

3 Yr. Degree/4 Yr. Honours 1st Semester Examination, 2025 (CCFUP)

Subject : Chemistry
Course: CHEM1011 (MAJOR)
(Basic Chemistry-I)

Time: 2 Hours

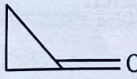
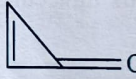
Full Marks: 40

The figures in the margin indicate full marks.

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

1. Answer any five questions:

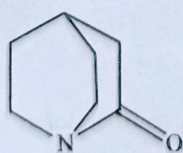
2×5=10

- (a) What is the physical reason behind $\left(\frac{\partial U}{\partial V}\right)_T = 0$ for an ideal gas?
- (b) Find the dimension and CGS unit of van der Waals' constant 'a'.
- (c) A zero order reaction cannot be a single-step reaction.— Justify.
- (d) The C—C bond distance in Cl_3CCHO is higher than that in CH_3CHO — Explain.
- (e) Compare the dipole moments of  and .
- (f) Which one should be more acidic and why?
 H_3PO_3 and H_3PO_4
- (g) What are 'Super acids'? Mention acidity function value of such acids.
- (h) How many radial nodes are present in (i) 3s-orbital and (ii) 2p-orbital?

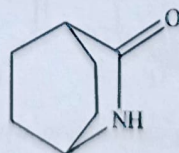
2. Answer any two questions:

5×2=10

- (a) (i) For a second order reaction, $\text{A} \rightarrow \text{products}$, show that the time required for three-fourths of the reactants to decay ($t_{3/4}$) is equal to $3t_{1/2}$ ($t_{1/2}$ = half-life period). 2
- (ii) One mole of a monoatomic gas at 298 K expands to double its volume at constant pressure. Calculate the heat absorbed by the gas. 2
- (iii) Define 'critical temperature' of a gas. 1
- (b) (i) The amide A is more basic than isomeric amide B.— Explain. 3

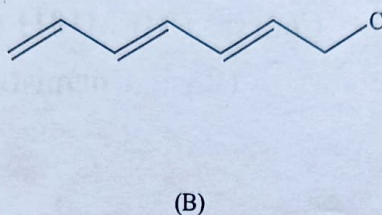
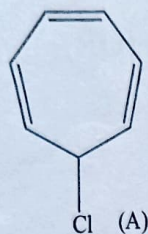


(A)



(B)

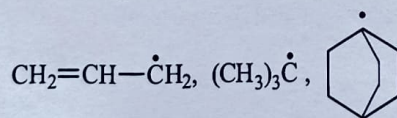
- (ii) Which one of the following compounds will undergo faster reaction with AgNO_3 solution? — Explain. 2



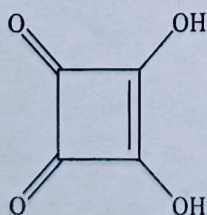
- (c) (i) Write down the conjugate base of HSO_4^- . 1
- (ii) Apply Hund's rule to predict the ground term symbol of ' P^2 ' system. 2
- (iii) How does ionisation potential vary along a period of a periodic table? 2
- (d) (i) Calculate pH of 10^{-2} (M) aqueous solution of ammonia at 25°C .
(Given, $K_b(\text{NH}_4\text{OH}) = 1.8 \times 10^{-5}$ at 25°C) 2
- (ii) A gas obeying the equation $P(\bar{V} - b) = RT$ has the compressibility factor, $Z = 1.0018$ at 27°C and 1 atm pressure. Assuming the gas molecule to be a spherical in shape, calculate its molecular diameter. 3

3. Answer any two questions: 10×2=20

- (a) (i) Provide any two methods for generation of free radicals. 2
- (ii) Arrange the following free radicals in order of increasing stability with reason 3



- (iii) What are called 'proton sponges'? Give examples. 2
- (iv) The following cyclic diol is almost strong acid as H_2SO_4 . — Explain. 2



- (v) Give an example of a carbocation which can be stored for long time as a salt. 1

- (b) (i) State the Heisenberg's uncertainty principle. Calculate the de Broglie wavelength associated with an electron moving with velocity of $1.0 \times 10^7 \text{ms}^{-1}$.
(Mass of an electron $9.1 \times 10^{-31} \text{ kg}$) 1+2
- (ii) "Electron affinity of Li is negative but that of Be is positive." — Why? 2
- (iii) The wavelength of the first line in the Balmer series of H-atom is 15200 cm^{-1} . Calculate the wavelength of the first line in the same series of Li^{2+} ion. 3
- (iv) 2, 6-dihydroxybenzoic acid is a much stronger acid ($\text{pka} = 1.30$) than 2-hydroxybenzoic acid ($\text{pka} = 3.0$) — Explain. 2
- (c) (i) The gas phase reaction, $2\text{N}_2\text{O}_5 \longrightarrow 4\text{NO}_2 + \text{O}_2$, has
- $$k = 2.05 \times 10^{13} e^{\frac{-24.65 \text{ kcal mole}^{-1}}{RT}} \text{ s}^{-1} \text{ (k = rate constant)}$$
- (I) Calculate the values of frequency factor (A) and energy of activation (Ea).
- (II) Find rate constant(k) and $t_{1/2}$ at 0°C . 2+2
- (ii) An ideal gas is expanded adiabatically against a constant pressure P_2 until it doubles its volume. If the initial temperature and pressure be T_1 and P_1 respectively, find an expression of the final temperature. 3
- (iii) What is 'Boyle temperature'? Show that a gas characterised by the equation $P(\bar{v} - b) = RT$ has no Boyle temperature. 1+2
- (d) (i) The enthalpy of neutralisation of HCN by NaOH is -2900 cal . Calculate the enthalpy of ionisation of one mole HCN. (Given ΔH for $\text{H}^+ + \text{OH}^- \longrightarrow \text{H}_2\text{O}$ is -13.8 kcal). 3
- (ii) Compare the acid strengths of BF_3 , BCl_3 and BBr_3 . 3
- (iii) N,N-Dimethylaniline is a weaker base than N,N,2,6-tetramethyl aniline.— Explain. 2
- (iv) Using Frost diagram, show that benzene is an aromatic compound. 2
-