Notes for Class 9th

Chemistry

Chapter 3

NAME: _____

F.NAME: _____

CLASS:_____ SECTION: _____

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Periodic Table and Periodicity of Properties
(TOPIC WISE QUESTIONS)

Q1: Define the modern periodic law. Discuss the periods and groups in the modern form of the periodic table.

Ans: **Modern Periodic Law:**

In 1911, Moseley presented a new idea for the classification of elements on the bases of increasing their atomic number instead of atomic masses, It is stated that;

The physical and chemical properties of the elements are the periodic function of their atomic number. This means that the elements are arranged in ascending order. (increasing order) of their atomic number. The elements possessing similar properties and valence shells electronic configuration were repeated at a regular interval.

Periods:

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

First Period:

1st period is the shortest period containing two elements Hydrogen (H) S-Block and Helium (He) P-Block.

2nd and 3rd Period:

2nd and 5th period are called long period. Each containing 18 elements out of 18, 2 elements are S-block (representative) 10 are outer transition (d-block) and 6 are P-block, elements (non-metal)

6th Period:

The 6th period is a long period containing 32 elements. Out of 32 elements, 2 are S-Block, 10 are outer transition or d-block and 6 are p-block. The remaining 14 are inner transition or lanthanide series of f-block.

7th Period:

The 7th period is also called long period. Still incomplete and continue it contains 2 S-block elements 6 P-block and 10 outer transition (d-block) and 14 inner transition elements (f-block) called actinides series. They are present at the bottom of the periodic table.

Groups:

The vertical columns in the periodic table are called groups. There are eight groups in the periodic table. These groups are further sub-divided into two subgroups. Sub group A called normal elements or representative elements and sub-group B are called transition elements.

The groups are given special number.

Group – I A = Alkali metals
Group – II A = Alkaline metals
Group – III A = Boron family
Group – IV A = Carbon family
Group – V A = Nitrogen family
Group – VI A = Chalcogens or oxygen family
Group – VII A = Halogens
Group – VIII A = Noble gases or inert gases or zero groups.

The groups IA and IIA are called S-block element. The group IIIA – VIII A are called P-block elements. All the S and P-block are called normal elements or representative elements. The transition elements are called the d-block elements while the lanthanide and actinide series are called f-block elements.

Q2. Define and explain the ionization energy of an elements. Discuss the periodic variation energies of the elements in the periodic table.

Ans: **Ionization Energy (I.E):**

The minimum energy required to remove an electron from its gaseous atom to form an ion (cation) is called ionization energy. It is also called ionization potential.

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The energy which is required for the removal of electron is given in the form of heat, light or electrical conductance. The process by which electron is removed from the valence shell of an atom to form a gaseous positive ion (cation) is called ionization. The process of ionization can be represented by the following general equation.

$A_{(g)}$ + energy ➔ $A^{+}_{(g)}$ 1 e^{-}

Where "A" is an any gaseous atom another chemical examples are as follow:

$Na_{(g)}$ + energy ➔ Na^{+} + 1e = 1.E = 496 Kj/mol

$Mg_{(g)}$ + energy ➔ Mg^{+} + 1e = 1.E = 738 Kj/mol

The above two values for $Na_{(g)}$ and $Mg_{(g)}$ atoms are called first ionization potential. The energy required to remove second electron in the 2nd attempt is called second ionization potential.

e.g. Mg^{+} energy ➔ Mg^{++} + 1e- I.E = 1450Kj/mol

The energy required to remove the 3rd electron from an atom is very difficult in the 2nd and 3rd attempt due to higher charge density and smaller size of the atom. The removal of 1st electron causes the shrinkage in size of the atom as well as increase in nuclear charge. This make the valence electron tightly bounded and increases the value of ionization energy for 2nd and 3rd electron.

It is observed that ionization energies of atoms depend upon several factors. They include

i. Atomic radius of the atom
ii. Nuclear charge of the atom
iii. Shielding effect of low-lying electrons
iv. Electronic configuration of the atom

Variation of I.E values in the periodic table

Period Wise:

In a period from left to right the I.E increase with the increase in atomic number. This is because with the increase in atomic number the charge on the nucleus also increase which leads to a stronger force of attraction between the nucleus and electrons. This ultimately causes a decrease in the atomic size and hence the valence electrons need more energy for their removal.

Group Wise:

In a group from top to bottom the I.E decrease. This is because of successive addition of electronic shells due to which valence electronic are placed at larger distance from the nucleus. As the force of attraction between the nucleus and valence electron decrease with the increase in distance. The valence electrons can be easily removed.

Q3. What do you mean by Electron affinity of an elements? Discuss its periodic variation in the table.

Ans: **Electron Affinity (E.A):**

Electron affinity means love for an accepting electron. The electron affinity of an atom is measured in term of energy. It is therefore defined as

"The energy released when an electron is absorbed by (added to) the gaseous atom in its outer most shell to form an anion (-ve charges)".

The energy released is measure in joules or kilo joules per mole of an element.

For example

Cl + 1e ➔ Cl = 349kj/mol

The new incoming electron when absorbed by the atom is tightly bound by the nucleus through attractive force. The case an evolution of heat energy. The heat energy is released outside, therefore the sign of E.A will be negative.

Atom with smaller atomic radii greater nuclear charge and poor shielding effect have usually high E.A values.

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Variation of E.A values in the periodic table:

Period Wise:

In a periodic wise from left to right, the value of E.A increase with the increase in atomic number. As the atomic number increase the charge on the nucleus is also increase which lead to a stronger force of attraction between the nucleus and in coming electron. As a result, atomic radii greater nuclear charge and poor shielding effect have usually high E.A values.

Group Wise:

In a group from top to bottom the value of electron affinity (E.A) decreases. This is because of successive addition of electronic shells due to which attraction between the nucleus and incoming electrons are decreases.

When the atomic size increases group wise increases, the incoming electrons are less tightly bounded to the nucleus. Thus E.A decreases. The shielding effect of low-lying electron also causes to decrease the force of attraction between the nucleus and incoming electrons, Thus electron affinity is decreases from top to bottom.

Q4. Define the electro negativity of an element. Discuss its periodic variation in a period and in a group in the periodic table?

Ans: **Electro Negativity:**

The ability of an atom of an element to attract the shared pair of electrons towards its self in a covalent bond is called electro negativity.

E.N is a property associated with the atoms. When they are chemically bonded to the each other in a covalent bond the two atoms involve in bond formation mutually share electrons. This shared pair of electrons is then attached by the nuclei of both the atoms. But different atom has different abilities to attract the shared pair of electrons to form covalent bond. If the two atoms have the same ability to attract the shared pair of electrons equally both them is said to be Non-polar covalent bond. e.g.

1: H_2 ➔ H – H

2: Cl_2 ➔ Cl – Cl

On the other hand, if the bond is formed between atoms of different E.N it is said to be polar covalent bond e.g.

H_2O H^{-8} O^{-8} H^{-8}

HCl H^{-8} cl^{-8}

The E.N of an element mainly depend upon on

The Atomic size:

The larger the atomic size of an element the smaller will be E.N of that element.

Nuclear Charge:

The smaller the nuclear charge of an atom, the smaller will be E.N of that element.

The nature of bond formation.

Pauling calculated and developed the orbitary E.N values and assigned fluorine (F) a value variation of E.N values in the periodic table.

Period Wise:

In a period from left to right the values of E.N increase due to the decrease in atomic size and increase in nucleus charge.

Group Wise:

In a group from top to bottom, the E.N value of the element generally decreases. This is due to the increase in the atomic size of the elements.

Properties	Left to right (Period Wise)	Top to bottom (Group Wise)
I.E	Increases	Decreases
E. A	Increases	Decreases

Shielding Effect	Constant	Increases
F. N	Increases	Decreases
Atomic Size	Decreases	Increases

Periodic Table and Periodicity of Properties

(LONG QUESTIONS)

Q1: How modern periodic table is different from Mendeleev periodic table?

Ans: **Differences between Modern periodic table and Mendeleev periodic table:**

MODERN PERIODIC TABLE	MENDELEEV PERIODIC TABLE
a. This periodic table was put forward by Henry Moseley, an English physicist in 1914.	a. This periodic table was put forward by Dmitri Mendeleev a Russian chemist in 1869.
b. This periodic table is based on increasing order of atomic number of elements.	b. This periodic table is based on increasing order of relative atomic masses of elements.
c. It is based on modern periodic law which states that "The physical and chemical properties of the elements are the periodic function of their atomic number.	c. It is based on Mendeleev periodic law which states that "The physical and chemical properties of the elements are the periodic function of their relative atomic masses.
d. It contains 118 elements.	d. It contains 64 elements.
e. In this table elements are arranged in groups in such manner that elements in same group showing same physical and chemical properties.	e. In this table elements were arranged in groups in such manner that elements in same group showing different physical and chemical properties. Such as Ar with K, Co and Ni.
f. In this table the position of f-block elements (lanthanides and actinides) is clear.	f. In this table the position of f-block elements (lanthanides and actinides) is not clear.
g. There are eighteen groups which are divided into eight sub-groups (sub-group A and sub-group B) and seven periods in this table.	g. There are eight groups and twelve periods in this periodic table.
h. This table is known as Long form of periodic table.	h. This table is known as Short form of periodic table.

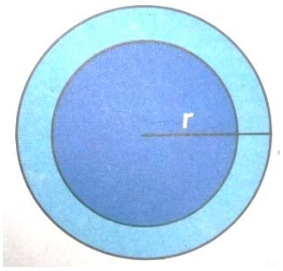
Q2. Differentiate between Atomic radii and covalent radii. Explain the trends of atomic radius in the periodic table.

Ans: **Atomic Size:**

The size of the atom is not rigidly fired but it varies when atom combined with other atoms. The same atom may have different sizes in different combination. The atomic sizes are usually expressed in term of atomic radii or radius, covalent radii or ionic radii.

Atomic Radii or Radius:

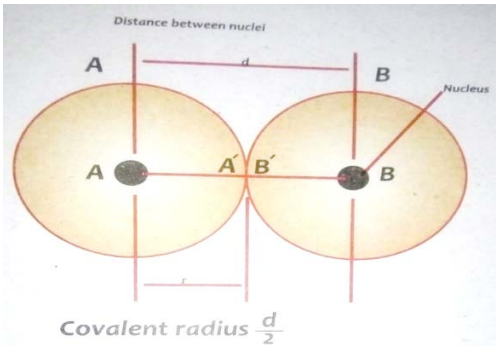
The distance between the nucleus and the valence shell of an atom is called atomic radii or radius.



One way for the prediction of the size of the single atom is the covalent radius may be defined as:

Covalent Radius:

Half of the distance between the centers of the two adjacent bonded atoms are called covalent radius.



The unit of atomic radii are Nanometer (10^{-9}), Picometer (10^{-12}m) and Angstrom (10^{-10}cm)

Trends in the Periodic Tables

Period Wise:

i. In a periodic the atomic size decrease from left to right. This is because one proton is added to the nucleus period wise. Therefore, the attraction of the nucleus is increase for the valence shell electron which pull them nearer to the nucleus.

Group Wise:

ii. In a group the atomic size increase from top to bottom because the shell after shell are added due to which the atomic size increases.

Q3. What is electronegativity? Identify the most and least electronegative groups of elements in the periodic table. Why fluorine is special in terms of electronegativity?

Ans: **Electro Negativity:**

The ability of an atom of an element to attract the shared pair of electrons towards its self in a covalent bond is called electro negativity.

E.N is property associated with the atoms. When they are chemically bonded to the each other in covalent bond the two atoms involve in bond formation mutually share electrons. This shared pair of electrons is then attached by the nuclei of both the atoms. But different atom has different abilities to attract the shared pair of electrons to form covalent bond.

The E.N of an element mainly depend upon on

The atomic size.

Nuclear Charge.

The nature of bond information.

Besides this three points electronegativity also depends upon atomic volume, the value of electron affinity and the value of ionization energy.

The most electronegative group in periodic table group VIIA (Halogen family) in which fluorine has highest electronegativity value (4.0). The least electronegative group of periodic tables is IA (Alkali metals) in which cesium has the lowest electronegativity value (0.7).

Pauling calculated the electro-negativities values of element and made an arbitrary scale. On this Fluorine has assigned E.N value of 4.0 which is highest among all elements. Electronegativity E.N depends upon the atomic size. Greater the atomic size smaller will be its E.N. value and smaller atomic size show higher E.N value. Fluorine is the top element group VIIA (halogen) which are present in the right side of Periodic-table. Due to smaller size it's considered the most E.N element the whole periodic table and that's why it is special in term of electronegativity.

Q4. Define shielding effect and its affects the ionization energy, electron affinity and electronegativity?

Ans: **Shielding Effect:**

The reduction in force of attraction b/w the nucleus and electron by the electrons present in the inner sub-shell is called shielding effect is also called screening effect.

Electrons present in the inner shells cut off attraction between the nucleus and valence shells electrons due to which shielding effect is increases. Shielding effect is responsible for decrease in the force of attraction between the nucleus and electrons present in the valence shell. It has therefore, a direct impact on the atomic radii, ionization potential and electron affinities of the elements. As the shielding effect increases the atomic size will be also increases but the ionization potential and electron affinities will be decreases.

Variation of shielding effect in the periodic table:

Period Wise:

In a period from left to right, the number of electrons in the inner shells remain constant. Therefore, the shielding effect remain constant in a period the positive charge or the nucleus increases, with the increase in atomic number. As the atomic number increases the shielding effect decrease due to the less number of shells and the attraction between valence electron and nucleus increases. This result in the contraction of atomic size and increases in an ionization energy, electron affinities and electronegativities of the element.

Group Wise:

In a group from top to bottom the number of electronic shells increases. So, the number of electrons in the inner shells also increases. As a result, shielding effect increase. This is because a new shell is added each time down the group, which screen out the outer electrons form the nucleus and decrease the force of attraction between the nucleus and outer electrons. This cause a decrease in the I.E, E.A and E.N of the element down the group.

Q5. Explain the following terms:

a. Periodicity of Properties.
b. Electron affinity.
c. Modern periodic law.

Ans: **a. Periodicity of properties:**

The properties of elements are gradually and repeated after some interval from left to right period wise and top to bottom group wise. Their repetition of properties of elements after a certain interval in group wise and period wise are called periodically of properties and the phenomena is called periodicity.

b. Electron Affinity:

Electron affinity means love for an accepting electron. The electron affinity of an atom is a measured in term of energy. It is therefore defined as:

"The energy released when an electron is absorbed by (added to) the gaseous atom in its outer most shell to form an anion (-ve charges)".

The energy released is measure in joules or kilo joules per mole of an element.

For example

$Cl + 1e^- \rightarrow Cl^- = 349$ km/mol

The new incoming electron when absorbed by the atom is tightly bound by the nucleus through attractive force. The case an evolution of heat energy. The heat energy is released outside, therefore the sign of E.A will be negative.

Atom with smaller atomic radii greater nuclear charge and poor shielding effect has usually high E.A values.

C. Modern Periodic Law:

In 1911, Moseley presented a new idea for the classification of elements on the bases of increasing their number, instead of atomic masses. It is stated that "The physical and chemical properties of the elements are the periodic function of their atomic number".

This mean that the elements are arranged in ascending order (Increasing order) of their atomic number. The elements possessing similar properties and valence shell electronic configuration were repeated at a regular interval.

Periodic Table and Periodicity of Properties
(SHORT ANSWERS)

Q1: Which element to group IA is not an Alkali metal and why?

Ans: Hydrogen of group IA is not an Alkali metal because.

a. Hydrogen is non-metal while group IA elements are metals.

b. Hydrogen is gas at room temperature while Alkali metals are solids at room temperature.

c. Hydrogen can make both covalent compounds and ionic compounds while Alkali metals only make ionic compounds.

d. Ionization energy of Hydrogen is very high as compare to alkali metals i.e. ionization of Hydrogen is 1312 kj/mol and the highest ionization energy among alkali metals is 520kj/mol.

Q2. Place the following elements in order of increasing ionization energy: Na, S, Mg and Ar.

Ans: Sodium – Magnesium – Sulphur – Argon (OR)

Na, Mg, S, Ar

Q3. Name the group and state the group number of each of the following elements.

a. K b. Ne c. Be d. Cl e. C

Ans:

	Elements	Symbol	Group No.
A	Potassium	K	Group IA
B	Neon	Ne	Group VIII A
C	Beryllium	Be	Group IIA
D	Chlorine	Cl	Group VIIA
E	Carbon	C	Group IVA

Q4. Which element is the most electronegative among C, N, O, Br and S? Which group does it belongs to?

Ans: The most electronegative element among C, N, O, Br and S is O (Oxygen). It is present in period 2^{nd} and group VIA which is known as Chalcogen family or Oxygen family.

Q5. How do first ionization energies of representative elements vary across a period and down a group?

Ans: First ionization Energies of Representative Elements.

Period Wise:

In a period from left to right the I.E increase with the increase in atomic number. This is because with the increase in atomic number the charge on the nucleus also increase which leads to a stronger force of attraction between the nucleus and electrons. This ultimately causes a decrease in the atomic size and hence the valence electrons need more energy for their removal.

Group Wise:

In a group from top to bottom the I.E decrease. This is because of successive addition of electronic shells due to which the valence electronic are placed at larger distance from the nucleus as the force of attraction between the nucleus and valence electron decrease with the increase in distance. The valence electrons can be easily removed.

Q6. Which element is found in,

a. Period 2, Group VIIA **b. Period 4, Group IIIA**

c. Period 5, Group VIA **d. Period 1, Group VIIIA**

Ans: a. Fluorine (F) is present in Period 2, Group VII.

b. Gallium (Ga) is present in Period 4, Group IIIA

c. Tellurium (Te) is present in Period 5, Group VIA

d. Helium (He) is present in Period 1, Group VIIIA

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Q7. How will you differentiate between representative and transition elements?

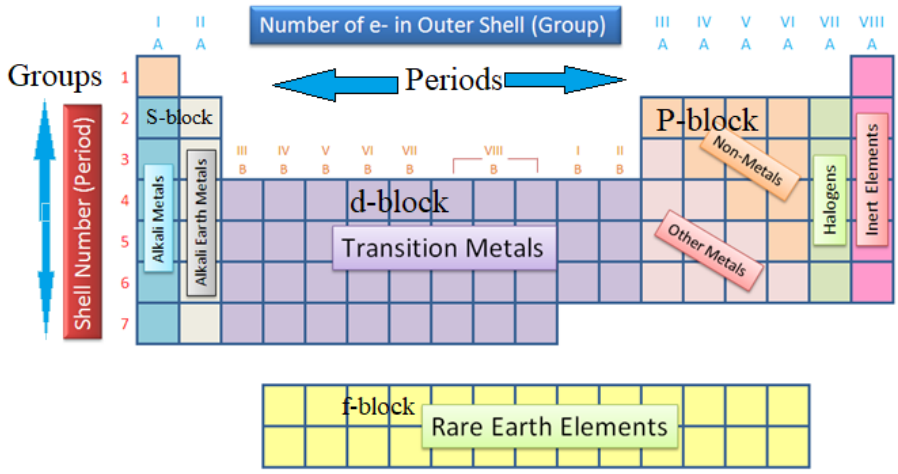
Ans: Differentiate between representative and transition elements.

REPRESENTATIVE ELEMENTS	TRANSITION ELEMENTS
a. All the s and p-block elements are called representative elements.	a. All the d and f-block elements are called transition elements.
b. They have "s" and "p" subshells in the process of completion.	b. They have "d" and "f" subshells in the process of completion.
c. They show constant valencies.	c. They show variable valencies.
d. Mostly they form colorless compounds.	d. Mostly they form colored compounds.
e. Representative elements contain metals, non-metals are also metalloids.	e. Transition elements are all metals.
f. All elements of sub group A (group IA to group VIIIA) are the example of representative elements.	f. All elements of sub group B (group IB to VIIIB) as well as lanthanides and actinides are examples of transition elements.

Q8. Make a general sketch of the periodic table showing s, p, d and f-block elements (without showing the symbols of elements).

Ans: **<u>General sketch of the periodic table.</u>**

- Sketch the general shape of the periodic table and label the s-, p-, d-, and f-blocks.



Q9. Why the s-bock elements have two groups only?

Ans: All elements of S-block will complete its sub shell by entering its last electron in their s-sub shell are called s-block element. The sub shell's can accommodate only two electrons with opposite spin. So, two groups come in this category which is group IA (Alkali metal) and group IIA (Alkaline earth-metal).

Q10. What type of element in Sulphur (S), a representative element, a transition element or lanthanide element?

Ans: Sulphur (S) is a representative element. As by definition that all the "S" and "P" blocks elements are called representative elements whose "S" and "P" sub shells are in the process of completion. Atomic number of Sulphur is 16 i.e. K = 2es, L= 8es and M = 6es. Its electronic configuration is $1s^2$, $2s^2$, $2p^5$, $3s^2$, $3p^4$. From electronic configuration it is clear that it has p-orbital in the process of completion so it is a representative element.

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