

B.Tech 2nd Semester Exam., 2021

(New Course)

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 in brief : $2 \times 7 = 14$

- (a) State de Broglie's principle.
- (b) What is an orbital?
- (c) What are the shapes of BF_3 and ClF_3 molecules?

- (d) Out of NH_3 , PH_3 , AsH_3 and SbH_3 , which possesses largest bond angle? Give reason.
- (e) Out of Cr^{2+} and Cr^{3+} , which one is stable in aqueous solution?
- (f) Cu^+ is colourless but Cu^{2+} is coloured. Why?
- (g) What is selection rule?
- (h) A gas expands against vacuum. What is the work done on it?
- (i) What is the condition for a reaction to be in equilibrium?
- (j) The presence of CO_2 in boiler feed water should be avoided. Why?

2. (a) A water sample had the following constituents per litre :

- $\text{CaCO}_3 = 160 \text{ mg}$
- $\text{MgHCO}_3 = 150 \text{ mg}$
- $\text{CaSO}_4 = 136 \text{ mg}$
- $\text{MgSO}_4 = 120 \text{ mg}$
- $\text{NaCl} = 10 \text{ mg}$

Calculate the quantity of temporary and permanent hardness in the water sample. Calculate the quantity of lime (78% purity) and soda (92% purity) required for softening of 25 million litre of above water sample. 9

(b) In an experiment to determine the hardness of a sample of water, 50 mL of $N/50$ Na_2CO_3 solution was added to 200 mL of water sample. After complete precipitation of insoluble carbonate, the unreacted Na_2CO_3 was titrated against $N/50$ H_2SO_4 solution, when 20 mL of acid was required. Calculate the hardness and comment on the nature of hardness so determined. 5

3. (a) Write short notes on the following : 10

(i) Photoelectric effect

(ii) Heisenberg's uncertainty principle

(b) How many photons of light having a wavelength of 3000 Å are necessary to provide 1 J of energy?
($h = 6.626 \times 10^{-34}$ J-s) 4

4. (a) Explain the behaviour of CO as ligand with different metal ions using molecular orbital theory. 6

(b) Draw the MO energy-level diagram for NO molecule. Using this diagram, calculate and explain bond order and magnetic behaviour of (i) NO, (ii) NO^+ and (iii) NO^- . 8

5. (a) Which type of electronic transition(s) is/are observed in UV-visible spectrum of aniline in the range 200 nm to 900 nm? Justify your answer with suitable figure. <https://www.akubihar.com> 6

(b) The internuclear distance of NaCl is 2.36×10^{-10} m. Calculate the reduced mass and moment of inertia of NaCl. (Atomic mass of Cl = 35×10^{-3} kg mol⁻¹ and Na = 23×10^{-3} kg mol⁻¹) 4

(c) Calculate the force constant for CO, if it absorbs at 2.143×10^5 m⁻¹. (Atomic mass of C = 12×10^{-3} kg mol⁻¹ and O = 16×10^{-3} kg mol⁻¹) 4

6. (a) How many types of ¹H NMR signals are expected for (i) $\text{CH}_3\text{COOCH}_2\text{CH}_3$ and (ii) CH_3CHCl_2 ? Mention the relative intensity ratio for the signal(s) observed for (i) and (ii). 6

- (b) 0.6 mol of NH_3 at 25°C occupies a volume of 3 dm^3 . Calculate the pressure using van der Waals equation ($a = 0.417 \text{ N m}^4 \text{ mol}^{-2}$ and $b = 0.037 \times 10^{-3} \text{ m}^3 \text{ mol}^{-1}$).

Compare the above result with the pressure calculated using ideal gas equation.

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7. (a) 7 mol of a monatomic ideal gas are compressed reversibly and adiabatically. The initial volume is 15 dm^3 and the final volume is 9 dm^3 . The initial temperature is 27°C . (i) What would be the final temperature in this process? (ii) Calculate w , q and ΔU for the process. Given, $C_v = 20.91 \text{ J K}^{-1} \text{ mol}^{-1}$ and $\gamma = 1.4$.

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- (b) Write a cell representation (in proper cell representation) whose cell reaction is $\text{AgCl} \rightarrow \text{Ag}^+ + \text{Cl}^-$, using the following standard electrode potentials at 298 K :

$$E^\circ_{\text{AgCl}/\text{Ag}, \text{Cl}^-} = 0.22 \text{ V}$$

$$E^\circ_{\text{Ag}^+/\text{Ag}} = 0.80 \text{ V}$$

Calculate E° of the cell. Calculate solubility product (or solubility constant) of AgCl and its solubility at 298 K .

7

8. (a) Write notes on the following : 7

- (i) Optical isomerism of lactic acid
(ii) Optical isomerism of tartaric acid

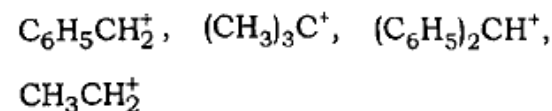
- (b) Differentiate between the following : 7

- (i) Enantiomers and Diastereomers
(ii) Racemic mixture and Meso-compounds

9. (a) Explain the following : 6

- (i) Trichloroacetic acid is stronger acid than acetic acid.
(ii) The amino group in aniline is *o*- and *p*-directing but nitro group is *m*-directing.

- (b) Arrange the following carbocations in order of increasing stability with suitable reasons : 4



(c) Write short notes on the following : 4

(i) Markownikoff's rule

(ii) Kharasch's rule

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