Code : 100103

B.Tech 1st Semester Exam., 2018 (New)

CHEMISTRY

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

1. Answer any *seven* questions (answer in brief) : 2×7=14

(a) How is bond order related with dissociation energy?

(b) Write the ground state electronic configuration of N_2^-.

(c) Which of Cr^+ or Cu^+ is expected to be coloured?

(d) What is the basic criterion for a nucleus to show NMR spectrum?

(e) A gas expands against vacuum. What is the work done on it?

(f) What is the significance of free energy?

(g) Why is water softened by zeolite process unfit for use in boilers?

(h) What happens when temporary hard water is boiled? (Give equations).

(i) Which of the following is not a nucleophile?

H_2O, BF_3, NH_3, OH^-

(j) Why are Br^+ and CCl_2 electrophiles?

2. *(a)* 5 moles of a monoatomic ideal gas are compressed reversibly and adiabatically. The initial volume is $6\,dm^3$ and final volume is $2\ dm^3$. The initial temperature is 27 °C. Calculate the final temperature in this process. Calculate w, q and ΔU for the process. Given $C_v = 20{\cdot}91\,JK^{-1}\ mol^{-1}$ and $\gamma = 1{\cdot}4$. 7

(b) At 298 K, the standard free energies of formation of CH_3COOH (aq), CH_3COO^- (aq) and H^+ (aq) are $-396 \cdot 6$, $-369 \cdot 4$ and 0 kJ mol^{-1}, respectively. Calculate the equilibrium constant for the dissociation of acetic acid at 298 K. 7

3. (a) The speed of an electron moving at 600 m s^{-1} is measured to an accuracy of 0·005%. What would be the minimum error in determining its position? (Mass of electron $9 \cdot 1 \times 10^{-31}$ kg and Planck constant, $h = 6 \cdot 6 \times 10^{-34}$ kg m^2 s^{-1}.) 4

(b) Discuss the failures of classical mechanics to explain properties of particles at atomic and sub-atomic level. 5

(c) Electromagnetic radiation of wavelength 242 nm is just sufficient to ionize sodium ion. Calculate the ionization energy of sodium atom in kJ/mol ($c = 10^8$ ms^{-1} and $h = 6 \cdot 626 \times 10^{-34}$ J-S.) 5

4. (a) Draw the MO energy-level diagram for N_2 and based on the diagram, explain the magnetic property observed in N_2. 8

(b) Explain geometrical isomerism and optical isomerism for transition metal complex with an example for each. 6

5. (a) Calculate the force constant of CO molecule, if its fundamental vibrational frequency is 2140 cm^{-1}. (At. mass of carbon = $1 \cdot 99 \times 10^{-26}$ kg and O = $2 \cdot 66 \times 10^{-26}$ kg.) 4

(b) Microwave spectrum of gaseous HCl molecule exhibits a series of equally spaced lines with interspacing of $20 \cdot 7 cm^{-1}$. Calculate the internuclear distance of HCl molecule. 4

(c) How many ^1H NMR signals are there in the following? 6

(i) $CH_3 - CH_3$

(ii) $CH_3 - CH_2 - CH_3$

(iii) $CH_3 - CH_2 - Cl$

(iv) $CH_3 - CHCl - CH_3$

(v) $C_6H_5CH_3$

(vi) $C_6H_5CH_2CH_3$

6. *(a)* Write short notes on the following : 9

(i) Magnetic resonance imaging

(ii) Fingerprint region in infrared spectroscopy

(iii) Different types of electronic excitations

(b) Use the equation of state of van der Waals to calculate the pressure of 8 g of gaseous CO_2 occupying a volume of 8 L at 27 °C. (Given, $a = 3 \cdot 6 L^2 \text{ atm mol}^{-2}$, $b = 0 \cdot 043 L \text{ mol}^{-1}$, $R = 0 \cdot 082 \text{ L atm K}^{-1} \text{ mol}^{-1}$). Compare the above result with the pressure calculated using ideal gas equation. 5

7. *(a)* Calculate the quantity of lime and soda required for softening 50000 litres of water containing the following : 5

$Ca(HCO_3)_2 = 8 \cdot 1$ ppm, $Mg(HCO_3)_2 = 7 \cdot 5$ ppm

$CaSO_4 = 13 \cdot 6$ ppm, $MgSO_4 = 12$ ppm,

$MgCl_2 = 2$ ppm, $NaCl = 4 \cdot 7$ ppm

(b) 20 mL of standard hard water (containing 15 g $CaCO_3$ per litre) required 25 mL of EDTA solution for end point. 100 mL of water sample required 18 mL of EDTA solution, while same water after boiling required 12 mL EDTA solution. Calculate carbonate and non-carbonate hardness of the water sample. 3

(c) 20 mL of 0·1 *N* Na_2CO_3 solution was added to 100 mL of a sample of hard water. The filtrate from the above required 3 mL of 0·05 *N* H_2SO_4 for complete neutralization. Calculate the hardness of the water sample. 3

(d) Describe the removal of hardness of water by ion-exchange method. 3

8. *(a)* Describe two methods used for resolving racemic mixtures into optically active compounds. 6

(b) Write the possible optical isomers of tartaric acid. 2

(c) Differentiate between *(i)* enantiomers and diastereomers and *(ii)* racemic mixture and meso compounds. 6

9. *(a)* Write the product for the following reactions together with reaction mechanism : 7

(i) $2CH_3COCH_3 + OH^- \rightarrow$

(ii) CH_3CH_2OH (heated with H_2SO_4) $\rightarrow$

(b) Write short notes on the following : 7

(i) Steric effects

(ii) Diels-Alder reaction

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