Class XI Session 2025-26
Subject - Chemistry
Sample Question Paper - 9

Time Allowed: 3 hours **Maximum Marks: 70**

General Instructions:

1. There are 33 questions in this question paper with internal choice.
2. SECTION A consists of 16 multiple-choice questions carrying 1 mark each.
3. SECTION B consists of 5 very short answer questions carrying 2 marks each.
4. SECTION C consists of 7 short answer questions carrying 3 marks each.
5. SECTION D consists of 2 case-based questions carrying 4 marks each.
6. SECTION E consists of 3 long answer questions carrying 5 marks each.
7. All questions are compulsory.
8. The use of log tables and calculators is not allowed

Section A

1. The molar mass of $AgBO_3$ is **[1]**

   a) 189.9 amu b) 165.9 u

   c) 159.9 u d) 179.9 g

2. In an atom of sodium with atomic number 11 and mass number 23, the number of neutrons present is: **[1]**

   a) equal to the number of electrons b) greater than the number of protons

   c) equal to the number of protons d) less than the number of protons

3. Consider the reactions given below. On the basis of these reactions find out which of the algebraic relations given in options (i) to (iv) is correct? **[1]**

   A. $C\ (g) + 4\ H\ (g) \rightarrow CH_4\ (g)\ ;\ \Delta_r H = x\ kJ\ mol^{-1}$

   B. $C\ (graphite,s) + 2H_2\ (g) \rightarrow CH_4\ (g)\ ;\ \Delta_r H = y\ kJ\ mol^{-1}$

   a) x = y b) x > y

   c) x < y d) x = 2y

4. The total energy of an electron in the first excited state of the hydrogen atom is about −3.4 eV. What is the kinetic energy of the electron in this state? **[1]**

   a) +1.7 eV b) +3.4 eV

   c) -3.4 eV d) +6.8 eV

5. Which of the following always has a negative value? **[1]**

   a) Heat of combustion b) Heat of reaction

c) Heat of formation

d) Heat of solution

6. Bohr's model of atom explains the spectrum of: **[1]**

a) deuterium

b) Hydrogen

c) oxygen

d) carbon

7. Displacement of hydrogen from cold water is done by: **[1]**

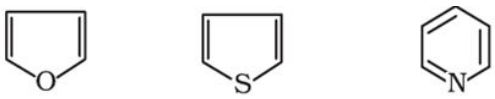
a) All transition elements

b) Superoxides

c) All alkali metals

d) All alkaline earth metals

8. The following compounds are called: **[1]**



a) benzenoid compounds

b) aromatic hetrocyclic compounds.

c) Alicyclic compounds

d) aliphatic heteroyclic compounds

9. What does Marsh gas mainly contains? **[1]**

a) CH_4

b) CO

c) C_2H_2

d) H_2S

10. The tendency of an atom to attract the shared pair of electrons to itself in a bond is called as _____. **[1]**

a) Ionization enthalpy

b) Electron gain enthalpy

c) Electronegativity

d) Electropositivity

11. According to the first law of thermodynamics ΔU = q + w, here what is a sign of q and w? **[1]**

a) q is negative if heat is transferred into the system and w is negative if work is done on the system.

b) q is positive if heat is transferred into the system and w is positive if work is done on the system.

c) q is positive if heat is transferred into the system and w is positive if work is done by the system.

d) q is negative if heat is transferred from the system and w is negative if work is done by the system.

12. The given reaction, $CH_3 - CI + H_2 \xrightarrow{Zn,\ H^+} CH_4 + HCI$ is an example of **[1]**

a) hydration

b) carbocation

c) reduction process

d) dehydrogenation

13. **Assertion (A):** NC-CH_2CH_2COOH is called 3-cyanopropanoic acid while OHC-CH_2CH_2COOH is called 4-oxobutanoic acid. **[1]**

Reason (R): While naming polyfunctional compounds, -COOH group gets preference over cyano and oxo groups.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

14. **Assertion (A):** $AlCl_3$ is an electrophile. **[1]**

Reason (R): $AlCl_3$ is an electron deficient compound.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

15. **Assertion (A):** Energy of the orbitals increases as 1s < 2s = 2p < 3s = 3p < 3d < 4s = 4p = 4d = 4f < ... **[1]**

Reason (R): Energy of the electron depends completely on principal quantum number.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) Both A and R are false.

16. **Assertion (A):** Equivalent mass of an acid $= \frac{\text{Molecularmass}}{\text{Acidity}}$. **[1]**

Reason (R): Acidity is the number of replaceable hydrogen atoms in one molecule of the acid.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

Section B

17. We know that the relationship between K_c and K_p is $K_p = K_c(RT)^{\Delta n}$ **[2]**

What would be the value of $\triangle n$ for the reaction?

$NH_4Cl(s) \rightleftharpoons NH_3(g) + HI(g)$

OR

The pH of 0.1 M monobasic acid is 4.50. Calculate the concentration of species H^+, A^- and HA at equilibrium. Also, determine the value of K_a and pK_a of the monobasic acid.

18. State Markownikov's Rule. **[2]**

19. Give the electronic configuration of the transition elements. Write down their four important characteristics. **[2]**

20. Use the data given in the following table to calculate the molar mass of naturally occurring argon isotopes: **[2]**

Isotope	Isotopic molar mass	Abundance
^{36}Ar	35.96755 g mol^{-1}	0.337%
^{36}Ar	37.96272 g mol^{-1}	0.063%
^{40}Ar	39.9624 g mol^{-1}	99.600%

21. In Rutherford's experiment, generally the thin foil of heavy atoms, like gold, platinum etc. have been used to be bombarded by the α -particles. If the thin foil of light atoms like aluminium etc. is used, what difference would be observed from the above results? **[2]**

Section C

22. Define Octet rule. Write its significance and limitations. **[3]**

23. **Answer:** **[3]**

(a) Define non-spontaneous process. **[1]**

(b) What is free energy in terms of thermodynamics? **[1]**

(c) Which quantity out of $\Delta_r G$ and $\Delta_r G^\circ$ will be zero at equilibrium? **[1]**

24. i. What is a spontaneous process? Mention the conditions for a reaction to be spontaneous at constant temperature and pressure. **[3]**

ii. Discuss the effect of temperature on the spontaneity of anexothermic reaction.

25. Using Stock notation, represent the following compounds: $HAuCl_4$, Tl_2O, FeO, Fe_2O_3, CuI, CuO, MnO, and MnO_2. **[3]**

26. What transition in a hydrogen spectrum would have the same wavelength Balmer transition n = 4 to n = 2 of $\bar{v} = \frac{1}{\lambda} = R_H Z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$ spectrum? **[3]**

27. Name different blocks of elements in the periodic table. Give general electronic configuration of each block. **[3]**

28. Define the law of multiple proportions. Explain it with two examples. How does this law point to the existence of atoms? **[3]**

Section D

29. **Read the following text carefully and answer the questions that follow:** **[4]**

Once an organic compound is extracted from a natural source or synthesised in the laboratory, it is essential to purify it. Various methods used for the purification of organic compounds are based on the nature of the compound and the impurity present in it. Finally, the purity of a compound is ascertained by determining its melting or boiling point. This is one of the most commonly used techniques for the purification of solid organic compounds. In crystallisation Impurities, which impart colour to the solution are removed by adsorbing over activated charcoal. In distillation Liquids having different boiling points vaporise at different temperatures. The vapours are cooled and the liquids so formed are collected separately. Steam Distillation is applied to separate substances which are steam volatile and are immiscible with water. Distillation under reduced pressure: This method is used to purify liquids having very high boiling points.

i. Which method can be used to separate two compounds with different solubilities in a solvent?

ii. Distillation method is used to separate which type of substance?

iii. Which technique is used to separate aniline from aniline water mixture?

OR

Why chloroform and aniline are easily separated by the technique of distillation?

30. **Read the following text carefully and answer the questions that follow:** **[4]**

In order to explain the characteristic geometrical shapes of polyatomic molecules, Pauling introduced the concept of hybridisation. The orbitals undergoing hybridisation should have nearly the same energy. There are various type of hybridisations involving s, p and d-type of orbitals. The type of hybridisation gives the characteristic shape of the molecule or ion.

i. Why all the orbitals in a set of hybridised orbitals have the same shape and energy?

ii. Out of XeF_2 and SF_2 which molecule has the same shape as NO_2^+ ion?

iii. Out of XeF_4 and XeF_2 which molecule doesn't have the same type of hybridisation as P(Phosphorus) has in PF_5?

OR

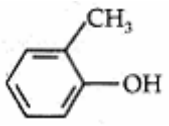
Unsaturated compounds undergo additional reactions. Why?

Section E

31. **Attempt any five of the following:** **[5]**

(a) Write the IUPAC name:  **[1]**

(b) Write the IUPAC name given below: **[1]**



(c) Convert methane into ethane. **[1]**

(d) Why is benzene extraordinarily stable though it contains three double bonds? **[1]**

(e) Write IUPAC name: $CH_3CH - C(CH_3)_2$ **[1]**

(f) What is electrophile in sulphonation? **[1]**

(g) Write chemical equation for the combustion of hexyne. **[1]**

32. Determine the degree of ionization and pH of a 0.05M of ammonia solution. The ionization constant of ammonia can be taken from table given below. **[5]**

Base	K_b
Dimethylamine, $(CH_3)_2NH$	5.4×10^{-4}
Triethylamine, $(C_2H_5)_3N$	6.45×10^{-5}
Ammonia, NH_3 or NH_4OH	1.77×10^{-5}
Quinine, (A plant product)	1.10×10^{-6}
Pyridine, C_5H_5N	1.77×10^{-9}
Aniline, $C_6H_5NH_2$	4.27×10^{-10}
Urea, $CO(NH_2)_2$	1.3×10^{-14}

Also, calculate the ionization constant of the conjugate acid of ammonia.

OR

13.8g of N_2O_4 was placed in a 1L reaction vessel at 400K and allowed to attain equilibrium

$N_2O_4\ (g) \rightleftharpoons 2NO_2\ (g)$

The total pressure at equilibrium was found to be 9.15 bar. Calculate K_c, K_p and partial pressure at equilibrium.

33. **Answer:** **[5]**

(a) i. By mistake, an alcohol (boiling point 97°C) was mixed with a hydrocarbon (boiling point 68°C). Suggest a suitable method to separate the two compounds. Explain the reason for your choice. **[2.5]**

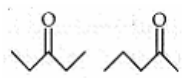
ii. Explain why the name butanol is not specific whereas the name butanone represents a specific compound? **[2.5]**

OR

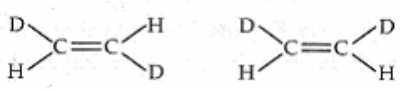
i. Explain, how is the electronegativity of carbon atoms related to their state of hybridization in an organic compound. **[2.5]**

ii. What is the relationship between the members of following pairs of structures? Are they structural or geometrical isomers or resonance contributors? **[2.5]**

i.



ii.



iii. H - C(+OH) - OH H - C(OH)+ - OH

Solution

Section A

1.

(b) 165.9 u

Explanation:

Molar mass of $AgBO_3$ = [atomic mass of Ag + atomic mass of B + 3 (atomic mass of O))] u

Substituting the atomic masses of Ag, B & O as 107.9, 10 & 16 respectively. we get -

Molar mass of $AgBO_3$ = [107.9 + 10 + (3 $\times$ 16)]u

= 165.9 u

2.

(b) greater than the number of protons

Explanation:

Atomic Number = Number of protons = 11

The number of neutrons = mass number - atomic number = 23-11= 12

Therefore, the number of neutrons i.e. 12 is greater than the number of protons i.e.11.

3.

(b) x > y

Explanation:

Here, x > y. Because in equation (B) all the reactants are in their most stable states of aggregation hence have zero standard molar enthalpies of formation.

4.

(b) +3.4 eV

Explanation:

Total energy of the electron, E = −3.4 eV

Kinetic energy of the electron is equal to the negative of the total energy.

K = −E = − (− 3.4) = +3.4 eV

Hence, the kinetic energy of the electron in the given state is +3.4 eV.

5. **(a)** Heat of combustion

Explanation:

Combustion is an exothermic process. Hence heat of combustion has a negative value.

6.

(b) Hydrogen

Explanation:

The emission spectrum of atomic hydrogen is divided into a number of spectral series, with wavelengths given by the Rydberg formula. These observed spectral lines are due to the electron making transitions between two energy levels in the atom.

Bohr tells us that the electrons in the Hydrogen atom can only occupy discrete orbits around the nucleus (not at any distance from it but at certain specific, quantized, positions, or radial distances each one corresponding to an energetic state of your H atom) where they do not radiate energy.

When the electron moves from one allowed orbit to another it emits or absorbs photons of energy matching exactly the separation between the energies of the given orbits (emission/absorption spectrum).

7.

(c) All alkali metals

Explanation:

A common characteristic of most Alkali metal is their ability to displace H_2 (g) from water. This is represented by their large, negative electrode potentials. In this event, the Group 1 metal is oxidized to its metal ion, and water is reduced to form hydrogen gas and hydroxide ions. The general reaction of an alkali metal (M) with H_2O (l) is given in the following equation:

$2M(s) + 2H_2O(l) \longrightarrow 2M + (aq) + 2OH^-(aq) + H_2(g)$

From this reaction it is apparent that OH- is produced, creating a basic or alkaline environment. Group 1 elements are called alkali metals because of their ability to displace H_2 (g) from water and create a basic solution. Alkali metals are also known to react violently and explosively with water. This is because enough heat is given off during the exothermic reaction to ignite the $H_2(g)$.

8.

(b) aromatic hetrocyclic compounds.

Explanation:

Aromatic compounds may also have heteroatom in the ring. Such compounds are called heterocyclic aromatic compounds. Thus the given compounds are aromatic heterocyclic compounds namely furan, thiophene and pyridine respectively.

9. **(a)** CH_4

Explanation:

Marsh gas which is also called methane is produced by the anaerobic bacterial decomposition of vegetable matter and the rumen of herbivorous animals underwater.

10.

(c) Electronegativity

Explanation:

Electronegativity

11.

(b) q is positive if heat is transferred into the system and w is positive if work is done on the system.

Explanation:

The first law is simply the conservation of energy equation. q is positive if heat is added to the system, and negative if heat is removed; w is positive if work is done on the system, and negative if work is done by the system.

12.

(c) reduction process

Explanation:

reduction process as hydrogen atom has been added.

13.

(b) Both A and R are true but R is not the correct explanation of A.

Explanation:

The name cyano includes the carbon atom of the CN group but the name oxo simply implies = O and as such does not include the carbon atom of the - CHO group.

14. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation:

Electrophiles are electron deficient and contain, generally, two electrons less than the octet. Electrophiles act as Lewis acid.

15.

(d) Both A and R are false.

Explanation:

Energy of electron depends on both 'n' and 'l' hence the order given in assertion is totally wrong as per (n + l) rule. However, exception to this is 'H' and H-related species, which are very few.

16.

(d) A is false but R is true.

Explanation:

Eq. mass of acid $= \frac{\text{Molecularmass}}{\text{basicity}}$.

Basicity is number of replaceable hydrogen atoms in one molecule of an acid while number of replaceable hydroxyl group in one molecule of the base is known as acidity.

Section B

17. The relationship between K_p and K_c is

$K_p = K_c(RT)^{\Delta n_g}$

where, $\triangle n_g$ = (number of moles of gaseous products) - (number of moles of gaseous reactants)

For the reaction,

$NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g)$

$\triangle n_g = 2 - 0 = 2$

OR

According to the question, pH of 0.1 M monobasic acid is 4.50.

We know that, pH = - log $[H^+]$

$\therefore [H^+] = 10^{-pH}$

$= 1 \times 10^{-4.50}$

$= 3.16 \times 10^{-5}$

Also $\left[H^+\right] = [A^-] = 3.16 \times 10^{-5}$

Now, $K_a = \frac{[H^+][A^-]}{[HA]}$

$[HA] = 0.1 - (3.16 \times 10^{-5}) \approx 0.1$

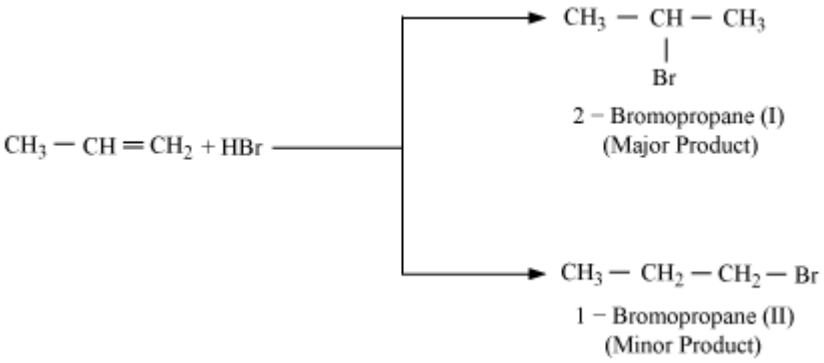
$\therefore K_a = \frac{(3.16 \times 10^{-5})^2}{0.1} = 1.0 \times 10^{-8}$.

We know that, $pK_a = -\log(K_a)$

$= -\log(10^{-8})$

$\therefore pK_a = 8$.

18. Markovnikov's rule states that during the addition of polar compounds like protic acids (HX) to unsymmetrical alkenes or alkynes, positive part goes to the most substituted carbon atom and negative part goes to the least substituted carbon atom. For example:



19. **General electronic configuration of Transition elements:** $(n-1)d^{1-10}\ ns^{1-2}$

The d-block elements are known as transition elements.

Characteristics of d-block elements:

i. They show variable oxidation states.

ii. Their compounds are generally paramagnetic in nature.

iii. Most of the transition elements form coloured compounds.

iv. They are all metals with high melting and boiling points.

20. Molar mass of argon (Ar) = $\left[\left(35.96755 \times \frac{0.337}{100}\right) + \left(37.96272 \times \frac{0.063}{100}\right) + \left(39.9624 \times \frac{90.60}{100}\right)\right]$ $gmol^{-1}$

= [0.121 + 0.024 + 39.802] $gmol^{-1}$

= 39.947 $gmol^{-1}$

21. Heavy atoms such as gold, platinum have a heavy nucleus. The heavy nucleus contains a large amount of positive charge. When a beam of α-particles are shot at a thin gold foil most of them pass through without much effect.

Some, however, are deflected back or by small angles due to the enormous repulsive force of heavy nucleus. If light aluminium foil is used, the number of α-particles deflected back or those deflected by small angles will be negligible. Therefore, In Rutherford's experiment, generally the thin foil of heavy atoms, like gold , platinum etc., have been used to be bombarded by the α-particles.

Section C

22. **Octet rule:** Atoms of elements combine with each other in order to complete their respective octets so as to acquire the stable gas configuration,

Significance: It helps to explain why different atoms combine with each other to form ionic compounds or covalent compounds.

Limitations of Octet rule:

i. According to Octet rule, atoms take part in chemical combination to achieve the configuration of nearest noble gas elements. However, some of the noble gas elements like Xenon have formed compounds with fluorine and oxygen. For example: XeF_2, XeF_4 etc. Therefore, the validity of the octet rule has been challenged.

ii. The octet rule is not applicable for all the non-metals. It is not applicable after Silicon because they can expand their octet.

iii. The octet rule is not applicable for those molecules which contain odd no. of electrons.

23. Answer:

(i) **Non-spontaneous process:** The process which does not occur by itself is known as non-spontaneous process. non-spontaneous process occurs only when an external force is applied

(ii) Free energy of a system is the capacity to do work.

G = H-TΔS

(iii) We know that, $\Delta_r G = \Delta_r G^\circ + RT \ln K$

At equilibrium, $\Delta_r G = 0$

So, $0 = \Delta_r G^\circ + RT \ln K$

$\therefore \Delta_r G^\circ$ = - RT ln K

$\Delta_r G^\circ = 0$ when K = 1

For all other values of K, $\Delta_r G^\circ$ will be non-zero.

Therefore, $\Delta_r G$ will be zero at equilibrium.

24. i. A process is said to be spontaneous if it takes place by itself by own or under some condition.

ΔG gives a criteria for spontaneity at constant temperature and pressure.

ii. If the temperature is so high that TΔS > ΔH in magnitude, ΔG will be positive and the process will be non-spontaneous.

If the temperature is made low so that TΔS < ΔH in magnitude, ΔG will be negative and the process will be spontaneous.

25. By applying various rules of calculating the oxidation number of the desired element in a compound, the oxidation number of each metallic element in its compound is as follows:

$HAuCl_4 \longrightarrow$ Au has 3

$Tl_2O \longrightarrow$ Tl has 1

$FeO \longrightarrow$ Fe has 2

$Fe_2O_3 \longrightarrow$ Fe has 3

$CuI \longrightarrow$ Cu has 1

$CuO \longrightarrow$ Cu has 2

$MnO \longrightarrow$ Mn has 2

$MnO_2 \longrightarrow$ Mn has 4

Therefore, these compounds may be represented as:

$HAu(III)Cl_4$, $Tl_2(I)O$, $Fe(II)O$, $Fe_2(III)O_3$, $Cu(I)I$, $Cu(II)O$, $Mn(II)O$, $Mn(IV)O_2$.

26. For an atom, $\bar{v} = \frac{1}{\lambda} = R_H Z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

For He^+ spectrum Z = 4,n_2 =4,n_1 = 2

$\therefore$ For hydrogen spectrum: $\bar{v} = \frac{3R_H}{4}$ and Z = 1

$\therefore \bar{v} = \frac{1}{\lambda} = R_H \times 1 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$

or $R_H \left(\frac{1}{n_1^2} - \frac{1}{m_2^2} \right) = \frac{3R_H}{4}$ or $\frac{1}{n_1^2} - \frac{1}{n_2^2} = \frac{3}{4}$

This corresponding to $n_1 = 1, n_2 = 2$ and means that the transition has taken Lyman series from n = 2 to n = 1.

Thus, the transition is from n_2 to n_1 in case of hydrogen spectrum.

27. Elements in the long form of the periodic table have been divided into four blocks i.e., s, p, d and f. This division is based upon the name of the orbital which receives the last electron. General electronic configuration of

s-block elements: ns^{1-2} where n = 2-7

p-block elements: $ns^2\ np^{1-6}$ where n = 2 - 6

d-block elements: $(n - 1)d^{1-10}\ ns^{0-2}$ where n = 4 - 7

f - block elements: $(n - 2)\ f^{0-14}\ (n - 1)d^{0-1}\ ns^2$ where n = 6 - 7

28. The law states that "If two elements combine to form more than one compound, then the mass of one element that combines with a fixed mass of the other element, are in the ratio of small whole numbers.

For example, carbon combines with oxygen to form two compounds, namely, carbon dioxide and carbon monoxide. The masses of oxygen which combine with a fixed mass of carbon in CO_2 and CO are 32 and 16 respectively. These masses of oxygen bear a simple ratio of 32 : 16 or 2 : 1 to each other.

For example, sulphur combines with oxygen to form two compounds, namely, sulphur trioxide and sulphur dioxide. The masses of oxygen which combine with a fixed mass of sulphur in SO_3 and SO_2 are 48 and 32 respectively. These masses of oxygen bear a simple ratio of 48 : 32 or 3 : 2 to each other.

This law shows that there are constituents which combine in a definite proportion. These constituents may be atoms. Thus, the law of multiple proportions shows the existence of atoms which combine to form molecules.

Section D

29. i. Fractional crystallizationis used to separate two compounds with different solubilities in a solvent.

ii.
- volatile liquids from nonvolatile impurities.
- the liquids having sufficient difference in their boiling points.

iii. Aniline is separated from aniline water mixture by steam distillation as one of the substances in the mixture is water and the other, a water insoluble substance.

OR

Chloroform and aniline are easily separated by the technique of distillation because chloroform and aniline have sufficient difference in their boiling points.

30. i. Hybrid orbitals are formed after combining atomic orbitals and have the equivalent shape and energy in the given set of hybridised orbitals.

ii. XeF_2 molecule has the same shape as NO_2^+ ion.

iii. XeF_4 molecule doesn't have the same type of hybridisation as P(Phosphorus) has in PF_5.

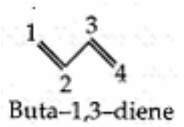
OR

Unsaturated hydrocarbon molecules include two- or three-fold bonds of carbon. The π -bond is a multiple bond, which becomes unstable and hence adds across numerous bonds.

Section E

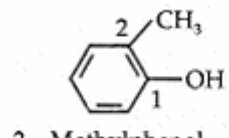
31. Attempt any five of the following:

(i)



Buta–1,3–diene

(ii)



2 – Methylphenol

(iii) Conversion of methane into ethane:

Step 1:

$$CH_4 \xrightarrow[\text{UV light}]{Cl_2} CH_3Cl$$

Step 2:

$$2\,CH_3Cl \xrightarrow[\text{Dry ether}]{2\,Na} \underset{\text{Ethane}}{CH_3—CH_3}$$

(iv)Due to resonance, benzene is extraordinarily stable.

(v) 2-methylbutane

(vi)SO_3

(vii) $C_6H_{10}(g) + \frac{17}{2}O_2(g) \xrightarrow{\text{Heat}} 6CO_2(g) + 5H_2O(g)$

32. The ionization of NH_3 in water is represented by the equation:

$NH^3 + H_2O \; NH_4^+ + OH^-$

We use equation (7.33) to calculate hydroxyl ion concentration,

$[OH^-] = c\,\alpha = 0.05\,\alpha$

$K_b = 0.05\,\alpha^2 / (1 - \alpha)$

The value of α is small, therefore the quadratic equation can be simplified by neglecting α in comparison to 1 in the denominator on right-hand side of the equation,

Thus,

$K_b = c\,\alpha^2$ or $\alpha = \sqrt{}(1.77 \times 10^{-5} / 0.05)$

$= 0.018.$

$[OH^-] = c\,\alpha = 0.05 \times 0.018 = 9.4 \times 10^{-4}$ M.

$[H^+] = K_w / [OH^-] = 10^{-14} / (9.4 \times 10^{-4})$

$= 1.06 \times 10^{-11}$

$pH = -\log(1.06 \times 10^{-11}) = 10.97.$

Now, using the relation for conjugate acid-base pair,

$K_a \times K_b = K_w$

using the value of K_b of NH_3 from table.

We can determine the concentration of conjugate acid NH_4^+

$K_a = K_w / K_b = 10^{-14} / 1.77 \times 10^{-5}$

$= 5.64 \times 10^{-10}$

OR

We know pV = nRT

Total volume (V) = 1 L

Molecular mass of N_2O_4 = 92 g

Number of moles = 13.8g/92 g = 0.15 of the gas (n)

Gas constant (R) = 0.083 bar L $mol^{-1}K^{-1}$

Temperature (T) = 400 K

pV = nRT

$p \times 1L = 0.15\ mol \times 0.083\ bar\ L\ mol^{-1}K^{-1} \times 400\ K$

p = 4.98 bar

$N_2O_4 \rightleftharpoons 2NO_2$

Initial pressure: 4.98 bar 0

At equilibrium: (4.98 – x) bar 2x bar

Hence,

P_{total} at equilibrium = $P_{N_2O_4} + P_{NO_2}$

9.15 = (4.98 – x) + 2x

9.15 = 4.98 + x

x = 9.15 – 4.98 = 4.17 bar

Partial pressures at equilibrium are,

$P_{N_2O_4}$ = 4.98 – 4.17 = 0.81bar

P_{NO_2} = 2x = 2 × 4.17 = 8.34 bar

Kp = $(p_{NO_2})^2 / p_{N_2O_4}$

= $(8.34)^2/0.81$ = 85.87

$K_p = K_c (RT)^{\Delta n}$

85.87 = Kc $(0.083 \times 400)^1$

K_c = 2.586 = 2.6

33. Answer:

(i) i. A mixture of alcohol and hydrocarbon can be separated by simple distillation because both the components have a large difference in their boiling points. When the temperature is raised to the low boiling liquid i.e., hydrocarbon, the vapours consist only hydrocarbon without any contamination of alcohol. The vapour then cooled and the liquid so formed are collected separately.

ii. Butanol may have - OH group on the first or on the second carbon atom as

$\underset{Bu\tan-1-oI}{CH_3CH_2CH_2CH_2OH}$ *or* $\underset{Bu\tan-2-oI}{\overset{\overset{OH}{|}}{CH_3CH_2CHCH_3}}$

Therefore, butanol does not represent a specific compound. Whereas, butanone cannot have a carbonyl group at any other position.

$CH_3\overset{\overset{O}{||}}{C}CH_2CH_3$

Therefore, it represents a specific compound.

OR

i. If C is sp hybridized then S character is 50%.

If C is sp^2 hybridized then S character is 33%.

If C is sp^3 hybridized then S character is 25%.

Electronegativity of carbon is directly proportional to ‘s’ character.

Hence, sp hybridized carbon has strong S character.

We know that, s electrons are more strongly attracted by nucleus than p-electrons as they lie closer to nucleus..

Thus, electronegativity of carbon increases with increase in ‘s’ character.

ii. i. Structural isomers (actually position isomers as well as metamers)

ii. Geometrical isomers

iii. Resonance contributors because they differ in the position of electrons but not atoms