# 2020
# CHEMISTRY
## [HONOURS]
## Paper : VII

Full Marks : 50 Time : 2 Hours

*The figures in the right-hand margin indicate marks.*

*Candidates are required to give their answers in their own words as far as practicable.*

1. Answer any **five** questions: 2×5=10

a) What is the [111] interplanar distance ratio of a bcc lattice?

b) For the reaction $H_2(g)+S \rightleftharpoons H_2S$,

$K_p = 6.02\times10^5$ at $25^oC$. Calculate standard free energy of $H_2S$.

c) Show that surface tension is numerically the same as the surface energy/Area of a liquid.

d) What is 'viscosity average molar mass'?

e) Explain why sulphate ions are good precipitating agent for Barium ions.



f) Consider the following reactions:

$$Fe_2O_3(s)+CO(g)=2FeO(s)+CO_2(g)$$

$$FeO(s)+CO(g)=Fe(s)+CO_2(g)$$

$$CO(g)+\text{Air}=CO_2(g),$$

show that the system is bivariant.

g) State one application of addition of a foreign substance in a partially miscible liquid system.

h) What do you mean by micelle and reverse micelle?

2. Answer any **four** questions: 5×4=20

a) i) For an equilibrium phase transition at temperature T, $\left(\frac{\partial S}{\partial V}\right)_T = \frac{\Delta H}{T\Delta V^x}$. Find x. Terms have their usual meanings.

ii) Explain how a wetting liquid rises in a capillary tube. 2+3

b) Draw a fcc lattice structure. Show that 74% of the spaces of such a crystal is occupied by the constituent species. 2+3

c) i) Show that for a real gas

$$\text{fugacity} = P e^{BP/RT},$$

where $V_{Real} = V_{Ideal} + B$. Terms have their usual meanings.

ii) If pH of a 0.02(M) MCl solution is 5.48, where MOH is a weak base, calculate its degree of hydrolysis. 3+2

d) Draw free energy vs. extent of reaction graph showing different stages of reaction and correlate it to Van't Hoff reaction isotherm. 5

e) Find the expression of $C_V$ for a monoatomic solid according to Einstein model. What is Dulong-Petit's law? $3\frac{1}{2}+1\frac{1}{2}$

f) i) At 35°C, in a phenol-water two layer system, 40% by weight of phenol is present. Water is present in the two layers by weight of 30% and 92%. Calculate the relative weights of two layers.

ii) Write down the combined form of Van't Hoff's laws of osmotic pressure. 4+1



g) i) Justify: Eutectic mixture has a definite composition and melting point, yet it is not a compound.

ii) Calculate pH of a 0.03(M) $H_2SO_4$ solution. First dissociation is complete, second dissociation constant is $1.01\times10^{-2}$. 2+3

3. Answer any **two** questions: 10×2=20

a) i) Give one example of utilization of Micellar solubilization.

ii) For this equilibrium $X_{(g)} \rightleftharpoons Y_{(g)} + Z_{(g)}$, arrive at the expression for $\Delta K_p$ if an excess amount of Y is present at constant volume before reaction.

iii) Show that in a liquid-liquid solution, if one component shows negative deviation from Raoult's law, the other component will exhibit the same.

iv) Write down the expression for glancing angle in the powder method of crystal analysis. 2+3+3+2

b) i) Derive Bragg's equation in connection with diffraction of X-ray by crystals.

ii) A crystallographic plane makes intercepts $\frac{1}{2}, \infty, 2$ units to the crystallographic axes. Find the maximum value of wave length that can be used here in Bragg's method if it is a simple cubic system with edge length $a = 1.5\,\text{Å}$.

iii) Define Miller indices. Arrive at the general formula for the inter-planar spacing in a cubic system. 3+4+3

c) i) If elevation of boiling point of a dilute solution $\Delta T_b = X\pi$, find X. $\pi =$ Osmotic pressure of the solution.

ii) Draw the cooling curve of a molten mass for a two-component system.

iii) Explain why at CMC, the solutions of long chain fatty acids have minimum surface tension.

iv) A liquid rises 2 cm in a capillary tube of radius 0.002 cm. Calculate its surface tension if its density is 0.92 gm/cc. 3+2+3+2



d) i) Show that the excess pressure inside a spherical soap bubble of radius 'r' formed within liquid has the expression $2\gamma/r$ (where $\gamma =$ surface tension). Hence prove that there is no excess pressure inside the flat surface.

ii) Calculate the decrease in surface area when droplets of average radius $1.0\times10^{-6}$ m coalesce to form $1.0\times10^{-3}\,m^3$ of water at 278 K.

iii) Calculate the viscosity coefficient of $CO_2$ at $27^oC$. Given that van der Waal's constant $b = 32\,cc\,mol^{-1}$, average velocity of $CO_2$ molecule at that temperature is $3.8\times10^4\,cm\,s^{-1}$. 4+3+3