RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. FIRST SEMESTER EXAMINATION, DECEMBER 2017

FIRST YEAR [BATCH 2017-20]

Date : 12/12/2017 **INDUSTRIAL CHEMISTRY (Honours)**

Time : 11.00 am – 3.00 pm Paper : I Full Marks : 75

(Use a separate Answer Book for each group)

Group – A

Answer **any five** questions: [5 X 5]

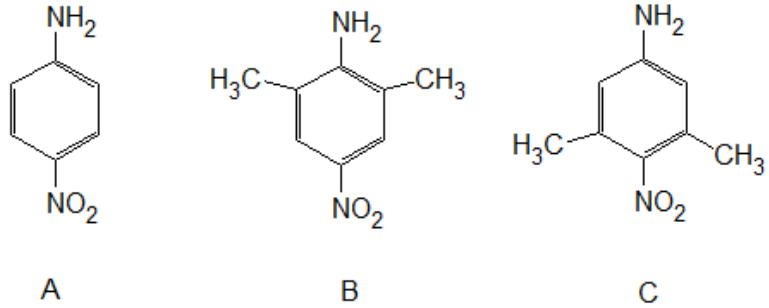
1. i) Predict the change in structure and stability of the following radicals.

$\overset{\bullet}{C}H_3,\ \overset{\bullet}{C}F_3,\ \overset{\bullet}{C}HF_2,\ \overset{\bullet}{C}H_2F$

ii) Between cis-2-butene and trans-2-butene which one under goes hydrogenation in faster rate and why? (2+3)

2. i) Arrange the following compounds with increasing order of acidity and give explanation.
(a) Ethanol, (b) Phenol, (c) Acetic acid

ii) Compare the basicity strength of the following compounds with proper explanations. (2+3)

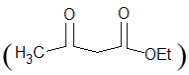


A B C

3. Describe the Hammond postulate of a reaction and utilize it to draw an energy profile diagram for the following reaction.

$$A \underset{K_{-1}}{\overset{K_1}{\rightleftharpoons}} B \underset{K_{-2}}{\overset{K_2}{\rightleftharpoons}} C$$

Here, stability of $C > A > B$ and $K_2 > K_{-1} > K_1$ K_{-2} (2+3)

4. (i) Between keto and enol form of ethylacetoacetate () which one is more stable in vapour phase and why? (2)

(ii) Predict the stability of thermodynamically and kinetically controlled products during the sulfonation of Naphthalene and draw the energy profile diagram for it. (3)

5. Draw all possible stereoisomers of 2,3,4-trihydroxypentane and state the relationship among themselves. Mark all the stereocentres as chirotopic, achirotopic, stereogenic and nonstereogenic as applicable. (5)

6. i) Draw the potential energy diagram for different conformations of *n*-butane with respect to $C_2 - C_3$ single bond rotation.

   ii) Arrange the following molecules in increasing order of dipole moment with proper explanation $(a)\,CH_3CL \quad (b)\,CH_2Cl_2 \quad (c)\,CHCl_3 \quad (d)\,CCl_4$ (3+2)

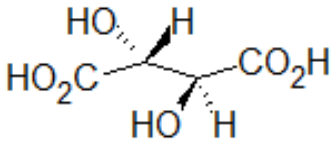
7. i) Write two conditions for a molecule to exhibit geometrical isomerism.

   ii) Draw the orbital picture of acrylonitrile $(CH_2{=}CH\text{-}C{\equiv}N)$ indicating the state of hybridisation of each carbon atom. 2+(1+2)

8. i) Define resonance energy taking benzene molecule as an example.

   ii) What do you mean by specific rotation?

   iii) Convert the following molecule to staggered form in Newmann and sawhorse Projection. (2+1+2)



Group – B

Answer **any five** questions: [5 X 5]

9. i) Which quantum number solely determines the allowed energies for a hydrogen like species? Write the expression for energy and explain the terms and sign present therein.

   ii) Find out the radius values for first and second Bohr orbits of Be^{3+}. (Given: a_0 of H atom $= 0.529\,\text{Å}$) (1+2)+2

10. i) State and explain Hund's rule of maximum spin and orbital multiplicity.

    ii) Find out the ground state term symbol of oxygen atom. (3+2)

11. i) A, B, C and D are four elements of the same period in Periodic Table. The first ionisation (I_1, ev) and second ionisation energy (I_2, ev) of the elements are listed below:

Element	A	B	C	D
I_1	5.39	21.50	6.11	17.40
I_2	75.60	41.00	11.87	35.00

Using the above letters identify (i) alkali metal, (ii) the alkaline earth metal, (iii) the non-metal and (iv) the noble gas.

   ii) What is Effective Nuclear charge? Find the shielding constant and effective nuclear charge of 3d electron and 1s electron in Zinc (Z = 30). (2+3)

12. i) State and explain the basis of the Pauling electronegativity scale.

    ii) Calculate the N–O and C–O bond length.
    Given: Radius of N, O and C are 70, 74 and 77 pm, respectively, while electronegativities of those three are 3.0, 3.5 and 2.5 respectively. (3+2)

13. i) Estimate the electronegativity of phosphorus if P–P distance in elemental phosphorus is 220 pm.
    ii) The electron affinity (EA) of 'Au' (Gold) is abnormally high and it may exist as auride — Justify. (3+2)

14. i) Are the bond angles <H–C–H and <F–C–F in CH_2F_2 molecule equal? Give reasons in support of your answer.
    ii) Explain, with suitable example, the *p*-type and *n*-type semiconductors from metallic bond concept. (2+3)

15. Select the best response for each question below: [1 X 5]
    (i) Which of the following molecules has zero dipole moment?
    (a) NH_3 (b) $CHCl_3$ (c) H_2O (d) BF_3
    (ii) Energy band gap size for insulators is in the range _____ eV.
    (a) 1-2 (b) 2-3 (c) 3-4 (d) >4
    (iii) Mobility of holes is _____ mobility of electrons in intrinsic semiconductors.
    (a) Equal (b) Greater than (c) Less than (d) cannot define
    (iv) Which of the following substances has the least ionic character in its bond?
    (a) CCl_4 (b) KCl (c) $BeCl_2$ (d) $MgCl_2$
    (v) The tendency of an atom to attract, a shared electron pair towards itself is called
    (a) Electron affinity (b) Electronegativity (c) Dipole moment (d) Ionization potential

16. i) If the radius of cation is 96 pm and that of anion is 618 pm, determine the coordination number and structure of the crystal lattice.
    ii) Can the colour intensities of Silver halides (AgX) be explained on the light of Fajan's Rule? Explain if possible, with suitable explanation. (2+3)

Group – C

Answer **any five** questions: [5×5]

17. Define and explain the physical significances of the following terms: (a) Free energy (b) Entropy. (2½+2½)

18. i) What is Joule-Thomson Effect?
    ii) Define Joule-Thomson coefficient.
    iii) Write down the significance of Joule-Thomson coefficient. (2+2+1)

19. i) What do you mean by inversion temperature?
    ii) An ideal monoatomic gas (one mole) is heated from 27 ^oC to 227 ^oC. The volume expands from 10L to 100L. What is the change in molar entropy? (1+4)

20. Write a short note on Gibbs-Helmholtz equation and explain its significance. (3+2)

21. At N.T.P., 11.2 litre of oxygen is mixed with 36 g of Helium. Calculate the entropy change and molar entropy change of mixing. (5)

22. Show that

(i) for a reversible adiabatic process of an ideal gas, $TV^{\gamma-1} = \text{constant}$

(ii) for an adiabatic process of an ideal gas, $W = C_V(T_1 - T_2)$ (2½+2½)

23. i) Prove that maximum work can be obtained from an isothermal reversible process.

ii) Prove that adiabatic PV–curve is more steeper than isothermal PV–curve. (3+2)

24. Define degrees of freedom. Write down the law of equipartition of energy principle and show different degrees of freedom for a linear molecule using the law. (2+3)

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