CHAPTER NO 04

PERIODICITY OF ELEMENTS

Q1. Define periodicity.

PERIODICITY:

"The repetition of properties after regular intervals is called periodicity"

Q2. Define Dobereiner's classification with example.

DOBEREINER'S CLASSIFICATION (Law of Traids):

INTRODUCTION:

In 1829 a German Chemist John Dobereiner presented this law.

STATEMENT:

" He stated that, Central atom of each set of traid had an atomic mass almost equal to the arithmetical mean of the atomic masses of other two elements."

Elements		Atomic Mass	Mean Atomic Mass
Traid	Lithium Sodium Potassium	7 23 39	At. mass of Na = $\frac{7+39}{2}$ =23
Traid	Chlorine Bromine Iodine	35.5 81 126.5	At. mass of Br = $\frac{35.5 + 126.5}{2}$ =81

Q3. Define Newland's classification with example.

NEWLAND'S CLASSIFICATION (LAW OF OCTAVE):

INTRODUCTION:

In 1863 an English Chemist John Newland presented this law.

STATEMENT:

"If the elements are arranged in ascending order of their atomic masses then every eighth element shows similar properties as the first".

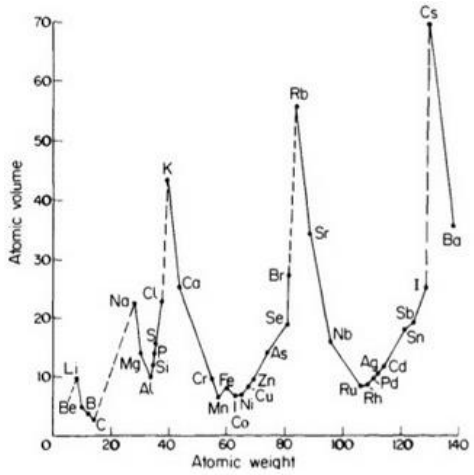
Element	Li	Be	B	C	N	O	F
Atomic Mass	7	9	11	12	14	16	19
Element	Na	Mg	Al	Si	P	S	Cl
Atomic Mass	23	24	27	28	31	32	35.5
Element	K	Cl					
Atomic Mass	39	40					

Q4. State Lother Meyer's classification.

LOTHER MEYER'S CLASSIFICATION:

In 1869 a German scientist Lother Meyer published a periodic table in which 56 discovered elements were arranged on the basis of their atomic masses in nine vertical columns or group from I to X. but he laid down emphasis on the physical properties of element.

He calculated the atomic volumes of elements and plotted a graph between also volumes of the elements against their increasing atomic mass.



OBSERVATION:

He observed that the elements with similar properties occupy same position on the curve.

Q5. Define Drawbacks of Dobereiner's and Newland's laws.

DRAWBACK OF DOBEREINER'S LAW:

This law cannot be extended to the classification of all elements because it is true only in the cases of few elements.

DWARBACK OF NEWLAND'S LAW:

i. **Hydrogen was not included in Newland's periodic table.**

ii. **This arrangement is true only for first sixteen element but from seventeenth element this arrangement is not valid.**

Q6. State Mendeleev's law. Write down salient features, advantages and disadvantages of Mendeleev's table.

MENDELEEV'S LAW:

INTRODUCTION:

In 1869 a Russian Chemist Dimitri Mendeleev presented this law.

STATEMENT:

"He stated that, The physical and chemical properties of elements are a periodic function of their atomic weight (mass)".

Mendeleev's Periodic Table of 1872

ROW	Group I	Group II	Group III	Group IV	Group V	Group VI	Group VII	Group VIII
1	H = 1							
2	Li = 7	Be = 94	B = 11	C = 12	N = 14	O = 16	F = 19	
3	Na = 23	Mg = 24	Al = 27.3	Si = 28	P = 31	S = 32	Cl = 35.5	
4	K = 39	Ca = 40	___ = 44	Ti = 48	B = 51	Cr = 52	Mn = 55	Fe = 56 , Co = 59 Ni = 59 , Cu = 63
5	(Cu = 63)	Zn = 65	___ = 68	___ = 72	As = 75	Se = 78	Br = 80	
6	Rb = 85	Sr = 87	?Yt = 88	Zr = 90	Nh = 94	Mo = 96	___ = 100	Ru = 104 , Rh = 104 Pb = 106 , Ag = 108
7	(Ag=108)	Cd = 112	In = 113	Sn = 118	Sb = 122	Te = 125	I = 127	
8	Cs = 133	Ba = 137	?Di = 138	?Ce = 140	...	...	...	
9	...	...	...	...	...	...	...	
10	...	...	?Er = 178	?La = 180	Ta = 182	W = 184	...	Os = 195 , Ir = 197 Pt = 198 , Au = 199
11	(Au = 199)	Hg = 200	T1 = 204	Pb = 207	Bi = 208	...	...	
12	...	...	...	Th = 231	...	U = 240	...	

Spaces were left for the unknown elements with atomic masses 44, 68, 72 and 100.

SALIENT FEATURES OF MENDELEEV'S TABLE:

i. It has eight vertical columns called groups and twelve horizontal rows called periods.

ii. Elements in each vertical columns have similar properties.

iii. Vacant spaces were left for the elements not discovered until them.

iv. The group number indicate the highest valency that can be attained by element of that group.

ADVANTAGES:

i. It helped in systematic study of elements.

ii. Prediction of new elements was made possible.

iii. This table helped in correcting many doubtful atomic masses.

DISADVANTAGES:

i. It gave no idea about the structure of an atom.

ii. It gave no indication about the position of isotopes.

iii Dissimilar elements placed in same group i.e Alkali metals (Li, Na, K, Rb, Sc) were placed with coinage metals (Ag, Cu, Au).

iv. Similar elements placed in different groups i.e (Ba, Pb) resembles in many properties but they are placed in different groups.

v. Lanthanides and Actinides have not been provided separate and proper space in Mendeleev's periodic table.

Q7. State Modern Periodic Table.

MODERN PERIODIC TABLE:

INTRODUCTION:

Modern Periodic law was proposed by Moseley in 1914.

STATEMENT:

"He stated that, The physical and chemical properties of elements are the periodic function of their atomic number".

Q8. Define groups and periods.

GROUPS:

The vertical columns of elements of periodic table are called groups. Groups are further divided into two classes.

i. Sub group A ii. Sub group B

SUB GROUP A (MAIN OR REPRESENTATIVE ELEMENTS):

Those elements which have incomplete outer most shell (valence shell) are called normal elements and are placed in sub group A. These elements are called main or representative elements.

SUB GROUP B (TRANSITION ELEMENTS):

Those elements which have incomplete last and second last shell from electron are called transition elements. These elements are placed in sub group B.

PERIODS:

The horizontal rows of elements in modern periodic table are called 'periods".

1st PERIOD (SHORTEST PERIOD):

1st period contains only 2 elements. Hydrogen (H) and Helium (He). This period is called shortest period.s

2nd PERIOD (FIRST SHORTEST PERIOD):

This period contains only 8 elements and it is called first short period.

3rd PERIOD (SECOND SHORT PERIOD):

This period also contains 8 elements and it is called second short period.

4th PERIOD (FIRST LONG PERIOD):

This period contains 18 elements and it is called first long period.

5th PERIOD (SECOND LONG PERIOD):

This period also contains 18 elements and it is called second long period.

6th PERIOD (LONGEST PERIOD):

This period contains 32 elements some of the elements of this period are known as Lanthanides and this period is called longest period.

7th PERIOD (INCOMPLETE PERIOD):

This period is still incomplete and most of elements of this period are artificially created. Most of the elements of this period is called actinides.

Q9. Write down the names of elements and characteristics of group I-A, II-A, III-A, IV-A, VII-A, VIII-A.

GROUP I-A (THE ALKALI METALS OR LITHIUM FAMILY):

Name of elements:

Lithium (Li), Sodium (Na), Potassium (K), Rubidium (Rb), Caesium (Cs), Fransium (Fr)

Characteristics:

i. **This group is also called alkali group because they produce alkali with water.**

ii. **They are solid and metals.**

iii. **Their valency is +1 because they have only one electron in their outer most shell.**

iv. **These element are highly reactive and have tendency to form compounds.**

v. **These elements are electropositive in nature.**

GROUP II-A (BERYLLIUM FAMILY OR ALKALINE EARTH METALS):

Name of elements:

Beryllium (Be), Magnesium (Mg), Calcium (Ca), Strontium (Sr), Barium (Ba), Radium (Ra)

Characteristics:

i. **This group is also known as alkaline earth metal because their oxides and hydroxides are strongly basic.**

ii. **They are solid and metals.**

iii. **Their valency is +2 because they have 2 electrons in their outer most shell.**

iv. **Elements of this group are moderately reactive and have moderate tendency to form compounds.**

v. These elements are electropositive in nature.

vi. They form ionic bond.

GROUP III-A (BORON FAMILY):

Name of elements:

Boron (B), Aluminium (Al), Gallium (Ga), Indium (In), Thallium (Tl)

Characteristics:

i. They are monoatomic and they exist in solid state.

ii. Their valency is +3 because they have 3 electrons in their outer most shell.

iii. Elements of this group are quite reactive and they form ionic and covalent bonds.

iv. Elements of this group have moderate tendency to form compounds.

v. In this group Boron is metalloid while rest of the members of the group are metals.

GROUP IV-A:

Name of elements:

Carbon (C), Silicon (Si), Germanium (Ge), Tin (Sn), Lead (Pb)

Characteristics:

i. They are monoatomic and they exit in solid state.

ii. Outer most shell of these elements are incomplete having 4 electrons.

iii. Elements of this group are quite reactive.

iv. This group shows intermediate character between electropositivity and electronegativity.

v. In this group carbon and tin are exist in different allotropic forms.

GROUP VII-A (THE HALOGENS):

Name of elements:

Flourine (F), Chlorine (Cl), Bromine (Br), Iodine (I), Astatine (At)

Characteristics:

i. This group is also known as halogens which means salt former.

ii. They are diatomic expect Astatine.

iii. They are very active non-metals.

iv. Their valency is -1 because they need only one electron to complete their outer most shell.

v. They are very highly electronegative in nature and they form covalent bonds.

vi. In this group Fluorine and Chlorine are gases, Bromine is liquid and Astatine is solid at room temperature.

vii. All these elements are non-metals except Astatine which is metalloid.

GROUP VIII-A (NOBLE OR INERT GASES):

Name of elements:

Helium (He), Neon (Ne), Argon (Ar), Krypton (Kr),

Xenon (Xe), Radon (Rn)

Characteristics:

i. This group also known as zero group or noble gases.

ii. Their valency is zero because their outer most shell is complete having 8 electrons.

iii. They are monoatomic and they exist in gaseous state.

iv. These elements are mostly chemically non-reactive.

v. All of these elements are present in atmosphere except Radon which is radioactive element.

Q10. Define transition elements. Also write their characteristics.

TRANSITION ELEMENTS:

Elements in group I-B to VIII-B are known as transition elements. They are metals. Transition elements are classified into two classes.

i. Inner transition elements **ii. Outer transition elements.**

Characteristics:

i. They have incomplete inner electron shell.

ii. In chemical reaction they show variable valency (more than one valencies).

iii. They are electropositive in nature and they all are metals.

iv. They have high melting and boiling point.

v. They form complex compound / ion.

vi. Mostly they form coloured compounds.

Q11. Define metals and non-metals.

METALS:

"They are electropositive elements. They lose electrons to form cations. They form basic oxides. They are good conductor of electricity".

In the periodic table elements of group I-A, II-A and all transition elements are metals. Some of the elements of group III-A, IV-A, V-A and VI-A are also metals.

NON-METALS:

"They are electronegative elements. They gain electron to form anions. They form acidic oxides. They are bad conductor of electricity. Most of them are gases."

In the periodic table majority of elements of group III-A, IV-A, V-A, VII-A and VIII-A are non-metals.

Q12. What are metalloids? Write down the names of elements which are metalloid.

METALLOIDS:

"These are the elements which exhibit dual character. That is they show the properties of both metals as well as non-metals. For example: Their oxides are amphoteric i.e have basic as well as acidic in natures."

Example:

Boron of group III-A

Silicon and Germanium of group IV-A

Arsenic and Antimony of group V-A

Tellurium and Polonium of group VI-A

Astatine of group VII-A

Q13. Define atomic radius, electronegativity, ionization energy, electron affinity and also write their trends in periodic table.

ATOMIC RADIUS:

"Half of the distance between two adjacent nuclei of two similar atoms in touch with each other is called atomic radius"

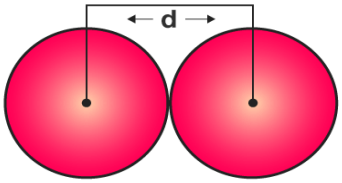
Unit:

The unit of atomic radius is Angstrom, A°.

Example:

The atomic radius of magnesium is 1.3 A°.

The atomic radius of aluminium is 1.25 A°.



TRENDS OF ATOMIC RADIUS IN PERIODIC TABLE:

In group:

In group from top to bottom in the periodic table the atomic radius increases due to increase in number of shells.

In period:

From left to right in the periodic table atomic radius decreases due to increasing number of protons.

ELECTRONEGATIVITY:

"The tendency of an atom to attract a shared pair of electron towards itself is called electronegativity"

Example:

The E.N of nitrogen is 3.0.

The E.N of bromine is 2.1.

TRENDS OF ELECTRONEGATIVITY IN PERIODIC TABLE:

In group:

From top to bottom in the periodic table electronegativity decreases due to addition of new shells.

In period:

From left to right in the periodic table electronegativity increases due to increases in nuclear charge.

IONIZATION ENERGY OR IONIZATION POTENTIAL:

"The amount of energy which required to remove one electron from gaseous state is called ionization energy or ionization potential".

Unit:

The unit of ionization energy is KJ/mole.

Example:

The ionization energy of hydrogen is -1312 KJ/mole.

The ionization energy of sodium is -495 KJ/mole.

TRENDS OF IONIZATION ENERGY IN PERIODIC TABLE:

In group:

From top to bottom in periodic table the ionization energy decreases due to increase in number of shells.

In periods:

From left to right in the periodic table the ionization energy increases due to strong nuclear charge.

ELECTRON AFFINITY:

" The energy change that accurs when an electron is gained by an atom in gaseous state is known as electron affinity".

Unit:

The unit of electron affinity is KJ/mole.

Example:

The electron affinity of chlorine is 348 KJ/mole.

The electron affinity of oxygen is 142 KJ/mole.

TRENDS OF ELECTRON AFFINITY IN PERIODIC TABLE:

In group:

From top to bottom in the periodic table electron affinity decreases due to increase in number of shells.

In period:

From left to right in the periodic table electron affinity increases due to strong nuclear charge.

Q14. Define Lanthanides and Actinides series.

LANTHANIDES AND ACTINIDES:

i. Lanthanides and actinides belongs to group B in the periodic table.

ii. They are also called outer transition elements.

iii. They all are metals.

iv. They have variable valencies.

Q15. Write down the discovery of noble gases.

DISCOVERY OF NOBLE GASES:

None of the noble gases was known when Mendeleev proposed his periodic table in 1812. The English scientist Ramsay become interested in the discovery that nitrogen obtained from the air had a slight highest density than that prepared by chemical reactions. After careful investigation, he concluded that higher density must be due to the present of unknown gas. When he separated this gas from the air it was completely unreactive. He called it argon, the "idle or lazy" gas in Greek. In the same year Ramsay isolated Helium (He) the lighter of all noble gases, from Uranium ores. During 1898 Ramsay and Rayleigh isolated three additional noble gases from air, neon (Ne) Krypton (Kr) and Xenon (Xe).