Periodic Table and Periodicity of Properties

Major Concepts

3.1 Periodic Table
3.2 Periodic Properties

Time allocation

Teaching periods	12
Assessment periods	02
Weightage	10%

Students Learning Outcomes

Students will be able to:

- Distinguish between period and group in the Periodic table.
- State the Periodic law.
- Classify elements (into two categories: groups and periods) according to the configuration of their outermost electrons.
- Determine the demarcation of the periodic table into s-block and /?-block.
- Explain the shape of the periodic table.
- Determine the location of families of the periodic table.
- Recognize the similarity in the physical and chemical properties of elements in the same family of the elements.
- Identify the relationship between electronic configuration and position of elements in the periodic table.
- Explain how shielding effect influences periodic trends.
- Describe how electronegativities change within a group and within a period in the periodic table.

Introduction

In nineteenth century, chemists devoted much of their efforts in attempts to arrange elements in a systematic manner. These efforts resulted in discovery of periodic law. On the basis of this law, the elements known at that time, were arranged in the form of a table which is known as periodic table. One of the significant features of the table was that it predicted the properties of those elements which were not even discovered at that time. The vertical columns of that table were called groups and horizontal lines were called periods. That orderly arrangement of elements generally coincided with their increasing atomic number. The periodic table contains huge amount of information for scientists.

3.1 PERIODIC TABLE

With the discovery of the periodic table the study of individual properties of the known elements is reduced to study of a few groups. We will describe various attempts which were made to classify the elements into a tabular form.

Dobereiner's Triads

A German chemist Dobereiner observed relationship between atomic masses of several groups of three elements called triads. In these groups, the central or middle element had atomic mass average of the other two elements. One triad group example is that of calcium (40), strontium(88) and barium (137). The atomic mass of strontium is the average of the atomic masses of calcium and barium. Only a few elements could be arranged in this way. This classification did not get wide acceptance.

Newlands Octaves

After successful determination of correct atomic masses of elements by Cannizzaro in 1860, attempts were again initiated to organize elements. In 1864 British chemist Newlands put forward his observations in the form of *'law of octaves'*. He noted that there was a repetition in chemical properties of every eighth element if they were arranged by their increasing atomic masses. He compared it with musical notes. His work could not get much recognition as no space was left for undiscovered element. The noble gases were also not known at that time.

Mendeleev (1834-1907) was a Russian chemist and inventor. He was the creator of first version of periodic table of elements. With help of the table, he predicted the properties of elements yet to be discovered.

Mendeleev's Periodic Table

Russian chemist, Mendeleev arranged the known elements (only 63) in order of increasing atomic masses, in horizontal rows called periods. So that elements with similar properties were in the same vertical columns.

This arrangement of elements was called Periodic Table. He put forward the results of his work in the form of periodic law, which is stated as *"properties of the elements are periodic functions of their atomic masses"*

Although, Mendeleev periodic table was the first ever attempt to arrange the elements, yet it has a few demerits in it. His failure to explain the position of isotopes and wrong order of the atomic masses of some elements suggested that atomic mass of an element cannot serve as the basis for the arrangement of elements.

Periodic Law

In 1913 H. Moseley discovered a new property of the elements i.e. atomic number. He observed that atomic number instead of atomic mass should determine the position of element in the periodic table and accordingly the **periodic law** was amended as *"properties of the elements are periodic function of their atomic numbers"*. Atomic number of an element is equal to the number of electrons in a neutral atom. So atomic number provides the basis of electronic configurations as well.

Do you know?

Atomic number is a more fundamental property than atomic mass because atomic number of every element is fixed and it increases regularly by 1 from element to element. No two elements can have the same atomic number.

Test yourself 3.1

I. What was the contribution of Dobereiner towards classification of elements?
ii. How Newlands arranged the elements?
iii. Who introduced the name Periodic Table ?
iv. Why the improvement in Mendeleev's periodic table was made?
v. State Mendeleev's periodic law.
vi. Why and how elements are arranged in a period?

Modern Periodic Table

Atomic number of an element is more fundamental property than atomic mass in two respects, (a) It increases regularly from element to element, (b) It is fixed for every element. So the discovery of atomic number of an element in 1913 led to change in Mendeleev's periodic law which was based on atomic mass.

The modern periodic table is based upon the arrangement of elements according to increasing atomic number. When the elements are arranged according to increasing atomic number from left to right in a horizontal row, *properties of elements were found repeating after regular intervals* such that elements of similar properties and similar configuration are placed in the same group.

It was observed that after every eighth element, ninth element had similar properties to the first element. For example, sodium (Z=ll) had similar properties to lithium (Z=3). After atomic number 18, every nineteenth element was showing similar behaviour. So the long rows of elements were cut into rows of eight and eighteen elements and placed one above the other so that a table of vertical and horizontal rows was obtained.

Long form of Periodic Table

The significance of atomic number in the arrangement of elements in the modern periodic table lies in the fact that as electronic configuration is based upon atomic number, so the arrangement of elements according to increasing atomic number shows the periodicity (repetition of properties after regular intervals) in the electronic configuration of the elements that leads to periodicity in their properties. Hence, the arrangement of elements based on their electronic configuration created a long form of periodic table as shown in figure 3.1.

The horizontal rows of elements in the periodic table are called ***periods***. The elements in a period have continuously increasing atomic number i.e. continuously changing electronic configuration along a period. As a result properties of elements in a period are continuously changing. The number of valence electrons decides the position of an element in a period. For example, elements which have 1 electron in their valence shell occupies the left most position in the respective periods, such as alkali metals. Similarly, the elements having 8 electrons in their valence shells such as noble gases always occupy the right most position in the respective periods.

The vertical columns in the periodic table are called ***groups***. These groups are numbered from left to right as 1 to 18. The elements in a group do not have continuously increasing atomic numbers. Rather the atomic numbers of elements in a group increase with irregular gaps.

But the elements of a group have similar electronic configuration i.e. same number of electrons are present in their valence shells. For example, the first group elements have only 1 electron in their valence shells. Similarly, group 2 elements have 2 electrons in their valence shells. It is the reason due to which elements of a group have similar chemical properties.

Salient Features of Long Form of Periodic Table:

i. This table consists of seven horizontal rows called periods.

ii. First period consists of only two elements. Second and third periods consist of 8 elements each. Fourth and fifth periods consist of 18 elements each. Sixth period has 32 elements while seventh period has 23 elements and is incomplete.

iii. Elements of a period show different properties.

iv. There are 18 vertical columns in the periodic table numbered 1 to 18 from left to right, which are called groups.

v. The elements of a group show similar chemical properties.

vi. Elements are classified into four blocks depending upon the type of the subshell which gets the last electron.

Light metals | Heavy metals | Non-metals | Nobel gases

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H 1.0079																	2 He 4.00
2	3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 15.99	9 F 18.99	10 Ne 20.18
3	11 Na 22.99	12 Mg 24.30											13 Al 26.98	14 Si 28.08	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
4	19 K 39.09	20 Ca 40.08	21 Sc 44.95	22 Ti 47.87	23 V 50.94	24 Cr 51.99	25 Mn 54.94	26 Fe 55.84	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
5	37 Rb 85.47	38 Sr 87.62	39 Y 88.90	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc 97.91	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
6	55 Cs 132.90	56 Ba 137.33	*	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.2	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po 208.98	85 At 209.99	86 Rn 222.02
7	87 Fr 223.02	88 Ra 226.02	**	104 Rf 261.11	105 Db 262.11	106 Sg 263.12	107 Bh 262.12	108 Hs 265	109 Mt 266.14	110 Ds 269	111 Rg 272	112 Uub 277	113 Uut 284	114 Uuq 289	115 Uup 288	116 Uuh 292	117 Uus 293	118 Uuo 294

* Lanthanides	57 La 138.90	58 Ce 140.11	59 Pr 140.91	60 Nd 144.24	61 Pm 144.91	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.92	66 Dy 162.5	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
** Actinides	89 Ac 227.03	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np 237.05	94 Pu 244.66	95 Am 243.06	96 Cm 247.07	97 Bk 247.07	98 Cf 251.08	99 Es 252.08	100 Fm 257.10	101 Md 258.10	102 No 259.10	103 Lr 262.11

Key:

Colour of box of elements		Colour of symbol of elements
Metals	(yellow)	**Black** = Solid
Non-metals	(blue)	**Blue** = Liquid
Metalloids	(green)	**Red** = Gas
Nobel Gases	(pink)	**Purple** = Synthetic

Fig. 3.1 Modern Periodic Table or long form of the Periodic Table of Elements.

Modern Periodic Table

On the basis of completion of a particular subshell, elements with similar subshell electronic configuration are referred as a ***block*** *of elements.* There are four blocks in the periodic table named after the name of the subshell which is in the process of completion by the electrons. These are *s*, *p*, *d* and *f* blocks as shown in figure 3.2. For example, elements of group 1 and 2 have valence electrons in '*s*' subshell. Therefore, they are called *s*-block elements as shown in figure 3.2.

Elements of group 13 to 18 have their valence electrons in p subshell. Therefore, they are referred as p-block elements. The *d*-block lies between the *s* and *p* blocks. While *f*-block lies separately at the bottom. *d*-block constitutes period 4,5 and 6. Each period consists of ten groups starting from group 3 to group 12. These are called **transition metals**.

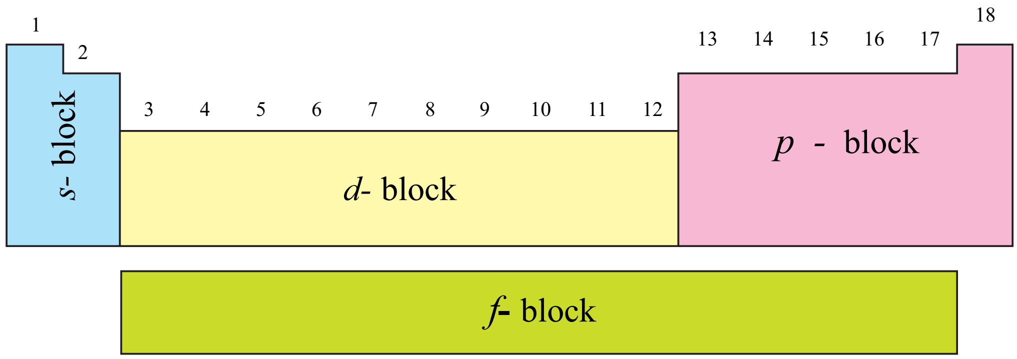

Fig. 3.2 Modern Periodic Table showing four blocks.

Do you know?

> ***Alchemy!*** *For thousand years alchemy remained field of interest for the scientists. They worked with two main objectives; change common metals into gold and second find cure to diseases and give eternal life to people. They believed all kinds of matter were same combination of four basic elements. Substances are different because these elements combine differently. Changing composition or ratio of any one element, new substances can be formed. The way of making gold from silver or lead was never found and secret of eternal life was never discovered. However, many methods and techniques invented by alchemists are still used in chemistry.*

3.1.1 Periods

First period is called short period. It consists of only two elements, hydrogen and helium. Second and third periods are called normal periods. Each of them has eight elements in it. Second period consists of lithium, beryllium, boron, carbon, nitrogen, oxygen, fluorine and ends at neon, a noble gas. Fourth and fifth periods are called long periods. Each one of them consists of eighteen elements.

Whereas, sixth and seventh periods are called very long periods. In these periods after atomic number 57 and 89, two series of fourteen elements each, were accommodated. Because of space problem, these two series were placed separately below the normal periodic table to keep it in a manageable and presentable form. Since the two series start after Lanthanum (Z=57) and Actinium (Z=89), so these two series of elements are named as Lanthanides and Actinides respectively. Table 3.1 shows the distribution of elements in periods.

All the periods except the first period start with an alkali metal and end at a noble gas. It is to be observed that number of elements in a period is fixed because of maximum number of electrons which can be accommodated in the particular valence shell of the elements.

Table 3.1 Different Periods of the Periodic Table

Period No.	Name of the Period	Number of Elements	Range of Atomic Numbers
1^{st}	Short Period	2	1 to 2
2^{nd}	Normal Period	8	3 to 10
3^{rd}		8	11 to 18
4^{th}	Long Period	18	19 to 36
5^{th}		18	37 to 54
6^{th}	Very Long Period	32	55 to 86
7^{th}		[32]*	87 to 118*

**Since new elements are expected to be discovered, it is an incomplete period*

3.1.2 Groups

Group 1 consists of hydrogen, lithium, sodium, potassium, rubidium, cesium and francium. Although elements of a group do not have continuously increasing atomic numbers, yet they have similar electronic configuration in their valence shells. That is the reason elements of a group are also called a family. For example, all the group 1 elements have one electron in their valence shells, they are given the family name of alkali metals.

The groups 1 and 2 and 13 to 17 contain the normal elements. In the normal elements, all the inner shells are completely filled with electrons, only the outermost shells are incomplete. For example, group 17 elements (halogens) have 7 electrons in their valence (outermost) shell.

The groups 3 to 12 are called transition elements. In these elements 'af' sub-shell is in the process of completion. Table 3.2 shows the distribution of elements in groups.

Table 3.2 Different Groups of the Periodic Table

Valence electrons	Group number	Family name	General Electronic configuration
1 electron	1	Alkali metals	ns^1
2 electrons	2	Alkaline earth metals	ns^2
3 electrons	13	Boron family	$ns^2\ np^1$
4 electrons	14	Carbon family	$ns^2\ np^2$
5 electrons	15	Nitrogen family	$ns^2\ np^3$
6 electrons	16	Oxygen family	$ns^2\ np^4$
7 electrons	17	Halogen family	$ns^2\ np^5$
8 electrons	18	Noble gases	$ns^2\ np^6$

Do you know?

Fire Works

Beautiful fireworks display are common on celebrations like Pakistan Day or even on marriages. A technology invented in China is used all over the world. It is dangerous but careful use of various elements and particularly metal salts of different composition give beauty and colors to the fireworks. Elements like magnesium, aluminium are used in powdered form. Salts of sodium give yellow color, calcium - red; strontium-scarlet; barium-green and copper-bluish green. Usually nitrates and chlorates are used. Other chemicals are added to give brilliance and different shades. Because of fire hazard and risk to life and property, only skilled professionals use them.

Test yourself 3.3

i. How the properties of elements repeat after regular intervals?
ii. In which pattern modern periodic table was arranged?
iii. How many elements are in first period and what are their names and symbols?
iv. How many elements are placed in 4th period?
v. From which element lanthanide series starts?
vi. From which period actinides series starts?
vii. How many elements are in 3rd period, write their names and symbols?
viii. How many periods are considered normal periods ?
ix. What do you mean by a group in a periodic table?
x. What is the reason of arranging elements in a group?
xi. What do you mean by periodic function?
xii. Why the elements are called sorp block elements?
xiii. Write down the names of elements of group 1 with their symbols?
xiv. How many members are in group 17, is there any liquid, what is its name ?

3.2 PERIODICITY OF PROPERTIES

3.2.1 Atomic Size and Atomic Radius

As we know that atoms are very small and don't have defined boundaries that fix their size. So it is difficult to measure the size of an atom. Therefore, the common method to determine the size of an atom is to assume that atoms are spheres. When they lie close to each other, they touch each other.

Half of the distance between the nuclei of the two bonded atoms is referred as the ***atomic radius*** *of* the atom. For example, the distance between the nuclei of two carbon atoms in its elemental form is 154 pm, its means its half 77 pm is radius of carbon atom as shown in Figure 3.3:

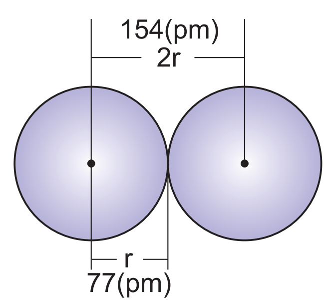

Fig. 3.3 The radius of carbon atom.

When we move from left to right in a period although atomic number increases, yet the size of atoms decreases gradually. It is because with the increase of atomic number, the effective nuclear charge increases gradually because of addition of more and more protons in the nucleus. But on the other hand addition of electrons takes place in the same valence shell i.e. shells do not increase. There is gradual increase of effective nuclear charge which increases due to addition of protons. This force pulls down or contracts the outermost shell towards the nucleus. For example, atomic size in period 2 decreases from Li (152 pm) to Ne (69 pm).

2nd period elements	^{3}Li	^{4}Be	^{5}B	^{6}C	^{7}N	^{8}O	^{9}F	^{10}Ne
Atomic radii (pm)	152	113	88	77	75	73	71	69

1st group elements	Atomic radii (pm)
^{3}Li	152
^{11}Na	186
^{19}K	227
^{37}Rb	248
^{55}Cs	265

The size of atoms or their radii increases from top to bottom in a group. It is because a new shell of electrons is added up in the successive period, which decreases the effective nuclear charge.

The trend of atomic size of transition elements has slight variation when we consider this series in a period. The atomic size of the elements first reduces or atom contracts and then there is increase in it when we move from left to right in 4th period.

3.2.2 Shielding Effect

The electrons present between the nucleus and the outer most shell of an atom, reduce the nuclear charge felt by the electrons present in the outer most shell. The attractions of outer electrons towards nucleus is partially reduced because of presence of inner electrons. As a result *valance electron experiences less nuclear charge than that of the actual charge, which is called **effective nuclear charge*** (Z_{eff}). It means that *the electrons present in the inner shells screen or shield the force of attraction of nucleus felt by the valence shell electrons. This is called **shielding effect***. With increase of atomic number, the number of electrons in an atom also increases, that results in increase of shielding effect.

The shielding effect increases down the group in the periodic table as shown in the figure 3.4. Because of this it is easy to take away electron from Potassium (Z=19) than from Sodium (Z=ll) atoms. Similarly the shielding effect decreases in a period if we move from left to right.

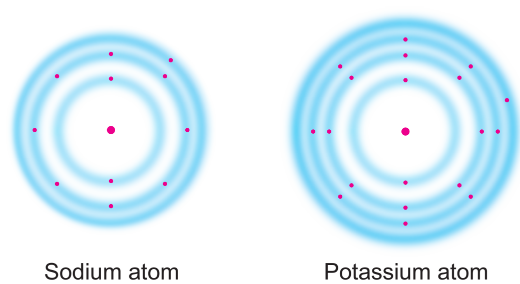

Fig. 3.4: Shielding effect is more in potassium atom than that of sodium atom.

3.2.3 Ionization Energy

The **ionization energy** is *the amount of energy required to remove the most loosely bound electron from the valence shell of an isolated gaseous atom.* The amount of energy needed to remove successive electrons present in an atom increases. If there is only 1 electron in the valence shell, the energy required to remove it will be called first ionization energy. For example, the first ionization energy of sodium atom is + 496 kJmol^{-1}.

$$Na \longrightarrow Na^{+} + e^{-} \qquad \Delta \boldsymbol{H} = +\ 496\ kJmol^{-1}.$$

But when there are more than one electrons in the valence shell, they can be removed one by one by providing more and more energy. Such as group 2 and 3 elements have more than one electrons in their shells. Therefore, they will have more than one ionization energy values.

If we move from left to right in a period, the value of ionization energy increases. It is because the size of atoms reduces and valence electrons are held strongly by the electrostatic force of nucleus. Therefore, elements on left side of the periodic table have low ionization energies as compared to those on right side of the periodic table as shown for the 2nd period.

2nd period elements	^{3}Li	^{4}Be	^{5}B	^{6}C	^{7}N	^{8}O	^{9}F	^{10}Ne
Ionization energy (kJmol^{-1})	520	899	801	1086	1402	1314	1681	2081

Ionization energy increasing in a period

As we move down the group more and more shells lie between the valence shell and the nucleus of the atom, these additional shells reduce the electrostatic force felt by the electrons present in the outermost shell. Resultantly the valence shell electrons can be taken away easily. Therefore, ionization energy of elements decreases from top to bottom in a group.

1st group elements	Ionization energy (kJmol^{-1})
^{3}Li	520
^{11}Na	496
^{19}K	419
^{37}Rb	403
^{55}Cs	377

Ionization energy decreasing in a group

3.2.4 Electron Affinity

Electron Affinity *is defined as the amount of energy released when an electron is added in the outermost shell of an isolated gaseous atom.*

$$F \quad + \quad e^- \longrightarrow F^- \qquad \Delta H = -328 \text{ kJmol}^{-1}$$

Affinity means attraction. Therefore, electron affinity means tendency of an atom to accept an electron to form an anion. For example, the electron affinity of fluorine is –328 kJ mol^{-1} i.e. one mole atom of fluorine release 328 kJ of energy to form one mole of fluoride ions.

Let us discuss the trend of electron affinity in the periodic table. Electron affinity values increase from left to right in the period.

2^{nd} period elements	^{3}Li	^{4}Be	^{5}B	^{6}C	^{7}N	^{8}O	^{9}F	^{10}Ne
Electron affinity ($kJmol^{-1}$)	–60	>0	–29	–122	0	–141	–328	0

The reason for this increase is, as the size of atoms decreases in a period, the attraction of the nucleus for the incoming electron increases. That means more is attraction for the electron, more energy will be released.

In a group electron affinity values decrease from top to bottom because the size of atoms increases down the group. With the increase in size of atom shielding effect increases that results in poor attraction for the incoming electron i.e. less energy is released out. For example, as the size of iodine atom is bigger than chlorine, its electron affinity is less than iodine, as given in the adjacent table.

17^{th} group elements	Electron affinity ($kJmol^{-1}$)
^{9}F	–328
^{17}Cl	–349
^{35}Br	–325
^{53}I	–295

3.2.5 Electronegativity

*The ability of an atom to attract the shared pair of electrons towards itself in a molecule, is called **electronegativity.*** It is an important property especially when covalent type of bonding of elements is under consideration.

The trend of electronegativity is same as of ionization energy and electron affinity. It increases in a period from left to right because higher Z_{eff} shortens distance from the nucleus of the shared pair of electrons. This enhances the power to attract the shared pair of electrons. For example, electronegativity values of group 2 are as follow:

2^{nd} period elements	^{3}Li	^{4}Be	^{5}B	^{6}C	^{7}N	^{8}O	^{9}F
Electronegativity	1.0	1.6	2.0	2.6	3.0	3.4	4.0

Electronegativity increasing in a period

It generally decreases down a group because size of the atom increases. Thus attraction for the shared pair of electrons weakens. For example, electronegativity values of group 17 (halogens) are presented here.

17^{th} group elements	Electro negativity
^{9}F	4.0
^{17}Cl	3.2
^{35}Br	3.0
^{53}I	2.7

Electronegativity decreasing in a group

Test yourself 3.3

i. Define atomic radius?
ii. What are SI units of atomic radius?
iii. Why the size of atoms decreases in a period?
iv. Define ionization energy.
v. Why the 2^{nd} ionization energy of an elements is higher than first one?
vi. What is the trend of ionization energy in a group?
vii. Why the ionization energy of sodium is less than that of magnesium?
viii. Why is it difficult to remove an electron from halogens?
ix. What is shielding effect?
x. How does shielding effect decrease the forces of electrostatic attractions between nucleus and outer most electrons?
xi. Why does the bigger size atoms have more shielding effect?
xii. Why does the trend of electron affinity and electronegativity is same in a period?
xiii. Which element has the highest electronegativity?

Key Points

- In nineteenth century attempts were made to arrange elements in a systematic manner.
- Dobereiner arranged elements in a group of three called triads.
- Newlands arranged elements in groups of eight like musical notes.

- Mendeleev constructed Periodic Table containing periods and columns, by arranging elements in order of increasing atomic weights.
- There are total eighteen groups and seven periods in the modern Periodic Table.
- Depending on outermost electrons and electronic configuration, element in periodic table are grouped in *s*, *p*, *d* and *f* blocks.
- Atomic size increases down a group but decreases along the period .
- Ionization energy decreases down a group but increases along a period.
- Shielding effect is greater in atoms with greater number of electrons.
- Electronegativity increases along a period and decreases down the group.

EXERCISE

Multiple Choice Questions

Put a (✓) on the correct answer

1. **The atomic radii of the elements in Periodic Table:**
   (a) increase from left to right in a period
   (b) increase from top to bottom in a group
   (c) do not change from left to right in a period
   (d) decrease from top to bottom in a group
2. **The amount of energy given out when an electron is added to an atom is called:**
   (a) lattice energy (b) ionization energy
   (b) electronegativity (d) electron affinity
3. **Mendeleev Periodic Table was based upon the:**
   (a) electronic configuration (b) atomic mass
   (c) atomic number (d) completion of a subshell
4. **Long form of Periodic Table is constructed on the basis of:**
   (a) Mendeleev Postulate (b) atomic number
   (c) atomic mass (d) mass number
5. **4^{th} and 5^{th} period of the long form of Periodic Table are called:**
   (a) short periods (b) normal periods
   (c) long periods (d) very long periods
6. **Which one of the following halogen has lowest electronegativity?**
   (a) fluorine (b) chlorine
   (c) bromine (d) iodine
7. **Along the period, which one of the following decreases:**
   (a) atomic radius (b) ionization energy
   (c) electron affinity (d) electronegativity

8. Transition elements are:

(a) all gases (b) all metals
(c) all non-metals (d) all metalloids

9. Mark the incorrect statement about ionization energy:

(a) it is measured in $kJmol^{-1}$ (b) it is absorption of energy
(c) it decreases in a period (d) it decreases in a group

10. Point out the incorrect statement about electron affinity:

(a) it is measured in $kJmol^{-1}$ (b) it involves release of energy
(c) it decreases in a period (d) it decreases in a group

Short answer questions.

1. Why are noble gases not reactive?
2. Why Cesium (at. no.55) requires little energy to release its one electron present in the outermost shell?
3. How is periodicity of properties dependent upon number of protons in an atom?
4. Why shielding effect of electrons makes cation formation easy?
5. What is the difference between Mendeleev's periodic law and modern periodic law?
6. What do you mean by groups and periods in the Periodic Table?
7. Why and how are elements arranged in 4^{th} period?
8. Why the size of atom does not decrease regularly in a period?
9. Give the trend of ionization energy in a period.

Short answer questions.

1. Explain the contributions of Mendeleev for the arrangement of elements in his Periodic Table.
2. Show why in a '*period*' the size of an atom decreases if one moves from left to right.
3. Describe the trends of electronegativity in a period and in a group.
4. Discuss the important features of modern Periodic Table.
5. What do you mean by blocks in a periodic table and why elements were placed in blocks?
6. Discuss in detail the periods in Periodic Table?
7. Why and how elements are arranged in a Periodic Table?
8. What is ionization energy? Describe its trend in the Periodic Table?
9. Define electron affinity, why it increases in a period and decreases in a group in the Periodic Table.
10. Justify the statement, bigger size atoms have more shielding effect thus low ionization energy.