

# RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. FIRST SEMESTER EXAMINATION, DECEMBER 2016

FIRST YEAR [BATCH 2016-19]

INDUSTRIAL CHEMISTRY [Honours]

Date : 13/12/2016

Time : 11 am – 3 pm

Paper : I

Full Marks : 75

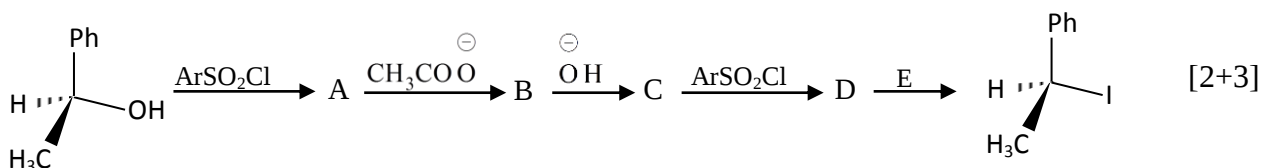
[Use a separate Answer Book for each Group]

## Group – A

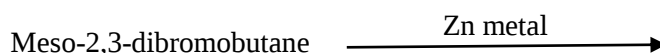
(Answer any five questions)

[5 x 5]

- Draw the orbital picture of allene indicating the state of hybridisation of carbon atoms.
  - Arrange ortho, meta and para dichlorobenzene in increasing order of dipole moment with proper explanation.
  - The dipole moment of  $\text{CO}_2$  is zero. Comment on the shape of the molecule. [2+2+1]
- Draw the Newman Projection formula of erythro-3-phenyl-2 butylacetate.
  - Write the conditions of a molecule to be optically active.
  - Explain the term 'chirotopic' and 'stereogenic' with proper example. [2+1+2]
- Which one is more nucleophilic and why?  
(i)  $\text{RO}^-$  and  $\text{RCOO}^-$  (ii)  $\text{NH}_3$  and  $\text{H}_2\text{O}$
  - Complete the following sequences:

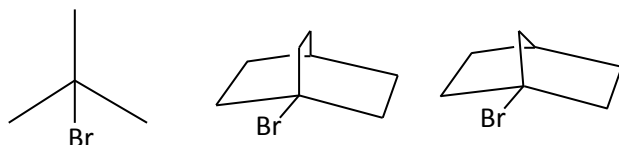


- Comment on the stereochemistry and stability of a tertiary carbocation.
  - The rate of reaction of methyl iodide with azide increases several fold with the change of solvent from methanol to DMSO. Explain
  - Hydrolysis of methyl chloride takes place much faster rate in presence of sodium iodide. Explain. [2+1½+1½]
- Write two conditions for a molecule to exhibit geometrical isomerism.
  - Why ethylene glycol exists exclusively in the gauche form?
  - Explain the statement: "An optically pure sample of  $(-)$  2-butanol shows a specific rotation –  $13.6^\circ$ ". [2+2+1]
- Draw the energy profile diagram of E1, E2 and E1cB mechanism of elimination reaction.
  - Write the product of the following reaction with detailed mechanism: [3+2]

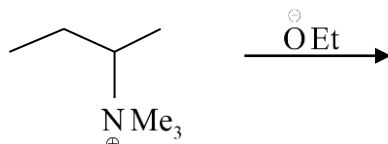


- What do you mean by nucleofuge?
  - Give an example of  $\text{S}_{\text{N}}\text{i}$  reaction and explain the mechanism.

- c) Arrange the following molecules in decreasing order of rate of hydrolysis with proper justification: [1+2+2]



8. a) Write the product of hydrolysis of (S)-2-bromopropanoate with high and low concentration of hydroxide ion. Justify the stereochemistry of product formation in both cases.  
b) Explain the formation of major product of the following reaction. [3+2]



**Group – B**  
(Answer any five questions)

[5 x 5]

9. a) Electron affinity of chlorine is higher than that of fluorine —Explain.  
b) Indicate the type of semiconduction (*n* or *p*) in the followings:  
(i) As doped Ge (ii) In doped Si  
c) Determine the limiting radius ratio for an octahedral Lattice. [1½+1+2½]
10. a) Discuss the conductivity, semiconductivity and insulation properties of metals by band theory with pictorial representation.  
b) What are the four quantum numbers?  
c) Calculate the A-R electronegativity of Zn taking its covalent radius as 125 pm. [2½+1+1½]
11. a) Calculate the electronegativity of iodine in  $IF$  and  $IF_7$  by Pauling scale (Taking  $x_F = 4.0$ ).  
Given  $I - F$  bond energy in  $IF = 278 \text{ KJ mol}^{-1}$   
 $I - F$  bond energy in  $IF_7 = 231 \text{ KJ mol}^{-1}$   
 $I - I$  bond energy in  $I_2 = 149 \text{ KJ mol}^{-1}$   
 $F - F$  bond energy in  $F_2 = 155 \text{ KJ mol}^{-1}$   
b) Compare and explain about the magnitude of 1<sup>st</sup> and 2<sup>nd</sup> electron affinity of oxygen and sulphur from the data given below:  
 $O_{(g)} \xrightarrow{+e} O_{(g)}^- (\Delta H = -141 \text{ KJ mol}^{-1})$ ,  $O_{(g)}^- + e \rightarrow O_{(g)}^{2-} (\Delta H = +844 \text{ KJ mol}^{-1})$   
 $S_{(g)} \xrightarrow{+e} S_{(g)}^- (\Delta H = -200 \text{ KJ mol}^{-1})$ ,  $S_{(g)}^- + e \rightarrow S_{(g)}^{2-} (\Delta H = +590 \text{ KJ mol}^{-1})$  [2½+2½]
12. a) Write down the expression of Lattice energy for an ionic solid and explain the terms involved therein.  
b) Write down the name and symbol of the element of atomic number 116 according to IUPAC nomenclature (2002).  
c) First ionization energy of Ti (22), Zr (40) and Hf (72) are as follows 658, 674 and 760 (KJ mol<sup>-1</sup>). Explain this phenomenon. [2+1+2]

13. Write the Bohr's basic postulates for its atomic model and deduce the expression for energy of the revolving electron in Bohr's orbit (In SI unit). [5]
14. a) Explain the fine spectra obtained in the light of Sommerfeld's first modification when electron transition takes place from  $n = 3$  to  $n = 2$ .  
 b) With pictorial representation show the ground state electron distribution (configuration) of  $p^3$  following Hund's rules. [2½+2½]
15. a) Write the significance of magnetic Quantum number.  
 b) Derive the expression of radius of Bohr's orbit (In SI unit) and show that the radius of first Bohr orbit of a hydrogen atom is 53 picometer (1 picometer =  $10^{-12}$  m). [2+3]
16. a) Determine the ground state term symbol of  $\text{Co}^{3+}$  ion.  
 b) The melting point of  $\text{MgBr}_2$  is  $700^\circ\text{C}$  while that of  $\text{AlBr}_3$  is only  $97^\circ\text{C}$  — Explain.  
 c) Explain the degree of solubility of the following salts given below:  
 $\text{LiClO}_4$ ,  $\text{NaClO}_4$  and  $\text{KClO}_4$  [1½+2+1½]

**Group – C**  
**(Answer any five questions)**

[5×5]

17. Write down the three dimensional Maxwell velocity distribution law for ideal gas with graphical representation. Calculate average velocity from the equation. [2½+2½]
18. Apply the equipartition principle to calculate  $\gamma$  for an ideal gas that is non linear tri atomic. Calculate critical temperature ( $T_c$ ), pressure ( $P_c$ ) and volume ( $V_c$ ) from Van der Waals equation for real gas. [2+3]
19. a) State the zeroth law of thermodynamics.  
 b) Differentiate between state functions and path functions.  
 c) What is Clausius inequality? [1+2+2]
20. State second law of thermodynamics. 20g of hydrogen gas at  $27^\circ\text{C}$  are compressed isothermally to one-fourth of the original volume. Find the value of work done. [2+3]
21. Write and explain Gibbs phase rule. Prove that the maximum number of phases that can coexist in equilibrium is 3 for one component pVT system. [2½+2½]
22. State and explain Carnot's theorem. Show that  $\frac{E_s}{E_T} = \frac{C_p}{C_v}$  by using Jacobian.  $E$  is elastic bulk modulus. [2+3]
23. What is Joule Thomson effect? What is inversion temperature?  
 Show  $T dS = C_p dT - TV \alpha dp$  [ $\alpha$  = volume expansivity] [2+1+2]
24. Define triple point. Indicate it for water in its phase diagram and hence explain the anomalous behaviour of water. [2+3]

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