

2026

CHEMISTRY — HONOURS

Paper : DSCC-2

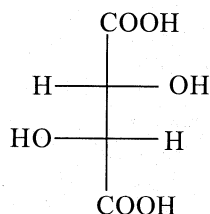
(Fundamentals of Chemistry - II)

Full Marks : 75

*The figures in the margin indicate full marks.**Candidates are required to give their answers in their own words as far as practicable.*Answer **question nos. 1, 2, 3 and 4** (compulsory) and **any four** questions from the rest (**question nos. 5 to 10**).1. Answer **any ten** questions :

2×10

- (a) Calculate the R.M.S. speed of molecules of nitrogen gas at 300 K using two-dimensional Maxwell distribution of molecular speed.
- (b) Give one example each of metal excess and metal deficiency defect.
- (c) In the following compound, designate C-2 as chirotopic/achirotopic and stereogenic/non-stereogenic :



- (d) Compare the nature of the Maxwell speed distribution curve and Kinetic energy distribution curve in 3-D at the same temperature for a given gas.
- (e) Among Cu^{2+} , Pb^{2+} , Zn^{2+} , As^{3+} and Co^{2+} , which radical(s) will not be precipitated by passing H_2S in hydrochloric acid medium? Which parameter of the metal sulphide is considered here?
- (f) Name two optically pure bases used in resolution of racemic acids.
- (g) State the law of corresponding states.
- (h) Between LiCl and NaCl , in which case it is difficult to get anhydrous salt? Which parameter of the cation is responsible for this?
- (i) Identify the most stable carbocation with proper reasoning :
methyl cation, allyl cation and ter-butyl cation.
- (j) A gas obeys the equation of state $P(V - nb) = nRT$. Find the numerical value of the compressibility factor when $nb/V = 1/20$.

Please Turn Over

(7509)

(k) Write down the Kapustinskii expression for lattice energy explaining all the terms involved.

(l) Define : pseudoasymmetric centre with a proper example.

2. Write a short note on (using the following points) :

(a) Maxwell speed distribution in two dimensions :

(i) Expression mentioning all terms and derivation of root mean square speed of gas molecules.

(ii) Derivation of Maxwell distribution for Kinetic energy from it. 2+3

Or

(b) Compressibility factor, Z :

(i) Definition.

(ii) Derivation of the expression of Z as a function of P for a van der Waals' gas and obtain an expression for Boyle temperature. 1+4

3. Write a short note on (using the following points) :

(a) Radius Ratio Rule :

(i) Calculation of the limiting radius ratio for NaCl structure (C.N. = 6)

(ii) Two limitations. 3+2

Or

(b) Bent's Rule :

(i) Statement

(ii) Structure of PCl_3F_2 .

(iii) One limitation with a suitable example. 1+2+2

4. Write a short note on (using the following points) :

(a) Priority rules for ligands :

(i) CIP rules to determine priority of ligands with proper examples.

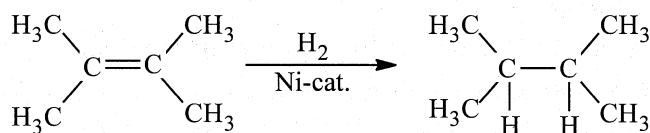
(ii) R - and S - forms of $\text{H}_3\text{C}-\text{CH}(\text{Cl})-\text{COOH}$. 3+2

Or

(b) Reaction Thermodynamics :

(i) Meaning of 'enthalpy driven reaction' and 'entropy driven reaction' with suitable examples.

(ii) Calculation of ΔH for the following reaction :

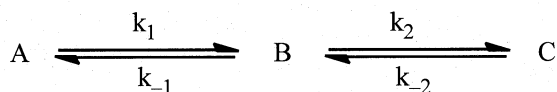


Given, Bond energies (in k cal mol⁻¹) : $\text{C}=\text{C} \Rightarrow 145$, $\text{C}-\text{C} \Rightarrow 83$; $\text{C}-\text{H} \Rightarrow 99$;
 $\text{H}-\text{H} \Rightarrow 103$. 3+2

5. (a) Calculate the pressure at which the mean free path of nitrogen molecule will be 1 mm at 27°C. Estimate the number of binary collisions between nitrogen molecules per unit volume per second at 27°C and at the estimated pressure (Assume ideal behaviour).

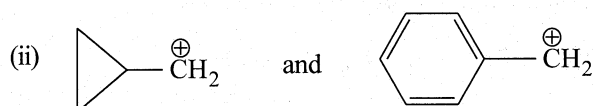
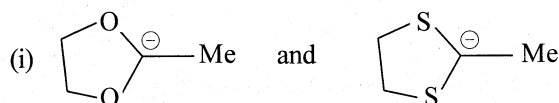
$$(d_{N_2} = 3.7 \text{ \AA}, \langle c \rangle = 400 \text{ ms}^{-1}).$$

- (b) Using VSEPR theory, predict the shapes of ClF_3 and XeF_4 .
- (c) Explain the process of racemisation of a suitable organic compound involving carbanion intermediate. 4+3+3
6. (a) The H-H bond energy is 435 kJ mol^{-1} . The heat of sublimation of Li(s) is 160 kJ mol^{-1} and its ionization energy is 518 kJ mol^{-1} . The heat of formation of LiH(s) is $-90.4 \text{ kJ mol}^{-1}$ and its lattice energy is -916 kJ mol^{-1} . Use this information with an appropriate thermochemical cycle to evaluate the electron affinity of hydrogen.
- (b) Construct an energy profile diagram for the following reaction :



The relative stabilities of three species is $C > A > B$ and the relative order of rate constant $k_2 > k_{-1} > k_1 \gg k_{-2}$. Answer the following questions :

- (i) Identify the intermediate
- (ii) Which one is the rate determining step?
- (c) Define mean free path of gas molecules. Explain the dependence of mean free path on T and P . 4+3+3
7. (a) Which one is more stable in each of the following pairs and why?



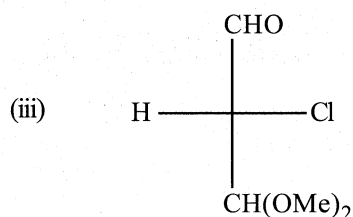
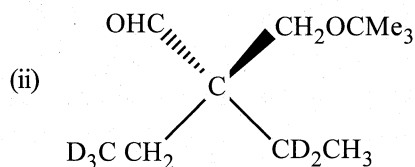
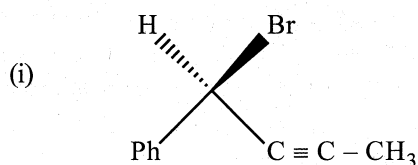
- (b) Draw and explain Andrews isotherm for carbon dioxide gas —
- (i) below critical temperature,
- (ii) at critical temperature,
- (iii) above critical temperature.

- (c) Why is the melting point of CuCl (422°C) much lower than that of KCl (776°C)? 4+3+3

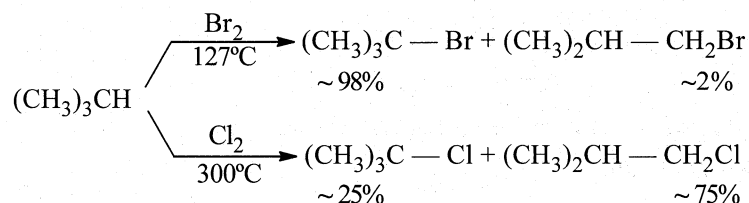
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8. (a) State and explain the principle of equipartition of energy. State its limitations.
 (b) How the presence of oxalate ion interferes in the detection of cation(s) in the analytical group separation? How its interference can be removed?
 (c) Explain the terms — chirotopicity and stereogenicity using suitable examples. 4+3+3
9. (a) What do you mean by stoichiometric crystal defect? Mention their different types. Discuss the defects with proper examples.
 (b) Assign *R/S* descriptors for the following chiral centres mentioning priority sequence of ligands :



- (c) Draw and explain the speed distribution plots of gas molecules moving in 1-D at two different temperatures T_1 and T_2 ($T_2 > T_1$). 4+3+3
10. (a) Explain the following observations using reactivity-selectivity principle :



- (b) For one mole each of an ideal gas, H_2 and NH_3 , all at 27°C , draw PV vs P plots on a common set of axes and explain the deviations of the real gases from ideal behaviour.
 (c) Write down the procedure for the separation of Group-II A and II B basic radicals. State the relevant chemical reactions. 4+3+3