

# Bihar Engineering University, Patna

## B.Tech 2<sup>nd</sup> Semester Examination, 2025

Course: B.Tech  
Code: 100215

Subject: Engineering 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** Choose the correct option / answer the following (Any seven question only):

(a) Planck's constant has the same dimensions as that of

- (i) angular momentum (iii) radiant energy
- (ii) work (iv) power

(b) Which of the following is not a property of electromagnetic radiation?

- (i) It can travel through vacuum (iii) It shows wave-particle duality
- (ii) It travels at the speed of light (iv) It requires a medium for propagation

(c) Identification of functional groups in a compound can be established by using

- (i) IR spectroscopy (iii) NMR spectroscopy
- (ii) UV-Vis spectroscopy (iv) chromatography

(d) Which of the following is an application of NMR spectroscopy?

- (i) Determination of molecular vibrations (iii) Determination of molecular mass
- (ii) Structural elucidation of organic compounds (iv) Determination of color intensity

(e) A fuel cell converts

- (i) electrical energy into chemical energy (iii) chemical energy directly into electrical energy
- (ii) mechanical energy into electrical energy (iv) thermal energy into electrical energy

(f) Temporary hardness of water is caused due to presence of

- (i) sulphates of Ca and Mg (iii) chlorides of Ca and Mg
- (ii) bicarbonates of Ca and Mg (iv) nitrates of Ca and Mg

(g) In the Zeolite process, the exhausted zeolite is regenerated by using

- (i) NaCl solution (iii) Ca(OH)<sub>2</sub> solution
- (ii) Na<sub>2</sub>CO<sub>3</sub> (iv) HCl

(h) Neoprene is a polymer of

- (i) isoprene (iii) chloroprene
- (ii) butadiene (iv) acryl nitrate

(i) Phenol-formaldehyde resin is obtained by polymerization of

- (i) condensation polymerization (iii) Copolymerization
- (ii) addition polymerization (iv) None of these

(j) Aspirin is mainly used as

- (i) antimarial (iii) antiseptic
- (ii) antibiotic (iv) analgesic and antipyretic

**Q.2** (a) (i) Discuss Einstein's photoelectric equation and explain how it supports the particle nature of light. [7]  
(ii) Calculate the uncertainty in the velocity of a cricket ball of mass 150 g if the uncertainty in its position is of order of 1 Å. [ $h = 6.6 \times 10^{-34} \text{ kg m}^2 \text{s}^{-1}$ ] [7]

(b) (i) Explain VSEPR theory. Predict the structures of  $\text{NH}_3$ ,  $\text{H}_2\text{O}$ , and  $\text{SF}_6$ .  
(ii) Discuss Bent's rule and its significance in predicting molecular shapes. [7]

**Q.3** (a) (i) What are metal carbonyls? Explain in brief the synthesis, structure and geometry of  $\text{Ni}(\text{CO})_4$ .  
(ii) Define isomerism in coordination compounds. Enumerate the different types of isomerism in coordination compounds with suitable examples. [7]

(b) Define corrosion by giving an example. Describe the different types of corrosion with suitable examples. [7]

**Q.4** (a) (i) Explain the working of a Leclanche cell with chemical reactions.  
(ii) Calculate the potential of the following electrochemical cell at 25 °C:  
 $\text{Cu(s)} \mid \text{Cu}^{2+} \text{ (aq)} (0.50 \text{ M}) \parallel \text{H}^+ (0.01) \mid \text{H}_2 \text{ (0.95 atm)}; \text{Pt}$   
Given:  $E_{\text{cathode}}^\circ = 0.00 \text{ V}$  and  $E_{\text{anode}}^\circ = 0.34 \text{ V}$  [7]

(b) (i) Calculate the gross and net calorific value of coal sample having the following composition: C = 80%, H = 7%, O = 3%, S = 3.5%, N = 2.1, and ash = 4.4%  
(ii) What are biofuels? Discuss their types and advantages over conventional fuels. [7]

**Q.5** (a) (i) Distinguish between rotational and vibrational spectroscopy.  
(ii) Explain the selection rules for vibrational transitions in diatomic molecules and their applications. [7]

(b) (i) State Beer's and Lambert's law and derive mathematical expression for Lambert-Beer's law.  
(ii) Explain the basic principle and applications of Nuclear Magnetic Resonance (NMR) spectroscopy. [7]

**Q.6** (a) Name the various methods which are used for softening of water. Explain with equations which is the best method and why? [7]  
(b) (i) How would you determine the alkalinity of water sample containing hydroxide and carbonate ion?  
(ii) 50 ml of standard hard-water containing 1 mg of pure  $\text{CaCO}_3$  per ml consumed 20 ml of EDTA. 50 ml of a water sample consumed 25 ml of the same EDTA solution. Using eriochrome T as indicator, calculate the total hardness of water in ppm. [7]

**Q.7** (a) Explain scale formation, caustic embrittlement, priming and foaming in boilers. What are the methods employed to remove these defects. [7]  
(b) What are the different types of polymerization mechanisms? Explain free radical polymerization mechanism in detail. [7]

**Q.8** (a) Write short notes on:  
(i) Silicones  
(ii) Buna-S rubber  
(iii) Epoxy resin [7]  
(b) (i) Differentiate between thermoplastics and thermosetting plastics.  
(ii) Write the structure unit and two important applications of the Poly ethylene, Polyvinyl chloride, Polystyrene. [7]

**Q.9** (a) (i) Define and illustrate the terms carbonium ion (carbocation), carbanion, and free radical.  
(ii) Explain the various types of organic reaction with examples. [7]  
(b) (i) Give the mechanism and industrial applications of Diels-Alder cyclization reaction.  
(ii) What are drug molecules? Explain in brief synthesis of aspirin including the reaction, conditions, and uses. [7]