8 CHAPTER

PERIODIC TABLE AND PERIODICITY

Student Learning outcomes

After studying this chapter, students will be able to:

- Define the periodic table as an arrangement of elements in periods and groups in order of increasing proton number/atomic number
- Identify the group or period or block of an element using its electronic configuration (only the idea of sub-shélls related to the blocks can be introduced)
- Explain the relationship between group number and the charge of ions formed from elements in the group in terms of their outermost shells
- Explain sir-hilarities in the chemical properties of elements in the same group in terms of their electronic configuration
- Identify trends in group and periods, given information about the elements, including trends for atomic radius, electron affinity, electronegativity, ionization -energy, metallic character, reactivity and density.
- Use terms alkali metals, alkaline earth metals, halogens noble gases, transition metals; lanthanides and actinides in reference to the periodic table.
  Predict the characteristic-_properties of an- element -in a-given group by using knowledge of chemical periodicity.
- Deduce the nature, possible position in the Periodic Table and the identity of unknown elements from given information about their physical and chemical properties.

8.1 Modern Periodic Table

LONG QUESTIONS

Q.1 Define modern periodic table. What is basis of modern periodic table and periodicity of elements? ***(K.B)***

Ans:

MODERN PERIODIC TABLE

Introduction:

The discovery of atomic number of an element in **1913** led to change in Mendeleev's periodic law which was based on atomic mass. This led to the discovery of Modern Periodic table.

Definition

A table obtained by arrangement of elements into groups and periods on the basis of increasing atomic number is called modern periodic table.

Basis

The modern periodic table is based upon the arrangement of elements according to increasing atomic number.

Periodicity of elements

When the elements are arranged according to ascending order of their atomic numbers from left to right in a horizontal row, properties of elements are found repeating after regular intervals. This results in the form of a table in which elements of similar properties are placed in the same vertical columns.

Periods

The horizontal rows of elements in the periodic table are called periods.

Groups

The vertical columns are called groups.

In the modern periodic table the electronic configuration of the elements continues changing when we move from left to right in a period. Due to this, the elements in a period show a gradual change in the properties. Against this, elements present in a group possess similar electronic configurations in their outermost shells. Therefore, the elements in a group show similar chemical properties.

Periodicity of properties

As a whole the periodic table shows the repetition of the properties of elements after regular intervals. The study of properties in a sequence is called periodicity in the properties of elements.

SHORT QUESTIONS

Q.1 Define periodic table. **(SGD 2017 G-I)*(U.B+K.B)***

Ans:

PERIODIC TABLE

"*A table obtained by arrangement of elements into groups and periods on the basis of similarities and differences in their properties is called periodic table".*

Its helps to study the properties of elements easier.

Q.2 What is the significance of periodic table? ***(U.B+A.B)***

Ans:

SIGNIFICANCE OF PERIODIC TABLE

The significance of periodic table is as follows:

(i) It helps to predict the properties of undiscovered elements.

(ii) It makes the study of elements easier.

(iii) It contains huge amount of information for the scientists.

Q.3 How the elements were arranged in the modern periodic table? ***(U.B)***

Ans: **ARRANGEMENT OF ELEMENTS**

The orderly arrangement of elements generally coincided with their increasing atomic number.

Q.4 Differentiate between groups and periods. **(DGK 2017)*(U.B)***

Ans: **DIFFERENTIATION**

The differences between groups and periods are as follows:

Groups	Periods
Definition	
The **vertical columns of elements** in periodic table are called groups.	The **horizontal rows of elements** in the periodic table are called periods.
Number	
There are **18 groups**.	There are **seven periods** in the periodic table.
Direction of Study	
They are studied from top to bottom.	They are studied from left to right.

Q.5 Who introduced the name of Periodic Table? ***(K.B)***

Ans: **INTRODUCTION OF THE NAME OF PERIODIC TABLE**

A Russian chemist, Mendeleev (1869) introduced the name of periodic table. He arranged the known elements (63) in order of their increasing atomic masses.

Q.6 Why the improvement in Mendeleev's periodic table was made? ***(U.B)***

Ans: **IMPROVEMENT IN MENDELEEV'S PERIODIC TABLE**

It was based upon atomic masses instead of atomic number. The atomic number which is more fundamental property of elements.

Reasons for Improvement

The improvement in the Mendeleev periodic table was made due to two reasons:

Position of isotopes could not be explained

Wrong order of the atomic masses of some elements suggested that atomic mass of an element could not serve as the basis for arrangement of elements.

Q.7 State Mendeleev's periodic law. ***(K.B)***

Ans: *"Properties of the elements are periodic functions of their **atomic masses**"*

Q.8 Why and how elements are arranged in a period? ***(U.B)***

Ans: **ARRANGEMENT OF ELEMENTS IN A PERIOD**

Elements are arranged in a period according to their increasing atomic numbers because it can determine the position of an element more accurately due to the following reasons:

Atomic number is fixed for each element.

It increases regularly by one from element to element.

MULTIPLE CHOICE QUESTIONS

4. One of the significant features of the periodic table was that is predict the _____ of undiscovered particles. ***(U.B)***

(A) Qualities (B) Properties (C) Values (D) Mass

5. The vertical column of the table was called: ***(K.B)***

(A) Period (B) Line (C) Group (D) Row

6. Horizontal rows of the periodic table were called: **(GRW 2017 G-I)*(K.B)***

(A) Rows (B) Line (C) Period (D) Group

7. The orderly arrangement of elements generally coincided with the increasing: ***(U.B)***

(A) Atomic number (B) Atomic mass (C) Group (D) Period

5. According to the modern periodic law, the properties of the element are periodic function of their: ***(U.B+K.B)***

(A) Atomic number (B) Number of electrons

(C) Mass number (D) Number of valence electrons

8.2 SALIENT FEATERES OF MODERN TABLE

LONG QUESTIONS

Q.1 Write a detailed note on periods of periodic table. (DGK 2016, SWL 2016, SGD 2017)*(U.B+K.B)*

OR

Discuss in detail the periods of periodic table.

Ans:

PERIODS

Definition

The horizontal rows in the modern periodic table are called periods.

General Properties of Periods

(i) Number of periods

There are seven periods in total.

(ii) Starting and ending of period

Each period except the first starts with an alkali metal and ends at a noble gas.

(iii) Importance of periods

Each period also represents the completion of a shell.

(iv) Number of elements in periods

Since the number of electrons to be accommodated in a particular shell is fixed, the number of elements in a period is also fixed. The detail about the periods is given in Table (8.1).

(v) Information from Period Number:

The period number of an element represents **number of shells** in the element.

Table (8.1) Periods in the Periodic Table

Period No	Name of the period	Number of Elements	Number of Shell being filled	Range of Atomic Numbers
1st	Short	2	1st	1 to 2
2nd	Normal	8	2nd	3 to 10
3rd	Normal	8	3rd	11 to 18
4th	Long	18	4th	19 to 36
5th	Long	18	5th	37 to 54
6th	Very long	32	6th	55 to 86
7th	Incomplete	23	7th	87 to 118

(vi) First Period:

It is called **short period**. It consists of only **two elements, hydrogen** and **helium**.

(vii) **Second and Third Periods:**

These 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.

(viii) **Fourth and Fifth Periods:**

These are called **long periods**. Each one of them consists of **eighteen elements**.

(ix) 6th and 7th periods

In 6th and 7th periods, two series of fourteen elements each have been accommodated.

Why actinides were placed at the bottom of the periodic table?

Because of the space problem, these two series were placed at the bottom of the periodic table to keep it in a manageable and presentable form.

Why called lanthanides and actinides?

The first series starts after lanthanum (La = 57) and it is called lanthanides. The second series starts after actinium (Ac = 89) and it is called actinides. Together the elements present in these two series are also called rare earths or f block elements.

Q.2 Write a detailed note on groups of periodic table. (DGK 2016, SWL 2016, SGD 2017)*(U.B+K.B)*

OR

Discuss in detail the groups of periodic table.

Ans:

GRROUPS

Definition

The vertical columns present in the periodic table are called groups.

General properties of groups

(i) Number of groups

There are in total eighteen groups.

(ii) Chemical properties of groups

Elements present in a group resemble one another in their chemical properties since they contain the same number of electrons in their outermost shells.

(iii) Other name of each group

Elements present in a group are also called a family and each group has also been given a family name. The distribution of electrons in the outer most shells (electronic configuration) and other information about the groups are given in the following Table (8.2).

Table (8.2) Electronic Configurations of Elements in The Outermost Shell

Group No	Family Name	Electronic Configuration in the Outermost Shell	Valence Electrons
1	Alkali metals	ns^1	1
2	Alkali earth metals	ns^2	2
3 to 12	Transition metals	nd^1, ns^2	
13	Boron family	ns^2, np^1	3
14	Carbon family	ns^2, np^2	4
15	Nitrogen family	ns^2, np^3	5
16	Oxygen family	ns^2, np^4	6
17	Halogen family	ns^2, np^5	7
18	Noble gases	ns^2, np^6	8

(iv) Groups 1 to 2 and 13 to 17

The groups 1 to 2 and 13 to 17 contain the normal elements.

(v) Normal elements

In the normal elements, all the inner shells are completely filled while the outermost shell is incomplete.

(vi) Groups 3 to 12

The groups 3 to 12 are called transition elements and in these elements the inner sub-shells are in the process of completion.

Q.3 What do you mean by blocks in the periodic table and why elements were placed in blocks? *(U.B+K.B)*

Ans:

BLOCKS OF ELEMENTS

Elements present in the periodic table are also classified into blocks. It depends upon the type of the subshell which is being filled; s, p, d and f.

Types of Blocks:

These are s, p, d and f blocks in the periodic table.

(i) s-Block:

*"The elements in which **valence electrons are present in the s-subshell** are called s-block elements."*

Elements of **group l, 2 and helium have valence electrons in 's' subshell**. Therefore, they are called s-block elements.

(ii) p-Block:

*"The elements in which **valence electrons are present in the p-subshell** are called p-block elements."*

Elements of **group 13 to 18 (except helium)** have their valence electrons in 'p' subshell. Therefore, they are referred as p-block elements.

(iii) d-Block:

*"The elements in which **valence electrons are present in the d-subshell** are called d-block elements."*

The **d-block lies between the s and p blocks**.

The elements of **group 3 to group 12** have their **valence electrons in d subshell**. Therefore, they are called d-block elements.

The d-block constitutes period 4, 5 and 6. Each period in d-block consists of ten groups starting from group 3 to group 12. These are called **transition metals**."

(iv) f-Block:

*"The elements in which **valence electrons are present in the f-subshell** are called f-block elements."*

f-block elements lie separate at the bottom of the periodic table. It consists of **Lanthanides** and **Actinides**.

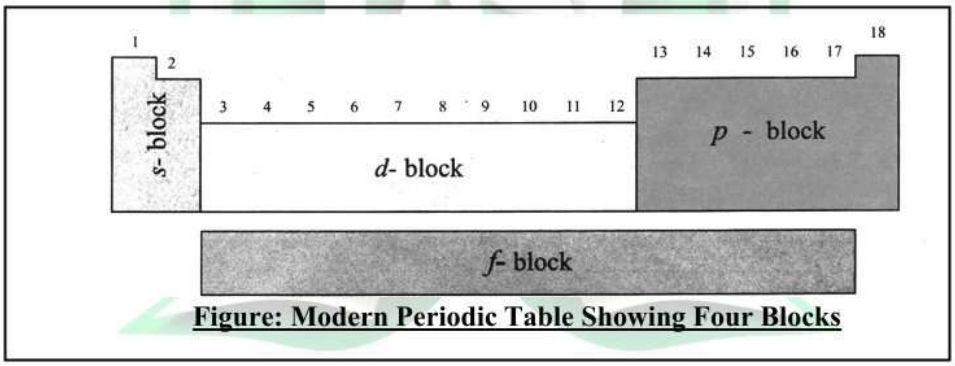


Figure: Modern Periodic Table Showing Four Blocks

INTERESTING INFORMATION

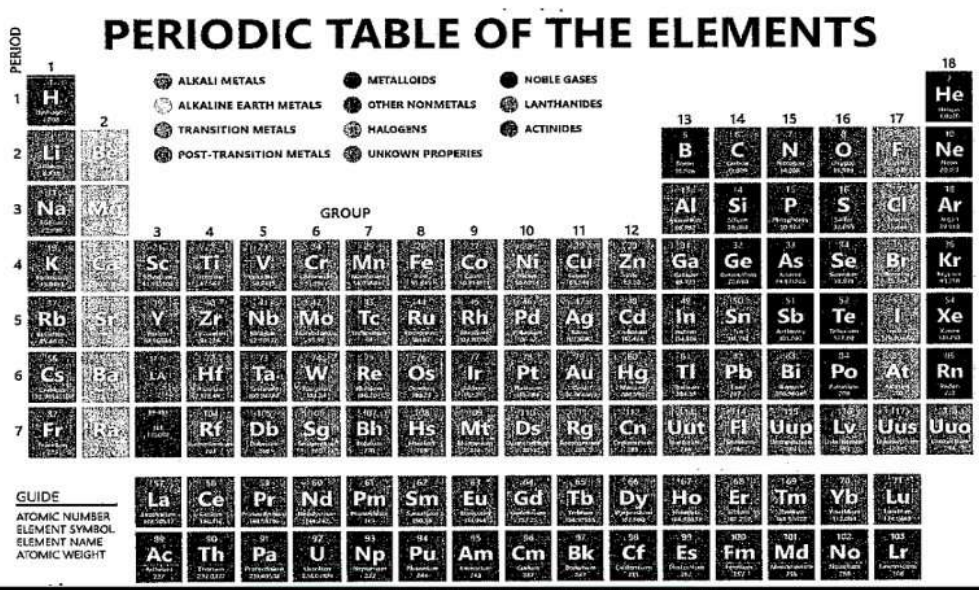
MANDELEEV'S PERIODIC TABLE

Number of elements

- Mandeleev only arranged 63 elements in his periodic table because only these elements were discovered at that time.

Vacant spaces

- He left many spaces vacant for those elements which were yet to be discovered.



INTERESTING INFORMATION

FORMS OF PERIODIC TABLE

E.G. Mazurs collected 700 different published versions of periodic table. Many form retain the regular rectangular structure. Some form had spirals, circles and triangular shapes

EXERCISE

(1) The electronic configuration of the outermost shell of an element is s^2p^3. Find out period number and the group number of the element. In which block will' you place this element?

Ans:

Periodic number: 2
Group number: 15
Block of element: we will place this element in p-block

(2) What is the group of the element having eight electrons in its outermost shell? In which physical state does this element exist?

Ans:

Group number: 18
Physical state: gas

(3) An element belongs to sixth group and it is a gas. To which period does it belong?

Ans:

Periodic number: 2

SHORT QUESTIONS

Q.1 Why Lanthanides and Actinides are placed separately? *(U.B)*
Ans: Answer given on page # 207

Q.1 Why lanthanides and actinides are called so? *(U.B)*
Ans: Answer given on page # 207

Q.2 What do you know about group 1 elements? **(SGD 2016)***(K.B)*
Ans: Answer given on page # 208

Q.3 Define groups and periods in the periodic table. **(SGD 2017 G-II)***(K.B)*
Ans: Answer given on page # 208, 207

Q.4 How the properties of elements repeat after regular intervals? *(U.B)*

Ans:

REPETITION OF PROPERTIES

Properties of elements repeat after regular intervals because of increasing atomic number from left to right. The elements with similar electronic configuration repeat after regular interval in successive periods.

Q.5 In which pattern modern periodic table was arranged? *(U.B)*

Ans:

ARRANGEMENT OF MODERN PERIODIC TABLE

Modern periodic table was arranged in order of increasing atomic number of elements. The arrangement of elements on the basis of their electronic configuration gave a long form of periodic table. The elements were arranged in vertical columns (groups) and horizontal rows (periods) in the modern periodic table.

Q.6 How many elements are in first period and what are their names and symbols? *(K.B)*

Ans:

ELEMENTS OF 1ST PERIODS

Number of Elements:

There are two elements in first period of the modern periodic table.

Names of Symbols:

These are hydrogen (H) and helium (He).

Q.7 How many elements are placed in 4th period? **(FSD 2017 G-I)***(K.B)*

Ans:

NUMBER OF ELEMENTS IN 4TH PERIOD

There are eighteen elements placed in fourth period of modern periodic table. It starts from potassium (K) and ends at krypton (Kr).

Q.8 From which element lanthanide series starts? *(K.B)*

Ans:

START OF LANTHANIDE SERIES

Lanthanide series starts from Lanthanum-57. That is why it is called lanthanide series.

Q.9 From which period actinides series starts? *(K.B)*

Ans:

START OF ACTINIDE SERIES

Actinides series starts from 7th period and element actinium (Ac).

Q.10 How many elements are in 3rd period, write their names and symbols? *(K.B)*

Ans:

ELEMENTS IN 3RD PERIOD

Number of Elements:

There are eight elements in 3rd period of modern periodic table.

Names and Symbols:

Their names and symbols are: sodium (Na), magnesium (Mg), aluminum (Al), silicon (Si), phosphorus (P), sulphur (S), chlorine (Cl) and argon (Ar).

Q.11 How many periods are considered normal periods? *(K.B)*

Ans:

NORMAL PERIODS

There are two periods considered as normal periods. These periods are second and third. They are neither too small nor too long.

Q.12 What is the reason of arranging elements in a group? **(U.B)**

Ans:

ARRANGEMENT OF ELEMENTS IN GROUPS

Elements are arranged in groups because of having similar electronic configuration in their valence shell. Elements of a group have similar properties due to which they are called family.

Q.13 Why the elements are called s or p block elements? **(LHR 2017 G-I)***(U.B)*

Ans:

s OR p-BLOCK ELEMENTS

The elements are called s or p block elements because they have their valence electrons in their s or p subshells respectively.

Examples:

Elements of group 1 and 2 have valence electrons in 's' subshell. Therefore, they are called s-block elements.

Elements of group 13 to 18 have valence electrons in 'p' subshell. Therefore, they are called p-block elements.

Q.14 Write down the names of elements of group 1 with their symbols? ***(K.B)***

Ans:

GROUP I ELEMENTS

Group 1 consists of seven elements which are given below:
Hydrogen (H), Lithium (Li), Sodium (Na), Potassium (K), Rubidium (Rb), Cesium (Cs) and Francium (Fr).

Q.15 How many members are in group 17, is there any liquid, what is its name? **(GRW 2016)*(K.B)***

Ans:

GROUP 17 ELEMENTS

Number:

There are six elements (F, Cl, Br, I, At, Uus) in group 17 of the periodic table.

Liquid Element:

There is one liquid element.

Name of Element:

Its name is bromine (Br).

MULTIPLE CHOICE QUESTIONS

1. Sixth and seventh periods are called: ***(K.B)***
(A) Short periods (B) Normal periods (C) Long periods (D) Very long periods

2. The d-block elements lie between the blocks: ***(U.B+K.B)***
(A) s and p (B) d and f (C) p and s (D) f and d

3. Transition elements are: ***(K.B)***
(A) All gases (B) All metals (C) All non-metals (D) All metalloids

4. Halogens belong to the group: ***(K.B)***
(A) 17 (B) 16 (C) 18 (D) 32

5. How many elements are there in 4^{th} period of the periodic table? ***(K.B)***
(A) 7 (B) 8 (C) 18 (D) 32

6. Number of elements placed in 6^{th} period is: **(LHR 2016 G-I)*(K.B)***
(A) 18 (B) 8 (C) 32 (D) 14

7. Lanthanide series start after: ***(K.B)***
(A) La (B) Ba (C) Ra (D) Ca

8. For Boron Z = 5, it belongs to which block? ***(U.B)***
(A) s (B) p (C) d (D) f

9. Modern periodic table has _____ periods. **(GRW 2016, G-I)*(K.B)***
(A) 3 (B) 5 (C) 7 (D) 9

10. Which one of the following elements is not found in normal periods? **(GRW 2016 G-II)*(U.B+K.B)***
(A) Boron (B) Helium (C) Carbon (D) Nitrogen

11. Which one is the shortest period in the periodic table? **(LHR 2016 G-I, 2017 G-II, GRW 2016 G-II)*(K.B)***
(A) First period (B) Second period (C) Third period (D) Fourth period

12. How many elements are present in 6th period? **(LHR 2016)*(K.B)***
(A) 2 (B) 8 (C) 18 (D) 32

13. The vertical column in the periodic table are called: **(GRW 2014)*(K.B)***
(A) Period (B) Atomic number (C) Group (D) Atomic mass

14. Which one of the following is a metal? **(GRW 2014)*(K.B)***
(A) H (B) C (C) N (D) Mg

15. How many blocks are in modern periodic table? **(GRW 2014)*(K.B)***
(A) 3 (B) 4 (C) 5 (D) 6

16. 4th and 5th period of the long form of periodic table are called: ***(K.B)***
(A) Short period (B) Normal period (C) Long period (D) Very long periods

17. **Zero group or noble gases have general electronic configuration:** ***(U.B+K.B)***
(A) 2, 6 (B) 2, 5 (C) 2, 8 (D) 2, 4

18. **Elements of group I and II have valence electrons in:** ***(U.B+K.B)***
(A) s- subshell (B) p-subshell (C) d-subshell (D) f-subshell

19. **Group seventeen of periodic table belongs to:** **(LHR 2016 G-II)*(K.B)***
(A) Halogens (B) Noble gases
(C) Alkali metals (D) Alkaline earth metals

20. **The number of groups in the periodic table is:(RWP 2017 G-II, SGD 2017 G-I)*(K.B)***
(A) 8 (B) 9 (C) 18 (D) 12

21. **Which group of periodic table is called noble gases?** ***(K.B)***
(A) 15 (B) 16 (C) 17 (D) 18

22. **Number of elements in the first period:** ***(K.B)***
(A) 3 (B) 2 (C) 4 (D) 1

23. **The elements in group-II of periodic table are called** ***(K.B)***
(A) Transition metals (B) Alkaline earth metals
(C) Halogens (D) Alkali metals

24. **Actinides belong to which block of the periodic table?** ***(U.B+K.B)***
(A) d (B) s (C) f (D) p

8.3 SIMILARITIES IN THE CHEMICAL PROPERTIES OF ELEMENTS IN THE SAME GROUP

LONG QUESTIONS

Q.1 Describe similarities in the chemical properties of elements in the same group.

Ans: **SIMILARITIES IN CHEMICAL PROPERTIES**

Dependence of Chemical Properties

The chemical properties of elements depend largely upon the number of electrons present in their outermost shells. Since in a group of the periodic table all the elements have the same number of electrons in the outermost shell, they are expected to show similar chemical properties.

(A) Trends in properties of elements of group 1

(i) Electropositive metals

All elements of group I have one electron in their outermost shells, so they show a strong tendency to lose their electron forming cations. They are thus known as electropositive metals.

(ii) Reaction with water

These metals react vigorously with water producing hydrogen and giving alkali in the solution.

$$Na_{(s)} + H_2O_{(l)} \longrightarrow \underset{\text{Alkali}}{NaOH_{(aq)}} + H_{2\,(g)}$$

(iii) Nature of oxides

Oxides of these metals are also strongly basic in nature. They are readily soluble in water giving alkalies.

$$K_2O_{(s)} + H_2O_{(l)} \longrightarrow 2KOH_{(aq)}$$

(iv) Reaction with halogen

Alkali metals also react with halogens giving halides.

$$Na_{(s)} + Cl_{2\,(g)} \longrightarrow 2NaCl_{(s)}$$

(i) Reactivity of alkali metals

The reactivity of alkali metals gradually increases down the group.

(B) Trends in properties of element of group 2

(i) Electropositive metal

The second group elements also show a tendency to lose both of their outermost electrons forming dipositive ions.

$$Mg_{(s)} \longrightarrow Mg^{2+}_{(s)} + 2e$$

(ii) Atomic size

The tendency to lose electrons down the group increases due to gradual increase in their atomic sizes.

(iii) Nature of oxides

The oxides of these metals are also basic in nature and form alkalies in water.

$$CaO_{(s)} + H_2O_{(l)} \longrightarrow Ca(OH)_{2(aq)}$$

(C) Group 17 elements

(i) Outer shell electronic configuration

All elements in group 17 have s^2, p^5 configuration in their outer shells.

(ii) Formation of anion

They show a strong tendency to gain one electron to become an anion.

(iii) Electropositive nature

They are called electronegative elements.

(iv) Reactivity

These elements are very reactive non-metals and form salts with metals. Hence they are called halogens (salt forming). Unlike alkali metals, the reactivity of halogens decreases down the group.

$$Cl_{2(g)} + 2e \longrightarrow 2Cl^{1-}_{(g)}$$

$$Ca_{(s)} + Cl_{2(g)} \longrightarrow CaCl_{2(s)}$$

(D) Group 16

(i) Outershell electronic configuration

Elements present in group 1 6 have s^2, p^4 configuration in their outermost shells,

(ii) Di-negative ion

They have a tendency to accept two electrons to form a di-negative ion.

(iii) Strong

Oxygen behaves as a strong electronegative element.

$$O_{2(g)} + 2e \longrightarrow 2O^{2-}_{(g)}$$

RELATIONSHIP BETWEEN GROUP NUMBER AND CHARGE OF IONS

When we move from left to right in the periodic table, the main-group elements tend to form cations having a charge equal to the group number.

Example

- Group 1 elements form +1 ions
- Group 2 elements forms +2 ions
- Group 3 elements forms +3 ions

(i) Positive charge of ion & number of valence electron

The number of charges on the cations also correspond to the number of electrons present in their outermost shells.

(ii) Negative charge and group number

When we move from right to left in the periodic table, elements often form anions with a negative charge equal to the number of group towards the left side of the noble gases.

Example

Group 17 elements (which are located one group towards left to the noble gases) form 2- ions. The negative charges present on these ions correspond to number of electrons which these groups need to complete their octets.

SHORT QUESTIONS

Q.1 What is the nature of a metal oxide? *(U.B+K.B)*

Ans:

NATURE OF METAL OXIDE

Metal oxides are basic in nature because they change red litmus paper to blue.

Examples:

Na_2O, CaO, K_2O, MgO

Q.2 Which group of metal is highly reactive? *(K.B)*

Ans:

HIGHLY REACTIVE METAL

Alkali metals of group I **(Li, Na, K, Rb, Cs, Fr)** of the periodic table are **highly reactive** because they are **highly electropositive** in nature.

Q.3 Why Sodium metal is more reactive than magnesium metal? *(U.B)*

Ans:

REACTIVITY OF SODIUM AND MAGNESIUM

Sodium metal is more reactive than magnesium metal because **sodium has larger size,** low ionization energy than magnesium and thus can **lose electrons more easily** than magnesium.

Q.4 Why alkali metals are more reactive than alkaline earth metals? *(U.B)*

Ans:

REACTIVITY OF ALKALI AND ALKALINE EARTH METALS

Alkali metals are more reactive than alkaline earth metals because **alkali metals have the largest size** and the lowest ionization energy in their respective periods therefore alkali metals have highest metallic character, so these are more reactive than alkaline earth metals.

Q.5 What do you mean by metallic character? **(SGD 2017)** *(U.B+K.B)*

OR

Define electropositivity. **(SWL 2016, BWP 2016)** *(U.B+K.B)*

Ans:

ELECTROPOSITIVE CHARACTER / METALLIC CHARACTER

*"Metals have the tendency to **lose** their **valance electrons**. This property of a metal is termed as **electropositivity** or **metallic character***

Q.6 Why metallic character decreases along a period and increases in a group? *(U.B)*

Ans:

METALLIC CHARACTER

Metallic character in a period because size of atom decreases and increases in a group because size of atom increases.

MULTIPLE CHOICE QUESTIONS

1. Alkali metals have valence shell electronic configuration: *(K.B)*

● (A) 2, 8, 1 (B) 2, 8 (C) 2, 8, 2 (D) 2, 8, 5

2. Alkaline earth metals have valence shell electronic configuration: *(K.B)*

● (A) 2, 8, 1 (B) 2, 8 (C) 2, 8, 2 (D) 2, 8, 5

3. Which metal burn with golden yellow flame? **(GRW 2017 G-II)** *(K.B)*

● (A) Calcium (B) Barium (C) Sodium (D) Potassium

4. Which one of the following reacts with water vigorously? *(K.B)*

● (A) Alkaline earth metal (B) Alkali metals

● (C) Halogens (D) Noble gases

5. Metals can form ions carrying charges: **(GRW 2016)** *(U.B)*

● (A) Uni-positive (B) Dipositive (C) Tri-positive (D) All of these

6. Ionization energy of sodium is less than: *(U.B)*

- (A) Al (B) Mg (C) Cu (D) All of these

7. Electropositivity is also known as: ***(K.B)***

- (A) Metalloid character (B) Metallic character
- (C) Non-metallic character (D) Both B and C

8. The more easily a metal _____ its electrons the more electropositive it is. ***(U.B)***

- (A) Loses (B) Gains (C) Shares (D) Transfers

8.4 VARIATION OF PERIODIC PROPERTIES IN PERIODS AND GROUPS

LONG QUESTIONS

Q.1 What is meant by periodic properties or periodicity of properties? (LHR 2014) ***(U.B+K.B)***

Ans:

PERIODICITY OF PROPERTIES

Definition:

Repetition of similar properties of elements after regular intervals in the periodic table is called periodicity of properties.

Cause of periodic table

Periodic properties of the elements occur due to recurrence of similar electronic configuration in the outermost shells.

Periodic properties

They include:

- Atomic radius
- Ionization Energy
- Electron affinity
- Electronegativity

Q.2 What is meant by atomic size? Give its units of measurements and explain its trends in modern periodic table. (LHR 2014) ***(U.B+K.B)***

Ans:

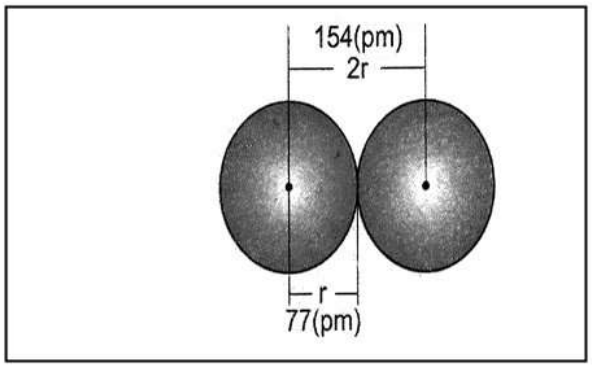
ATOMIC SIZE OR ATOMIC RADIUS

Definition:

Atomic radius is defined as half the distance between the nuclei of the two identical bonded atoms.

Example:

The distance between the nuclei of two bonded carbon atoms is 154 pm. Half of this distance i.e. 77pm is therefore the radius of carbon atom. This is also called covalent radius of carbon atom.



Measurement

The electron cloud of an atom has no definite limit. Because of this, the size of an atom cannot be defined easily. However, it is possible to measure the radius of an atom when it is bonded to an identical atom.

Unit of measurement

It is expressed in pm (l pm = 10^{12}m).

VARIATION OF ATOMIC RADIUS IN PERIODS

(a) Variation in periods

When we move from left to right in a period, the size of atoms decreases generally.

Reason

It is because as we go from lithium (Li) to neon (Ne) in the second period, we are adding electrons to the outermost shell. The charge on the nucleus also increases from +3 to +10. This tends to pull the electrons closer to the nucleus and hence the sizes of atoms decrease from lithium to neon Table (8.4).

Table(8.4) Atomic Radii of Second Period Elements

2nd period elements	Li	Be	B	C	N	O	F	Ne
Atomic Radii (pm)	152	113	88	77	75	73	71	69

(b) Variation in group

The atomic radii of atoms increase from top to bottom in a group. It is because a new shell is being added in the successive period down the group which increases the shielding effect.

Table(8.5)Atomic Radii of first Group Elements

First Group Elements	No of Electrons in the Inner Shells	Atomic Radius (pm)
Li	2	152
Na	10	186
K	18	227
Rb	36	248
Cs	54	265

INTERESTING INFORMATION

DETERMINATION OF SIZE OF ATOMS

Although you might expect atoms to become larger with the increase in their atomic numbers, this does not always occur because the size of an atom is determined by the diameter of its

electron shells.

Q.3 What is ionization energy? Describe its trends in periodic table.
(GRW 2014,16, LHR 2015, SWL 2016, DGK 2016, BWP 2016, SGD 2017)*(U.B+K.B)*

Ans:

IONIZATION ENERGY (I.E)

Definition:

"Ionization energy is the amount of energy required to remove the most loosely bound electron from the valence shell of an isolated gaseous atom."

Unit of measurement

It is expressed in KJ mol^{-1} .

Example

The first ionization energy of sodium atom is +496 KJ mol^{-1} .

$$Na \longrightarrow Na^+ + 1e^- \qquad \Delta H = +496 \text{ KJ mol}^{-1}$$

First Ionization Energy:

*The amount of energy required to remove the **first electron** from the valence shell of an isolated gaseous awtom is called first ionization energy.*

Example:

The first ionization energy of **sodium** atom is **+ 496 KJ mol^{-1}**

$$Na \longrightarrow Na^+ + 1e^- \qquad \Delta H = +496 \text{ kJ mol}^{-1}$$

Second Ionization Energy:

*"The amount of energy required to remove the **second electron** from the valence shell of an isolated gaseous **mono positive ion** is called second ionization energy."*

When there are more than one electrons in the valence shell, they can be removed one by one providing more and more energy.

Example

Mg has two electrons in its outermost shell.

Why is it easier to remove 1st electron than 2nd electron?

It is easier to remove the first electron from magnesium than the second one because when one electron is removed from an atom, the nuclear attraction on remaining electrons increases.

$$Mg_{(g)} \longrightarrow Mg^+_{(g)} + e^- \qquad \Delta H = +737 \text{ kJ mol}^{-1}$$

$$Mg^+_{(g)} \longrightarrow Mg^{2+}_{(g)} + e^- \qquad \Delta H = +1450 \text{ KJ mol}^{-1}$$

Third Ionization Energy:

*"The amount of energy required to remove the **third electron** from the valence shell of an isolated gaseous **di-positive ion** is called third ionization energy."*

Relationship between ionization energy and atomic size

Ionization energy value is related to the atomic size. The smaller the radius of an atom, the stronger the attraction between the nucleus and the outer electrons and higher the value for ionization energy.

TRENDS OF IONIZATION ENERGY

Trends in periods

The ionization energy values thus increase from left to right in a period.

Reason:

- The number of shells remains same.
- Shielding effect remains same.

- The effective nuclear charge on valence electrons increases.
- The distance between nucleus and valence shells decreases.
- Nuclear attraction on valence electrons increases.

Therefore, ionization energy increases from left to right in periods of the periodic table.

Table (8.6) ionization Energies of Elements of Second Period

2nd period elements	Li	Be	B	C	N	O	F	Ne
Ionization energy (kJ mol^{-1})	520	899	801	1086	1402	1314	1681	2081

Trends in groups

Decrease from top to bottom in a group.

Reason:

- The number of shells increases
- The distance between the nucleus and valence shells increases.
- Shelling effect increases.
- Nuclear attraction on valence electrons decreases.

Table(8.7)Ionization Energies of First Group

First Group Elements	Ionization Energy (kj mol^{-1}
Li	520
Na	496
K	419
Rb	403
Cs	377

Q.4 Define electron affinity? Why it increases in a period and decreases in a group in the periodic table? (LHR 2016, GRW 2014, BWP 2017, RWP 2016) ***(U.B+K.B)***

Ans:

ELECTRON AFFINITY

Definition:

"The ***amount of energy released when an electron is added in the outermost shell of an isolated gaseous atom*** *is called electron affinity".*

Example:

328 kJ mol^{-1} energy is released when an electron enters in the fluorine atom. The electron affinity of **Fluorine** is **-328 kJ mol^{-1}** i.e. one mole atom of fluorine releases 328 kJ of energy to form one mole of fluoride ions.

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

Relationship between electron affinity and atomic size

Electron affinity values are also related to the sizes of the atoms. The smaller the size of an atom, the higher the force of attraction with which the nucleus will attract the entering electron and hence higher is the value of electron affinity. Table (8.8)

TRENDS OF ELECTRON AFFINITY

(i) Trends in Periods:

Electron affinity values **increase** from left to right in the period.

Reason:

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.

Table (8.8) Electron Affinities of Second Period Elements

2nd period elements	Li	Be	B	C	N	O	F
Electron Affinity (kJ mol^{-1}	-60	0	-29	-122	7	-141	-328

(a) Trends in groups

In a group, the electron affinity values decrease from top to bottom.

Reason

The sizes of atoms increase down the group. In a bigger atom, the nucleus will attract the incoming electron with a weaker force and hence the electron affinity will also be low.

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

THINGS TO KNOW

1ST AND 2ND ELECTRON AFFINITIES

First electron affinities can be negative, positive or zero second electron affinities are always positive.

Q.5 What is electronegativity? Describe the trend of electronegativity in a period and in a group. (GRW 2014, 16, RWP 2017, FSD 2016, DGK 2016, BWP 2017)*(U.B+K.B)*

Ans:

ELECTRONEGATIVITY

Definition:

It is defined as the force with which an atom attracts the shared pair of electrons towards itself in a bond.

Electronegativity of an atom is its electron-attracting ability.

Electronegative atoms

Electronegative atoms are those whose outer electrons feel a large nuclear charge.

Unit of Measurement:

Electronegativity has **no unit** because it is a relative value. Electronegativity of **fluorine** is **4** (maximum value of electronegativity). The electronegativity of other elements is measured by comparing with the electronegativity of fluorine.

VARIATION OF ELECTRONEGATIVITY IN PERIODIC TABLE

(a) Variation in periods

It increases from left to right in a period.

Reason:

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.

Example:

Electronegativity values of group 2 are given as follows:

2nd 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

(b) Variation in groups

Decreases from top to bottom in a group. Thus the most electronegative atoms are found at the top, right-hand corner of the periodic table.

Example

The most electronegative atoms are F,O,Nand Cl. Table (8.9) and Table (8.10).

Most electropositive elements

The most electropositive elements lie at the bottom left of the periodic table.

Example
Cs, Fr, Ra
Example:
Electronegativity values of group 17 elements (halogens) are presented here.

17^{th} Group Elements	Electronegativity
^{9}F	4.0
^{17}Cl	3.2
^{35}Br	3.0
^{53}I	2.7

INTERESTING INFORMATION

Electronegative is one of the most well-known property for explaining why chemical reaction take place.

SHORT QUESTIONS

Q.1 What is the trend of atomic radius and atomic size in groups?
(MTN 2017, LHR 2016 G-I)*(U.B)*

Ans: Answer given on page # 216

Q.2 Give the trend of ionization energy in a period?
(FSD 2016,17, MTN 2017, DGK 2017)*(U.B)*

Ans: Answer given on page # 217, 218

Q.3 Define electron affinity. **(SWL 2017, RWP 2016, GRW 2017 G-II, LHR 2016 G-I)*(K.B)***

Ans: Answer given on page # 218

Q.4 What is electronegativity? Write down its trends in modern periodic table. ***(U.B+K.B)***

Ans: Answer given on page # 219

Q.5 Why electronegativity increases in a period? ***(U.B)***

Ans: Answer given on page # 219

Q.6 Define group. ***(K.B)***

Ans: Vertical columns of elements in the periodic table.

Q.7 Why the size of atom does not decrease regularly in a period? **(LHR 2016, DGK 2016)*(U.B)***

Ans:

IRREGULARITY IN ATOMIC SIZE

The size of atom does not decrease regularly in a period. This irregularity in the transition metal is due to the involvement of d orbital. It provides poor shielding effect.

Q.8 How can you define atomic radius? ***(K.B)***
(SWL 2016,17, RWP 2016, LHR 2017 G-I, RWP 2017 G-II)

Ans:

"*The **half of the distance between the nuclei of the two bonded atoms** is referred as the atomic radius of the atom.*

Example:

The distance between the nuclei of two **carbon** atoms in its elemental form is **154 pm,** it means its half **77 pm** is radius of carbon atom.

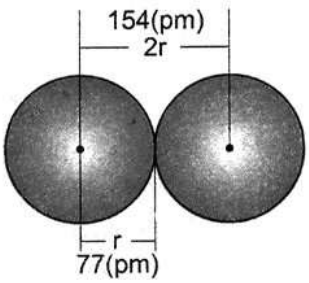


Figure: The Radius of Carbon Atom

Q.9 What are SI units of atomic radius? ***(K.B)***

Ans:

SI UNITS OF ATOMIC RADIUS

Although SI unit of length is meter but atom is too small to measure its radius in meters. Therefore, atomic radius is measured in picometer (pm) $= 10^{-12}$ m

Q.10 Why the size of atoms decreases in a period? ***(U.B)***

Ans: Size of the atom decreases in a period because **effective nuclear charge increases** in a period as a result force of attraction between nucleus and outer most shell increases which result in decrease of atomic size.

Q.11 Define ionization energy. **(GRW 201117 G-I)*(K.B)***

Ans:

IONIZATION ENERGY

*"The **amount of energy required to remove the most loosely bound electron from the valence shell of an isolated gaseous atom** is called ionization energy."*

$$Na \longrightarrow Na^{+} + 1e^{-} \qquad \Delta H = +496 \text{ KJ mol}^{-1}$$

Q.12 Why the 2nd ionization energy of an element is higher than first one? ***(U.B)***

Ans:

2nd IONIZATION ENERGY OF ELEMENT

A monopositive gaseous ion has more protons than electrons. The effective nuclear charge increases and it attracts the remaining electrons more strongly. Thus removal of 2nd electron becomes difficult. That is why 2nd I.E is higher than first one.

Q.13 What is the trend of ionization energy in a group? ***(U.B)***

Ans: Ionization energy of elements **decreases** from top to bottom in a group.

Reason:

The number of shells increases

The distance between the nucleus and valence shells increases.

Shelling effect increases.

Nuclear attraction on valence electrons decreases.

Q.14 Why the ionization energy of sodium is less than that of magnesium? ***(U.B)***

Ans:

IONIZATION ENERGY OF SODIUM AND MAGNESIUM

The ionization energy of the sodium is less than the magnesium because both sodium and magnesium belong to same period. When we move from left to right in a period, atomic size decreases and ionization energy increases that is why the ionization energy of sodium is less than that of magnesium.

Q.15 Why is it difficult to remove an electron from halogens? ***(U.B)***

Ans:

REMOVAL OF ELECTRON FROM HALOGEN

It is difficult to remove an electron form halogens because of following reasons:

Smaller atomic size

More effective nuclear charge (increase in proton number)

High electron affinity

High electronegativity values.

Q.16 Which element has the highest electronegativity? ***(K.B)***

Ans: **HIGHEST ELECTRONEGATIVE ELEMENT**

Fluorine (F) atom has the **highest electronegativity** value among all the elements.

Electronegative Value:

Its electronegativity value is **4.00**.

MULTIPLE CHOICE QUESTIONS

1. The atomic radii of the elements in periodic table: ***(U.B)***
(A) Decrease 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 distance between the nuclei of two carbon atom is: **(LHR 2014, GRW 2015)** ***(K.B)***
(A) 154 pm (B) 140 pm (C) 110 pm (D) 115 pm

3. The half of the distance between the nuclei of two bonded atoms is referred as: ***(U.B+K.B)***
(A) Atomic size (B) Atomic radius (C) Ionic radii (D) Both A and B

4. The shielding effect of inner electrons is responsible for: ***(U.B)***
(A) Increasing ionization energy value (B) Decreasing ionization energy value
(C) Increasing electron affinity (D) Increasing electronegativity

5. Along the period which one of the following decreases: ***(U.B)***
(A) Atomic radius (B) Ionization energy (C) Electron affinity (D) Electronegativity

6. Mark the incorrect statement about ionization energy: ***(U.B)***
(A) It is measured in kJ/mol (B) It is absorption of energy
(C) It decreases in a period (D) It decreases in group

7. Which is the best reason for increasing ionization energy from left to right in a period? ***(U.B)***
(A) The shielding effect remains same (B) The nuclear charge increases
(C) The number of inner electrons increases (D) Increasing electronegativity

8. If we move from left to right in a period, the value of ionization energy: ***(U.B)***
(A) Remains same (B) Decreases (C) Increases (D) Not affected

9. Point out among the following which has highest value of electron affinity: ***(K.B)***
(A) F (B) Cl (C) Br (D) I

10. Point out the incorrect statement about electron affinity: ***(U.B)***
(A) It is measured in $kJmol^{-1}$ (B) It involves release of energy
(C) It decreases in a period (D) It decreases in group

11. The amount of energy given out when an electron is added to an atom is called: ***(U.B+K.B)***
(A) Lattice energy (B) Ionization energy (C) Electronegativity (D) Electron affinity

12. Which one of the following halogens has highest electronegativity? **(RWP 2017 G-II)** ***(K.B)***
(A) Fluorine (B) Chlorine (C) Bromine (D) Iodine

13. Electronegativity of fluorine is: **(FSD 2017 G-I)** ***(K.B)***
(A) 2.5 (B) 4 (C) 3.0 (D) 3.4

14. The trend of electronegativity in periodic table is same as: ***(U.B)***
(A) Ionization energy (B) Electron affinity (C) Shielding effect (D) Both A and B

8.5 METALLIC CHARACTER AND REACTIVITY

Q.1 Write a comprehensive note on the metallic character and reactivity of elements. **(FSD 2016)** ***(U.B)***

Ans: **METALLIC CHARACTER**

Definition:

"The metallic character is the tendency of an element to lose electrons and form positive ions or

cation. This property of a metal is also called ***electropositivity*** *or* ***electropositive character****".*
The **more easily** a metal **loses its electrons** the **more electropositive** it is.

Examples:

(i) Sodium (Na) atom can lose **1 electron** to form a positive ion.

$$Na_{(s)} \longrightarrow Na^{+}_{(g)} + 1e^{-}$$

(ii) Zinc (Zn) metal can **lose 2 electrons** from its valence shell.

$$Zn_{(s)} \longrightarrow Zn^{2+}_{(g)} + 2e^{-}$$

Metallic character and reactivity

Since the ionization energy decreases down the group, the elements have increased ability to lose electrons. For this reason both the metallic character and reactivity increase down the group.
The chemical reactivity gradually decreases as we move from left to right in a period. Aluminium and silicon are less reactive than sodium and magnesium. This is because the number of valence electrons increases, making it difficult to lose electrons. Moving further right in a period towards non-metals, the chemical reactivity gradually increases.

TRENDS OF ELECTROPOSITIVITY

(i) Trends in Groups:

Since the ionization energy decreases down the group, the elements have increased ability to lose electrons. For this reason both the metallic character and reactivity increase down the group.

(i) Trends in Periods:

As we move from left to right in a period, the nuclear charge increases due to a gradual increase in the number of protons in the nucleus. Owing to this the valence electrons are pulled strongly by the nucleus making it difficult for the atoms to lose electrons. Hence the metallic character decreases in a period from left to right.

THINGS TO KNOW

Metallic character of a metal generally determines its level of reactivity.

Q.7 What is meant by density? Give its units of measurements and explain its trends in modern periodic table. (LHR 2014) ***(U.B+K.B)***

Ans:

DENSITY

Definition

It is mass of a substance in a unit volume.

OR

Mass per unit volume of a substance is called density.

Unit of Measurement

It is expressed in g/cm^3.

TRENDS OF DENSITY

(i) Trends in Groups:

Density of elements generally increases from top to bottom in a group

(ii) Trends in Periods:

It varies less significantly from left to right in a period.

Table (8.11) Densities of First Group Elements

First group Element	Li	Na	K	Rb	Cs
density	0.53	0.97	0.89	1.63	1.879

EXERCISE

(1) Barium (Ba) is present in 2nd group and 6th period. Answer the following questions about this element.

i. Is it a metal or a non-metal?

ii. Will it be electropositive or electronegative?

iii. What is the nature of its oxide?

iv. In which physical state you expect his element to exist?

Ans:

i. It is a metal.

ii. It be electropositive.
iii. Its oxide will be basic in nature.
iv. It is expected to be in solid state due to presence of metallic bond in it.

(2) In which- group and period you expect to find an element with the largest atomic radius?
Ans: Group 1 and period 7.

(3) Can you predict the group number of the most electropositive and the most electronegative elements?

Ans: **MOST ELECTROPOSITIVE AND ELECTRONEGATIVE ELEMENTS**
Most Electropositive Element's Group number
Group 1
Most Electronegative Element's Group number
Group 17

(4) Choose among the following the element having the lowest ionization energy and the element with highest electron affinity. Also assign its group number and period number.
Li, K, O, F, Cl.

Ans:
Element having the lowest ionization energy:
K
Element with highest electron affinity:
Cl

(5) Which two elements of the periodic table react to give
i. A basic oxide and
ii. An acidic oxide?

Ans:
i. Na and O react to give a basic oxide (Na_2O)
ii. C and O react to give an acidic oxide (CO_2)

ANSWER KEY

MULTIPLE CHOICE QUESTIONS

8.1 MODERN PERIODIC TABLE

1	B	**2**	C	**3**	C	**4**	A	5	A

8.2 SALIENT FEATURES OF MODERN PERIODIC TABLE

1	D	**2**	A	**3**	B	**4**	A	5	D	6	C
7	A	**8**	B	**9**	C	**10**	B	11	A	12	D
13	C	**14**	D	**15**	B	**16**	C	17	C	18	A
19	A	**20**	C	**21**	D	**22**	B	23	B	24	C

8.3 SIMILARITIES IN THE CHEMICAL PROPERTIES OF ELEMENTS IN THE SAME GROUP

1	A	**2**	C	**3**	C	4	B	5	D
6	D	**7**	B	**8**	A				

8.4 VARIATION OF PERIODIC PROPERTIES IN PERIODS AND GROUPS

1	A	**2**	A	**3**	D	**4**	B	5	A
6	C	**7**	B	**8**	C	**9**	B	10	C
11	D	**12**	A	**13**	B	**14**	D		

LAST
HOPE
STUDY

EXERCISE SOLUTION
MULTIPLE CHOICE QUESTIONS

1. Tick (V) the correct answer.

1. In which period and group will you place the element which is an important part of the solar cell?
(A) Third period and 14th group
(B) Second period and 14th group
(C) Third period and 15th group
(D) Third period and 16th group

2. Identify the electronic configuration of the outermost shell of a transition metal.
(A) $ns^2 np^4$
(B) $nd^x ns^2$
(C) $ns^2 np^6$
(D) $ns^2 np^5$

3. Which is the softest metal?
(A) Na
(B) Ca
(C) Al
(D) Zn

4. A yellow solid element exists in allotropic forms which is also present in fossil fuel Indicate the name.
(A) Carbon
(B) Iodine
(C) Aluminium
(D) Sulphur

5. How many electrons can nitrogen accept in its outermost shell?
(A) 2
(B) 3
(C) 4
(D) 5

6 Which element is the most reactive element?
(A) Oxygen
(B) Chlorine
(C) Fluorine
(D) Nitrogen

7. Which element has the highest melting point?
(A) Na
(B) K
(C) Rb
(D) Cs

8. In what order does the metallic character change in the second group?
(A) Mg > Ca > Ba > Sr
(B) Sr > Ba > Ca > Mg
(C) Mg > Sr > Ca > Ba
(D) Ba > Sr > Ca > Mg

9. Which of the following best describe the correct order of oxygen, fluorine, and nitrogen's atomic radii?

(A) O < F < N
(B) N < F < O
(C) F < O < N
(D) O < N < F

10. The element having less value of ionization energy and less value of electron affinity is likely to belong to:
(A) Group 1

(B) Group 13
(C) Group 16
(D) Group 17

ANSWER KEY

1	B	**2**	B	**3**	A	**4**	D	5	B
6	C	**7**	A	**8**	D	**9**	C	10	A

QUESTIONS FOR SHORT ANSWERS

2. Questions for Short Answers.

Q.1 Why was atomic number chosen to arrange the elements in the periodic table?

Ans: **ATOMIC NUMBER TO ARRANGE ELEMENTS**

Atomic number was chosen to arrange the elements in the periodic table because atomic number is more fundamental property and many of the discrepencies in Mendeleev's periodic table were removed when they were arranged in increasing order of their atomic number.

Q.2 What is the significance of the word periodic?

Ans: **SIGNIFICANCE OF THE WORD PERIODIC**

The significance of the word periodic is that it represents the recurring pattern after regular intervals. Periodic" means something happening or repeating at regular intervals of time.

Q.3 Why does the size of a period increase as we move down the periodic table?

Ans: **SIZE OF PERIOD DOWN THE P/T**

The size of a period increases as we move down the periodic table in groups because each new element in a group adds an additional electron shell. The addition of one more shell down the group results in increase in size of atoms down the group.

Q.4 In a group, the elements have the same number of electrons in the outermost shell. Why is it so?

Ans: **VALENCE ELECTRONS IN A GROUP**

In a group, the elements have the same number of electrons in the outermost shell because the group number represents the number of valence electrons (electrons in the outermost shell). Due to same number of valence electrons, all elements in a particular group will have similar chemical properties.

Q.5 Do you expect calcium to be more reactive than sodium? Give the reason of your answer.

Ans: **REACTIVITY OF CALCIUM AND SODIUM**

No, sodium is more reactive than the calcium because sodium has 1 electron in the valence shell (calcium has 2 electrons in the valence shell). It becomes easier for the sodium to lose 1 electron from its valence shell as compared to calcium.

Q.6 Which element has the maximum atomic radius and which element has the minimum atomic radius in third period?

Ans: **MAXIMUM AND MINIMUM ATOMIC RADIUS IN 3RD PERIOD**

Li (Lithium) has the maximum atomic radius (152 pm) and Ne (Neon) has the minimum atomic radius (69 pm) in third period.

Q.7 Why are the most electronegative elements present in sixth and seventh groups?

Ans: **ELECTRONEGATIVE ELEMENTS IN SIXTH AND SEVENTH GROUPS**

The most electronegative elements present in sixth and seventh groups because these elements have nearly complete valence shells. 6th group elements need two more electrons and 7th group elements need only one more electron to achieve a stable noble gas configuration and make them highly attractive to the electrons.

Q.8 The first ionization energy value of magnesium is less than the second one. Give reason.

Ans: **FIRST IONIZATION ENERGY OF MAGNESIUM**

The first ionization energy value of magnesium is less than the second one because after the removal of one electron it becomes positive ion and nuclear attraction on the remaining electrons increases thus it becomes difficult to remove the second electron from the ion.

Q.9 Is it possible for two metals or two non-metals to form an ionic bond?

Ans: **IONIC BOND BY METALS OR NON-METALS**

No, it is not possible for two metals or two non-metals to form an ionic bond. An ionic bond only occurs between a metal and a non-metal because it requires one atom to readily lose electrons (metal) and another atom to readily gain electrons (non-metal). Similarly, two metals can only share electrons rather than to lose and gain electrons.

Q.10 Which element has the least value of ionization energy and which element has the highest value of electronegativity?

Ans: **LEAST AND HIGHEST ELECTRONEGATIVITY**

Least Ionization Energy

Cesium has the least ionization energy.

Highest Ionization Energy

Helium (He) has the highest ionization energy.

CONSTRUCTED RESPONSE QUESTIONS

3. Constructed Response Questions.

Q.1 Suppose a new element is discovered. Where would you like to accommodate this element in the periodic table?

Ans: **POSITION OF NEW ELEMENT IN THE P/T**

If a new element (Atomic number 119) is discovered it will be placed in 8^{th} period and group 1 of the periodic table.

Q.2 What is the first element of the periodic table? Will it lose an electron or gain?

Ans: **FIRST ELEMENT OF THE PERIODIC TABLE**

The first element of the periodic table is hydrogen (H).

LOSS OR GAIN OF ELECTRON

It will lose an electron like an element in Group 1 (alkali metals). Hydrogen atom can also gain electron to form an anion.

Q.3 Atomic radii of boron and aluminum are 88 pm and 125 pm respectively. Which element is expected to lose electron or electrons easily?

Ans: **LOSS OF ELECTRON BY BORON-88 pm AND ALUMINUM-125 pm**

Aluminium is expected to lose electron or electrons easily because of its larger atomic size. The increase in atomic size decreases the nuclear charge and makes the atom more vulnerable to lose electron.

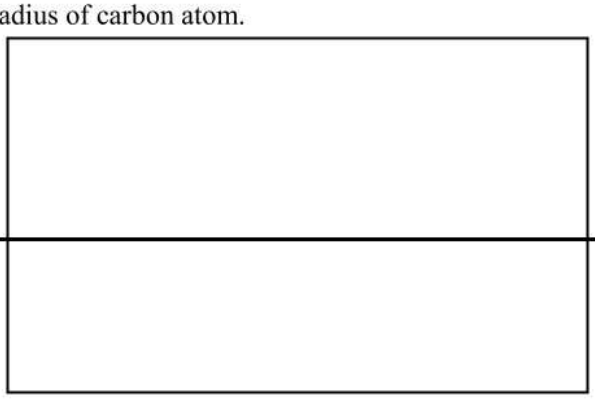
Q.4 How would you find the atomic radius of an atom?

Ans: **TO FIND ATOMIC RADIUS**

We can determine the atomic radius of an atom by measuring the distance between the nuclei of two atoms and dividing that distance by two.

Example:

The distance between the nuclei of two **carbon** atoms in its elemental form is **154 pm,** it means its half **77 pm** is radius of carbon atom.



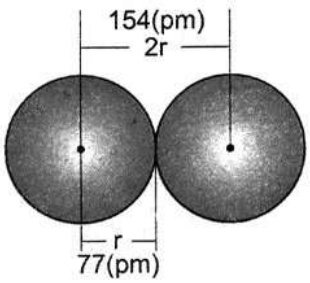


Figure: The Radius of Carbon Atom

Units:

The units of atomic radius are as follows:

Nanometer (10^{-9}m)

Picometer (10^{-12}m)

Q.5 Why is it not possible for oxygen atom to accept three electrons to form O^{3-} ion like nitrogen which can accept electrons to form N^{3-}?

Ans: **TO ACCEPT 3 ELECTRONS BY O-ATOM**

It is not possible for oxygen atom to accept three electrons to form O^{3-} ion like nitrogen which can accept electrons to form N^{3-} because valence shell of oxygen atom has the capacity to accept two electrons only.

DESCRIPTIVE QUESTIONS

4. Descriptive Questions.

Q.1 Which information is needed to locate the elements in the periodic table if you do not know its atomic number? Is atomic mass helpful for this purpose?

Ans: **TO LOCATE ELEMENTS IN P/T**

If we do not know the atomic number of an element, the most helpful information to locate the elements in the periodic table is its chemical symbol while atomic mass can be somewhat useful. More reliable one is the symbol because multiple elements can have similar atomic masses due to the existence of isotopes.

Q.2 How many blocks of elements are present in the periodic table? Are these blocks helpful in studying the properties of elements?

Ans: **BLOCKS IN THE P/T**

There are 4 blocks of elements present in the periodic table. These are s-block, p-block, d-block and f-block.

SIGNIFICANCE OF BLOCKS

These blocks are very helpful in studying the properties of elements because elements within the same block have similar chemical characteristics due to the similar electron configurations in the outermost orbital.

Q.3 Explain the variation in the following properties in the periods giving reasons.
(a) Atomic radius (b) Ionization energy

Ans: **VARIATION OF PROPERTIES IN PERIODS**

Answer given on page #

Q.4 Which physical properties of elements may lead us to know what type of bond it will form?

Ans: **PHYSICAL PROPERTIES AND TYPE OF BOND**

Electronegativity, ionization energy and electron affinity of elements may lead us to know the type of bond it will form. Most important factor that leads us to know the type of bond is electronegativity.

Q.5 Write down the names of four non-metals which exist in solid state at normal

temperature.

Ans: **NON-METALS IN SOLID STATE**

i. Carbon
ii. Sulphur
iii. Phosphorous
iv. iodine

Q.6 Why do second and third periods have equal number of elements while all other periods contain different number of elements?

Ans: **NUMBER OF ELEMENTS IN PERIODIC TABLE**

The second and third periods have equal number of elements while all other periods contain different number of elements because they both involve filling the s and p subshells only, in their respective energy levels while other periods also involve filling d and f subshells as well.

INVESTIGATIVE QUESTIONS

5. Investigative Questions.

Q.1 Arrangement of the elements in the form of a periodic table is a remarkable achievement of chemists. Comment on this statement citing the benefits of this table.

Ans: **BENEFITS OF PERIODIC TABLE**

Following are the benefits of the periodic table:

(i) It helps scientists to find information about an element, such as its atomic number, atomic mass, and chemical symbol, quickly.
(ii) It helps to understand the trends in physical properties of the elements such as ionization energy, electronegativity, and atomic radius.
(iii) Similarly, it helps to understand the trends in chemical properties of elements in the periodic table.
(iv) It helps the scientists to predict the properties of elements and the compounds, easily.

Q.2 Both lithium and beryllium show behaviour different from rest of the alkali and alkaline earth metals respectively. Can you think of the possible reasons for this difference?

Ans: **DIFFERENT BEHAVIOUR OF LITHIUM AND BERYLLIUM**

Both lithium and beryllium show behaviour different from rest of the alkali and alkaline earth metals respectively because of the following reasons:

(i) **Small size of atoms:**
Both lithium and beryllium have considerably smaller atomic radii compared to other elements in their groups which results in an increased attraction between the nucleus and the valence electrons.

(ii) **Higher Ionization energy of atoms:**
Due to their small size, lithium and beryllium require more energy to remove their outermost electrons, making them less reactive than other alkali and alkaline earth metals.

(iii) **High polarizing power of atoms:**
The small size and high positive charge of lithium and beryllium cations allows them to strongly polarize the electron clouds of nearby anions, leading to a more covalent character in their bonds.

(iv) **Absence of d-orbitals:**
Lithium and beryllium lack d-orbital in their atoms.

Q.3 Modern periodic table is the amended form of the earlier table developed by Mandeleev. Elaborate how these two tables are different from each other.

Ans: **DIFFERENTIATION**

The differences between mole and **Avogadro's number** are as follows:

Mendeleev's Periodic Table	Modern Periodic Table
Definition	

• *A table obtained by arrangement of elements into groups and periods in ascending order of their atomic masses is called Mendeleev's periodic table.*	• *A table obtained by arrangement of elements into groups and periods in ascending order of their atomic number is called Modern periodic table.*
Basis of Periodic Table	
• It is based on arrangement of elements in ascending order of their atomic masses.	• It is based on arrangement of elements in ascending order of their atomic masses.
Periodic Law	
• Properties of elements are periodic function of their atomic masses.	• Properties of elements are periodic function of their atomic number.

TERMS TO KNOW

Terms	Definitions
Modern periodic table	In the modern periodic table, elements have been arranged in the ascending order of atomic numbers. There are eighteen groups and seven periods in this table.
Blocks of Elements	In the modern periodic table, elements have been divided into s, p, d and f blocks.
Starting and Ending of a period	Each period starts with an alkali metal and ends at a noble gay A period also the completion of a shell.
S, p, d and f-block elements	The elements present in s and p blocks are called normal elements whereas those d and f, blocks are called transition elements.
Properties of Elements in a Group	All elements in a group are expected to show similar chemical properties because of number of electrons present in their outermost shells.
Gradation of Properties	Physical properties of the elements vary gradually as we move from left to right in a and from top to bottom in a group.
Atomic Size	Atomic sizes of elements decrease from left to-right in a period and increase from top to bottom in a group.
Ionization Energy	Ionization energy values increase from left to right in a period and decrease from top to bottom in a group.
Electron Affinity	Electron affinity and electronegativity values increase from left to right in a period and from top to bottom in a group.
Metallic	Metallic character increases from top to bottom in a group and decreases from left

Character	to a period.