SOLUTIONS FOR PRACTICE PAPER – 4

SECTION – A

1. Define 'receptor' and 'sink'.

Ans. Receptor : The medium which is effected by the pollutant is called receptor. **Eg :** Our eyes become red with burning sensation due to the smoke released from automobiles.

Sink : The medium which reacts with pollutant is called sink.

Eg : Sea water is a big sink for CO_2.

2. Which oxides cause acid rain ? What is its pH value ?

Ans. → Oxides of Nitrogen, Sulphur and Carbon dissolved in rain water forms acid rain.

→ pH of acid rain is less than 5.6

3. Write about the biological importance of Calcium.

Ans. Biological importance of Calcium :

→ Calcuim plays important role in neuromuscular function, inter neuromal transmission, cell membrane integrity and blood co-agulation.

→ Ca^{+2} ions are necessary for muscle contraction.

→ About 99% of body, calcuim is present in bones and teeth.

4. The empirical formula of a compound is CH_2O. Its molecular weight is 90. Calculate the molecular formula of the compound.

Ans. Molecular formula = n (Empirical formula)

$$n = \frac{\text{Molecular weight}}{\text{Emperical weight}} = \frac{90}{30} \qquad [\text{Empirical Wt} = 30]$$

$$= 3$$

Molecular formula = 3 (CH_2O)

$= C_3H_6O_3$

5. What is allotropy ? Give the crystalline allotropes of carbon.

Ans. Allotropy : The phenomenon of existence of an element in different properties is called allotropy.

Crystalline allotropes of carbon are a) Diamond b) Graphite c) Fullerenes.

6. Calculate kinetic energy of 5 moles of nitrogen at 27°C.

Ans. $K.E = \frac{3}{2} nRT = \frac{3}{2} \times 5 \times 2 \times 300$

$= 4500$ cal.

7. Why is carbon monoxide poisonous ?

Ans. 'CO' is majorly released into atmosphere due to automobile (vehicles).

→ 'CO' reacts with hemoglobin of blood & forms carboxy haemoglobin complex (stable)

→ Due to formation of above complex, prevention of transportation of O_2 to different parts of the body takes place.

→ If CO concentration is increased upto 1000 ppm in atmosphere then it leads to death.

8. Calculate the pH of 0.05 M NaOH solution.

Ans. $[OH^-] = 0.05 = 5 \times 10^{-2}$

$pOH = -\log[OH^-]$

$= -\log (5 \times 10^{-2})$

$= -0.699 + 2 = 1.3010$

$pH = 14 - pOH = 14 - 1.3010 = 12.699$

9. Why are alkali metals not found in a free state in nature.

Ans. Alkali metals are not found in the free state in nature because they readily lose their valency electron to form M^+ ion (a non-valent ion).

10. Write the structural formulae of the following compounds :

a) Trichloroethanoic acid b) Neo-pentane

Ans. a) Trichloroethanoic acid – CCl_3 COOH

b) Neopentate

$$\begin{array}{c} CH_3 \\ | \\ CH_3 - C - CH_3 \\ | \\ CH_3 \end{array}$$

SECTION – B

11. Write any four postulates of the kinetic molecular theory of gases.

Ans. Assumptions :

1. Gases are composed of minute particles called molecules. All the molecules of a gas are identical.
2. Gaseous molecules are always, at a random movement. The molecules are moving in all possible directions in straight lines with very high velocities. They keep on colliding against each other and against the walls of the vessel at very small intervals of time.
3. The actual volume occupied by the molecules is negligible when compared to the total volume occupied by the gas.
4. There is no appreciable attraction or repulsion between the molecules.
5. There is no loss of kinetic energy when the molecules collide with each other or with the wall of vessel. This is because the molecules are spherical and perfectly elastic in nature.
6. The pressure exerted by the gas is due to the bombardment of the molecules of the gas on the walls of the vessel.

7. The average kinetic energy of the molecules of the gas is directly proportional to the absolute temperature, Average K.E. $\propto$ T.
8. The force of gravity has no effect on the speed of gas molecules.

12. Calculate the molarity of sodium carbonate in a solution prepared by dissolving 5.3 g in enough water to form 250 ml of the solution.

Ans. Molarity (M) $= \frac{\text{Weight}}{\text{GMW}} \times \frac{1000}{V(ml)}$ | Weight = 5.3 gms

$= \frac{5.3}{106} \times \frac{1000}{250}$ | GMW (Na_2CO_3) = 106

$= 0.2$ M | V = 250 ml

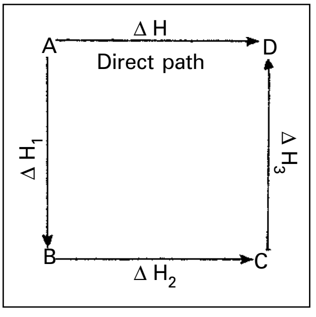
13. State Hess' law of constant heat summation. Explain with one example.

Ans. Hess's law states that the total amount of heat evolved or absorbed in a chemical reaction is always same whether the reaction is carried out in one step (or) in several steps.

Illustration : This means that the heat of reaction depends only on the initial and final stages and not on the intermediate stages through which the reaction is carried out. Let us consider a reaction in which A gives D. The reaction is brought out in one step and let the heat of reaction be ΔH.

$A \longrightarrow D; \Delta H$

Suppose the same reaction is brought out in three stages as follows –



$A \longrightarrow B : \Delta H_1$

$B \longrightarrow C : \Delta H_2$

$C \longrightarrow D : \Delta H_3$

The net heat of reaction is $\Delta H_1 + \Delta H_2 + \Delta H_3$.

According to Hess law $\Delta H = \Delta H_1 + \Delta H_2 + \Delta H_3$.

Ex : Consider the formation of CO_2. It can be prepared in two ways.

1) Direct method : By heating carbon in excess of O_2.

$C(s) + O_2(g) \longrightarrow CO_2(g); \Delta H = -393.5$ kJ

2) Indirect method : Carbon can be converted into CO_2 in the following two steps.

$C(s) + \frac{1}{2}O_2(g) \longrightarrow CO_2(g); \quad \Delta H_1 = -110.5$ kJ

$CO(g) + \frac{1}{2}O_2(g) \longrightarrow CO_2(g); \Delta H_2 = -283.02$ kJ

Total $\Delta H = -393.52$ kJ $(\Delta H_1 + \Delta H_2)$

The two ΔH values are same.

14. Derive the relation between K_P and K_C for the equilibrium reaction

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$$

Ans. Given equilibrium reaction

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$$

Relation between K_P and K_C is

$K_P = K_C (RT)^{\Delta n}$

$\Delta n = n_P - n_R$

$= 2 - (1 + 3)$

$= -2$

$\Delta n = -2$ (– Ve)

$\therefore K_P < K_C$

15. Write few lines on the utility of hydrogen as a fuel.

Ans. Hydrogen as a fuel :

→ The heat of combustion of hydrogen is high i.e about 242kj/mole. Hence hydrogen is used as industrial fuel.

→ The energy released by the combustion of dihydrogen is more than the petrol (3 times).

→ Hydrogen is major constituent in fuel gases like coal gas and water gas.

→ Hydrogen is also used in fuel cells for the generation of electric power.

→ 5% dihydrogen is used in CNG for running four-wheeler vehicles.

→ By hydrogen economy principle the storage and transportation of energy in the form of liquid (or) gaseous state. Here energy is transmitted in the form of dihydrogen and not as electric power.

16. What is borax ? Explain the borax bead test with a suitable example.

Ans. $Na_2B_4O_7.10H_2O$ is called Borax.

Borax bend test : This test in useful is the identification of basic radicals in qualitative analysis. On heating borax swells into a white, opaque mass of anhydrous sodium tetra borate. When it is fused, borax glass is obtained. Borax glass is sodium meta borate and B_2O_3. The boric anhydride, B_2O_3, combined with metal oxides to form metal metaborates as coloured beads. The reactions are as follows :

$$\underset{\text{Borax}}{Na_2B_4O_7.10H_2O} \xrightarrow{\Delta} \underset{\substack{\text{Anhy. sodium} \\ \text{tetra borate} \\ \text{(White, opaque mass)}}}{Na_2B_4O_7} \xrightarrow{\text{Fused}} \underset{\text{Borax glass}}{2NaBO_2 + B_2O_3}$$

Ex : Co^{+2} respond to borax bead test.

$$\underset{\substack{\text{Boric anhydride} \\ \text{(from borax glass)}}}{B_2O_3} + CoO \longrightarrow \underset{\substack{\text{Blue bead} \\ \text{(Cobalt metaborate)}}}{Co(BO_2)_2}$$

17. Explain Wurtz reaction and Friedel Crafts alkylation with one example for each.

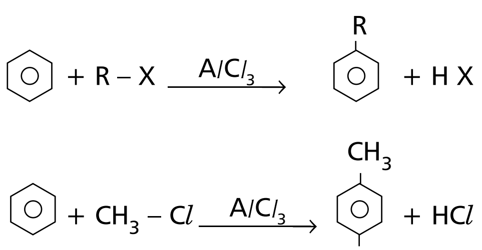
Ans. a) Wurtz reaction : When alkyl halides react with sodium metal in presence of dry ether to form alkanes.

$$R - X + 2Na + X - R' \xrightarrow{\text{dry ether}} \underset{\text{Alkane}}{R - R'} + 2NaX$$

Eg :

$$C_2H_5 - Cl + 2Na + Cl - 2Na \xrightarrow{\text{dry ether}} \underset{\text{n-Butane}}{C_4H_{10}} + 2NaCl$$

b) Friedal craft's reaction : When benzene reacts with alkyl halides in presence of anhydrous $AlCl_3$ to form alkyl benzene.



Tolune

18. Write about position isomerism and functional group isomerism.

Ans. Position isomerism : This type of isomerism arises due to the difference in the position of substituent group or in the position of multiple bond.

e.g.: 1. $CH_3 - CH_2 - CH_2 - CH_2 - Cl$ 1 – chloro butane

$CH_3 - \underset{\substack{| \\ Cl}}{CH} - CH_2 - CH_3$ 2 – chloro butane

e.g.: 2. $CH_3 - CH_2 - C \equiv CH$ 1 – butyne

$CH_3 - C \equiv C - CH_3$ 2 – butyne

Functional group isomerism : This type of isomerism arises in carbon compounds having the same molecular formula but with different functional groups.

e.g.: 1. $CH_3 - CH_2 - CH_2 - OH$ 1 – proparal (C_3H_8O)

$CH_3 - CH_2 - O - CH_3$ methoxy ethane (C_3H_8O)

e.g.: 2. $CH_3 - CH_2 - OH$ Ethanol

$CH_3 - O - CH_3$ methoxy methane

SECTION – C

19. What are the postulates of Bohr's model of a hydrogen atom ? Write any two limitations of Bohr's model of an atom.

Ans. Niels Bohr quantitatively gave the general features of hydrogen atom structure and it's spectrum. His theory is used to evaluate several points in the atomic structure and spectras.

The postulates of Bohr atomic model for hydrogen as follows

Postulates :

→ The electron in the hydrogen atom can revolve around the nucleus in a circular path of fixed radius and energy. These paths are called orbits (or) stationary states. These circular orbits are concentric (having same center) around the nucleus.

→ The energy of an electron in the orbit does not change with time.

→ When an electron moves from lower stationary state to higher stationary state absorption of energy takes place.

→ When an electron moves from higher stationary state to lower stationary state emission of energy takes place.

→ When an electronic transition takes place between two stationary states that differ in energy by ΔE is given by

$\Delta E = E_2 - E_1 = h\upsilon$

∴ The frequency of radiation absorbed (or) emitted

$\upsilon = \frac{E_2 - E_1}{h}$ E_1 and E_2 are energies of lower, higher energy states respectively.

→ The angular momentum of an electron is given by

$mvr = \frac{nh}{2\pi}$

An electron revolve only in the orbits for which it's angular momentum is integral multiple of $\frac{h}{2\pi}$.

Limitations :

→ Bohr's theory does not applicable to explain the Multi Electronic Systems Spectra.

→ This theory does not explained the fine structure of hydrogen atom.

→ It does not explained Zeeman effect and Stark effect.

20. Define first ionization energy and second ionization energy. Why is the second ionization energy greater than the first ionization energy for a given atom ? Discuss any four factors that affect the ionization energy of an element.

Ans. 1) Ionization energy is the amount of energy required to remove the most loosely held electron from isolated a neutral gaseous atom to convert it into gaseous ion. It is also known as **first ionization energy** because it is the energy required to remove the first electron from the atom.

It is denoted as I_1 and is expressed in electron volts per atom, kilo calories (or) kilo joules per mole.

$$M_{(g)} + I_1 \longrightarrow Mg^{+}_{(g)} + e^{-}$$

I_1 is first ionization potential.

2) The energy required to remove another electron from the unipositive ion is called the **second ionization energy**. It is denoted as I_2.

$$Mg^{+}_{(g)} + I_2 \longrightarrow Mg_{(g)}^{2+} + e^{-}$$

3) The second ionization potential is greater than the first ionization potential. On removing an electron from an atom, the unipositive ion formed will have more effective nuclear charge than the number of electrons. As a result the effective nuclear charge increases over the outermost electrons. Hence more energy is required to remove the second electron. This shows that the second ionization potential is greater than the first ionization potential.

For sodium, I_1 is 5.1 eV and I_2 is 47.3 eV.

$$I_1 < I_2 < I_3 ..... I_n$$

Factors affecting ionization potential :

1) Atomic radius : As the size of the atom increases the distance between the nucleus and the outermost electrons increases. So the effective nuclear charge on the outermost electrons decreases. In such a case the energy required to remove the electrons also decreases. This shows that with an increase in atomic radius the ionization energy decreases.

2) Nuclear charge : As the positive charge of the nucleus increases its attraction increases over the electrons. So it becomes more difficult to remove the electrons. This shows that the ionization energy increases as the nuclear charge increases.

3) Screening effect or shielding effect : In multielectron atoms, valence electrons are attracted by the nucleus as well as repelled by electrons of inner shells. The electrons present in the inner shells screen the electrons present in the outermost orbit from the nucleus. As the number of electrons in the inner orbits increases, the screening effect increases. This reduces the effective nuclear charge over the outermost electrons. It is called screening or shielding effect. With the increase of screening effect the ionization potential decreases. Screening efficiency of the orbitals falls off in the order **s > p > d > f.**

$$\text{(Magnitude of screening effect)} \propto \frac{1}{\text{(Ionization enthalpy)}}$$

Eletronic configurations : Half filled and full filled sub shells are more stable than others. These require more ionisation energy than others.

21. What do you understand by hybridization ? Explain the different types of hybridizations involving 's' and 'p' orbitals.

Ans. Hybridisation is defined as the process of mixing of atomic orbitals of nearly equal energy of an atom to give the same number of new set of orbitals of equal energy and shapes.

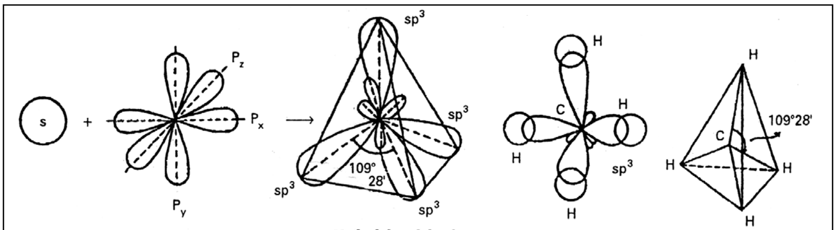
Depending on the number and nature of orbitals involving hybridisation it is classified into different types. If 's' and 'p' atomic orbitals are involved three types are possible namely sp^3, sp^2 and sp.

1. sp^3 hybridisation : In this hybridisation one 's' and three 'p' atomic orbitals of the excited atom combine to form four equivalent sp^3 hybridised orbitals.

This hybridisation is known as tetrahedral or tetragonal hybridisation.

Each sp^3 hybridised orbital possess 25% 's' nature and 75% of 'p' nature. The shape of the molecule is tetrahedral with a bond angle 109°28', **e.g. : Formation of Methane molecule :**

1) The central atom of methane is carbon.
2) The electronic configuration of carbon in ground state is $1s^2$ $2s^2$ $2p_x^2$ $2p_y^1$ $2p_z^0$ and on excitation it is $1s^2$ $2s^1$ $2p_x^1$ $2p_y^1$ $2p_z^1$. During excitation the 2s pair splits and the electron jumps into the adjacent vacant $2p_z$ orbital.
3) The $2s^1$ $2p_x^1$ $2p_y^1$ $2p_z^1$ undergo sp^3 hybridisation giving four equivalent sp^3 hybridised orbitals.
4) Each sp^3 hybrid orbital overlaps with the 1s orbitals of hydrogen forming σ_{sp^3-s} bond.
5) In case of methane four σ_{sp^3-s} bonds are formed. The bonds are directed towards the four corners of a regular tetrahedron. The shape of methane molecule is tetrahedral with a bond angle 109°28'.



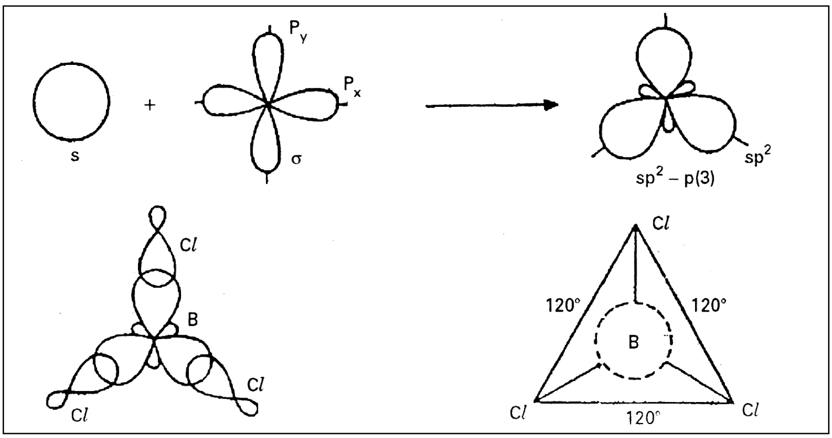
Hybrid orbitals

2. sp^2 hybridisation : In this hybridisation one 's' and two 'p' atomic orbitals of the excited atom combine to form three equivalent sp^2 hybridised orbitals.

This hybridisation is also known as trigonal hybridisation. In sp^2 hybridisation each sp^2 hybrid orbital has 33.33% 's' nature and 66.66% 'p' nature. The shape of the molecule is trigonal with a bond angle 120°.

E.g. : Boron trichloride molecule formation :

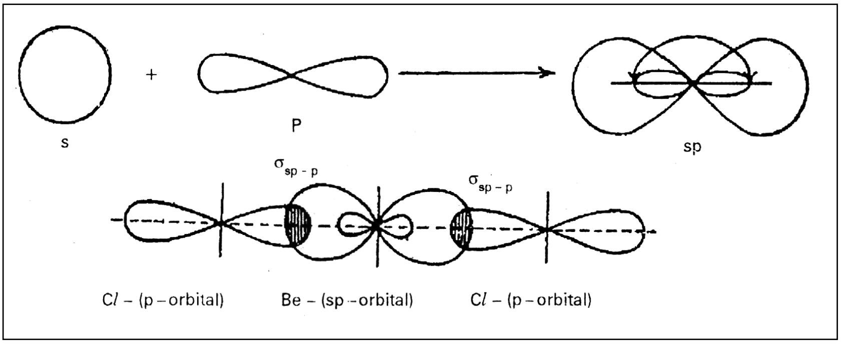
1) The electronic configuration of 'B' in the ground state is $1s^2\ 2s^2\ 2p_x^1\ 2p_y^0\ 2p_z^0$.
2) On excitation the configuration is $1s^2\ 2s^1\ 2p_x^1\ 2p_y^1\ 2p_z^0$. Now there are three half filled orbitals are available for hybridisation.
3) Now sp^2 hybridisation takes place at boron atom giving three sp^2 hybrid orbitals.
4) Each of them with one unpaired electron forms a 'σ' bond with one chlorine atom. The overlapping is σ_{sp^2-p} (C*l* atom has the unpaired electron in $2p_z$ orbital). In boron trichloride there are three 'σ' bonds.



3. sp hybridisation : In this hybridisation one 's' and one 'p' atomic orbitals of the excited atom combine to form two equivalent sp hybridised orbitals.

This hybridisation is also known as diagonal hybridisation. In sp hybridisation each sp hybrid orbital has 50% 's' character and 50% 'p' character. The shape of the molecule is linear or diagonal with a bond angle 180°. **Ex. : Beryllium chloride molecule formation :**

1) Be atom has $1s^2\ 2s^2\ 2p_x^0\ 2p_y^0\ 2p_z^0$ electronic configuration.
2) In ground state it has no half filled orbitals. On excitation the configuration becomes $1s^2\ 2s^1\ 2P_x^1\ 2p_y^0\ 2p_z^0$.
3) Now sp hybridisation takes place at beryllium atom giving two sp hybrid orbitals. Each of them with one unpaired electron forms a 'σ' bond with one chlorine atom.
4) The overlaping is $\sigma_{sp\text{-}p}$ (Cl atom has the unpaired electron in $2p_z$ orbital). In beryllium chloride there are two 'σ' bonds.



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