Time : 3 hours   Full Marks : 70
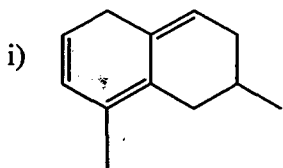
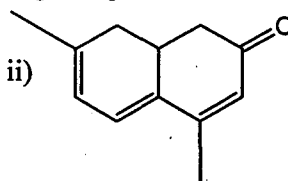*Use separate answer scripts for each half*

FIRST HALF

1. (a) State Lambert-Beer's law of absorption of light. With the help of this law, derive mathematical expression showing relation between absorbance and molar extinction co-efficient.

   b) Calculate the λ_{max} in nm each of the following compounds.
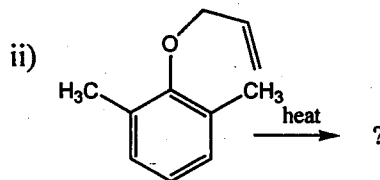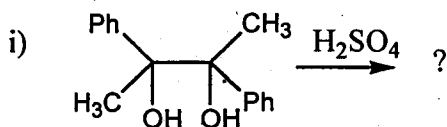
   i)   and   ii)

   c) What types of different electronic transition do you expect from each of the following compounds?

   i) Acetone ii) N,N-Dimethylaniline iii) Butadiene

   d) Predict the product with a reasonable mechanism:

   i)   ii)

   e) Explain why in presence trace of alkali colorless phenolphthalein solution shows deep orange color.

   $$4+3+3+6+1\frac{1}{2} = 17\frac{1}{2}$$

OR

2. a) Cholic acid, the major steroid found in bile, was found to have a rotation of $+2.22^0$ when a 5.00 gm sample was dissolve in 12 mL of alcohol in a sample tube with a 2.5 cm path length. Calculate the specific rotation of cholic acid.

   b) What are polymers? Classify them on the basis of *Tacticity*?

   c) How Nylon 66 is prepared? Give reaction.

   d) Differentiate Thermoplastic and Thermosetting polymer.

   e) A polymer sample consists of 10% by weight of macromolecules of molecular weight 10,000 and 90% by weight of macromolecules with molecular weight 100,000. Calculate number average molecular weight.

   f) Define the term with suitable example

   i) Diastereomer and Enantiomer ii) Bathochromic shift and Hypsochromic shift

   $$3+2\frac{1}{2}+2\frac{1}{2}+2\frac{1}{2}+3+2\times2 = 17\frac{1}{2}$$

3. (a) Predict the bond order and the number of unpaired electrons in O_2, O_2^{2-} and NO
   (b) Account for the instability of He_2
   (c) NO^+ has a stronger bond than NO itself – Explain
   (d) Name two neutral molecules which are isoelectronic with NO^+

$$6+3+4+4\frac{1}{2} = 17\frac{1}{2}$$

OR

4. (a) What are the essential elements of life
   (b) Explain with examples that essentiality of an elements is dependent on its oxidation state as well as its concentration.
   (c) Name two neutral ions whose compounds are used as medicine
   (d) What do you mean by chelation therapy? How do you remove Cu, Pb, Hg As (any two) from human body?

$$2+4+4+(3\times2\frac{1}{2}) = 17\frac{1}{2}$$

SECOND HALF

5. (a) Consider the following cell
   $$Sn / Sn^{+2} (aq) (a_1) // Pb^{+2} (aq) (a_2) / Pb$$
   where activity $a_1 = 0.6$; $a_2 = 0.3$ and calculate the free energy change for the cell reaction at $25°C$.
   (b) What are the types of electrodes in the following cell:
   $$Pt, Fe^{+2/+3} // Cl^- (aq) / AgCl (s)–Ag$$
   Write down the half cell reactions and the Nernst equation for the cell.
   (c) Illustrate with typical example, Primary and Secondary battery.
   (d) Schematically represent the working principle of a H_2-O_2 fuel cell and describe the electrochemical reactions occurring in the cell. Why such a cell is known as the most efficient clean energy conversion device?

$$3\frac{1}{2} + 5 + 4 + 5 = 17\frac{1}{2}$$

OR

6. (a) Write down individual electrode reaction and also the total cell reaction for the following cell.
   $$Pt | Fe^{+2} - Fe^{+3} || Cl^- | AgCl (s) | Ag$$

   (b) Construct cell for each of the following reactions.
   (i) $Hg_2Cl_2 = 2Hg + Cl_2$

   (ii) $Ag^+ + I^- = AgI (s)$
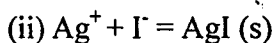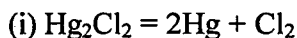
   (c) Given $E^0_{Cu|Cu^{+2}} = -0.337$ V and $E^0_{Cu|Cu^+} = 0.530$ V calculate the standard electrode potential for the reaction, $2Cu^+ = Cu^{+2} + Cu$. Justify which is easier to oxidize: $Cu \rightarrow Cu^{+2}$ or $Cu \rightarrow Cu^+$.
   (d) Define transport number and mobility of ions in solution. Given that ionic mobilities of NH_4^+ and ClO_4^- are 6.9×10^{-4} and 5.8×10^{-4} cm^2 $volt^{-1}$ sec^{-1} at room temperature, calculate the equivalent conductance of NH_4ClO_4

$$3+4+5+3+ 2\frac{1}{2} = 17\frac{1}{2}$$

7. (a) Show that if A undergoes two simultaneous reactions to produce B and C according to $A \xrightarrow{k_1} B$, $A \xrightarrow{k_2} C$, then E_a, the observed activation energy for the disappearance of A is given by $E_a = \dfrac{k_1 E_1 + k_2 E_2}{k_1 + k_2}$. Symbols have their usual significance.

(b) The rate of a reaction is given by $\log k = A - \dfrac{B}{T} + C \log T$. Find the value of activation energy.

(c) Both the 1s and 2s orbital of the Be atom are filled, yet the Be crystal is conducting – Explain with diagram.

(d) Draw the energy band spectrum of a diamond crystal, starting from its atomic levels and then discuss why Silicon has band gap energy less than that of diamond.

$$5+4+3 + 5\frac{1}{2} = 17\frac{1}{2}$$

OR

8. (a) Define the terms: i) Insulator, ii) Minority carriers, iii) Hall voltage

(b) Discuss the behaviour of a Germanium crystal doped with Arsenic atoms, at T = 0K and T > 0K.

(c) Show that if A simultaneously reacts to form B and C [as $A \xrightarrow{k_1} B$, $A \xrightarrow{k_2} C$], then $[A]_t = [A]_0 \, e^{-(k_1 + k_2) t}$ and the half of A is $\dfrac{0.693}{(k_1 + k_2)}$, where k_1 and k_2 are the two rate constants.

(d) What type of graph do you expect between $\log (k / k^0)$ and $1 / T$ (using Arrhenius equation)? What is the physical significance of its slope?

$$3 + 6+5+3\frac{1}{2} = 17\frac{1}{2}$$