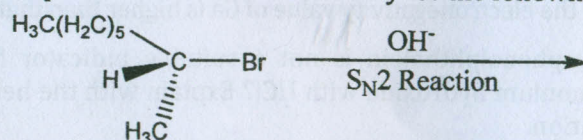


7. (a) Draw the curve for the conductometric titration of a strong acid vs a weak base and explain the nature of the curve.
- (b) Establish the relation between the cell EMF and the reaction enthalpy.
- (c) The rate of a first order reaction is  $0.04 \text{ mol. L}^{-1}\text{s}^{-1}$  at 10 minutes and  $0.03 \text{ mol.L}^{-1}\text{s}^{-1}$  at 20 minutes. Find the half life period of the reaction.
- (d) What type of a battery is lead storage cell? Write the anode and cathode reaction and overall reaction occurring in a lead storage battery during discharging and charging process.

$$3 + 2 + 3 + (1 + 3) = 12$$

### Group - E

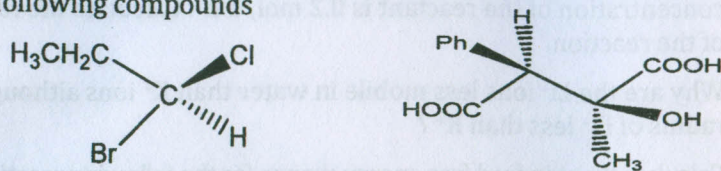
8. (a) Write down the Fischer projections of all the stereoisomers in tartaric acid and comment on their stereochemical relationship.
- (b) Write the total number of rotational axes and the total number of  $\sigma$  planes present in  $\text{H}_2\text{O}$  molecule and show their locations.
- (c) Predict the product with stereochemistry for the following reaction



- (d) Briefly write down the synthetic route for Aspirin and paracetamol.

$$3 + 3 + 2 + 4 = 12$$

9. (a) How does the potential energy of n-butane molecule vary with torsion angle (rotation about C-2 and C-3 bond)? Explain the nature of the curve using the geometry of the conformational isomers.
- (b) Identify the absolute configuration of the each stereocentre of the following compounds



- (c) Why propynoic acid ( $\text{CH}\equiv\text{CCOOH}$ ) is stronger than propenoic acid ( $\text{CH}_2=\text{CHCOOH}$ )? Explain the fact.
- (d) Why do we need to classify drugs in different ways? What are sulfa drugs?

$$3 + 3 + 2 + (3 + 1) = 12$$

### CHEMISTRY I (CHEM 1001)

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

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

### Group - A (Multiple Choice Type Questions)

1. Choose the correct alternative for the following: 10 × 1 = 10
- (i) The efficiency of a Carnot cycle ( $T_2 > T_1$ ) is  
(a)  $(T_2 - T_1)/T_2$  (b)  $(T_2 - T_1)/T_1$  (c) 1 (d)  $T_1/(T_2 - T_1)$ .
- (ii) Entropy of an ideal gas depends upon its  
(a) pressure only (b) temperature only  
(c) both (a) & (b) (d) neither (a) nor (b).
- (iii) The dipole moment of gas phase HBr molecule is  $0.827D$ . If the interatomic distance between H and Br is  $1.41\text{Å}$ , the percentage ionic character of HBr will be  
(a) 12.21 (b) 16.83 (c) 76.81 (d) 25.26.
- (iv) The correct order of electron affinities of halogens is  
(a)  $F > Cl > Br > I$  (b)  $I > Br > Cl > F$   
(c)  $Cl > F > Br > I$  (d)  $Cl > F > I > Br$ .
- (v) The hybridization of the central atom in  $\text{XeF}_2$  molecule is  
(a)  $sp^2$  (b)  $sp^3$  (c)  $sp^3d$  (d)  $sp^3d^2$ .
- (vi) In infrared spectroscopy which frequency range is known as the fingerprint region?  
(a)  $500 - 1500 \text{ cm}^{-1}$  (b)  $1400 - 900 \text{ cm}^{-1}$   
(c)  $900 - 600 \text{ cm}^{-1}$  (d)  $600 - 250 \text{ cm}^{-1}$ .
- (vii) The half-life of a first order reaction is 20 minutes. The time required for 75% completion of the reaction is  
(a) 30 minutes (b) 40 minutes  
(c) 50 minutes (d) 60 minutes.

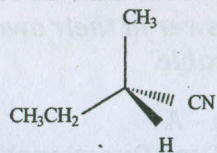
(viii) The element of symmetry which is not present in CH<sub>4</sub> molecule is

- (a) rotational axis of symmetry
- (b) plane of symmetry
- (c) centre of symmetry
- (d) alternating axis of symmetry.

(ix) Which one of the following carbanions is most stable

- (a) H<sub>3</sub>C<sup>-</sup>
- (b) H<sub>2</sub>C = CH<sup>-</sup>CH<sub>2</sub><sup>-</sup>
- (c) (CH<sub>3</sub>)<sub>2</sub>CH<sup>-</sup>
- (d) (CH<sub>3</sub>)<sub>3</sub>C<sup>-</sup>

(x) What is the correct absolute configuration for the following compounds?



- (a) R
- (b) S
- (c) Achiral
- (d) cannot be determined

**Group - B**

- (a) Derive the Gibbs-Duhem relations.
- (b) Calculate the wavelength of emitted light for the transition of energy level  $n = 4$  to energy level  $n = 1$  for the hydrogen electron transition. In which region of electromagnetic spectrum does this radiation fall? ( $h = 6.626 \times 10^{-34} \text{ m}^2 \text{ kg/s}$ ; mass of the electron =  $9.1 \times 10^{-31} \text{ kg}$ )
- (c) What is the de Broglie hypothesis? Consider a beam of electron with a speed of  $5 \times 10^6 \text{ m/s}$  and calculate the de Broglie wavelength.

(d) Write the basic principle and the applications of UV-visible spectroscopy.  
**3 + 3 + 3 + 3 = 12**

(a) How does the wave function of a particle in a one dimensional box look like for  $n = 1$  and  $n = 2$  energy levels. Comment on the number of nodes for each of the level.

(b) Calculate the change in entropy accompanying the isothermal expansion of 4 moles of an ideal gas at 300°K until its volume is increased three times.

(c) What is shielding and deshielding in NMR spectroscopy? Give proper example(s).

(d) What are activity and activity coefficient? What is the relation between chemical potential and activity?  
**3 + 3 + 3 + 3 = 12**

**Group - C**

4. (a) Using VSEPR theory, predict the shape and indicate the state of hybridization of central atom of the following chemical species: ICl<sub>4</sub>, ClF<sub>3</sub>.

(b) The first ionisation potentials of the coinage metals follow the order: Cu > Ag < Au – explain.

(c) What do you mean by a buffer solution? Derive Henderson's equation to calculate pH of an acid buffer solution.

(d) Explain why the most common oxidation state for the heaviest element in Group 13, thallium (Tl), is +1 rather than +3.  
**(2 + 2) + 3 + (1 + 2) + 2 = 12**

5. (a) Draw the molecular orbital diagram of O<sub>2</sub> molecule and for the species O<sub>2</sub>, O<sub>2</sub><sup>+</sup>, O<sub>2</sub><sup>-</sup> (superoxide) and O<sub>2</sub><sup>2-</sup> (peroxide) calculate their bond orders, compare their relative stabilities and indicate their magnetic properties.

(b) Using Slater's rule, find out the effective nuclear charge of Na atom. Explain why the electronegativity value of Ga is higher than that of Al.

(c) Why phenolphthalein is not a suitable indicator for the titration of ammonium hydroxide with HCl? Explain with the help of a pH curve for titration.  
**5 + (2 + 2) + 3 = 12**

**Group - D**

6. (a) Write the cell representation and calculate the equilibrium constant for the reaction, Fe<sup>3+</sup> + 3I<sup>-</sup> → Fe<sup>2+</sup> + I<sub>3</sub><sup>-</sup>. The E<sup>0</sup> values for Fe<sup>3+</sup>/Fe<sup>2+</sup> and I<sub>3</sub><sup>-</sup>/I<sup>-</sup> are 0.77 V and 0.54 V, respectively.

(b) The half life of a second order reaction 2A → P is 10 min and the initial concentration of the reactant is 0.2 mol/dm<sup>3</sup>. Calculate the rate constant of the reaction.

(c) Why are the Li<sup>+</sup> ions less mobile in water than K<sup>+</sup> ions although the ionic radius of Li<sup>+</sup> less than K<sup>+</sup> ?

(d) Calculate the standard free energy change for the following reaction at 25 °C, Au (s) + Ca<sup>2+</sup> (1M) → Au<sup>3+</sup> (1M) + Ca (s)  
The standard electrode potential values are Ca<sup>2+</sup>/Ca = -2.87V, Au<sup>3+</sup>/Au = +1.50 V. Predict whether the reaction will be spontaneous or not at 25° C.  
**4 + 3 + 2 + 3 = 12**