RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

FIRST YEAR [2017-20]

B.A./B.Sc. FIRST SEMESTER (July – December) 2017

Mid-Semester Examination, September 2017

Date : 12/09/2017

INDUSTRIAL CHEMISTRY (Honours)

Time : 11 am – 1 pm

Paper : I

Full Marks : 50

[Use a separate Answer Book for each group]

Group – A

Answer **any four** from **Question Nos. 1 to 7** : [4×5]

1. a) Draw the orbital picture of allene and 1,3–butadiene indicating the state of hybridisation of carbon atoms. [2+2]

   b) Phenol does not exist as cyclohexadienone. Explain. [1]

2. a) Arrange ortho, meta and para dichlorobenzene in increasing order of dipole moment with proper explanation. [2·5]

   b) Write the difference between inductive effect and mesomeric effect. [2·5]

3. a) Arrange the following compounds in increasing order of enol content with justification.
   (i) Acetyl acetone (ii) Ethylacetoacetate (iii) Diethylmalonate [3]

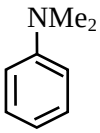
   b) State the state of hybridisation of carbon in methyl carbocation and methyl carbanion. [2]

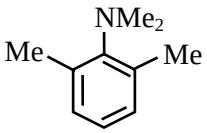
4. a) What is the basic difference between tautomerism and resonance? [2·5]

   b) Arrange the following compounds with increasing order of acidity with proper explanation.
   (i) Ethanol (ii) Phenol (iii) Acetic acid [2·5]

5. a) Arrange the following molecules in increasing order of dipole moment with proper explanation.
   (i) CH_3Cl (ii) CH_2Cl_2 (iii) $CHCl_3$ (iv) CCl_4 [3]

   b) Which one of the following is more basic and why? [2]

   i) 

   ii) 

6. a) Between ortho and para nitrophenol which one is higher boiling and why? [2]

   b) Draw the different resonating structure of diazomethane and find out the most contributing structure from them. [3]

7. a) Between cis and trans-2-butene which one undergoes hydrogenation in faster rate and why? [2]

   b) What is the difference between conjugation and hyperconjugation? [2]

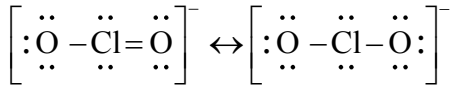
   c) What do you mean by time variable effect? [1]

Group – B

Question No. 8 is compulsory and answer **any one** from **Question No. 9 & 10** : [5+5]

8. Select the best response for each question below : [1×5]

A. The formal charges on the Cl atoms in the two resonance forms of $[ClO_2]^-$ are, respectively.



a) +1, 0 b) –1, 0 c) 0, 0 d) 0, +1 e) 0, –1

B. How many bonds are drawn in the best Lewis structure for NO_2^+?

a) 2 b) 3 c) 4 d) 5 e) 6

C. What is the oxidation number of the oxygen atoms in O_3?

a) –3 b) –1/3 c) 0 d) +1/3 e) +3

D. The enthalpy changes for which of the following processes represents the standard enthalpy of formation of AgCl?

a) $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$ b) $Ag(s) + Cl(g) \rightarrow AgCl(s)$

c) $AgCl(s) \rightarrow Ag(s) + \frac{1}{2}Cl_2(g)$ d) $Ag(s) + AuCl(s) \rightarrow Au(s) + AgCl(s)$

e) $Ag(s) + \frac{1}{2}Cl_2(g) \rightarrow AgCl(s)$

E. Consider the following information :

$A + B \rightarrow C + D \quad \Delta H° = -10 \cdot 0 \text{ kJ}$

$C + D \rightarrow E \quad \Delta H° = 15 \cdot 0 \text{ kJ}$

Which one of the following reactions would have $\Delta H° = -10$ kJ ?

a) C + D $\rightarrow$ A + B b) 2C + 2D $\rightarrow$ 2A + 2B c) A + B $\rightarrow$ E

d) $\frac{1}{2}E \rightarrow \frac{1}{2}C + \frac{1}{2}D$ e) 2E $\rightarrow$ 2A + 2B

9. a) Use the following information to calculate the heat of sublimation for potassium, showing the related energy cycle.

Heat of formation for KCl (s) = –437 kJ/mol

Electron affinity for Cl = –349 kJ/mol

Ionization energy for K = 418 kJ/mol

Lattice energy for KCl = 717 kJ/mol

Heat of formation for Cl(g) = 122 kJ/mol

Bond dissociation energy for Cl_2(g) = 243 kJ/mol [3]

b) Arrange the solubility order towards water for BeX_2 (X = Halides) with proper explanations. [2]

10. a) Calculate the second ionization energy for calcium using the following information :

Bond dissociation energy for gaseous molecular fluorine = 158 k/mol

First ionization energy for calcium = 589·8 kJ/mol

Heat of sublimation for calcium = 178·2 kJ/mol

Electron affinity for fluorine = –328 kJ/mol

Lattice energy for $CaF_2(s)$ = –2630 kJ/mol

Heat of formation for $CaF_2(s)$ = –1215 kJ/mol [3]

b) "The minimum radius ratio for tetrahedral system is 0·225". Prove that by proper geometrical calculation. [2]

Answer **any two** from **Question Nos. 11 to 14** : [2×5]

11. State the origin and physical significance of azimuthal quantum number. How is this quantum number related to the total quantum number? Draw the possible shapes of the Bohr-Sommerfeld orbits for n = 4. [2+1+2]

12. a) Calculate the frequency of electron rotation in the n = 10 state of hydrogen atom.

(Given : velocity of light = 3×10^{10} cm/s, mass of electron = $9\cdot11\times10^{-28}$ g, Planck's constant = $6\cdot625\times10^{-27}$ erg. sec, charge of electron = $4\cdot8\times10^{-10}$esu. [3]

b) Why is the energy of an electron at 'n' th shell negative? [2]

13. Calculate the frequency, energy and wavelength of the radiation corresponding to the spectral line of the lowest frequency in Lyman series in the spectrum of H-atom. Also calculate the energy for the corresponding line in the spectral of Li^{2+} ion. Given that $R_H = 1\cdot09678\times10^7\,m^{-1}, C = 3\times10^8\,ms^{-1}$ and $h = 6\cdot625\times10^{-34}\,JS$. [3+2]

14. a) Write down the energy value of an electron in Bohr-Sommerfeld orbit. Give the significance of this energy value. [2+1]

b) Discuss the fine spectral structure of H_∞ line of hydrogen atom. [2]

Group – C

Answer **any two** from **Question Nos. 15 to 17** : [2×5]

15. a) Prove that maximum work can be obtained from a isothermal reversible process. [3]

b) Prove that adiabatic PV-curve is more steeper than isothermal PV-curve. [2]

16. Prove that for an adiabatic reversible process. PV^γ = constant. [5]

17. One mole of an ideal mono-atomic gas at 27°C expands reversibly and adiabatically from a volume of 10 dm^3 to a volume 20 dm^3. Calculate ΔU and ΔH in joule (Assume that $C_V = 3/2\,R$). [2·5+2·5]

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