Five Year Integrated M. Sc. Examination 2022

Semester-III

Course: CH-2-3-1

(Chemistry)

Time: Three Hours **Full Marks: 60**

Questions are of value as indicated in the margin

Group-A

(Answer ***any four*** questions)

1. (a) With a suitable diagram, define a standard hydrogen electrode and mention the half-cell reaction associated. 2

   (b) Explain with appropriate example dipole-dipole and instantaneous dipole-induced dipole interaction. What is the potential energy of interaction in each case? 2+1

2. (a) Construct the Frost Diagram of manganese system up to n = 4, where n has its usual meaning, from the following portion of the Latimer Diagram. 3

$$Mn \xrightarrow{1.18V} Mn^{2+} \xrightarrow{-1.51V} Mn^{3+} \xrightarrow{-0.95V} MnO_2$$

   (b) Why water has highest density at 4 °C? 2

3. (a) In the titration of 100 mL Fe^{2+} with $KMnO_4$ of equal strength in 1M acid medium, what will be the potential of the solution when 90 mL $KMnO_4$ has been added? $E^o_{Fe3+/Fe2+} = 0.77$ V. 2+(1+2)

   (b) Differentiate between intermolecular and intramolecular hydrogen bonding. Discuss on the boiling point of the nitrophenols.

4. (a) Establish the Nernst equation for AsO_4^{3-}/AsO_3^{3-} couple in acidic medium. Find out the formal potential of the system at pH = 8. Given: E^o for $AsO_4^{3-}/AsO_3^{3-} = +0.56$ V. 2+1+2

   (b) Write the name of the transition elements with: (i) highest density, (ii) non-metallic property, (iii) highest melting point and (iv) noble property.

5. (a) Give an example of (i) disproportionation reaction and (ii) comproportionation reaction. 2+1+2

   (b) Write down the IUPAC names for atomic numbers 107 and 190.

   (c) Name one (i) positive monodentate, (ii) ambidentate, (iii) bridging and (iv) chelating ligand.

Group-B

(Answer ***any four*** questions)

6. Carry out the following transformations preparing Grignard reagents. 1.5+1.5+2

   (i) $C_2H_5Br \longrightarrow C_2H_5CO_2H$ (ii) $C_2H_5Br \longrightarrow CH_3COC_2H_5$

   (iii) $C_2H_5Br \longrightarrow C_4H_9OH$

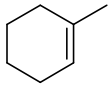
7. Carryout the following transformations with plausible reaction mechanism. 2.5 x 2

$$PhCH_2CH_2OH \longleftarrow PhCH{=}CH_2 \longrightarrow PhCH(OH)CH_3$$

8. Carryout the following conversions with plausible reaction mechanism. 2.5 x 2

(i) $PhCHO \longrightarrow PhCH{=}CHCH_3$ (ii) $PhCOCH_3 \longrightarrow PhCOCH_2CH_2NEt_2$

9. Predict the product(s) with plausible reaction mechanism. 2.5 x2

(i) $Me(Ph)C(OH)C(OH)Me(Ph) \xrightarrow{H^+} ?$ (ii)  $\xrightarrow[Me_2S]{O_3} ?$

10. Write short note on the followings reactions (mechanism, examples, and application) 2.5 x 2

(i) HVZ reaction (ii) Cannizaro reaction

Group-C

(Answer ***any four*** questions)

11. (a) What is the angle of contact (θ) between a pair of liquid and solid? Explain why mercury does not spread over, when falls on a flat and smooth solid surface? (1+2)+2

(b) Calculate the surface tension of water at 20°C given that at that temperature water climbs to a height of 4.96 cm in a clean glass capillary tube of internal radius 0.300 mm. The density of water at 20°C is 998.2 kg m^{-3}.

12. (a) Write down the Plank's heat theorem. How does it differ from Nernst heat theorem? 2+(2+1)

(b) For a gaseous reaction, $\alpha A + \beta B = \gamma C + \delta D$, obtain the thermodynamic relationship between equilibrium constant and temperature and show that the rate of the forward reaction will decrease with increase in temperature if the reaction is exothermic in nature.

13. (a) $\left(\frac{\partial\left(\frac{G}{T}\right)}{\partial\left(\frac{1}{T}\right)}\right)_P$ is a state function. Justify or criticize. 2+3

(b) For the reaction; $2A(g) + B(g) = 2D(g)$, $\Delta U^o_{298} = -2.50$ kcal and $\Delta S^o_{298} = -10.5$ $cal.K^{-1}$. Calculate ΔG^o_{298} for the reaction and predict whether the reaction will be spontaneous or not.

14. (a) What is the viscosity of a liquid? What is its unit in CGS system? (1+1)+3

(b) An Ostwald viscometer is calibrated using water at 20°C ($\eta = 1.0015$ cP, $\rho = 0.998$ $g.mL^{-1}$). It takes 15 s for water to fall from upper to the lower level of the viscometer. A second liquid is then placed in the viscometer and it takes 37 s for the liquid to fall between the levels. The weight of 100 mL of the liquid is 76.5 g. What is the viscosity of the liquid?

15. (a) Define the thermodynamic temperature scale enabled in Kelvin. In order to increase the efficiency of a Carnot engine would you increase the temperature of the source or decrease the temperature of the sink? Explain. (1+1)+3

(b) For the reaction at 298K; $A(g) + B(g) = C(g) + D(g)$, $\Delta H^o = -39.6$ kcal and $\Delta S^o = -0.12$ $kcal.mol^{-1}$. What is the value of the equilibrium constant for the reaction?