

**CHEMISTRY (Theory)***Time Allowed: 3 hours**Maximum Marks: 70***General Instructions:**

- (i) *All questions are compulsory.*
- (ii) *Questions No. 1 to 5 are very short answer type questions and carry 1 mark each.*
- (iii) *Questions No. 6 to 10 are short-answer questions and carry 2 marks each.*
- (iv) *Questions No. 11 to 22 are also short-answer questions and carry 3 marks each.*
- (v) *Questions No. 23 is a value based question and carry 4 marks.*
- (vi) *Questions No. 24 to 26 are long-answer questions and carry 5 marks each.*
- (vii) *Use Log Tables, if necessary. Use of calculators is **not** allowed.*

1. What holds iodine molecules in the crystal lattice? 1
2. What are the values of Van't Hoff factors for KCl, NaCl and Na<sub>2</sub>SO<sub>4</sub> respectively? 1
3. What does soap behave as at higher concentration of soap in water? 1
4. In extraction of copper from its sulphide ore, which compound reduces Cu<sub>2</sub>O to form metal? 1
5. Bond dissociation enthalpy of E—H (E = element) bonds is given

below. Which of the compounds will act as strongest reducing agent?

Compound	NH <sub>3</sub>	PH <sub>3</sub>	AsH <sub>3</sub>	SbH <sub>3</sub>	
$\Delta_{\text{diss}}(\text{E—H})/\text{kJ mol}^{-1}$	389	322	297	255	1

6. Why are aquatic species more comfortable in cold water in comparison to warm water? 2
7. State a condition under which a bimolecular reaction is kinetically first order reaction. 2
8. Why is an external emf of more than 2.2V required for the extraction of Cl<sub>2</sub> from brine? 2

**OR**

At what temperatures above 1073K coke can be used to reduce FeO to Fe. How can you justify this reduction with Ellingham diagram? 2

9. Arrange the following compounds in increasing order of acidity and give a suitable explanation.  
Phenol, o-nitrophenol, o-cresol 2
10. Under what conditions glucose is converted to gluconic and saccharic acid? 2
11. What is glycogen? How is it different from starch? How is starch structurally different from cellulose? 3

12. Define the following:
- Binary solution
  - Hypertonic solution
- 3
13. Name the factors responsible for the solubility of alcohols in water.
- 3
14. Predict the product of reaction of aniline with bromine in non-polar solvent such as  $\text{CS}_2$ .
- 3
15. Monosaccharides contain carbonyl group hence are classified, as aldose or ketose. The number of carbon atoms present in the monosaccharide molecule are also considered for classification. In which class of monosaccharide will you place fructose?
- 3
16. Under which situations can an amorphous substance change to crystalline form?
- 3
17. Why in the redox titration of  $\text{KMnO}_4$  vs oxalic acid, we heat oxalic acid solution before starting the titration?-
- 3
18. A colloid is formed by adding  $\text{FeCl}_3$  in excess of hot water. What will happen if excess sodium chloride is added to this colloid?
- 3

**OR**

- Why are some medicines more effective in the colloidal form?
- 3
19. On reaction with  $\text{Cl}_2$ , phosphorus forms two types of halides 'A' and 'B'. Halide A is yellowish-white powder but halide 'B' is

- colourless oily liquid. Identify A and B and write the formulas of their hydrolysis products. 3
20. In the ring test of  $\text{NO}_3^-$  ion,  $\text{Fe}^{2+}$  ion reduces nitrate ion to nitric oxide, which combines with  $\text{Fe}^{2+}$  (aq) ion to form brown complex. Write the reactions involved in the formation of brown ring. 3
21. Magnetic moment of  $[\text{MnCl}_4]^{2-}$  is 5.92 BM. Explain giving reason. 3
22. Out of o- and p-dibromobenzene which one has higher melting point and why? 3
23. Laboratory alcohol should not be used for sterilization of wounds.  
a. Why?  
b. What values do you derive from this? 4
24. What is Nernst equation? How will you calculate equilibrium constant from Nernst equation? 5

**OR**

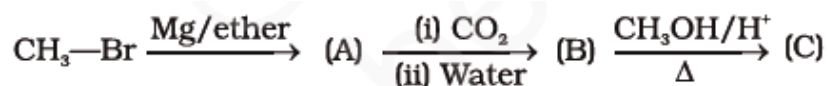
- What is the relationship between Gibbs free energy of the cell reaction in a galvanic cell and the emf of the cell? When will the maximum work be obtained from a galvanic cell? 5
25. On the basis of Lanthanoid contraction, explain the following :  
a. Nature of bonding in  $\text{La}_2\text{O}_3$  and  $\text{Lu}_2\text{O}_3$ .  
b. Trends in the stability of oxo salts of lanthanoids from La to Lu.  
c. Stability of the complexes of lanthanoids.

- d. Radii of 4d and 5d block elements.
- e. Trends in acidic character of lanthanoid oxides. 5

**OR**

Mention the type of compounds formed when small atoms like H, C and N get trapped inside the crystal lattice of transition metals. Also give physical and chemical characteristics of these compounds. 5

26. a. Identify the compounds A, B and C in the following reaction. Why?



- b. Ethylbenzene is generally prepared by acetylation of benzene followed by reduction and not by direct alkylation. Think of a possible reason. 5

**OR**

When liquid 'A' is treated with a freshly prepared ammoniacal silver nitrate solution, it gives bright silver mirror. The liquid forms a white crystalline solid on treatment with sodium hydrogensulphite. Liquid 'B' also forms a white crystalline solid with sodium hydrogensulphite but it does not give test with ammoniacal silver nitrate. Which of the two liquids is aldehyde? Write the chemical equations of these reactions also. 5

## ANSWERS

1. London forces
2. 2, 2 and 3
3. Associated colloid
4.  $\text{Cu}_2\text{S}$
5.  $\text{SbH}_3$
6. At a given pressure the solubility of oxygen in water increases with decrease in temperature. Presence of more oxygen at lower temperature makes the aquatic species more comfortable in cold water.
7. Bimolecular reaction becomes kinetically first order when one of the reactants is in excess.
8. Value of  $\Delta G^\theta$  is + 422kJ. Using the equation  $\Delta G^\theta = -nFE^\theta$  the value of  $E^\theta$  comes out to be  $-2.2\text{V}$ . Therefore extraction of  $\text{Cl}_2$  from brine will require an external emf of greater than  $2.2\text{V}$ .

### OR

As per Ellingham diagram at temperatures greater than 1073 K  $\Delta G(\text{C}, \text{CO}) < \Delta G(\text{Fe}, \text{FeO})$ . Hence coke can reduce FeO to Fe.

9. Increasing order of acidity : o-cresol < phenol < o-nitrophenol

[Hint : In substituted phenols, the presence of electron withdrawing groups, enhance the acidic strength of phenol whereas, electron releasing groups decrease the acidic strength of phenol.]

10. Glucose is converted to gluconic acid by bromine water and to saccharic acid by conc.  $\text{HNO}_3$ .
11. Glycogen is a form of carbohydrates stored in animal body. It is different from starch as it is more highly branched than starch.
12.
  - a. Binary Solution: Solution with two components.
  - b. Hypertonic Solution: A solution whose osmotic pressure is more than that of the another.
13. Name the factors responsible for the solubility of alcohols in water.
14. A mixture of 2-bromoaniline and 4-bromoaniline is formed.
15. Fructose is a ketohexose
16. On heating amorphous solids to a certain temperature.
17. The reaction between  $\text{KMnO}_4$  and oxalic acid is very slow. By raising the temperature we can enhance the rate of reaction.
18. Positively charged sol of hydrated ferric oxide is formed and on adding excess of  $\text{NaCl}$ , negatively charged chloride ions coagulate the positively charged sol of hydrated ferric oxide.

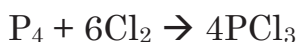
**OR**

Medicines are more effective in the colloidal form because of large surface area and are easily assimilated in this form.

19. A is  $\text{PCl}_5$  (It is yellowish white powder)



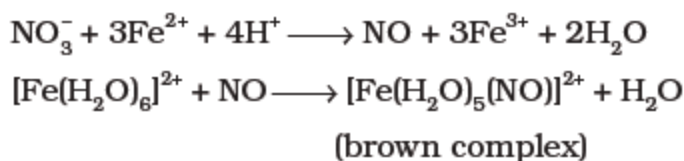
- B is  $\text{PCl}_3$  (It is a colourless oily liquid)



Hydrolysis products are formed as follows:



- 20.



21. The magnetic moment of 5.92 BM corresponds to the presence of five unpaired electrons in the d-orbitals of  $\text{Mn}^{2+}$  ion. As a result the hybridisation involved is  $\text{sp}^3$  rather than  $\text{dsp}^2$ . Thus tetrahedral structure of  $[\text{MnCl}_4]^{2-}$  complex will show 5.92 BM magnetic moment value.
22. *p*-Dibromobenzene has higher melting point than its *o*-isomer. It is due to symmetry of *p*-isomer which fits in crystal lattice better than the *o*-isomer.
23. a. Laboratory alcohol is denatured with methanol. Methanol is extremely poisonous. Hence it should not be used.  
b. Laboratory reagents/equipments should not be used for any purpose other than in using for laboratory works.



24. Nernst equation:

$$\begin{aligned} E_{(\text{cell})} &= E_{(\text{cell})}^{\ominus} - \frac{RT}{nF} \ln Q \\ &= E_{(\text{cell})}^{\ominus} - \frac{RT}{nF} \ln \frac{[C]^c [D]^d}{[A]^a [B]^b} \end{aligned}$$

Calculating Equilibrium constant from Nernst Equation:

$$E_{(\text{cell})} = 0 = E_{(\text{cell})}^{\ominus} - \frac{2.303RT}{2F} \log \frac{[\text{Zn}^{2+}]}{[\text{Cu}^{2+}]}$$

$$\text{or } E_{(\text{cell})}^{\ominus} = \frac{2.303RT}{2F} \log \frac{[\text{Zn}^{2+}]}{[\text{Cu}^{2+}]}$$

But at equilibrium,

$$\frac{[\text{Zn}^{2+}]}{[\text{Cu}^{2+}]} = K_c \text{ for the reaction 3.1}$$

and at T = 298K the above equation can be written as

$$E_{(\text{cell})}^{\ominus} = \frac{0.059 \text{ V}}{2} \log K_c = 1.1 \text{ V} \quad (E_{(\text{cell})}^{\ominus} = 1.1\text{V})$$

$$\log K_c = \frac{(1.1\text{V} \times 2)}{0.059 \text{ V}} = 37.288$$

$$K_c = 2 \times 10^{37} \text{ at } 298\text{K.}$$

In general,

$$E_{(\text{cell})}^{\ominus} = \frac{2.303RT}{nF} \log K_c$$

**OR**

Relationship between Gibbs free energy of the cell reaction in a galvanic cell and the emf of the cell:

$$\Delta_r G = -nFE(\text{cell})$$

When the cell reaction reaches equilibrium.

25. a. As the size decreases covalent character increases. Therefore  $\text{La}_2\text{O}_3$  is more ionic and  $\text{Lu}_2\text{O}_3$  is more covalent.
- b. As the size decreases from La to Lu, stability of oxosalts also decreases.
- c. Stability of complexes increases as the size of lanthanoids decreases.

- d. Radii of 4d and 5d block elements will be almost same.  
 e. Radii of 4d and 5d block elements will be almost same.

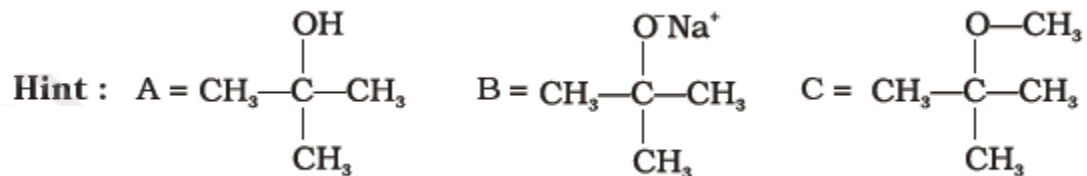
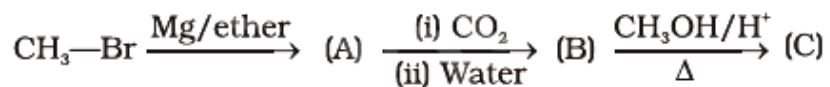
**OR**

Interstitial compounds.

Characteristic properties :

- a. High melting points, higher than those of pure metals.  
 b. Very hard.  
 c. Retain metallic conductivity.  
 d. Chemically inert.

26. a.



**OR**

Liquid A