



**FEDERAL PUBLIC SERVICE COMMISSION
COMPETITIVE EXAMINATION-2025 FOR RECRUITMENT
TO POSTS IN BS-17 UNDER THE FEDERAL GOVERNMENT**

Roll Number

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.

1. **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
2. **A reaction is exothermic if:**
(A) $\Delta H > 0$ (B) $\Delta H < 0$ (C) $\Delta G > 0$ (D) $\Delta G < 0$
3. **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
4. **Langmuir isotherm assumes:**
(A) Multilayer adsorption (B) Uniform surface without interactions between adsorbed molecules
(C) Gas behaves as ideal (D) None of these
5. **A zero-order reaction rate does not depend on:**
(A) Temperature (B) Pressure (C) Reactant concentration (D) None of these
6. **Enzymes act as catalysts by:**
(A) Increasing activation energy (B) Lowering activation energy
(C) Changing equilibrium position (D) None of these
7. **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
8. **Silicones are primarily:**
(A) Organic polymers (B) Inorganic polymers (C) Hybrid organic-inorganic polymers (D) None of these
9. **The Nernst equation relates electrode potential to:**
(A) Pressure (B) Temperature and concentration (C) Surface area (D) None of these
10. **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
11. **In gas chromatography, the mobile phase is:**
(A) Liquid (B) Gas (C) Solid (D) None of these
12. **Solubility of a salt is decreased in presence of:**
(A) Common ion (B) High temperature (C) High Ph (D) None of these
13. **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
14. **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
15. **Fugacity is used to measure:**
(A) Real gas behavior (B) Ideal gas compressibility (C) Equilibrium constant (D) None of these
16. **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
17. **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
18. **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
19. **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
20. **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



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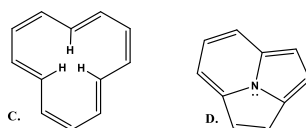
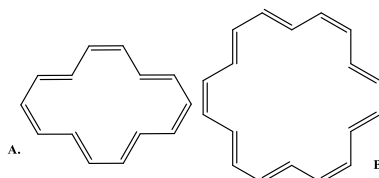
CHEMISTRY, PAPER-II

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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)
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- Which of the following is the primary site for the digestion of carbohydrates?
(A) Stomach (B) Mouth (C) Small intestine (D) None of these
- In glycolysis, the enzyme hexokinase catalyzes the conversion of:
(A) Glucose to glucose-6-phosphate (B) Pyruvate to lactate
(C) Fructose-6-phosphate to fructose-1,6-bisphosphate (D) None of these
- Which of the following is a common byproduct of the cement manufacturing process?
(A) Sulfur dioxide (SO₂) (B) Nitrogen oxides (NO_x) (C) Both (A) and (B) (D) None of these
- The raw materials for glass manufacturing typically include:
(A) Limestone and sand (B) Sand, soda ash, and lime (C) Clay and sodium hydroxide (D) None of these
- Starch is composed of:
(A) Amylose and amylopectin (B) Glycogen and amylopectin
(C) Amylopectin and cellulose (D) None of these
- An allosteric enzyme:
(A) Follows Michaelis-Menten kinetics (B) Is regulated by molecules that bind to a site other than the active site
(C) Is always inhibited by competitive inhibitors (D) None of these
- What type of fragmentation occurs in mass spectrometry?
(A) Homolytic cleavage (B) Heterolytic cleavage (C) Both (A) and (B) (D) None of these
- In IR spectroscopy, the fingerprint region is found in the range:
(A) 4000–2500 cm⁻¹ (B) 2500–1500 cm⁻¹ 1500–600 cm⁻¹ (D) None of these
- Which of the following is stereospecific?
(A) Free radical substitution (B) SN₂ reaction
(C) E₂ reaction with anti-periplanar elimination (D) None of these
- A molecule is chiral if:
(A) It has at least one plane of symmetry. (B) It has a chiral center and is non-superimposable on its mirror image.
(C) It rotates polarized light to the left. (D) None of these
- Which reaction is most likely to occur with a bulky base like *tert*-butoxide?
(A) SN₁ (B) SN₂ (C) E₂ (D) None of these
- What is the major product when ethyl acetate is hydrolyzed under acidic conditions?
(A) Acetic acid and ethanol (B) Acetaldehyde and ethanol
(C) Acetone and ethanol (D) None of these
- Which reaction involves the conversion of aldehydes into alcohols?
(A) Oxidation (B) Reduction (C) Hydrolysis (D) None of these
- Which compound will give a silver mirror test with Tollens' reagent?
(A) Propanone (B) Ethanal (C) Benzophenone (D) None of these
- The resonance energy of benzene is approximately:
(A) 150 kJ/mol (B) 200 kJ/mol (C) 250 kJ/mol (D) None of these
- Which of the following compounds are aromatic?



(A) A, B and D

(B) A, C and D

(C) A and D

(D) None of these

CHEMISTRY, PAPER-II CSS-2025

17. What is the main product when nitrobenzene reacts with chlorine in the presence of AlCl_3 ?
(A) Ortho-chloronitrobenzene (B) Meta-chloronitrobenzene (C) Chlorobenzene (D) None of these
18. Which type of substitution occurs predominantly in benzene?
(A) Nucleophilic substitution (B) Electrophilic substitution (C) Free radical substitution (D) None of these
19. What is the main product when 1-butyne reacts with excess of HBr ?
(A) 1-Bromobutene (B) 1-Bromobutane (C) 2,2-Bromobutene (D) None of these
20. Which of the following has the highest dipole moment?
(A) CO_2 (B) H_2O (C) CCl_4 (D) None of these

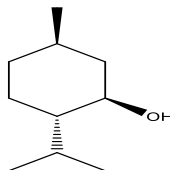
PART-II

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- Q.2. (a) Elaborate with examples that how resonance, hyperconjugation and inductive effect, can contribute towards the stability of carbocations. (10)
(a) How 'dipole moment' can be measured? Indicate, among the following molecules which does not have dipole moment and why? (10)

i. CCl_4 ii. BF_3 iii. CH_4 iv. NH_3

- Q.3. (a) How does the reaction mechanism work for the electrophilic addition of bromine to ethene? Explain the intermediate (s). (10)
(b) Describe the IUPAC rules for naming alkenes and alkynes with appropriate examples. (10)
- Q.4. (a) Categorize benzene substituents, into activating and deactivating groups. Explain their influence on *ortho*, *para* and *meta* orientation of incoming groups in electrophilic substitution reactions. (12)
(b) How did Kekulé propose the benzene structure, and what evidence supported his model? (8)
- Q.5. (a) Compare the reactivity of acid halides, anhydrides, esters, and amides toward nucleophilic substitution. What kind of products do you expect when these react with Grignard reagent (RMgX)? (10)
(b) Explain the reaction mechanism of Williamson synthesis to prepare ethers. (5)
(c) Discuss the acidic nature of phenols. Why picric acid ($\text{C}_6\text{H}_3\text{N}_3\text{O}_7$) is considered strong acid? (5)
- Q.6. (a) Given below is the structure of (1*R*, 2*S*, 5*R*) menthol. Draw the structures of all possible stereoisomers of menthol. (8)



- (b) How does Hofmann's rule differ from Zaitsev's rule? Explain each with suitable example. (6)
(c) Describe the main components of a UV/Visible spectrophotometer and their functions. (6)
- Q.7. (a) Write a comprehensive note on primary, secondary, tertiary, and quaternary structures of proteins. (10)
(b) Write a note on enzyme catalysis and enzyme inhibition. (10)
- Q.8. (a) Outline the steps of the Krebs cycle, and explain its role in cellular respiration. (10)
(b) Describe the environmental impact of the manufacturing industry of sugar, cement, glass, paper and fertilizers. How these industries can address environmental concerns? (10)
