
Sample Paper-05
Chemistry (Theory)
Class - XI

Time allowed: 3 hours
General Instructions:

Maximum Marks: 70

- 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.
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1. If a metal is higher than a particular metal in electrochemical series, will it be stronger reducing agent or weaker reducing agent? Why?
2. If the critical temperature for carbon dioxide and methane are 31.1°C and -81.9°C respectively, then which of these has strong intermolecular forces? Give reason.
3. Which of these contain the largest number of atoms – 1.0 g Li(s) and 1g Na(s)?
4. Predict the shape of the PH_3 molecule according to VSEPR theory.
5. Give reason: "Metal hydrides are used for storing hydrogen".
6. (a) Name the energy which arises due to motion of atoms or molecules in a body.
(b) How is this energy affected when the temperature is increased?

Or

Give the relationship between isothermal and free expansion of an ideal gas.

7. Predict the formulae of the stable binary compounds that would be formed by the combination of the following pairs of elements:
(a) Element 71 and F
(b) Al and I
(c) Si and O
(c) P and F.
 8. Why the bottle containing hydrogen peroxide should be cooled before opening?
 9. Why Be and Mg does not give colour to flame than the alkaline earth metals?
 10. Calculate the molality of the solution if the density of 3M solution of NaCl is 1.25g/mL .
 11. 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?
 12. Justify giving reactions that among halogens, fluorine is the best oxidant and among hydrohalic compounds, hydroiodic acid is the best reductant?
 13. Write the balance equation for the following:
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- (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) $B_2H_6 + NH_3 \rightarrow$

14. Explain the principle of paper chromatography?
15. Write a brief note on the following environmental terms:
(i) Acid rain
(ii) Eutrophication
(iii) Green Chemistry
16. 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?
17. (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.
18. 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 ?

19. Why is the entropy of a substance taken as zero at 0 K? calculate the standard Gibbs free energy change for the reaction
 $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ at 298 K.
 $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ at 298 K.
The Value of equilibrium constant for the above reaction is 6.6×10^5 . [$R=8.314 \text{ J K}^{-1} \text{ mol}^{-1}$]
20. Define the following:
(a) Critical temperature
(b) Avogadro law
(c) Charles Law
21. Define:
(i) Lattice enthalpy
(ii) Bond length
(iii) Bond angle.
22. (i) Name the class of hydrides to which H_2O and NaH belong.
(ii) What do you understand by the term hydride gap?
(iii) What do you mean by 15 volume H_2O_2 solution?
23. Ram uses urea and DAP for his crops whereas Shyam uses compost. Ammonia is prepared by Haber's process. It is used for making fertilizers. If it is used in excess, it is harmful for crops.
(i) What is DAP?
(ii) What can be done with waste products?
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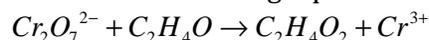
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- (iii) What is the use of avoiding excess of fertilizers?
(iv) Natural manure is preferred than synthetic fertilizers. Why?

24. (a) Convert :

- (i) Benzene to p-nitrobromobenzene
(ii) Ethyl chloride to ethene.
(b) Give mechanism of addition of HBr to propene.
(c) Write a note on Friedel-Crafts alkylation.

Or

Balance the following equation in acidic medium by half reaction method.



25. From the structures given below, answer the questions.

- (i) $CH_3 - CH_2 - CH(OH) - CH_3$
(ii) $(CH_3)_2 - C(OH) - CH_3$
(iii) $CH_3 - CH_2 - CH_2 - CH_2 - OH$
(iv) $CH_3 - O(CH_3) - CH - CH_3$
(v) $CH_3 - O - CH_2 - CH_2 - CH_3$
(vi) $CH_3 - CH_2 - O - CH_2 - CH_3$
(vii) $CH_3 - CH(CH_3) - CH_2 - OH$

- (a) The pair of compounds that represent chain isomerism.
(b) The pair of compounds that represent position isomerism.
(c) The pairs of compounds which are functional group isomers.
(d) The compounds that form pairs of metamers.
(e) Distinguish between position and functional isomerism with an example.

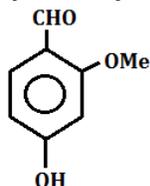
Or

Convert the following:

- (a) Benzene to Benzoic acid
(b) Bromoethane to Butan-1-ol
(c) Ethene to Propene
(d) Ethyne to Methane
(e) Propene to Propan-2-ol
26. (a) Give one method for industrial preparation and one for laboratory preparation of CO and CO₂ each.
(b) Select the member(s) of group 14 that (i) forms the most acidic dioxide (ii) used as semiconductors.
(c) Explain structure of Diborane.

Or

(a) Identify the functional groups in the following:



- (b) Draw the bond notation of heptan-4-one.
(c) Give the possible isomers for mono substituted
(d) Give the possible isomers for di substituted benzene?
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Answer

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1. It will be a weaker reducing agent if electrochemical series has elements in decreasing order of their reduction potential.
2. The intermolecular forces in carbon dioxide are more than in methane molecules because of greater polarity
3. g Li.
4. Trigonal pyramidal.
5. Metallic hydrides trap hydrogen in their voids forming interstitial hydrides, thus they can be used for storing hydrogen.
6. (a) Kinetic energy.
(b) It increases with increase in temperature.

Or

Work done in isothermal reversible expansion of an ideal gas

$$W = - 2.303 nRT \log V_2/V_1 = - 2.303 nRT \log P_1/P_2$$

In the free expansion of an ideal gas, $w = 0$ because ideal gases have negligible force of attraction, therefore work done is zero in free expansion because no external force is acting.

$$W = - P_{\text{ext}}\Delta V$$

$$P_{\text{ext}} = 0; w = 0$$

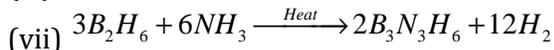
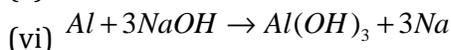
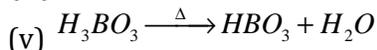
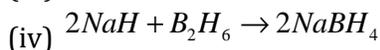
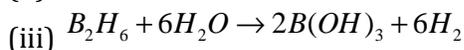
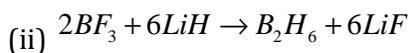
7. (a) LuF_3
(b) AlI_3
(c) SiO_2
(d) PF_5
 8. Hydrogen peroxide is unstable and so decomposes in water and oxygen on long standing or heating. Hence to lower the vapour pressure inside the bottle, it is cooled before opening.
 9. Due to small size, the ionization energy of Be and Mg are much higher than alkaline earth metals. So they need large amount of energy for excitation of electrons to higher energy levels. This energy is not available in Bunsen flame and so do not impart any colour to the flame.
 10. Molarity = 3M
Density = 1.25g/mL
Mass of NaCl in 1L solution
= Molarity x molar mass = 3 x 58.5 = 175.5g
Density = $\frac{\text{Mass}}{\text{Volume}}$
Mass of 1L NaCl solution = 1.25 x 1000 = 1250g
Mass of water in solution = 1250-175.5 = 1074.5g = 1.0745 kg
Molality = $\frac{\text{No. of moles of solute}}{\text{Mass of water}} = \frac{3}{1.0745} = 2.79 \text{ m}$
 11. (a) Sodium hydroxide and hydrogen gas will be formed which will catch fire
$$2\text{Na}(s) + 2\text{H}_2\text{O}(l) \rightarrow 2\text{NaOH}(aq) + \text{H}_2(g)$$

(b) Sodium peroxide is formed
$$2\text{Na} + \text{O}_2 \rightarrow \text{Na}_2\text{O}_2$$

(c) Sodium hydroxide and hydrogen peroxide are formed
$$\text{Na}_2\text{O}_2 + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2\text{O}_2$$
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12. 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 reductant due to low bond dissociation energy.



14. 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.

15. (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.

16. (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.

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

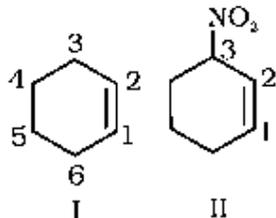
(b) Barium carbonate is thermally most stable alkaline earth metal carbonate because; its ion being larger in size is more stabilized by larger carbonate ion through the formation of stable lattice.

18. (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 $CH_3-CH_2-CH_2-CH_2-CH(Cl)-CH_3$.

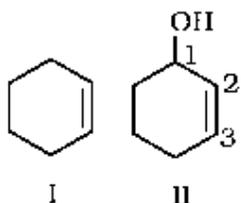
(b) The word 'pent' indicates that parent hydrocarbon contains 5 carbon atoms in the chain. 'en' and 'ol' correspond to the functional groups $C=C$ and $-OH$ at carbon atoms 4 and 2 respectively. Thus, the structure is $CH_2=CHCH_2CH(OH)CH_3$.

(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 $-\text{NO}_2$ group:

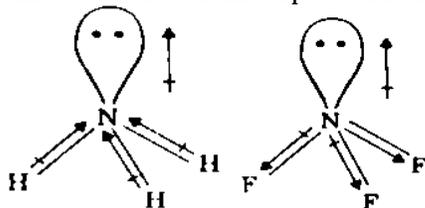


(d) '1-ol' means that a $-\text{OH}$ group is present at C-1. OH is suffixed functional group and gets preference over $\text{C}=\text{C}$ bond. Thus the structure is as shown in (II):



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.

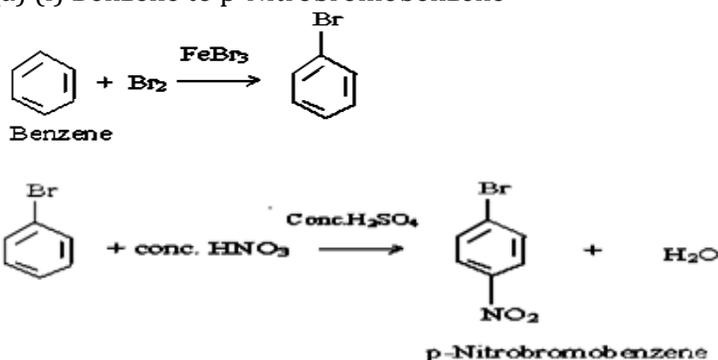


19. The entropy of all substances at absolute zero (0 K) is taken as zero because of complete order in the system. That is the atoms or molecule do not move at all in the perfectly crystalline state.

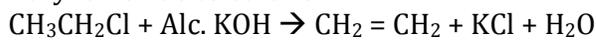
$$\begin{aligned}\Delta G^0 &= -2.303RT \log K \\ &= -2.303 \times 8.314 \text{ J K}^{-1} \text{ mol}^{-1} \times 298 \text{ K} \log 6.6 \times 10^5 \\ &= -19.147 \text{ J} \times 298 \log 6.6 \times 10^5 \\ &= -5705.8 [\log 6.6 + \log 10^5] \\ &= -5705.8 [0.8195 + 5.0000] \\ &= -5705.8 \times 5.8195 \text{ J} \\ &= -33204.903 \text{ J} \\ \Delta G^0 &= -33.205 \text{ kJ mol}^{-1}\end{aligned}$$

20. (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.
21. (a) The Lattice Enthalpy of an ionic solid is defined as the energy required to completely separating one mole of a solid ionic compound into gaseous constituent ions.

- (b) Bond length is defined as the equilibrium distance between the nuclei of two bonded atoms in a molecule.
- (c) Bond angle is defined as the angle between the orbitals containing bonding electron pairs around the central atom in a molecule/complex ion.
22. (a) H_2O is covalent hydride whereas NaH is ionic or saline hydride.
- (b) Group 7 to group 9 elements do not form hydrides. This region of periodic table from group 7 to 9 is called as hydride gap.
- (c) 1 L of H_2O_2 gives 15 L of O_2 at NTP.
23. (a) Diammonium phosphate.
- (b) It is used to produce bio gas.
- (c) It will make the soil basic which is not suitable for crops.
- (d) Manure does not harm the soil whereas fertilizers harm the soil.
24. (a) (i) Benzene to p-Nitrobromobenzene



- (ii) Ethyl chloride to ethane

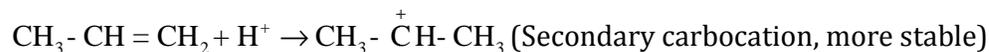


- (a) Mechanism of addition of HBr to propene

Step - 1



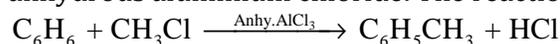
Step - 2



Step - 3

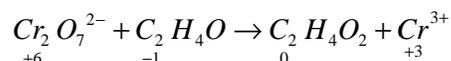


- (b) Friedel-Crafts alkylation - It is the reaction of benzene with alkyl halide in presence of anhydrous aluminium chloride. The reaction results in the formation of alkyl benzene.



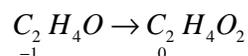
Or

- (a) Write the oxidation no. of each atom

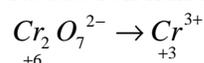


- (b) Write separately oxidation & reduction half reactions

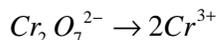
Oxidation half reaction:



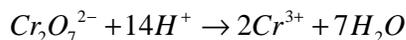
Reduction half reaction:



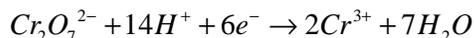
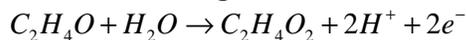
(c) Balance Cr atoms in reduction half reaction



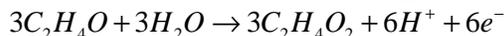
(d) Balance O atoms and H atoms



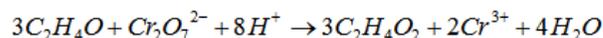
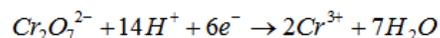
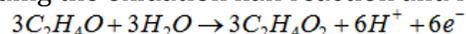
(e) Balance the charges



(e) Equalize the electrons lost and gained by multiplying the oxidation half reaction with 3



Adding the oxidation half reaction and reduction half reaction we get,



25. (a) I and III

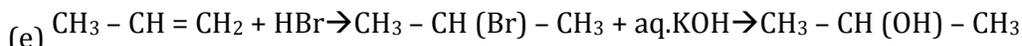
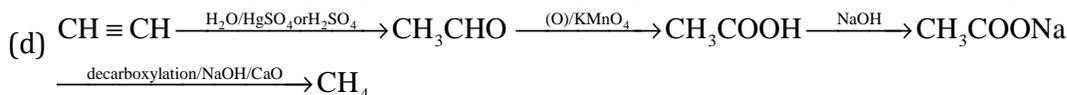
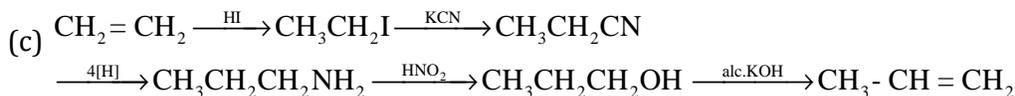
(b) I and III

(c) VI and VII

(d) V and VI

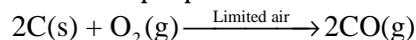
(e) Those isomers which differ in position of functional groups are called position isomers. Eg – But-1-ene and But-2-ene and those isomers which differ in functional groups are called functional isomers. Eg – Ethanol and Dimethyl ether.

Or

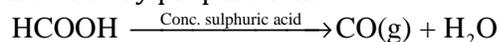


26. (a) Carbon monoxide:

Industrial preparation:

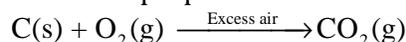


Laboratory preparation:



Carbon dioxide:

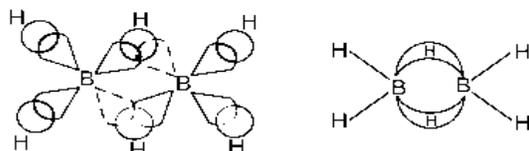
Industrial preparation:



Laboratory preparation:

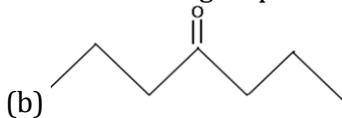


- (b) (i) Forms the most acidic oxide = Carbon (i.e. CO_2).
(ii) Used as semiconductor = Silicon and Germanium.
- (c) Each boron atom in diborane is sp^3 hybridised. Four sp^3 hybrid orbitals adopt tetrahedral arrangement. Two hybrid orbitals of each B atom overlaps with $1s$ orbital of two H atoms. Of the two hybrid orbitals left on each B atom one contains an unpaired electron while other is vacant. Hybrid orbital containing unpaired electron of one boron atom and vacant hybrid orbital of second boron atom overlaps simultaneously with $1s$ orbital of H atom to form B-H-B bond, a three centre electron pair bond. The four terminal B-H bonds are regular two centre-two electron bonds while the two bridge (B-H-B) bonds are can be described in terms of three centre-two electron bonds.

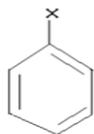


Or

- (a) The principal functional group is aldehydic group $-\text{CHO}$ and the secondary functional group is alcoholic group $-\text{OH}$ and methoxy ($-\text{OMe}$) group.



- (c) For mono-substituted benzene, there is only one isomer.



- (d) For disubstituted benzene, there are three isomers.

