

CHEMISTRY, PAPER-I

TIME ALLOWED: THREE HOURS	(PART-I MCQs)	MAXIMUM MARKS: 20
PART-I (MCQs) : MAXIMUM 30 MINUTES	(PART-II)	MAXIMUM MARKS: 80
NOTE: (i) First attempt PART-I (MCQs) on separate OMR Answer Sheet which shall be taken back after 30 minutes . (ii) Overwriting/cutting of the options/answers will not be given credit. (iii) There is no negative marking. All MCQs must be attempted.		

PART-I (MCQs)(COMPULSORY)

Q.1. (i) Select the best option/answer and fill in the appropriate Box ☐ on the **OMR Answer Sheet.(20x1=20)**
(ii) Answers given anywhere else, other than OMR Answer Sheet, will not be considered.

- Which of the following does not have the ground-state configuration $1s^2 2s^2 2p^6$?**
 (A) Ne (B) Na^+ (C) Cl^- (D) None of these
- A reaction is exothermic if:**
 (A) $\Delta H > 0$ (B) $\Delta H < 0$ (C) $\Delta G > 0$ (D) $\Delta G < 0$
- In chemometrics, multivariate calibration involves:**
 (A) Using multiple independent variables to predict dependent variables
 (B) Using regression only on X-data (C) Performing correlation without regression (D) None of these
- Langmuir isotherm assumes:**
 (A) Multilayer adsorption (B) Uniform surface without interactions between adsorbed molecules
 (C) Gas behaves as ideal (D) None of these
- A zero-order reaction rate does not depend on:**
 (A) Temperature (B) Pressure (C) Reactant concentration (D) None of these
- Enzymes act as catalysts by:**
 (A) Increasing activation energy (B) Lowering activation energy
 (C) Changing equilibrium position (D) None of these
- In an electrolytic cell:**
 (A) Electrons move from cathode to anode (B) The anode is negative
 (C) Energy is consumed to drive the reaction (D) None of these
- Silicones are primarily:**
 (A) Organic polymers (B) Inorganic polymers (C) Hybrid organic-inorganic polymers (D) None of these
- The Nernst equation relates electrode potential to:**
 (A) Pressure (B) Temperature and concentration (C) Surface area (D) None of these
- In solvent extraction, distribution coefficient is:**
 (A) Ratio of solute concentration in two phases (B) Ratio of solvents used
 (C) Ratio of extractant to sample volume (D) None of these
- In gas chromatography, the mobile phase is:**
 (A) Liquid (B) Gas (C) Solid (D) None of these
- Solubility of a salt is decreased in presence of:**
 (A) Common ion (B) High temperature (C) High Ph (D) None of these
- The solubility of a gas in a liquid is directly proportional to the partial pressure of the gas above the liquid. This statement is based upon:**
 (A) Raoult's law (B) Henry's law (C) Kohlrausch's law (D) None of these
- The heat capacity of a calorimeter is determined using:**
 (A) A bomb calorimeter (B) A known standard material (C) Adiabatic temperature rise (D) None of these
- Fugacity is used to measure:**
 (A) Real gas behavior (B) Ideal gas compressibility (C) Equilibrium constant (D) None of these
- Lattice enthalpy is always:**
 (A) Positive and represents energy absorption (B) Positive and represents energy release
 (C) Negative and represents energy absorption (D) Negative and represents energy release
- According to Hess's law:**
 (A) Enthalpy change depends on reaction pathway (B) Enthalpy change is path independent
 (C) Enthalpy depends on final state only (D) Enthalpy change includes entropy changes
- Debye-Hückel theory is used to calculate:**
 (A) Solubility of salts (B) Ionic strength of solutions (C) Gibbs free energy of ions (D) None of these
- Potentiometric titration involves measurement of:**
 (A) Current in the reaction (B) Volume at equivalence
 (C) Electrode potential as a function of titrant added (D) None of these
- According to molecular orbital theory the bond order of O_2^- is:**
 (A) 1.0 (B) 1.5 (C) 2.5 (D) None of these

PART-II

- NOTE: (i) Part-II is to be attempted on the separate Answer Book.**
- (ii) Attempt ONLY FOUR questions from PART-II by selecting TWO questions from EACH SECTION. ALL questions carry EQUAL marks.**
- (iii) All the parts (if any) of each Question must be attempted at one place instead of at different places.**
- (iv) Write Q. No. in the Answer Book in accordance with Q. No. in the Q.Paper.**
- (v) No Page/Space be left blank between the answers. All the blank pages of Answer Book must be crossed.**
- (vi) Extra attempt of any question or any part of the question will not be considered.**
- (vii) Use of Calculator is allowed.**

- Q. 2.** (a) Define adsorption and explain its types. Derive an expression for the Langmuir adsorption isotherm and discuss factors influencing adsorption on solids. (08)
- (b) Why are transition metal complexes often colored? Explain using crystal field theory with an example. (07)
- (c) Compare and contrast the Lewis concept and the Bronsted-Lowry theory of acids and bases. Include relevant examples and limitations. (05) (20)
- Q. 3.** (a) What is lanthanide contraction? Analyze its impact on the atomic radii and chemical properties of lanthanides and post-lanthanides. (08)
- (b) Analyze the quantum numbers associated with atomic orbitals and describe their importance in explaining electron configurations. (07)
- (c) Describe the catalytic activity of transition metals with reference to their variable oxidation states. Support your explanation with one example. (05) (20)
- Q. 4.** (a) Derive the Gibbs free energy equation from the first and second laws of thermodynamics and discuss its importance in predicting the spontaneity of chemical reactions. (10)
- (b) Explain the principle of fractional distillation. Compare it with simple distillation using a diagram and examples of their applications. (05)
- (c) Adsorption isotherms fail at high pressure. Why? Explain with reference to the limitations of the Freundlich isotherm. (05) (20)
- Q. 5.** (a) Why are Lewis's acids and bases more versatile in their applications than Bronsted-Lowry acids and bases? Provide two examples to support your answer. (10)
- (b) Derive the integrated rate law for a first-order reaction and explain why the half-life of such a reaction is independent of its initial concentration. (05)
- (c) State and explain the Heisenberg Uncertainty Principle. How does it limit our ability to precisely determine the position and momentum of particles? (05) (20)
- Q. 6.** (a) Discuss the Freundlich adsorption isotherm. Derive the equation and highlight its limitations. (07)
- (b) Using a diagram, explain the principle and working of a galvanic cell. Discuss its components with the example of a Zn-Cu system. (07)
- (c) Why does an exothermic reaction sometimes become non-spontaneous at high temperatures? (06) (20)
- Q. 7.** (a) Explain the relationship between entropy, enthalpy, and Gibbs free energy. Derive an expression for equilibrium using these thermodynamic quantities. (08)
- (b) Derive the first law of thermodynamics and explain its connection with internal energy and enthalpy. (07)
- (c) Define the concept of activation energy and illustrate its significance in reaction kinetics using the Arrhenius equation. (05) (20)
- Q. 8. Define the following:** (5 each) (20)
- (a) Difference between Homogenous and Heterogenous Catalysis
- (b) Define Molecular Orbital Theory (MOT)
- (c) Difference between ANOVA and Gaussian Distribution
- (d) Define Chromatography and write key differences between Paper Chromatography and Gas Chromatography
