

# Bihar Engineering University, Patna

B.Tech. 1<sup>st</sup> Semester Examination, 2023

Course: B.Tech.

Code: 100103

Subject: Chemistry

Time: 03 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.

Q.1 Answer the following (Any seven question only):-

[2 x 7 = 14]

- (a) Why are  $\text{Br}^+$  and  $\text{CCl}_2$  electrophiles?
- (b) What do you mean by single electrode potential?
- (c) Arrange molecular species  $\text{N}_2$ ,  $\text{N}_2^+$  and  $\text{N}_2^-$  in increasing order of stability.
- (d) A water sample contains 204 mg of  $\text{CaSO}_4$  per litre. Calculate the hardness in terms of  $\text{CaCO}_3$  equivalent?
- (e) What is the value of effective nuclear charge ( $z^*$ ) for last electron of  $\text{Cu}^+$ ? (Atomic no. of  $\text{Cu}=29$ )
- (f) Out of  $\text{Cr}^{2+}$  and  $\text{Cr}^{3+}$ , which one is stable in aqueous solution?
- (g) What is the direction of a reaction, when  $\Delta G = 0$ ?
- (h) How is the bond order related with dissociation energy?
- (i) The specific conductance of a decinormal solution of  $\text{KCl}$  at  $18^\circ\text{C}$  is  $0.0112 \text{ ohm}^{-1}\text{cm}^{-1}$ . The resistance of the cell containing the solution at  $18^\circ\text{C}$  was found to be 55 ohms. What is the cell constant?
- (j) A gas expands against vacuum. What is the work done on it?

Q.2

- (a) Discuss Heisenberg's uncertainty principle and deduce a mathematical expression involving position and velocity of uncertainty of an electron. [7]
- (b) Explain dual nature of light and give one example (property/experiment) in favour of its particle nature and wave nature. [7]

Q.3

- (a) Draw the MO energy-level diagram for  $\text{O}_2$  and based on the diagram explain the paramagnetic property observed in  $\text{O}_2$ . [7]
- (b) Explain ionization isomerism and linkage isomerism for transition metal complex with an example of each. [7]

Q.4

- (a) 1 mole of an ideal gas expands isothermally and reversibly from  $5 \text{ dm}^3$  to  $10 \text{ dm}^3$  at  $300 \text{ K}$ . Calculate  $q$ ,  $w$ ,  $\Delta U$ ,  $\Delta H$ ,  $\Delta G$  and  $\Delta A$ . [7]
- (b) Design electrochemical cells (in proper notation) in which each of the following reaction occurs: [7]
  - (i)  $\text{Ce}^{4+}(\text{aq}) + \text{Fe}^{2+}(\text{aq}) \rightarrow \text{Ce}^{3+}(\text{aq}) + \text{Fe}^{3+}(\text{aq})$
  - (ii)  $\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$
  - (iii)  $\text{HgO}(\text{s}) + \text{H}_2(\text{g}) \rightarrow \text{Hg}(\text{l}) + \text{H}_2\text{O}(\text{l})$
  - (iv)  $\text{Fe}^{2+}(\text{aq}) + \text{Ag}^+(\text{aq}) \rightarrow \text{Fe}^{3+}(\text{aq}) + \text{Ag}(\text{s})$

**Q.5**

- (a) Write the principle for lime soda process for softening of hard water? [7]
- (b) A water sample has the following constituents per litre:  $\text{CaCO}_3 = 81 \text{ mg}$ ,  $\text{Mg}(\text{HCO}_3)_2 = 75 \text{ mg}$ ,  $\text{CaSO}_4 = 136 \text{ mg}$ ,  $\text{MgSO}_4 = 120 \text{ mg}$ ,  $\text{NaCl} = 4.7 \text{ mg}$ . 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 1.5 million litres of the water sample. [7]

**Q.6**

- (a) The internuclear distance of NaCl is  $2.36 \times 10^{-10} \text{ m}$ . Calculate the reduced mass and moment of inertia of NaCl. (Atomic mass of Cl =  $35 \times 10^{-3} \text{ kg mol}^{-1}$  and Na =  $23 \times 10^{-3} \text{ kg mol}^{-1}$ ) [7]
- (b) Write the product for following reactions together with reaction mechanism: [7]
- (i)  $2\text{CH}_3\text{COCH}_3 + \text{OH}^- \rightarrow$
- (ii)  $\text{CH}_3\text{CH}_2\text{OH}$  (heated with  $\text{H}_2\text{SO}_4$ )  $\rightarrow$

**Q.7**

- (a) Discuss photoelectric effect and explain equations involved with this effect. [7]
- (b) How many photons of light having a wavelength of  $4000 \text{ \AA}$  are necessary to provide 1 J of energy? ( $h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s}$ ) [7]

**Q.8** Explain the following:-

[3½ x 4 = 14]

- (a)  $\text{S}_{\text{N}}1$  leads to racemic mixture, whereas  $\text{S}_{\text{N}}2$  gives rise to inverted product.
- (b) o-nitrophenol easily separates from p-nitrophenol by steam distillation.
- (c) The amino group in aniline is o- and p-directing, but amide group is m-directing.
- (d) Benzoic acid is weaker than formic acid.

**Q.9**

- (a) Write notes on the following:- [3½ x 2 = 7]
- (i) Optical isomerism of lactic acid
- (ii) Diels - Alder reaction.
- (b) Differentiate between the following:- [3½ x 2 = 7]
- (i) Enantiomers and diastereomers
- (ii) Racemic mixture and meso-compounds