

**Bihar Engineering University, Patna**  
**B.Tech. 2<sup>nd</sup> Semester Special Examination, 2024**

Course: B.Tech.  
 Code: 100203

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 questions (Any seven only):**

[2 x 7 = 14]

- (a) A gas expands against vacuum. What is the work done on it?
- (b) Transition metal ions like Cu<sup>+</sup> and Ag<sup>+</sup> are colorless. Why?
- (c) Presence of CO<sub>2</sub> in boiler feed water should be avoided. Why?
- (d) Arrange the following in increasing order of their stability?  
 N<sub>2</sub>, N<sub>2</sub><sup>+</sup>, N<sub>2</sub><sup>-</sup>
- (e) An example of phenolic resin is.....?
- (f) State de Broglie's principle.
- (g) What is the shape of the orbital BF<sub>3</sub>?
- (h) What is the significance of free energy?
- (i) What is critical temperature of a gas?
- (j) State the condition for a reaction to be in equilibrium.

**Q.2 (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? ( $h=6.626 \times 10^{-34} \text{ J} \cdot \text{s}$ )

[4]

**Q.3 (a) Which of the following two molecules has a higher bond length?**

[6]

- (i) O<sub>2</sub>
- (ii) O<sub>2</sub><sup>+</sup>
- (iii) O<sub>2</sub><sup>-</sup>

Explain using molecular orbital theory?

- (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<sup>+</sup>, (iii) NO<sup>-</sup>

[8]

**Q.4 (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.**

[8]

- (b) 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 =  $23 \times 10^{-3} \text{ kg mol}^{-1}$ .

[6]

**Q.5 (a) Write Vanderwall equation for real gases and predict the significance of 'a' and 'b'.**

[7]

- (b) Write in Nerst equation and calculate the e.m.f. of the following cell at 298 K and also write its cell equation.

[7]



$$\text{Given } E^{\circ}_{\text{Ag}^+/\text{Ag}} = 0.80 \text{ V,}$$

$$E^{\circ}_{\text{Cu}^{2+}/\text{Cu}} = 0.34 \text{ V}$$

- Q.6** (a) Write the possible isomers of tartaric acid and indicate the point of symmetry (if any) in the isomers. [7]
- (b) Differentiate between the following: [7]
- (i) enantiomers and diastereomers and
- (ii) racemic mixture and meso compounds.
- Q.7** A water sample had the following constituents per litre:  
CaCO<sub>3</sub>= 65 mg, (MgHCO<sub>3</sub>)<sub>2</sub> = 80 mg  
CaSO<sub>4</sub>= 155 mg, MgSO<sub>4</sub>= 135 mg, NaCl= 8 mg
- (a) Calculate the quantity of temporary and permanent hardness in the water sample. [7]
- (b) Calculate the quantity of lime (80% purity) and soda (90% purity) required for softening 1 million litre of above water sample. [7]
- Q.8** Write short notes on the following: [3½ x 4=14]
- (a) Magnetic resonance imaging
- (b) Different types of electronic excitations
- (c) Diels-Alder reaction
- (d) Crystal field theory (CFT)
- Q.9** (a) Explain the following: [8]
- (i) Acetic acid is stronger acid than phenol.
- (ii) The amino group in aniline is o- and p-directing but amide group is meta-directing.
- (b) Arrange the following carbocations in increasing order of their stability with suitable reasons: [6]
- (i) C<sub>6</sub>H<sub>5</sub>CH<sub>2</sub><sup>+</sup>
- (ii) (CH<sub>3</sub>)<sub>3</sub>C<sup>+</sup>
- (iii) (C<sub>6</sub>H<sub>5</sub>)<sub>2</sub>CH<sup>+</sup>
- (iv) CH<sub>3</sub>CH<sub>2</sub><sup>+</sup>

