_3	Cl_2O_7	
Nature	Strongly basic	Basic	Amphoteric	Amphoteric	Acidic	Acidic	Highly acidic	

Can you predict what will be the basic character down a group? As the electropositive character increases down a group, so also is the basic character. For example, calcium oxide is more basic than magnesium oxide and strontium oxide is more basic than calcium oxide.

The modern periodic table is a very satisfactory attempt to the classification of elements. It summarises the vast knowledge of the chemical elements and helps us to see the relationship between their physical and chemical properties and their electronic configuration to a very large measure. However it is still not free from certain defects, the details of which you will learn in higher classes. Chemists are still trying to evolve a still better periodic table.

Let us answer these.

1. What name has been given to the horizontal arrangement of elements in the periodic table? Is there any gradation in the properties of elements across these rows? Give two examples to illustrate.
2. How do the properties of group 1 elements differ from those of group 17 elements? Illustrate the differences in at least two properties?
3. From the standpoint of electronic configuration, determine which element will be the first and which will be the last in a period of the periodic table?

4. Accommodation of isotopic form of the same element was an upset in Mendeleev's periodic table. How could the Modern Periodic table remove the anomaly ?
5. Name two elements you would expect to show chemical reactions similar to lithium. What is the basis of your choice ?
6. **Name**
 - (i) three elements having one electron in their shells,
 - (ii) two elements having four electrons in their outermost shells,
 - (iii) three elements with completely filled shells.
7. Fluorine, chlorine and bromine belong to group 17 of the periodic table. What similarity is there in the atoms of these elements ?
8. By considering their position in the periodic table, which one of the following elements is expected to have maximum metallic character ?

In, Sn, Sb, Te, I.
9. How would be the tendency to gain electrons change as we go from left to right across a period ?
10. How would be the tendency to gain electrons change as we go down a group ?
11. Why are non-metals found on the right-hand side of the periodic table towards the top?

SUMMARY

- ✱ Elements are classified on the basis of similarities in their properties.
- ✱ The earliest attempt to classify the elements resulted in grouping the then known elements into two groups, metals and non-metals.
- ✱ Dobereiner classified elements having similar properties into triads and stated that when elements are arranged in the order of increasing atomic masses in a triad, the atomic mass of the middle element was approximately equal to the arithmetic mean of the atomic masses of the other two elements.

- ✱ Newlands found that when elements are arranged in the order of increasing atomic masses, the properties of the eight elements were found to resemble the properties of the starting element.
- ✱ Mendeleev arranged the elements in increasing order of their atomic masses and according to their chemical properties. He stated that the properties of elements are periodic functions of their atomic masses.
- ✱ Mendeleev's periodic table could predict the properties of several elements on the basis of their positions in the periodic table. He even predicted the existence of some yet to be discovered elements on the basis of gaps in the periodic table.
- ✱ In the modern periodic table, the basis for the classification of elements is the atomic number which is a more fundamental property of an element. It could remove the anomalies in the arrangement of elements based on increasing atomic mass.
- ✱ Elements in the modern periodic table are arranged in seven horizontal rows called periods and 18 vertical columns called groups.
- ✱ Elements thus arranged show periodicity in their properties.
- ✱ Trends like atomic size, valency, metallic and non-metallic character of elements could be predicted from their position in the periodic table.

EXERCISES

1. Why is there a need to classify the elements? What difficulties are likely to arise if the classification is not made?
2. Name the period and group to which the element with atomic number 15 belongs.
3. State one reason for keeping boron and aluminium in the same group of the periodic table.
4. Write the electronic configurations of the elements Na, Al, Ca, O and Si and justify their positions in the periodic table.
5. Why is atomic number more important than atomic mass to know the properties of the elements?

6. State how atomic size varies from left to right in a period and from top to bottom in a group.

7. **The atomic radii of the elements of second period are given below:**

2nd period elements : B Be O N Li C

Atomic radii (pm): 80 90 74 75 123 77

- (a) Arrange the elements in the decreasing order of their atomic radii, keeping the element with the largest atomic radius first.
- (b) Find out whether the arrangement is in the pattern of a period or not?
- (c) From this data, infer how the atomic size of the elements changed as one goes from left to right in a period.
8. By considering their position in the periodic table, which one of the following elements would you expect to have the maximum metallic character ?

Ga, Ge, As, Se, Br.

9. **The position of three elements A, B and C in the periodic table are shown below.**

Group16	Group 17
--	--
--	A
--	--
B	C

- (a) State whether A is a metal or non-metal ?
- (b) State whether C will be more reactive or less reactive than A
- (c) Will C be larger or smaller in size than B ?
- (d) What type of ion (cation or anion) will be formed by A ?
10. Element X forms a chloride with the formula XCl_2 . With which of the following elements, X would most likely be in the same group of the periodic table ?

Na, Mg, Al, C.

11. Name two elements you would expect to show chemical properties similar to Li. What is the basis of your choice ?
12. What properties do all elements in the same group of boron in the periodic table have in common ?
13. **An atom has electronic configuration 2, 8, 6.**
 - (a) What is the atomic number of this element ?
 - (b) Which of the following elements would it be similar in chemical properties?
N(7), F(9), P(15), O(8), Ar(18)
14. Nitrogen (at.no. 7) and Phosphorous (at. no. 15) belong to group 15 of the periodic table. Which of them will be more electronegative and why?
15. In the modern Periodic table, calcium (at. no. 20) is surrounded by elements with atomic numbers 12, 19, 21 and 38. Which of them have physical and chemical properties resembling calcium ?

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