Periodic Classification of Elements

Important Points:

- The first classification of elements is due to dobereiner in 1817.

- **Dobereiner Triad Theory:** "The atomic weight of the middle element is the arithmetic mean of first and third elements (or) the atomic weights of all the three elements are approximately the same"
  Eg: i) Li, Na, K ii) Fe, Co, Ni iii) Cl, Br, I.
- **Newland's Concept of Octaves:** Every eighth element is having the similar properties to that of the first element like in octave of music.
- Mendeleef, Lother Meyer used atomic property. Atomic weight for classification elements.
- **Mendeleef's Periodic Law:** The properties of the elements are the periodic functions of their atomic weights".
- **Modern Periodic Law:** The properties of the elements are the periodic functions of their atomic number (or) electronic configuration.
- Modern Periodic Table is called long form of periodic table.
- Long form of periodic table is divided into seven horizontal rows called "Periods" and eighteen vertical columns called "Groups"
- The first period has only two elements.
- The second and third period have 8 elements each.
- Fourth, Fifth and sixth periods have 18 elements each.
- Lanthanides and actinides are placed at the bottom of the periodic table.
- Seventh period is incomplete.
- Based on electronic configuration, the elements are classified into 4 types. They are inert gases, representative elements, transition elements representative elements and inner transition elements.
- **Atomic radius:** It is the distance between the centre of the nucleus and outermost orbital.
- It is expressed in units of Angstroms.
- **Ionization energy:** It is the energy required to remove an electron from the outermost orbital in the gaseous state.
- IE is expressed in ev or $KCal.mol^{-1}$ or $K.J.mol^{-1}$.
- **Electronegativity:** The ability of the bonded atom to attract the electron density of the shared electrons.
- Electronegativity is expressed ... pauling scale.
- In a period, Atomic radius decreases and ionisation energy and electronegativity increases.
- In a group, atomic radius increases and IE and EN value decreases.

PART - A

Section-I:

Short Answer Questions (2 Marks each)

1. How does the atomic radius (size) vary in a period and a group?

2. Why does atomic size decreases from left to right?
3. How does the ionsation energy vary in a period and a group?
4. Distinguish between oxidation and Reduction?
5. Which group elements can be used as oxidising and reducing agents?
6. What is Newland's concept of Octaves?

Section-II

Very Short Answer Questions (1 Mark Each)

1. Which group elements can be used as strong reducing agents?
2. On which atomic property is the Mendeleef's periodic table based?
3. What is oxidation?
4. Explain the relationship between ionisation energy and size of the molecule?
5. What are inner transition elements?
6. Write the general electronic configuration of inert gases?
7. Define atomic radius?
8. Which group of elements have the highest electropositive character?
9. State Mendeleef's periodic law?
10. Define electropositive character?

Section III

Long Answer Questions (4 Marks each)

1. How does atomic size and ionisation energy vary in a period and in a group?
2. How does the following properties vary in a period and in a group?
   a) Atomic Size (or) Atomic radius
   b) Oxidising Property
   c) Electronegativity
   d) Electropositivity
   e) Ionisation energy
3. Explain the main features of long form of the periodic table?
4. Explain the electronic configuration of inert gases?
5. Answer the following
   a) Define Ionisation Energy
   b) Newland's Concept of Octaves
   c) Inner Transition Elements
   d) Transition Elements

Section IV

- Diagrams

KEY

Part - A, Section - I

Short Answers

1A. In a period: The atomic radius decreases from left to right. This is because, as the

atomic number increases in a period, the nuclear attraction over the valence electrons increases and the atomic radius decreases.

In a group: The atomic radius increases from to to bottom in a group. This is due to the addition of one extra shell from one element to another element.

2A. 1. Atomic size is expressed in °A units.
2. Atomic size decreases from left to right in the periodic table.
3. This is because, as the atomic number increases in a period, the nuclear attraction over the electron charge cloud increases and as a result the radius decreases.

3A. **Period:**
1. In a period, from left to right, the ionisation energy do not follow any regular trend. In the first period it increases form hydrogen to helium.
2. But, in second period, it increases from Li to Be decreases at Boron.
3. From boron to nitrogen it again increases and then decreases at oxygen.
4. This is because nitrogen has half filled electron configuration ($2p^3$) which is stable.
5. Therefore, Ionisation energy do not follow any regular trend in a period.

Groups:
1. In a group, Ionisation energy decreases from top to bottom.
2. As we go from top to bottom, the size of the atom increases and attractive power of the nucleus on the outermost electron decreases.
3. Hence, ionisation energy decreases in a group.

4A.

OXIDATION	REDUCTION
1.Addition of oxygen to a given compound is called oxidation.	1. Addition to hydrogen to a compound is Reduction.
2.Removal of hydrogen from a compound is called oxidation.	2. Removal of oxygen atom from a called compound is called Reduction

5A. 1. Group - IA and IIA elements can be used as reducing agents.
2. Group - VII A elements can be used as oxidising agents.

6A. Newland's concept of octaves:
If the elements are arranged sequentially in the increasing order of their atomic weights, every eighth element is having the similar properties to that of the first element like in the octave of music. This is called "Newland's Concept of Octaves".

Eg:

1	2	3	4	5	6	7	8
Li	Be	B	C	N	O	F	Na

Here, properties of Lithium and sodium are the same.

Section II

Very Short Answers:

1.A Group - IA and Group - IIA elements can be used as strong reducing agents.

2A. Mendeleef's periodic table is based on atomic weights of the elements.

3A. Oxidation: Addition of oxygen atom to a compound (or) Removal of hydrogen from a compound is called oxidation.

4A. In a period, as the atomic size decreases, hence he ionisation energy increases. In a group, as the atomic size increases, hence the ionisation energy decreases.

5A. The elements belonging to f-block are called "inner-transition elements"

6A. The general electronic configuration of inert gases is "$ns^2\ np^6$"

7A. Atomic radius: "The distance between the centre of the nucleus and the outer most orbital of an atom" is defined as atomic radius.

8A. Group - IA and Group-IIA elements are having the highest electropositive character.

9A. Mendeleef's Periodic law: "The physical and chemical properties of the elements are the periodic functions of their atomic weights"

10A. Electropositive Character:

- The ability of a bonded atom in a molecule to attract the bonded pair of electrons towards itself is called "electropositive character".

Section III

Long Answer Questions (4 Marks Each)

1A. Atomic Radius (or) Atomic Size:

1. "The distance between the nucleus and outermost orbital of an atom" is called "Atomic radius.
2. Atomic radius (or) Atomic size is expressed in Angstrom units (1 °A = 10^{-8} cm)
3. In a period, the atomic radius decreases from left to right of the periodic table.
4. This is because, as the atomic number increases in a period, the nuclear attraction over the electron charge cloud increases and as a result the radius decreases.
5. In a group, the atomic radius increases front top to bottom.
6. This is due to the addition of one extra shell from one element to another.

Ionization Energy:

1. The minimum energy required to remove an electron from the outermost orbital of an atom in the gaseous state" is called ionisation energy.
2. Its units are electron volt (or) kilo joules/mole.
3. In a period from left to right, ionisation energy do not follow any regular trend. In the

first period ionisation energy increases from hydrogen to helium, as it has stable configuration $1s^2$

4. In the second period. I.E. increases from Li to Be and decreases at Boron.
5. From Boron to nitrogen it again increases and then decreases at oxygen. This is because nitrogen has half - filled stable electronic configuration (2p3)
6. In a group the I.E. decreases from top to bottom. This is because as we go from top to bottom the size increases, so it is easy to remove the electron.

2A. **a) Atomic Radius:**

1. In a period, the atomic radius decreases from left to right.
2. In a group, the atomic radius increases from top to bottom.

b) Oxidising Property:

1. In a period, oxidising property increases from left to right.
2. In a group, the oxidising property decreases from top to bottom.

c) Electronegativity:

1. In a period, the electroneagativity increases due to the decrease in the size of the atom.
2. In a group, the electronegativity decreases due to increase in the size of the atom.

d) Electropositivity Character:

1. In a period, the electropositive character decreases.
2. In a group, the electropositive character increases.

3A. Main Features of Long form of the Periodic Table:

The long form of the periodic table relates the properties of elements to their electronic configuration. This is otherwise called "Modern Periodic Table".

1. It consist of 7 periods and 18 groups.
2. Every period starts with alkali metal and ends with inert gas.
3. First period has 2 elements.
4. 2^{nd} and 3^{rd} periods have 8 elements.
5. 4^{th} and 5^{th} periods have 18 elements each.
6. Sixth period consists of 32 elements.
7. Seventh period is incomplete period.
8. All the elements are classified into four blocks like s,p,d and f.
9. IA and IIA group elements are called s-block elements.
10. IIIA and IIIA group elements are called p-block elements.
11. The elements between s and p - blocks are known as d-block elements.
12. The elements lie at the bottom are called f-block elements.
13. Based on electronic configuration, elements are classified into four types like representative, Transition, inert gases and inner transition elements.
14. s and p block elements together known as representative elements.
15. d - block elements are called transition elements.
16. Zero group elements are known as inert gases.
17. f - block elements are called inner transition elements.
18. f - block elements with atomic numbers 58 to 71 are called lanthanides and 90 to

103 called actinides.

4A. Electric Configuration of Inert gases:

1. Helium, Neon, Argon, Krypton, Xenon and Radon are the inert gas elements which belongs to VIIIA group.
2. They has ns^2np^6 octet electronic configuration. They are very stable.

Element		At.number	e configuration
Helium	He	2	$1s^2$
Neon	Ne	10	$1s^22s^22p^6$ [He] $2s^22p^6$
Argon	Ar	18	$1s^22s^22p^63s^23p^6$ [Ne] $3s^23p^6$
Krypton	Kr	36	[Ar] $4s^24p^6$
Xenon	Xe	54	[Kr] $5s^24p^6$
Radon	Rn	86	[Re] $6s^26p^6$

5A. a) Ionisation Energy:

1. The minimum amount of energy required to remove an electron from the outermost orbital of an atom in the gaseous state.
2. In a period IE increases, as the atomic size decreases and in a group, the IE decreases, as the size of the atom increases.

b. Newland's concept of octaves:

- If the elements are arranged according to the increasing order of atomic weights, every eighth element resemblances the first in properties.

c. Inner transition elements:

- f - block elements, both lanthanides and actinides are called f-block elements.

d. Transition Elements: d-block elements (except IIIB) are called transition elements.

Part - B

I. Multiple choice Questions **(1/2 Mark each)**

1. Which of the following is a Dobereiner's triad. **[ ]**
   a) Ne, Ca
   b) Li, Na, K
   c) H_2, C_2, O_2
   d) Na, Br, Ar

2. Alkali metals are powerful **[ ]**
   a) oxidising agents
   b) readily reduced
   c) not reduced at all
   d) reducing agents.

3. The number of outermost electrons present in inert gas atom is [ ]
   a) 2
   b) 6
   c) 8
   d) 10

4. Mendeleev's periodic table is based on the [ ]
   a) Atomic weight
   b) Atomic number
   c) atomic radius
   d) Ionisation Energy

5. The Ionization energy in a group from top to bottom. [ ]
   a) decreases
   b) Increases
   c) remains same
   d) None

6. The size of sodium ion is [ ]
   a) bigger than sodium atom
   b) same as sodium atom
   c) smaller than sodium atom
   d) None

7. The electronegativity of fluorine is [ ]
   a) 1
   b) 2
   c) 3
   d) 4

8. The least electropositive element is [ ]
   a) oxygen
   b) Fluorine
   c) Chlorine
   d) Nitrogen

9. The first period has _____ elements [ ]
   a) 1
   b) 3
   c) 2
   d) 5

10. The lightest metal is [ ]
   a) Mg
   b) Na
   c) Li

d) Ca

11. One Angstrom unit is equal to [ ]
    a) 10^{-10} cm
    b) 10^{-8} cm
    c) 10^{-15} cm
    d) 10^{-28}cm

12. $x^{+}_{(g)} + \text{Energy} \rightarrow x^{2-}_{(g)} + e^{-1}$ [ ]

    In the above equation the energy is
    a) First I.E.
    b) Second I.E.
    c) Electron affinity
    d) None

13. Which of the following has highest electronegativity [ ]
    a) Chlorine
    b) Lithium
    c) Fluorine
    d) Helium

14. Which of the following has the minimum atomic radius? [ ]
    a) N b) Na c) K d) F

15. f - block elements are also called [ ]
    a) Transition elements
    b) Inner transition elements
    c) A noble gas
    d) An alkaline earth metal

II. Fill in the blanks **(1/2 mark each)**

16. The first classification of elements is attempted by _____
17. Elements from atomic number 58 to 71 are known as _____
18. The electronegativity is measured in _____ scale.
19. _____ group elements are oxidising agents.
20. Gallium was discovered by _____
21. Eka boron is discovered as scandium by _____
22. IIA group elements are known as _____
23. Electropositive character is otherwise called _____
24. In a period left to right the reducing property ____ and oxidising property.
25. The addition of oxygen to a compound is called _____
26. The outermost electronic configuration of the most electronegative element is ____
27. The ___ Period is incomplete
28. Modern periodic table is divided into _____ periods and _____ groups.
29. _____ and _____ periods have 18 elements each.

30. The group number of an element represents _____

III. Matching

I.	**Group A**		**Group B**
31.	s-block elements	()	A) Zero Group elements
32.	p-block elements	()	B) lies between s and p blocks
33.	d-block elements	()	C) IA & IIA group elements
34.	f-block elements	()	D) IIIA to VII A group elements
35.	Inert Gases	()	E) Lanthanides and Actinides.

II.	**Group - A**	**Group - B**	
36.	Triad Theory	()	A) VII A group elements
37.	Law of octave	()	B) Actinides
38.	Halogens	()	C) John A.R. Newlands
39.	Rare earth elements	()	D) J.W. Dobereiner
40.	The elements with atomic number 89 to 102	()	E) Lanthanides

Part - B Key

I.	1) B	2) D	3) C	4) A	5) A
	6) C	7) D	8) B	9) C	10) C
	11) B	12) B	13) C	14) D	15) B

II. 16) J.W. Dobereiner
17. Lanthanides
18. Pauling
19. VII A
20. De Boisabudran
21. Nilson
22. Alkaline Earth
23. Metallic Character
24. Decreases increases
25. Oxidation
26. $2s^2 2p^5$
27. 7
28. 7, 18
29. IV and V
30. Valence Electrons

III.	31.C	32. D	33. B	34. E	35. A
IV	36. D	37. C	38. A	39. E	40. B