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BRAINWARE UNIVERSITY

Term End Examination 2025-2026
Programme – B.Tech.(CSE)-AIML-2025
Course Name – Applied Chemical Sciences
Course Code - BBS00024
(Semester II)

Full Marks : 60

Time : 2:30 Hours

[The figure in the margin indicates full marks. Candidates are required to give their answers in their own words as far as practicable.]

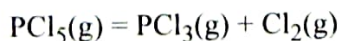
Group-A

(Multiple Choice Type Question)

1 x 15=15

1. Choose the correct alternative from the following :

- (i) According to Bohr, radiation is emitted by an atom when an electron
 - a) revolves in a stationary orbit
 - b) moves from higher to lower energy orbit
 - c) moves in a circular path
 - d) remains in ground state
- (ii) The radius of the first Bohr orbit of hydrogen atom is approximately
 - a) 0.53 Å
 - b) 1.06 Å
 - c) 0.25 Å
 - d) 1.00 Å
- (iii) Which of the following is an incorrect statement?
 - a) Corrosion is an irreversible process
 - b) Corrosion is a non-spontaneous process
 - c) Corrosion is a degradation process
 - d) Corrosion is a spontaneous process
- (iv) Which of the following is the most corrosion-resistant metal at room temperature?
 - a) Fe
 - b) Cu
 - c) Pt
 - d) Al
- (v) Waterline corrosion in steel tank is an example of:
 - a) Stress corrosion
 - b) Differential aeration corrosion
 - c) Pitting corrosion
 - d) Differential metal corrosion
- (vi) According to the Nernst equation, when concentration of reactants increases, the cell potential generally.....
 - a) Decreases
 - b) Increases
 - c) Remains zero
 - d) Becomes negative always
- (vii) Predict the relationship between enthalpy change (ΔH) and internal energy change (ΔU) for the following reaction at gaseous state.



- a) $\Delta H = \Delta U$
- b) $\Delta H > \Delta U$

- c) $\Delta H < \Delta U$ d) $\Delta H = 1/\Delta U$
- (viii) The entropy change in a reversible cyclic process is:
- a) positive b) zero
c) negative d) infinity
- (ix) During the mixing of ideal gases at constant temperature and pressure, the entropy:
- a) Remains unchanged b) Decreases
c) Initially increases, then decreases d) Increases
- (x) The effect of increasing conjugation on UV-Visible absorption can be illustrated as:
- a) Shift of $\lambda_{\max}$ to shorter wavelength b) No shift of $\lambda_{\max}$
c) Disappearance of $\lambda_{\max}$ d) Shift of $\lambda_{\max}$ to longer wavelength
- (xi) Select the correct amount of energy absorbed from the following when radiation of wavelength 250 nm is used
- a) 7.9×10^{-19} J b) 4.9×10^{-19} J
c) 2.9×10^{-19} J d) 5.9×10^{-19} J
- (xii) Identify the transition that requires the highest energy.
- a) $n \rightarrow \pi^*$ b) $\pi \rightarrow \pi^*$
c) $\sigma \rightarrow \sigma^*$ d) $n \rightarrow \sigma^*$
- (xiii) Determine the number of fundamental vibrational modes present in a CO_2 molecule.
- a) 2 b) 3
c) 4 d) 5
- (xiv) A compound can be identified in Thin Layer Chromatographic (TLC) technique by comparing its
- a) R_f values with standards b) Color intensity
c) Spot diameter d) Solvent viscosity
- (xv) Select the correct retention time if a peak appears 5 minutes after injection.
- a) 5 min b) 10 min
c) 15 min d) 20 min

Group-B

(Short Answer Type Questions)

3 x 5 = 15

- Using Slater's rules, calculate the effective nuclear charge experienced by an outermost (3) electron of an atom having the electronic configuration $1s^2 2s^2 2p^6 3s^2 3p^5$.
- Using standard SMILES conventions, construct the SMILES representations of cis-2-butene and trans-2-butene. (3)
- Define differential metal corrosion. (3)
 - The standard reduction electrode potentials of some metals are as follows: Mg^{2+}/Mg (-2.52 V), Zn^{2+}/Zn (-0.76 V), Fe^{2+}/Fe (-0.44 V), Cu^{2+}/Cu (0.34 V), Ag^+/Ag (0.80 V). Show which metal undergoes corrosion in the bimetallic couples: Fe/Cu, Zn/Ag, Mg/Cu.
- Consider the reaction: $\text{PCl}_5 (\text{g}) + \text{Heat} \rightleftharpoons \text{PCl}_3 (\text{g}) + \text{Cl}_2 (\text{g})$ (3)

Explain the changes in the equilibrium position according to Le Chatelier's Principle when:

- (i) PCl_5 is added to the system.
- (ii) The temperature of the reaction vessel is decreased.
- (iii) An inert gas is added to the system at constant pressure.

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6. (3)
- a. An analyst obtains the following calibration data for an analyte using a spectrophotometric method:

Concentration (ppm) Absorbance

2 0.18

4 0.36

6 0.54

- i) Determine the calibration equation.
 - ii) Comment on the linearity of the method.
- b. In an analytical method, the standard deviation of the blank response is 0.004, and the slope of the calibration curve is 0.020. Calculate the Limit of Detection (LOD).

OR

- a. Two analytical methods are proposed for estimating the same analyte. Method A (3) shows high precision but low accuracy, while Method B shows high accuracy but poor precision. Analyze which method is more reliable and justify your answer.
- b. A calibration curve shows good linearity at low concentrations but deviates at higher concentrations. Analyze the possible reasons for this deviation and suggest one corrective measure.

Group-C

(Long Answer Type Questions)

5 x 6=30

7. a. Explain why the Carnot cycle is considered an ideal cycle. Write the expression for (5) the efficiency of a Carnot engine and explain why its efficiency can never be 100%.
- b. A Carnot engine operates between a heat source at 600 K and a heat sink at 300 K. Predict the efficiency of the Carnot engine. If the engine absorbs 2000 J of heat from the source, determine the work done by the engine.

8. a. State the significance of the principal quantum number in Bohr's atomic model. (5)
 b. How can the discrete nature of the hydrogen atom spectrum be explained using Bohr's theory?
 c. Define the following
 i. Zeeman effect ii. Stark effect iii. Stationary orbit
9. Calculate the wavelength and frequency of the radiation emitted during the following (5)
 transitions in a hydrogen atom:
 a. Highest energy transition in Lyman series
 b. Lowest energy transition in Balmer series.
10. Explain the hybridization of phosphorus in PCl_5 in the gaseous state and sulphur in SF_4 , and relate it to the shape of each molecule. (5)
11. a. The EMF of a cell involving the cell reaction $3\text{Sn}^{4+} + 2\text{Cr} \rightarrow 3\text{Sn}^{2+} + 2\text{Cr}^{3+}$ is (5)
 0.89 V. Predict the free energy change for the reaction.
 b. Predict the equilibrium constant for the reaction, $2\text{Fe}^{3+} + 2\text{I}^- \rightarrow 2\text{Fe}^{2+} + \text{I}_2$.
 Where, the standard reduction potentials for $\text{Fe}^{3+}/\text{Fe}^{2+}$ and I_2/I^- are 0.77 and 0.54 V, respectively.
12. a. Prove that for an ideal gas under isothermal conditions, $\Delta G = \Delta A$, where $\Delta G =$ (5)
 Change in Gibbs free energy and $\Delta A =$ Change in Helmholtz free energy.
 b. Determine the change in entropy when 2 moles of an ideal gas are compressed from 10 L to 1 L under isothermal conditions.

OR

- a. Establish the following equation. (5)

$$\Delta G = \Delta H + T[d(\Delta G)/dT]_p$$

Where, $\Delta G =$ Change in Gibbs free energy, $\Delta H =$ Change in enthalpy, $T =$ temperature in kelvin scale.

- b. Choose from the following processes that would be spontaneous and also justify your answer:
- An exothermic process where entropy increases.
 - An endothermic process where entropy decreases.

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