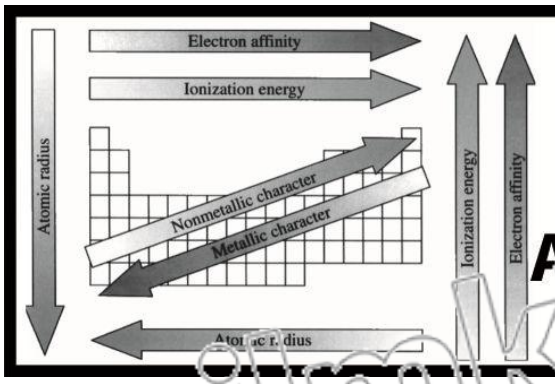

CHAPTER 3

PERIODIC TABLE AND PERIODICITY OF PROPERTIES

INTRODUCTION

Q.1 Define periodic table. **(SGI 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.

INTRODUCTION

MULTIPLE CHOICE QUESTIONS

1. 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

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

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

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

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

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

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

3.1 PERIODIC TABLE

Q.1 (a) Describe Dobereiner's triads with the help of an example.

(LHR 2015, SGD 2016, RWP 2016, SWL 2016, EWP 2016) ***(U.B+K.B+A.B)***

(b) What is the contribution of Cannizzaro? ***(K.B)***

(c) Write a note on Newland's octaves. **(GRW 2016, DGK 2016, 17, BWP 2016, 17)** ***(U.B+K.B)***

Ans: (a) **DOBEREINER'S TRIADS**

Introduction:

A German chemist **(1829) Dobereiner** observed relationship between atomic masses of several groups of **three elements** called **triads**.

Law of Triads:

"In a triad the ***central or middle element had atomic mass average of the other two elements****."*

Example:

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.

Ca = 40

Sr = 88

Ba = 137

$$\frac{40+137}{2} = 88.5 = 88$$

Drawbacks:

- Only a few elements could be arranged in this way.
- This classification did not get wide acceptance.

(b) Cannizzaro

He successfully determined the **correct atomic masses** of elements in **1860**.

(c) Newland's Octaves

Introduction:

In **1864** British chemist and musician Newlands put forward his observations in the form of "**Law of Octaves**".

Statement:

"According to Law of Octaves there was a ***repeation in chemical properties of every eighth element if they were arranged by their increasing atomic masses****."*

Comparison:

He compared it with **musical notes**.

Drawbacks:

- His work could not get much recognition as **no space** was left for **undiscovered elements**.
- The **noble gases** were also **not known** at that time.

Q.2 Explain the contributions of Mendeleev's for the arrangement of elements in his Periodic Table. **(Ex-Q.1)*(K.B)***

Ans:

MENDELEEV'S PERIODIC TABLE

Introduction:

A 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**.

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

Mendeleev's Periodic Law:

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

Demerits of Mendeleev's Periodic Table:

Although Mendeleev's periodic table was the **first ever attempt to arrange the elements,** yet it has few demerits in it.

- It did not explain the **position of isotopes**.
- **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.

Q.3 Discuss in detail how elements are arranged in a periodic table? **(Ex-7)**
(FSD 2016, 17, RWP 2016)*(U.B)*

Ans:

ARRANGEMENT OF ELEMENTS

*"A table obtained by **arrangement of elements** into groups and periods in **increasing order of their atomic number** is called modern periodic table."*

Atomic number is more fundamental property:

Atomic number of an element is more fundamental property than atomic mass because:

- It **increases regularly by 1** from element to element.
- It is **fixed** for every element.
- No two elements have same atomic number.

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.

Basis of Modern Periodic Table:

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

Periodicity of Properties:

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 as the **first** element.

Examples:

- **Sodium (Z=11)** had similar properties as **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.

Q.4 (a) What is the significance of atomic number in modern periodic table? *(U.B+A.B)*

(b) Describe the characteristics of periods and groups of the long form of the periodic table. *(U.B+K.B)*

Ans: (a) **SIGNIFICANCE OF ATOMIC NUMBER**

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.

Periodicity:

*"The **repetition of properties** of elements **after regular intervals** in the periodic table is called periodicity".*

(b) **CHARACTERISTICS OF PERIODS AND GROUPS**

Periods:

"*The **horizontal rows of elements** in a periodic table are called period".*

Properties:

- 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**.

Examples:

- 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.

Groups:

*"The **vertical columns in a periodic table** are called groups".*

Properties:

- 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 the valence shell**.

Examples:

- The **first group** elements have only **1 electron** in their **valence shells**.
- Similarly **group 2** elements have **2 electrons** in their **valence shells**.

Note

It is the reason elements of a group have **similar properties**.

Q.5 Discuss the important features of Periodic Table.(FSD 2016, SGD 2016,17, SWL 2016)*(U.B+K.B)*

Ans:

IMPORTANT FEATURES OF LONG FORM OF PERIODIC TABLE

The important features of long form of the periodic table are as follows:

Periods:

(i) Number of Periods:

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

(ii) Number of elements in a period:

- **First period** consists of only **two elements**.
- **Second and third periods** consist of **8 elements** each.
- **Fourth and fifth period** consist of **18 elements** each.
- **Sixth period** has **32 elements**.
- **Seventh period** also has **32 elements** and is **incomplete**, since new elements are expected to be disconcerted.

(iii) Properties of Elements of a Period:

Elements of a period show **different properties**.

Groups:

(i) Number of Groups:

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

(ii) Properties of Elements of a Group:

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

Blocks of the Periodic Table:

Elements are classified into **four** blocks depending upon the **type of the subshell** which gets the **last electron**. These are: **s, p, d** and **f** blocks in the periodic table.

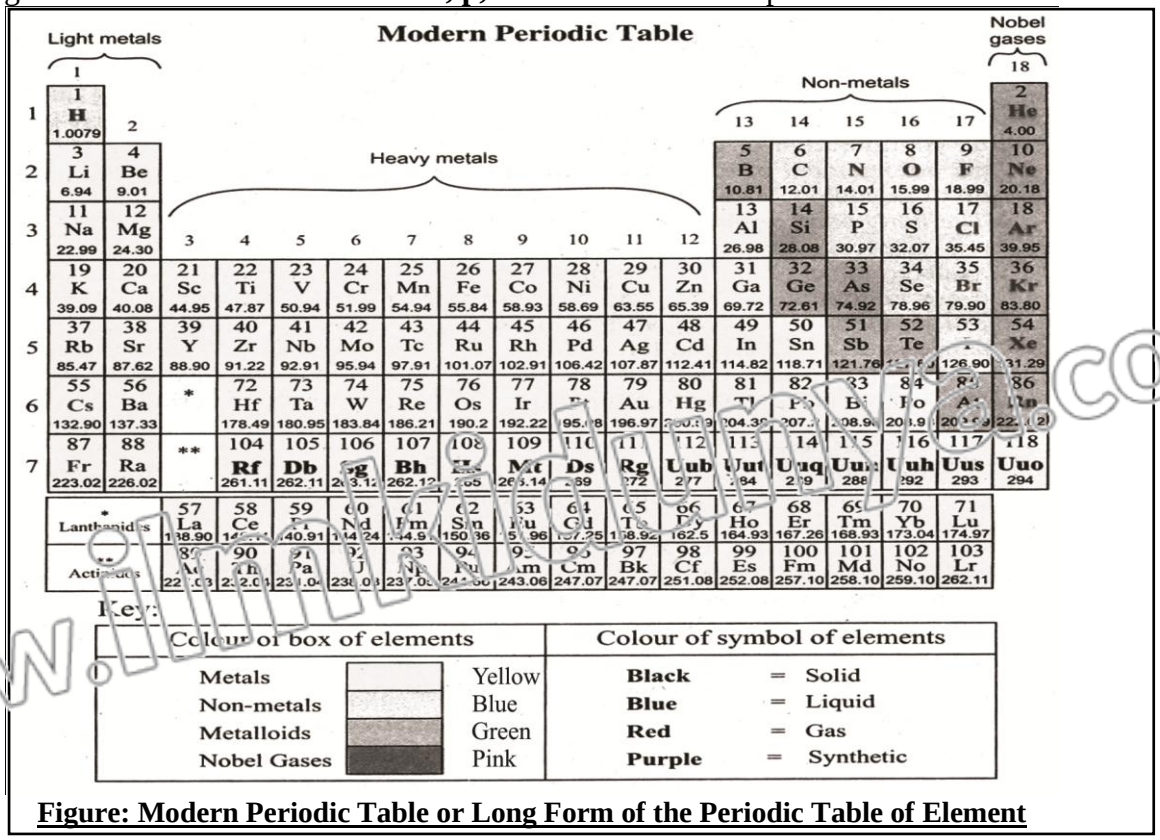

Figure: Modern Periodic Table or Long Form of the Periodic Table of Element

Q.6 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

"On the basis of ***completion of a particular subshell,*** *elements with* ***similar valence subshell*** *electronic configuration are referred as a block of elements".*

Types of Blocks:

- 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 in the periodic table.

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.

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.

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**."

f-Block:

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

f-block lies separately at the bottom of the periodic table. It consists of **Lanthanides** and **Actinides**.

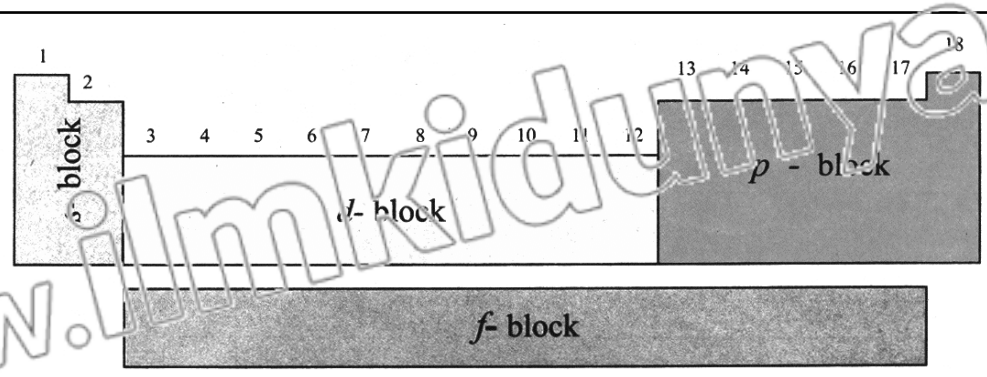

Figure: Modern Periodic Table Showing Four Blocks

3.1 PERIODIC TABLE

SHORT QUESTIONS

Q.1 Define Dobereiner's Law of Triads. *(K.B)*

Ans: *Answer given on pg # 93*

Q.2 Define Mendeleev's periodic law? *(K.B)*

Ans: *Answer given on pg # 94*

Q.3 What are drawbacks/demerits of Newland's Octaves? *(U.B+K.B)*

Ans: *Answer given on pg # 94*

Q.4 Define periodicity. *(K.B)*

Ans: *Answer given on pg # 95*

3.1 PERIODIC TABLE

MULTIPLE CHOICE QUESTIONS

1. 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

2. Which scientist gave the idea of octaves for the arrangement of elements? *(K.B)*

(A) Mendeleev's (B) Al-Razi (C) Newland (D) Dobereiner

3. How many elements were arranged by Mendeleev in order of increasing atomic masses? *(K.B)*

(A) 60 (B) 61 (C) 62 (D) 63

4. Modern Periodic Law was presented by: **(LHR 2016 G-II)** *(K.B)*

(A) Dobereiner's (B) Newland's (C) Mendeleev's (D) H. Moseley

***5.* Mendeleev's Periodic Table was based on the:** **(GRW 2016)** *(K.B)*

(A) Electronic configuration (B) Atomic mass
(C) Atomic number (D) Completion of sub-shell

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

(A) Atomic number (B) Number of electrons
(C) Mass number (D) Number of valence electrons

7. Sixth and seventh periods are called: *(K.B)*

(A) Short periods (B) Normal periods (C) Long periods (D) Very long periods

8. 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

9. Transition elements are: *(K.B)*

(A) All gases (B) All metals (C) All non-metals (D) All metalloids

10. Who presented law of Octaves? *(K.B)*

(A) Mosely (B) Mendeleev (C) Newlands (D) Dobereiner

3.1 TEST YOURSELF

i. What was the contribution of Dobereiner towards classification of elements? ***(U.B+K.B)***

Ans: **Introduction:**

A German chemist **(1829) Dobereiner** observed relationship between atomic masses of several groups of **three elements** called **triads**.

Law of Triads:

"In a triad the central or middle element had atomic mass average of the other two elements."

Example:

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.

$$\begin{aligned} Ca &= 40 \\ Sr &= 88 \\ Ba &= 137 \end{aligned}$$

$$\frac{40+137}{2} = 88.5 = 88$$

ii. How Newlands arranged the elements? ***(U.B)***

Ans: *"According to Law of Octaves there was a* ***repetition in chemical properties of every eighth element if they were arranged by their increasing atomic masses****."*

iii. 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.

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

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

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.

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

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

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

vi. 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.

3.1.1 PERIODS
3.1.2 GROUPS

Q.1 Write a detailed note on periods of periodic table. **(DGK 2013, SWL 2016, SGD 2017)** ***(U.B+K.B)***

OR

Discuss in detail the periods of periodic table. **(Ex-Q.6)**

Ans:

PERIODS

*"**Horizontal rows of elements in the periodic table** are called periods"*.

Number of Periods.

There are **seven** periods in the modern periodic table.

Information of Period Number:

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

First Period:

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

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.

Fourth and Fifth Periods:

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

Sixth and Seventh Periods:

These are called **very long periods**. Sixth period contains **32 elements** whereas seventh period is incomplete.

Lanthanides and Actinides:

In **sixth** and **seventh period after atomic number 57 and 89,** two series of **fourteen elements** each, were accommodated.

(i) Why Lanthanides and Actinides are Placed Separately?

Because of **space problem**, these two series were placed separately below the normal periodic table to **keep it in a manageable and presentable form**.

(ii) Why Lanthanides and Actinides are Called so?

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.

Starting and Ending of a Period:

- 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.

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

Table: Different Periods of the Periodic Table

Q.2 Write a detailed note on the groups of periodic table. **(BWP 2016,17)*(U.B+K.B)***

Ans:

GROUPS

Definition:

*"The **vertical columns of elements in the periodic table** are called groups."*

Number of Groups:

There are **18** groups in the modern periodic table.

IMPORTANT GROUPS

Group 1:

It consists of **hydrogen (H), lithium (Li), sodium (Na), potassium (K), rubidium (Rb), cesium (Cs)** and **francium**. They are generally called **alkali metals**.

Although elements of a group do not have continuously increasing atomic numbers, yet they have similar electronic configuration in their valence shells.

Family Name:

Elements of this group are also called a family (for example alkali metals) because **normal elements** of a group have **similar chemical properties** and **similar electronic configuration in their valence shells**.

Group 2:

It consists of **beryllium (Be), magnesium (Mg), calcium (Ca), strontium (Sr), barium (Ba)** and **radium (Ra)**. They are called **alkaline earth metals**.

Group 17:

It consists of **fluorine (F), chlorine (Cl), bromine (Br), iodine (I) and astatine (At)**. The elements of this group are called **halogens**.

Group 18:

The **gaseous** elements of group 18 or **zero group** are called noble gases. It consists of **helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe) and radon (Rn)**. The elements of this group are called **noble gases**.

Groups of Normal Elements: (Representative or Typical Elements):

"***All s-block and p-block elements excluding noble gases** are called normal elements"..*

The **groups 1, 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**.

Examples:

Group 17 elements **(halogens)** have **7** electrons in their outermost (valence) shell.

Transition Elements:

*"The elements in which **d or f subshells are in the process of completion** are called transition elements".*

Table: Different Groups of the Periodic Table

Valence Electrons	Group Number	Family Name	General 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	$ns^2\ np^6$

Q.3 What are fire works? Describe composition of fire works?(Do you know Pg. # 51)*(U.B+K.B)*

Ans:

FIRE WORKS

*"It is a technology **invented in China** and used all over the world".*

Importance:

Beautiful fireworks display are common on celebrations like Pakistan Day or even on marriages. It is dangerous but careful use of various elements and particularly metal salts of different composition give **beauty** and **colors** to the fireworks.

COMPOSITION:

Elements like magnesium, aluminium are used in powdered form. Usually nitrates and chlorates are used. Other chemicals are added to give brilliance and different shades.

Salt	Colour Imparted
Sodium salts	Yellow
Calcium salts	Red
Strontium salts	Scarlet
Barium salts	Green
Copper salts	Bluish green

Precautions:

Because of fire hazard and risk to life and property, only skilled professionals use them.

3.1.1 PERIODS
3.1.2 GROUPS

SHORT QUESTIONS

Q.1 Why Lanthanides and Actinides are placed separately? ***(U.B)***

Ans: *Answer given on pg # 100*

Q.2 Why lanthanides and actinides are called so? ***(U.B)***

Ans: *Answer given on pg # 100*

Q.3 What is the composition of fire works? **(Do you know Pg. # 51)*(K.B)***

Ans: *Answer given above*

Q.4 What do you know about group 1 elements? **(SGD 2016)*(K.B)***

Ans: *Answer given on pg # 101*

Q.5 Define groups and periods in the periodic table. **(SGD 2017 G-II)*(K.B)***

Ans: *Answer given on pg # 100 and 101*

3.1.1 PERIODS
3.1.2 GROUPS

MULTIPLE CHOICE QUESTIONS

1. Halogens belong to the group: ***(K.B)***

(A) 17 (B) 16 (C) 18 (D) 32

2. How many elements are there in 4^{th} period of the periodic table? ***(K.B)***

(A) 7 (B) 8 (C) 18 (D) 32

3. Number of elements placed in 6^{th} period is: **(LHR 2016 G-I)*(K.B)***

(A) 18 (B) 8 (C) 32 (D) 14

4. Lanthanide series start after: *(K.B)*

(A) La (B) Ba (C) Ra (D) Ca

5. For Boron Z = 5, it belongs to which block? *(K.B)*

(A) s (B) p (C) d (D) f

6. Modern periodic table has _____ periods. **(GRW 2016, G-I)***(K.B)*

(A) 3 (B) 5 (C) 7 (D) 9

7. 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

8. 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

9. How many elements are present in 6th period? **(LHR 2016)***(K.B)*

(A) 2 (B) 8 (C) 18 (D) 32

10. The vertical column in the periodic table are called: **(GRW 2014)***(K.B)*

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

11. Which one of the following is a metal? **(GRW 2014)***(K.B)*

(A) H (B) C (C) N (D) Mg

12. How many blocks are in modern periodic table? **(GRW 2014)***(K.B)*

(A) 3 (B) 4 (C) 5 (D) 6

13. 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

14. Zero group or noble gases have general electronic configuration: *(U.B+K.B)*

(A) ns^2, np^2 (B) ns^2, np^4 (C) ns^2, np^6 (D) ns^2, np^5

15. 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

16. 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

17. The number of groups in the periodic table is: **(GRW 2014, RWP 2017 G-II, SGD 2017 G-I)***(K.B)*

(A) 8 (B) 9 (C) 18 (D) 12

18. Which group of periodic table is called noble gases? *(K.B)*

(A) 15 (B) 16 (C) 17 (D) 18

19. Number of elements in the first period: *(K.B)*

(A) 3 (B) 2 (C) 4 (D) 1

20. The elements in group-II of periodic table are called *(K.B)*

(A) Transition metals (B) Alkaline earth metals

(C) Halogens (D) Alkali metals

21. Actinides belong to which block of the periodic table? *(U.B+K.B)*

(A) d (B) s (C) f (D) p

3.2 TEST YOURSELF

i. 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.

ii. 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.

iii. 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).

iv. How many elements are placed in 4^{th} 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).

v. 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.

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

Ans: **START OF ACTINIDE SERIES**

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

vii. 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).

viii. How many periods are considered normal periods? *(U.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.

ix. 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.

x 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.

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

Ans:

GROUP 1 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).

xii. 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).

3.2 PERIODICITY OF PROPERTIES

3.2.1 ATOMIC SIZE AND ATOMIC RADIUS

Q.1 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:

"*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.

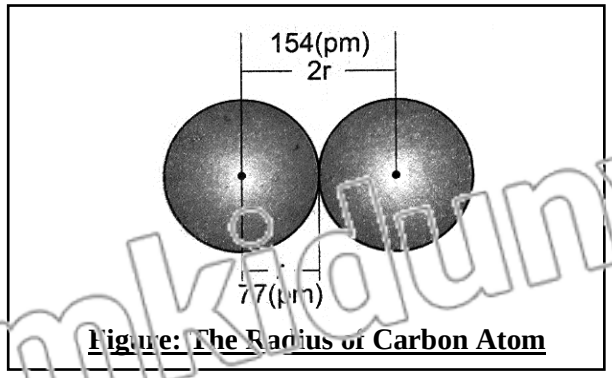

Figure: The Radius of Carbon Atom

Units:

The units of atomic radius are as follows:

- Nanometer (10^{-9}m)
- Picometer (10^{-12}m)

TRENDS OF ATOMIC SIZE

(i) Trends in Periods:

The atomic radii gradually **decrease** from left to right in a period.

Reasons:

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. This nuclear force pulls down or contracts the outermost shell towards the nucleus.

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

(ii) Trends in Groups:

The atomic radii **increase** from top to bottom in a group.

Reason:

The number of shells increases in the successive elements. The distance between the nucleus and valence shells increases, the effective nuclear charge decreases and atomic radius increases.

Example:

Atomic size of **1st group** elements **increases** from **lithium (152 pm) to cesium (265 pm)**.

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

Q.2 What is shielding effect? Write down its trends in modern periodic table. ***(U.B+K.B)***

Ans:

SHIELDING EFFECT

Definition:

*"The **decrease in attractive force exerted by the nucleus on the valence shell electrons due to the presence of electrons lying between the nucleus and valence shell** is called shielding effect."*

OR

*"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".*

Explanation:

The electrons present between the nucleus and the outer most shell of an atom reduce the effective nuclear charge felt by the electrons present in the outermost shell.

The attraction of outer electrons toward nucleus is partially reduce because of presence of inner electrons.

Dependence of shielding effect:

It depends on inner shell electrons.

Effective Nuclear Charge:

"The attraction of outer electrons toward nucleus is partially reduced because of presence of inner electrons. As a result an atom experiences less nuclear charge than that of the actual charge, which is called effective nuclear charge (Z_{eff})*".*

TRENDS OF SHIELDING EFFECT

(i) Trends in Groups:

The shielding effect **increases** down the group in the periodic table.

Reason:

This is because the number of inner shells increases from top to bottom in a group.

Example:

Due to greater size of the atom it is easy to take away electron from **potassium (Z=19)** than from **sodium (Z =11)** atom.

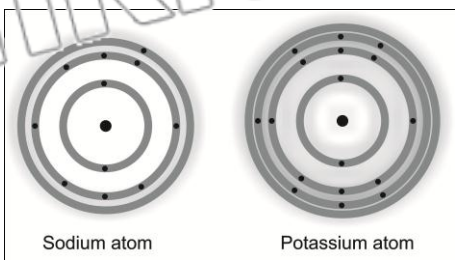

Figure: Shielding Effect is More in Potassium Atom Than That of Sodium Atom.

(ii) Trends in Periods:

The shielding effect **does not change in a period** if we move from left to right in periodic table.

Reason:

This is because the number of inner shells remain the same from left to right in the periods.

Q.3 What is ionization energy? Describe its trends in periodic table.

(Ex-Q.8) (GRW 2014,16, LHR 2015, SWL 2016, DGK 2016, BWP 2016, SGD 2017)*(U.B+K.B)*

Ans:

IONIZATION ENERGY (I.E)

Definition:

*"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."*

Units of I.E:

The units of ionization energy are:

- $kJ\ mol^{-1}$

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 $kJmol^{-1}$**

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

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

Example:

$$Mg \longrightarrow Mg^{+} + 1e^{-} \qquad \Delta H = +738\ kJ\ mol^{-1}$$

$$Mg^{1+} \longrightarrow Mg^{2+} + 1e^{-} \qquad \Delta H = +1450\ kJ\ mol^{-1}$$

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."*

TRENDS OF IONIZATION ENERGY

(i) Trends in Groups:

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.

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

Therefore, ionization energy decreases from top to bottom in the groups of the periodic table.

(ii) Trends in Periods:

Ionization energy values of elements **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.

2^{nd} 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

Q.4 Define electron affinity? Why it increases in a period and decreases in a group in the periodic table? **(Ex-Q.9)(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:

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.

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

Affinity means **attraction**. Therefore, electron affinity means tendency of an atom to accept an electron to form an **anion**.

Units of Measurement:

The units of electron affinity are:

- $kJmol^{-1}$

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.

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

(ii) Trends in Groups:

In a group electron affinity values **decrease** from top to bottom because the size of elements of atoms increases down the group.

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

Reason:

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 chlorine.

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:

*"The **ability of an atom to attract the shared pair of electrons towards itself in a molecule** is called electronegativity."*

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.

Importance:

It is an important property especially when **covalent type of bonding** of elements is under consideration.

TRENDS OF ELECTRONEGATIVITY

(i) Trends in Periods:

Electronegativity **increases** from left to right in the periodic table. The trend of electro negativity is same as of ionization energy and electron affinity. It increases in a period from left to right.

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:

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

(iii) Trends in Groups:

Electronegativity **decreases** from top to bottom in the group.

Reasons:

It generally decreases down a group because size of the atom increases. Thus attraction for the shared pair of electrons weakens.

Example:

Electronegativity values of group 17 elements (halogens) are presented here.

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

3.2 PERIODICITY OF PROPERTIES

3.2.1 ATOMIC SIZE AND ATOMIC RADIUS

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 pg # 106*

Q.2 Give the trend of ionization energy in a period? **(Ex-9) (FSD 2016,17, MTN 2017, DGK 2017)*(U.B)***

Ans: *Answer given on pg # 108*

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

Ans: *Answer given on pg # 109*

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

Ans: *Answer given on pg # 109*

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

Ans: *Answer given on pg # 110*

Q.6 Define Shielding effect. ***(K.B)***

Ans: *Answer given on pg # 106*

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.

3.2 PERIODICITY OF PROPERTIES

3.2.1 ATOMIC SIZE AND ATOMIC RADIUS

MULTIPLE CHOICE QUESTIONS

1. The atomic radii of the elements in periodic table: ***(U.B)***

(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 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

3.3 TEST YOURSELF

i. **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.

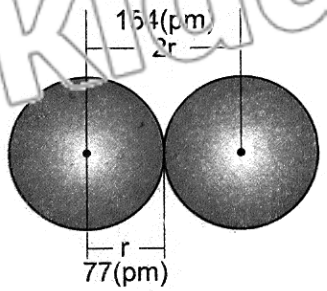

Figure: The Radius of Carbon Atom

ii. What are Sl 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

iii. 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.

iv. 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."*

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

v. 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 2^{nd} electron becomes difficult. That is why 2^{nd} I.E is higher than first one.

vi. 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.

vii. 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.

viii. 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.

ix. What is shielding effect? **(SWL 2017)*(K.B)***

Ans: *"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".*

x. How does shielding effect decreases the force of electrostatic attractions between nucleus and outermost electrons? *(U.B)*

Ans: **EFFECT OF SHIELDING EFFECT ON FORCE OF ATTRACTION**

The electrons present between the nucleus and the outermost shell of an atom, reduce the nuclear charge felt by the electrons present in the outermost shell. The attraction of outer electrons towards nucleus is partially reduced because of inner electrons. As a result an atom experiences less nuclear charge than that of the actual charge, which is called effective nuclear charge (Z_{eff}).

xi. Why do the bigger size atoms have more shielding effect? *(U.B)*

Ans: **SHIELDING EFFECT OF BIGGER SIZE ATOMS**

The bigger size atoms have more shielding effect because in bigger size atoms the number of inner shells and inner shell electrons increases which increases shielding effect.

xii. 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**.

ANSWER KEYS

INTRODUCTION

1	B	2	C	3	C	4	A

3.1 PERIODIC TABLE

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

3.1.1 PERIODS AND GROUPS

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

3.2 PERIODICITY OF PROPERTIES

3.2.1 ATOMIC SIZE AND ATOMIC RADIUS

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

EXERCISE SOLUTION

MULTIPLE CHOICE QUESTIONS

1. The atomic radii of the elements in Periodic Table: (BWP 2016 G-II, DGK 2016 G-I)*(U.B)*

(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:
(FSD 2017 G-II, BWP 2016 G-I,II 2017 G-II)*(U.B+K.B)*

(a) Lattice energy (b) Ionization energy (c) Electronegativity (d) Electron affinity

3. Mendeleev Periodic Table was based upon the:
(GRW 2016 G-I, RWP 2017 G-I, SWL 2017 G-II, MTN 2016 G-II) *(K.B)*

(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:
(RWP 2017 G-I, DGK 2017 G-I, II, SWL 2016 G-II)*(K.B)*

(a) Mendeleev Postulate (b) Atomic number (c) Atomic mass (d) Mass number

5. 4th and 5^{th} period of the long form of Periodic Table are called:
(SGD 2017 G-II, BWP 2017 G-I, MTN 2016 G-I, SGD 2016 G-I)*(K.B)*

(a) Short periods (b) Normal periods (c) Long periods (d) Very long periods

6. Which one of the following halogen has lowest electronegativity?
(LHR 2017 G-I, SWL 2017 G-I, FSD 2016 G-I,II)*(K.B)*

(a) Fluorine (b) Chlorine (c) Bromine (d) Iodine

7. Along the period, which one of the following decreases: (DGK 2017 G-II, FSD 2016 G-I)*(U.B)*

(a) Atomic radius (b) Ionization energy (c) Electron affinity (d) Electronegativity

8. Transition elements are:
(LHR 2017 G-I, SGD 2017 G-II, SWL 2017 G-I, BWP 2016 G-I, RWP 2016 G-II, SGD 2016 G-I)*(K.B)*

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

9. Mark the incorrect statement about ionization energy: (BWP 2017 G-I)*(U.B)*

(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: (BWP 2017 G-I)*(U.B)*

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

ANSWER KEY

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

EXERCISE SHORT QUESTIONS

1. What do you mean by groups and periods in a Periodic Table?
(RWP 2016, GRW 2017 G-II, LHR 2017 G-I, GRW 2016 G-I)*(U.B+K.B)*

Ans: *Answer given on pg # 95*

2. Give the trend of ionization energy in a period. (FSD 2017-GII)*(U.B)*

Ans: *Answer given on pg # 108*

3. Why the size of atom does not decrease regularly in a period? *(U.B)*

Ans:

SIZE OF ATOM IN PERIOD

Because of electronic configuration of 3d and 4s orbitals, there is a variation in atomic size in transition series. For example, atomic size decreases in 4^{th} period but from Nickel (Ni) to Zinc (Zn) it increases and again decreases.

4. Why noble gases are not reactive? **(GRWP 2016-I)*(U.B)***

Ans: **REACTIVITY OF NOBLE GASES**

Noble gases are not reactive because they have their valence shells completely filled. They have 2 or 8 electrons in their valence shells. Their atoms do not have vacant spaces in their valence shell to accommodate more electrons. Therefore they do not gain, lose or share electrons.

5. Why Cesium (at.no.55) requires little energy to release its one electron present in the outermost shell? ***(U.B)***

Ans: **ENERGY REQUIRED BY CESIUM**

Cesium require little energy because it has greater atomic size, more shielding effect (due to presence of more electrons) that's why it required little ionization energy to release its one electron present in outmost shell.

6. How is periodicity of properties dependent upon number of protons in an atom?*(U.B)*

Ans: **DEPENDENCE OF PERIODICITY**

Number of protons in an atom represents atomic number of that element which increases regularly by one from element to element. So the arrangement of elements according to increasing atomic number shows the periodicity in the electronic configuration of the elements that leads to periodicity in their properties.

7. Why shielding effect of electrons makes cation formation easy? ***(U.B)***

Ans: **FORMATION OF CATIONS**

The shielding effect of electrons makes the cation formation easy because it reduces the nuclear pull on the outermost electrons and they are less tightly held by the nucleus and can easily be lost from the outermost shell.

8. What is the difference between Mendeleev's Periodic Law and Modern Periodic Law? **(GRW 2016 G-I, LHR 2016 G-I, FSD 2017 G-II)*(U.B)***

Ans: **DIFFERENTIATION**

The differences between Mendeleev's Periodic Law and Modern Periodic Law are as follows:

Mendeleev's Periodic Law	Modern Periodic Law
Definition	
• Properties of the elements are periodic function of their atomic masses.	• Properties of the elements are periodic function of their atomic numbers.
Basis of Law	
• Atomic masses is less fundamental property and it is the basis of Mendeleev's periodic law.	• Atomic number is more fundamental property and it is the basis of modern periodic law.

9. Why and how are elements arranged in 4^{th} period? ***(U.B)***

Ans: **ELEMENTS OF 4^{TH} PERIOD**

Why Arranged?

The elements are arranged in the 4^{th} period because they are all having four electronic shells.

Mode of Arrangement:

They are arranged by increasing atomic number from left to right in the period.

EXERCISE LONG QUESTIONS

1. Explain the contributions of Mendeleev for the arrangement of elements in his Periodic Table. ***(U.B+K.B)***

Ans: *Answer given on pg #* 94 (Topic 3.1)

2. Show why in a 'period' the size of an atom decreases if one moves from left to right?

Ans:

TRENDS OF ATOMIC SIZE IN PERIODS

The atomic size gradually decrease from left to right in a period.

Reasons:

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. This nuclear force pulls down or contracts the outermost shell towards the nucleus.

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

3. Describe the trends of electronegativity in a period and in a group.

Ans: *Answer given on pg #* 109, 110 (Topic 3.2)

4. Discuss the important features of Modern Periodic Table.

Ans: *Answer given on pg #* 96 (Topic 3.1)

5. What do you mean by blocks in a periodic table and why elements were placed in blocks?

Ans: *Answer given on pg #* 97 (Topic 3.1)

6. Discuss in detail the periods in Periodic Table?

Ans: *Answer given on pg #* 100 (Topic 3.1.1)

7. Why and how elements are arranged in a Periodic Table?

Ans: *Answer given on pg #* 99 (Topic 3.1)

8. What is ionization energy? Describe its trends in the Periodic Table?

Ans: *Answer given on pg #* 107 (Topic 3.2)

9. Define electron affinity, why it increases in a period and decreases in a group in the Periodic Table.

Ans: *Answer given on pg #* 108 (Topic 3.2)

10. Justify the statement, bigger size atoms have low ionization energy and have more shielding effect. ***(U.B)***

Ans:

LOW IONIZATION ENERGY AND MORE SHIELDING EFFECT

Justification:

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 electron present in the outermost shell which results more shielding effect by such bigger size atoms. Resultantly the valence shell electrons can be released easily. Therefore bigger size atoms have more shielding effect and low ionization energies.

ADDITIONAL CONCEPTUAL QUESTIONS

Q.1 Which is more fundamental property than atomic mass? **(Do you know Pg. # 48)** ***(U.B)***

Ans:

ATOMIC NUMBER IS MORE FUNDAMENTAL PROPERTY

Atomic number of an element is more fundamental property than atomic mass because:

- It **increases regularly by 1** from element to element.
- It is **fixed** for every element.
- No two elements have same atomic number.

Q.2 Explain with examples that how you can define position of an element a period? ***(U.B+A.B)***

Ans:

POSITION OF AN ELEMENT ALONG A PERIOD

- Valence electrons decide the position of an element along a period.
- Elements with 1 valence electron occupy the left most position in the respective period like alkali metals.
- Elements with 8 valence electrons occupy the right most position in the respective periods like noble gasses (Except helium).

Q.3 What are demerits/drawbacks of Mendeleev's periodic table? ***(U.B)***

Ans:

DEMERITS/DRAWBACKS OF MENDELEEV'S PERIODIC TABLE

- Based on atomic mass instead of atomic number.
- Did not explain the position of Isotopes.
- Wrong order of atomic masses of some elements.

Q.4 What is the contribution of Moseley? ***(K.B)***

Ans:

CONTRIBUTION OF MOSELEY

In 1913 H. Moseley discovered a new property of the element i.e. atomic number. He observed that atomic number instead of atomic mass should determine the position of elements in the periodic table.

Q.5 Who were Alchemists and what was Alchemy? **(Do you know Pg. # 49)**

Ans:

ALCHEMIST AND ALCHEMY

"A group of Muslim scientists who tried to convert common metals into gold and find cure to diseases and give eternal life to the people is called alchemists and this branch of chemistry is called alchemy."

For thousands years alchemy remained field of interest for the scientists.

Q.6 What are transition elements? **(FSD 2017)(K.B)**

Ans:

TRANSITION ELEMENTS

"Elements in which d or f subshells are in the process of completion are called transition elements"

Examples:

The elements of groups 3 to 12 and lanthanides as well as actinides are called transition elements. They belong to periods 4, 5, 6 and 7.

Q.7 What is the basis of electronic configuration? **(U.B)**

Ans:

BASIS OF ELECTRONIC CONFIGURATION

Atomic number of an element is equal to the number of electrons in neutral atom. So atomic number provides the basis of electronic configuration.

Q.8 What was the main objective of Al-chemists?(Do you know Pg. # 49)(U.B+K.B)

Ans: **MAIN OBJECTIVE OF ALCHEMIST**

Alchemists (A group of Muslim scientists) worked with two main objectives;

(i) Change common metals into gold

(ii) Find cure to diseases and give eternal life to people

Idea about Composition of Matter:

They believed all kinds of matter were same combination of four basic elements. Substances are different because these elements combine differently. By changing composition or ratio of anyone element, new substances can be formed.

Q.9 What are the advantages and disadvantages of the work of Alchemists? ***(U.B+K.B)***

Ans: **ADVANTAGES AND DISADVANTAGES OF ALCHEMISTS**

Advantages:

Many methods and techniques invented by alchemists are still used in chemistry.

Disadvantages:

The way of making gold from silver or lead was never found and secret of eternal life was never discovered.

Q.10 Why number of elements in a period is fixed? ***(U.B)***

Ans: **FIXED NUMBER OF ELEMENTS IN A PERIOD**

Number of elements in a period is fixed because of maximum number of electrons a particular valence shell accommodates.

Q.11 Why elements of a group named as family? ***(U.B)***

Ans: **ELEMENTS OF A GROUP NAMED AS FAMILY**

"Due to similar chemical properties because of similar valence shell electronic configuration, elements of a group called as family."

Example:

For example group eighteen known as noble gases.

Q.12 Write down the types of elements on basis of completion of their inner & valence shells. ***(U.B+K.B)***

Ans: **TYPES OF ELEMENTS ON BASIS OF COMPLETION OF INNER & VALENCE SHELL**

On basis of completion of inner & valence shell, elements of modern periodic table are divided into 3 types:

1. Normal elements
2. Transition elements
3. Noble gases

1. NORMAL ELEMENTS

Definition:

"Those elements whose inner shells are completely filled with electrons, only valence (outermost) shells are incomplete."

Examples:

- Group 1
- Group 2
- Group 13 – 17

2. TRANSITION ELEMENTS

Definition:

"Those elements whose both inner & valence shells are incomplete with electrons."

- In these elements 'd' subshell is in the process of completion.

Examples:

Group 3 to 12 elements

3. NOBLE GASES

Definition:

"Those elements whose both inner & valence shells are completely filled with electrons."

- They are non-reactive elements.

Examples:

He, Ne, Ar, Kr, Xe, Rn

Q.13 Why and how elements are arranged in the 3rd period? (FSD 2017)*(U.B)*

Ans:

ARRANGEMENT OF ELEMENT IN 3RD PERIOD

Why Arranged?

The elements (Na, Mg, Al, Si, P, S, Cl and Ar) are arranged in the 3rd period because they are all having three electronic shell.

Mode of Arrangement:

They are arranged by increasing atomic number from left to right in the period.

Q.14 Write the names of elements of the first period. (RWP2017,GRW2017G-I,II)*(K.B)*

Ans:

FIRST PERIOD

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

Q.15 Write about group 18 elements? (SWL 2017)*(K.B)*

OR

Write down symbols of noble gases. (SGD 2017 G-I)*(K.B)*

Ans:

GROUP 18 ELEMENTS

The gaseous elements of group 18 or zero group are called noble gases. It consists of helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe) and radon (Rn).

Q.16 Why Li has greater ionization energy than Rb? *(U.B)*

Ans:

GREATER IONIZATION ENERGY OF Li

Lithium has little greater ionization energy (520 $kJmol^{-}1$) then rubidium ($403kJmol^{-1}$) because 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.

Q.17 Why chlorine has greater electron affinity as compared to fluorine? *(U.B)*

Ans:

ELECTRON AFFINITY OF FLUORINE

Fluorine has smaller atomic size and its nine electrons are tightly held by the nucleus so that the thick electronic cloud shield the force of the attraction of the nucleus on the incoming electron. Due to this weak force of attraction less energy is released as compared to chlorine.

Q.18 Why is energy required to remove an electron from an atom? *(U.B)*

Ans: As we know that there is force of attraction present between nucleus and the revolving electrons. In order to remove an electron we have to provide energy to break this force of attraction.

$$Na \rightarrow Na^{+} + 1e^{-1}$$

Q.19 Why is energy released when an electron added in to the outermost shell of an atom? *(U.B)*

Ans: Energy is released when an electron added into outermost shell of an atom because a new force of attraction developed between nucleus and incoming (extra) electron.

$$F + 1e^{-} \rightarrow F^{-1}$$

TERMS TO KNOW

Terms	Definitions
Dobreiner law of Triads	A German chemist **(1829) Dobereiner** observed relationship between atomic masses of several groups of **three elements** called **triads**. **Law of Triads:** *"In a triad the central or middle element had atomic mass average of the other two elements."*
Newland law of Octaves	In **1864** British chemist and musician Newlands put forward his observations in the form of **'Law of Octaves'**. **Statement:** *"According to Law of Octaves there was a* ***repetition in chemical properties of every eighth element if they were arranged by their increasing atomic masses****."*
Mendeleev's Periodic Table	***"Properties of the elements are periodic functions of their atomic masses"***
Modern Periodic table	***"Properties of the elements are periodic functions of their atomic number"***
Blocks	*"On the basis of* ***completion of a particular subshell,*** *elements with* ***similar valence subshell*** *electronic configuration are referred as a block of elements".*
Periods	*"****Horizontal rows of elements in the periodic table*** *are called periods".*
Groups	*"The* ***vertical columns of elements in the periodic table*** *are called groups."* **Number of Groups:** There are **18** groups in the modern periodic table.
Atomic Radius	*"The* ***half of the distance between the nuclei of the two bonded atoms*** *is referred as the atomic radius of the atom.*
Shielding effect	*"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".*
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".*
Electron affinity	*"The* ***amount of energy released when an electron is added in the outermost shell of an isolated gaseous atom*** *is called electron affinity".*
Electronegativity	*"The* ***ability of an atom to attract the shared pair of electrons towards itself in a molecule*** *is called electronegativity."*

SELF TEST

Time: 35 Minutes **Marks: 25**

Q.1 Four possible answers (A), (B), (C) and (D) to each question are given, mark the correct answer. (6×1=6)

1. The general electronic configuration of Halogens is:

(A) ns^2np^2 (B) ns^2np^4 (C) ns^2np^5 (D) ns^2np^6

2. The d-block elements lie between the blocks:

(A) s and p (B) d and f (C) p and f (D) f and s

3. Which halogens have highest electron affinity:

(A) Fluorine (B) Chlorine (C) Bromine (D) Iodine

4. Which of the following have more shielding effect:

(A) Hydrogen (B) Lithium (C) Sodium (D) Potassium

5. Electronegativity of Fluorine is:

(A) 4.0 (B) 3.2 (C) 3.0 (D) 2.7

6. Normal elements which groups:

(A) Group 1 and 2 (B) Group 13 to 17 (C) Both a and b (D) Group 3 to 12

Q.2 Give short answers to the following questions. (5×2=10)

(i) Differentiate between Periods and Groups.

(ii) How many elements are their in 3^{rd} period, write their names and symbols?

(iii) Why electron affinity increases in a period?

(iv) Define Electronegativity. Give its trends.

(v) What is the difference between Mendeleev's Periodic law and Modern Periodic law?

Q.3 Answer the following questions in detail. (5+4=9)

(i) What is Ionization Energy? Describe its trends in periodic table. (5)

(ii) Discuss the Important features of periodic table. (4)

Note:

Parents or guardians can conduct this test in their supervision in order to check the skill of students.