Five Year Integrated M. Sc. Examination 2024
Semester-III
Course: CH-2-3-1 (2016)
(Chemistry)

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

Questions are of values as indicated in the margin

Group-A

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

1. (a) Comment on the boiling points of dimethylamine and trimethylamine.
   (b) With a suitable diagram, define a standard hydrogen electrode and mention the half-cell reaction associated.
   (c) Write down the IUPAC names for atomic numbers 111 and 290.

   (2+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.

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

   (b) Establish with proper justification the possible geometry for coordination number 6.

   (3+2)

3. (a) Write four distinctive features of transition metals.
   (b) Considering the example of Mn^{3+}/Mn^{2+} system, both of which form sparingly soluble hydroxo-species with different solubility products, show the dependence of formal potential on pOH.

   (2+3)

4. (a) Name a redox indicator and draw its structure in oxidized and reduced forms.
   (b) Explain with appropriate example dipole-dipole and instantaneous dipole-induced dipole interaction. What is the potential energy of interaction in each case?

   (2+(2+1)

5. (a) What are the first and second order inner metallic complexes? Explain with appropriate examples.
   (b) In the titration of 100 mL Fe^{2+} with 100 mL $KMnO_4$ of equal strength in 1M acid medium, what will be the potential of the solution at the equivalence point? $E^{\circ}_{MnO4-,Mn2+}$ = 1.51 V, $E^{\circ}_{Fe3+,Fe2+}$ = 0.77 V

   (2+3)

Group-B

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

6. Carry out the following transformations.

   (i) $C_6H_6 \longrightarrow PhCO_2H$ (ii) $C_2H_5Br \longrightarrow C_2H_5CO_2Me$

   2.5 x 2

7. Carryout the following transformations with plausible reaction mechanism.

   $PhCH_2CH_2Br \longleftarrow PhCH{=}CH_2 \longrightarrow PhC{\equiv}CH$

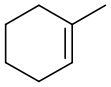
   2.5 x 2

8. Carryout the following conversions with plausible reaction mechanism.

(i) $PhCHO \longrightarrow PhCH{=}CHCH_3$ (ii) $PhCHO \longrightarrow PhCH(Br)CH_3$

2.5 x 2

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

(i) $PhCHO + HCHO \xrightarrow{NaOH} ?$ (ii)  $\xrightarrow[(ii)\ H_2O/H^+]{(i)\ O_3} ?$

2.5 x2

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

(i) Wolff-Kishner reduction (ii) Mannich reaction

2.5 x 2

Group-C

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

11. (a) What is entropy? Show that the entropy is a state function using Carnot cycle. 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.

(b) A Carnot engine has the same efficiency (i) between 150 K and 300 K and (ii) between T K and 800 K. Calculate the temperature T of the sink.

(1+2+1)+1

12. (a) Define the term "contact angle (θ)" between a pair of liquid and solid? Explain why mercury contracts when it comes in contact with a smooth glass surface?

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

(1+2)+2

13. (a) Define the terms "bubbles", "droplets" and cavities?

(b) Shows that the pressure on the concave side of a spherical bubble is always greater than convex side by $\frac{4\gamma}{r}$. Symbols have their usual meaning.

2+3

14. (a) Starting from the definition of the Gibb's free energy expression 'G', obtain the corresponding Maxwell's relation.

(b) For one component (C = 1) and two phase system (P = 2), write the number of variances (F) by which the phase boundary may be defined. Also derive an expression of the slope of a phase boundary when the two phases are liquid and gas.

2+3

15. (a) Derive the expression of the Nernst distribution co-efficient (K_D) of a solute between two immiscible solvents and hence formulate the distribution co-efficient (K_D) of benzoic acid in between benzene and water layers.

(b) Is $\left(\frac{\partial\left(\frac{G}{T}\right)}{\partial\frac{1}{T}}\right)_P$ a state function? Justify or criticize. (1+2)+2