SAMPLE PAPER-05 (solved)

CHEMISTRY (Theory)

Class – XI

Time allowed: 3 hours Maximum Marks: 70

General Instructions:

a) All the questions are compulsory.
b) There are **26** questions in total.
c) Questions **1** to **5** are very short answer type questions and carry **one** mark each.
d) Questions **6** to **10** carry **two** marks each.
e) Questions **11** to **22** carry **three** marks each.
f) Questions **23** is value based question carrying **four** marks.
g) Questions **24** to **26** carry **five** marks each.
h) There is no overall choice. However, an internal choice has been provided in one question of two marks, one question of three marks and all three questions in five marks each. You have to attempt only one of the choices in such questions.
i) Use of calculators is **not** permitted. However, you may use log tables if necessary.

1. What is the maximum number of electrons in f subshell with same spin?
2. Two litres of an ideal gas at a pressure of 10 atm expands isothermally into a vacuum until its total volume is 10 litres. How much heat is absorbed and how much work is done in the expansion?
3. "BeH_2 molecule has zero dipole moment although the Be-H bonds are polar" Explain.
4. Give water gas shift reaction.
5. Arrange the following metals in the order in which they displace each other from the solution of their salts. Al, Cu, Fe, Mg and Zn.
6. What is hydride gap? Why is heavy water used in nuclear reactors?
7. Though carbon dioxide is inert and harmless gas, it is thought to be a serious pollutant. Why?
8. Which of these electrons experience lowest effective nuclear charge?
   a) The Br atom containing 35 electrons in which 6 electrons are in 2p orbital or
   b) 6 electrons in 3p orbital and 5 electrons in 4p orbital.
9. Write structural formulas of the following compounds :
   a) 3, 4, 4, 5–Tetramethylheptane
   b) 2,5-Dimethyhexane

   Or

   Write the structural formula of:
   a) O-Ethylanisole
   b) 2,3 - Dibromo -1 - phenylpentane
10. a) How change in velocity of a moving particle change the wavelength of the particle?

b) Give the difference in the angular momentum of an electron present in 3p and 4p orbitals?

11. A liquid is in equilibrium with its vapour in a sealed container at a fixed temperature. The volume of the container is suddenly increased.
    a) How do rates of evaporation and condensation change initially?
    b) What is the initial effect of the change on vapour pressure?
12.
    a) How would you distinguish between $BeSO_4$ and $BaSO_4$?
    b) Which is thermally most stable alkaline earth metal carbonate among $MgCO_3$, $CaCO_3$, $SrCO_3$, $BaCO_3$? Give reasons.
13. Derive the structure of :
    a) 2-Chlorohexane
    b) Pent-4-en-2-ol
    c) 3- Nitrocyclohexene
    d) Cyclohex-2-en-1-ol

Or

Why NH_3 has a higher dipole moment than NF_3?

14. Why is the entropy of a substance taken as zero at 0 K? calculate the standard Gibbs free energy change for the reaction
    $N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3(g)$ at 298 K.

    The Value of equilibrium constant for the above reaction is 6.6×10^5. [R=8.314 J K^{-1} mol^{-1}]

15. Define the following:
    a) Critical temperature
    b) Avogadro law
    c) Charles Law
16. What happens when
    a) Sodium metal is dropped in water?
    b) Sodium metal is heated in free supply of air?
    c) Sodium peroxide dissolves in water?
17. Justify giving reactions that among halogens, fluorine is the best oxidant and among hydrohalic compounds, hydroiodic acid is the best reductant?
18. Write the balance equation for the following:
    i) $BF_3 + LiH \rightarrow$
    ii) $B_2H_6 + H_2O \rightarrow$
    iii) $NaH + B_2H_6 \rightarrow$
    iv) $H_3BO_3 \xrightarrow{\Delta}$
    v) $Al + NaOH \rightarrow$
    vi) $B_2H_6 + NH_3 \rightarrow$
19. Explain the principle of paper chromatography?

20. Write a brief note on the following environmental terms:
    i) Acid rain
    ii) Eutrophication
    iii) Green Chemistry

21.
    i) List two differences between Orbit and Orbital
    ii) If an electron is moving with a velocity 600 m/s which is accurate up to 0.005%nthen calculate the uncertainty in its position. [h=6.626 x 10^{-34} Js and mass of electron = 9.11 x 10^{-31} kg]

22. Explain in brief for the following:
    i) Anions are bigger in size than their parent atom.
    ii) Oxygen has lesser first ionization enthalpy than nitrogen
    iii) Fluorine has less negative electron gain enthalpy than chlorine

23. John was arrested by the custom officials as he was smuggling drugs and caught by x-ray machines. According to Roentgen when electrons strike a material in the cathode ray tube, it produces a ray which can cause fluorescence in the fluorescent material placed outside the cathode ray tubes. These rays were called x-rays. These were not deflected by electric and magnetic field. It was used as diagnostic tool in the treatment of diseases and bone fractures.
    a) What is the approx. wavelength of x-rays?
    b) Why x-rays are used to screen luggage's in airports?
    c) How would you prevent smuggling?

24.
a) The species H_2O, HCO_3, HSO_4^- and NH_3 can act both as Bronsted acids and bases. For each case give the corresponding conjugate acid and base.

b) Consider the following endothermic reaction: $CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$
    i) Write expression for Kp for the above reaction.
    ii) How will the equilibrium be affected by?
    1. Increasing the pressure 2. Using a catalyst

Or

a) Predict the acidic, basic or neutral nature of the following salt: NaCN, KBr, $NaNO_2$, NH_4NO_3.
b) How many grams of KBr are added to 1 L of 0.05 M solution of silver nitrate just to start the precipitation of AgBr? Ksp of AgBr = 5.0 x 10^{-13}

25. With the help of structures, give the IUPAC names of different chain isomers of alkanes corresponding to the molecular formula C_6H_{14}.

Or

The preparation of acetaldehyde by passing mixture of ethene and oxygen under pressure into aqueous solution of $PdCl_2$ and $CuCl_2$ as a catalyst is called Wacker's process. Acetalydehyde is a useful chemical which is used for silvering of mirror. It can be prepared by various methods. It is used in the commercial preparation of acetic acid, ethyl acetate etc. Paraldehyde, a trimer of aldehyde is used as hypnotic.

a) Give the best method to prepare acetaldehyde. Give two reasons.

b) Give the chemical equation for Wacker's process of preparation of acetaldehyde.

c) Give the disadvantage of preparing it from ethyne.

26. Give the net ionic equation for the reaction of potassium dichromate (VI) with sodium sulphite in an acid solution to give chromium (III) ion and the sulphate ion.

Or

Explain the reason for the following reactions to proceed differently.

$Pb_3O_4 + 8\ HCl \rightarrow 3\ PbCl_2 + Cl_2 + 4\ H_2O$ and

$Pb_3O_4 + 4\ HNO_3 \rightarrow 2\ Pb(NO_3)_2 + PbO_2 + 2\ H_2O$

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CHEMISTRY (Theory)

Class – XI

Time allowed: 3 hours **Answer** Maximum Marks: 70

1. Total number of electrons in f subshell is 14 but half of them will have the same spin i.e. 7 electrons will have same spin.
2. We have $q = -w = p_{ex}(10 - 2) = 0(8) = 0$

   No work is done; no heat is absorbed.
3. BeH_2 is a linear molecule with H-Be-H bond angle as 180°. Although the Be-H bonds are polar, the bond polarities cancel each other and the net dipole moment is zero.
4.

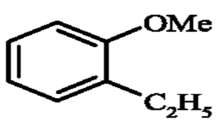
   i) $C + H_2O$ (steam) $\rightarrow CO + H_2$

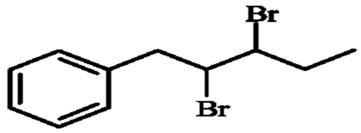
   ii) $CO + H_2O$ (steam) $+ H_2 \rightarrow CO_2 + 2H_2$
5. Mg, Al, Zn, Fe, Cu.
6. The metals of groups 7, 8 and 9 do not form hydrides. This region of periodic table from group 7 to 9 is referred to as hydride gap. Heavy water is used in the nuclear reactors to slow down the speed of neutrons (as moderator).
7. Carbon dioxide absorbs IR radiations from atmosphere which lead to global warming. So, if carbon dioxide level increases beyond 0.03%, the natural greenhouse balance may get disturbed. So it is considered as serious pollutant.
8. As we go away from the nucleus, the effective nuclear charge pull goes on increasing. Hence electrons present in 4p orbital experience the lowest effective nuclear charge.
9. :

   a) $CH_3 - CH_2 - CH(CH_3) - C(CH_3)_2 - CH(CH_3) - CH - CH_3$

   b) $CH_3 - CH(CH_3) - CH_2 - CH_2 - CH(CH_3) - CH_3$

Or

a) 

b) 

10.

a) Wavelength decreases with increase in velocity of moving particle.

b) Angular momentum of 3p and 4p orbitals will be same because l = 1 for p-orbital.

11.

a) Initially the vapour pressure will decrease.

b) The rate of evaporation remains constant at constant temperature in a closed vessel. But the rate of condensation will be low initially because there are fewer molecules per unit volume in the vapour phase and hence the no. of collisions per unit time with the liquid surface decreases.

12.

a) Barium and Beryllium sulphate can be distinguished by solubility test. Beryllium sulphate is soluble in water and barium sulphate is insoluble in water.

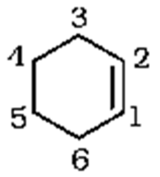
b) Barium carbonate is thermally most stable alkaline earth metal carbonate because; its ion being larger in size is more stabilized by larger carbonate ion through the formation of stable lattice.

13. :

a) The word 'hexane' indicates the presence of 6 carbon atoms in the chain. The functional group chloro is present at carbon 2. Hence, the structure of the compound is CH_3-CH_2-CH_2-CH_2-CH (Cl)-CH_3.

b) The word 'pent' indicates that parent hydrocarbon contains 5 carbon atoms in the chain. 'en' and 'ol' correspond to the functional groups C=C and -OH at carbon atoms 4 and 2 respectively. Thus, the structure is CH_2=$CHCH_2$CH (OH) CH_3.

c) Six membered rings containing a carbon-carbon double bond is implied by cyclohexene, which is numbered as shown in (I). The prefix 3-nitro means that a nitro group is present on C-3. Thus, complete structural formula of the compound is (II). Double bond is suffixed functional group whereas NO_2 is prefixed functional group therefore double bond gets preference over –NO_2 group:



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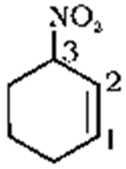
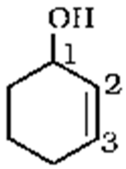


II

d) '1-ol' means that a -OH group is present at C-1. OH is suffixed functional group and gets preference over C=C bond. Thus the structure is as shown in (II):

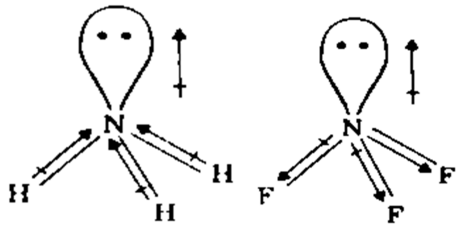
I



II

Or

NH_3 has a higher dipole moment than NF_3. In case of NH_3 orbital dipole due to lone pair is in same direction as resultant dipole due to three N-H bonds. Therefore lone pair moment adds on the resultant dipole of N-H bonds. In case of NF_3 orbital dipole due to lone pair is in opposite direction as resultant dipole due to three N-F bonds. Therefore lone pair moment cancels the resultant dipole of N-F bonds.



14. The entropy of all substances at absolute zero (0 K) is taken as zero because of complete order in the system. That is the atoms or molecule do not move at all in the perfectly crystalline state.

$$\Delta G^0 = -2.303RT \log K$$

= -2.303 x 8.314 J K^{-1} mol^{-1} x 298 K log 6.6 x 10^5

= - 19.147 J x 298 log 6.6 x 10^5

= - 5705.8 [log 6.6 + log 10^5]

= - 5705.8 [0.8195 + 5.0000]

= - 5705.8 x 5.8195 J = - 33204.903 J

$$\Delta G^0 = -33.205 kJmol^{-1}$$

15. :

a) Critical temperature – It is the temperature above which a gas cannot be liquefied.

b) Avogadro law – Equal volumes of all gases contain equal number of molecules at same conditions of temperature and pressure.

c) Charles Law – Pressure remaining constant, the volume of a fixed mass of a gas is directly proportional to its absolute temperature.

16.

a) Sodium hydroxide and hydrogen gas will be formed which will catch fire

$$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$$

b) Sodium peroxide is formed

$$2Na + O_2 \rightarrow Na_2O_2$$

c) Sodium hydroxide and hydrogen peroxide are formed

$$Na_2O_2 + 2H_2O \rightarrow 2NaOH + H_2O_2$$

17. F_2 is best oxidizing agent because it has highest standard reduction potential. It has low bond dissociation energy, high electron affinity and highest hydration energy of F^- ions.
H-I is best reductnt due to low bond dissociation energy.

18. :

i) $2BF_3 + 6LiH \rightarrow B_2H_6 + 6LiF$

ii) $B_2H_6 + 6H_2O \rightarrow 2B(OH)_3 + 6H_2$

iii) $2NaH + B_2H_6 \rightarrow 2NaBH_4$

iv) $H_3BO_3 \xrightarrow{\Delta} HBO_3 + H_2O$

v) $Al + 3NaOH \rightarrow Al(OH)_3 + 3Na$

vi) $3B_2H_6 + 6NH_3 \xrightarrow{Heat} 2B_3N_3H_6 + 12H_2$

19. Paper chromatography – it is a type of partition chromatography. A special quality of paper known as chromatographic paper is used which traps water and act as a stationary phase. The mixture of components is dissolved in suitable solvent. This solvent act as a mobile phase. It is based on continuous differential partitioning of components of mixture between stationary and mobile phase.

20. :

i) Acid rain – It is a rain which contains water along with sulphuric acid, nitric acid and hydrochloric acid which are formed from the oxides of sulphur, nitrogen and CO_2 present in the air as pollutants and has a pH of 4-5.

ii) Eutrophication – It refers to the ageing of the confined water bodies, for example lakes. Normally it is a slow geological phenomenon but the process is accelerated due to the flow of excessive nutrients into the lake. Excessive flow of fertilizers, pesticides etc., into the lake lead to the algae bloom that ultimately leads to the death of aquatic life. The dead matter sinks to the bottom of the lake making lake shallow and marshy.

iii) Green Chemistry – The term green chemistry is used to refer the procedures of synthesis of chemical of our needs through a process that neither use nor emit toxic chemicals. For example earlier chlorine gas was used for bleaching paper which is a highly toxic gas but it has now been replaced by hydrogen peroxide with a suitable catalyst.

21.

i)

	Orbit	Orbital
1	Orbit is a well-defined 2D circular path around the nucleus in which the electrons revolve.	Orbital is a 3D space around the nucleus within which the probability of finding the electrons is maximum.
2	Concept of Orbit is not in accordance with the wave nature of electrons	It is in accordance with the wave nature of electrons
3	Orbits do not have directional characteristics	All orbitals except s-orbitals have directional characteristics

ii) Uncertainty in speed $\Delta V = \frac{0.005}{100} x 600\,\text{m/s} = 0.03\ \text{m s}^{-1}$

Heisenberg Uncertainty Principle

$$\Delta x \text{ x } m\Delta V = \frac{h}{4\pi}$$

$$\Delta x = \frac{6.626 \text{ x} 10^{-34}\, Js}{4 \text{ x } \frac{22}{7} \text{ x } 9.11 \text{ x } 10^{-31} kg \text{ x } 0.03 ms^{-1}} = 1.93 \text{ x } 10^{-3}\text{m}$$

22. :

i) Anions are formed when a neutral atom gains one or more electrons. Since the number of electrons increases and the number of protons remains same, the effective nuclear charge decreases which results in decreases in ionic radii.

ii) Due to the half-filled orbital nitrogen $1s^2\ 2s^2\ 2p^3$, the stability of this configuration is more and ionization energy is higher than oxygen.

iii) Due to the smaller size and seven electrons in its outermost shell, incoming electrons experience less attraction in F. hence less energy will be released in case of F than Cl.

23.

a) 0.1 nm

b) It is done to screen any undesirable or dangerous items carried by passengers.

c) Life imprisonment for such crimes can be useful to prevent smuggling

24.

a)

Species	Conjugate Acid	Conjugate Base
H_2O	H_3O^+	OH^-
HCO_3^-	H_2CO_3	CO_3^-
HSO_4^-	H_2SO_4	SO_4^{2-}
NH_3	NH_4^+	NH_2^-

b) For the reaction: $CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$

i) $K_p = \frac{(p_{CO})\,(p_{H_2})^3}{(p_{CH_4})\,(p_{H_2O})}$

ii)

a) On increasing pressure, the reaction equilibrium will shift in the backward direction.

b) There is no effect of catalyst in equilibrium composition; however the equilibrium will be attained faster.

Or

a) NaCN , $NaNO_2$ – Solution are basic as they are salts of strong base and weak acid. (HCN and HNO_2 are weak acids and NaOH is strong base). NH_4NO_3- Its solution is acidic as it is salt of strong acid (HNO_3) and weak base (NH_4OH).

b) KBr - This solution is neutral as it salt of strong acid HBr and strong base KOH.

25. CH_3- CH_2- CH_2- CH_2- CH_2- CH_3 - n-hexane

CH_3- CH (CH_3)- CH_2- CH_2- CH_3- 2-Methylpentane

CH_3- CH_2- CH (CH_3)- CH_2- CH_3- 3-Methylpentane

CH_3- C (CH_3)$_2$- CH_2- CH_3- 2,2-Dimethylpentane

CH_3- CH(CH_3) - CH(CH_3) - CH_3 - 2,3-Dimethylbutane

Or

a) Wacker's method.

i. Eco-friendly and safest method.

ii. It gives 90% yield.

b) In Wacker's method,

$$R - CH = CH_2 \xrightarrow{PdCl_2 \ / \ air \ / \ Cu_2Cl_2} R - CO - CH_3$$

$$CH_2 = CH_2 \xrightarrow{PdCl_2 \ / \ air \ / \ Cu_2Cl_2} CH_3 - CHO$$

c) $HgSO_4$ is unsafe for the environment.

26. Step 1: The skeletal ionic equation is:

$$Cr_2O_7^{2-}(aq) + SO_3^{2-}(aq) \rightarrow Cr^{3+}(aq) + SO_4^{2-}(aq)$$

Step 2: Assign oxidation numbers for Cr and S $\overset{+6}{Cr_2}\overset{-2}{O_7}(aq) + \overset{+4}{S}\overset{-2}{O_3}(aq) \rightarrow \overset{+3}{Cr}(aq) + \overset{+6}{S}\overset{-2}{O_4}(aq)$

Step 3: Calculate the increase and decrease of oxidation number, and make them equal: $\overset{+6}{Cr_2}\overset{-2}{O_7}(aq) + 3\overset{+4}{S}\overset{-2}{O_3}(aq) \rightarrow 2\overset{+3}{Cr}(aq) + 3\overset{+6}{S}\overset{-2}{O_4}(aq)$

Step 4: As the reaction occurs in the acidic medium, and further the ionic charges are not equal on both the sides, add 8H+ on the left to make ionic charges equal

$$Cr_2O_7^{2-}(aq) + 3SO_3^{2-}(aq) + 8H^+ \rightarrow 2Cr^{3+}(aq) + 3SO_4^{2-}(aq)$$

Step 5: Finally, count the hydrogen atoms, and add appropriate number of water molecules on the right to achieve balanced redox change.

$$Cr_2O_7^{2-}(aq) + 3SO_3^{2-}(aq) + 8H^+(aq) \rightarrow 2Cr^{3+}(aq) + 3SO_4^{2-}(aq) + 4H_2O$$

Or

Pb_3O_4 is actually a stoichiometric mixture of 2 mol of PbO and 1 mol of PbO_2. In PbO_2, lead is present in +4 oxidation state, whereas the stable oxidation state of lead in PbO is +2. PbO_2 thus can act as an oxidant (oxidising agent) and, therefore, can oxidise Cl^- ion of HCl into chlorine. Since PbO is a basic oxide, the reaction

$Pb_3O_4 + 8HCl \rightarrow 3PbCl_2 + Cl_2 + 4H_2O$ can be splitted into two reactions namely:

$2PbO + 4HCl \rightarrow 2\ PbCl_2 + 2H_2O$ (acid-base reaction)

+4 –1 +2 0

$PbO_2 + 4HCl \rightarrow PbCl_2 + Cl_2 + 2H_2O$ (redox reaction)

Since HNO_3 itself is an oxidising agent therefore, it is unlikely that the reaction may occur between $PbO_2$and HNO_3. However, the acid-base reaction occurs between PbO and HNO_3 as:

$2PbO + 4HNO_3 \rightarrow 2Pb(NO_3)_2 + 2H_2O$

It is the passive nature of PbO_2 against HNO_3 that makes the reaction different from the one that follows with HCl.