

2021

CHEMISTRY (Honours)

Paper Code : XI - A & B

[New Syllabus]

Important Instructions for Multiple Choice Question (MCQ)

- Write Subject Name and Code, Registration number, Session and Roll number in the space provided on the Answer Script.

Example : Such as for Paper III-A (MCQ) and III-B (Descriptive).

Subject Code :

III	A	&	B
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Subject Name :

- Candidates are required to attempt all questions (MCQ). Below each question, four alternatives are given [i.e. (A), (B), (C), (D)]. Only one of these alternatives is 'CORRECT' answer. The candidate has to write the Correct Alternative [i.e. (A)/(B)/(C)/(D)] against each Question No. in the Answer Script.

Example — If alternative A of 1 is correct, then write :

1. — A

- There is no negative marking for wrong answer.

মাল্টিপল চয়েস প্রশ্নের (MCQ) জন্য জরুরী নির্দেশাবলী

- উত্তরপত্রে নির্দেশিত স্থানে বিষয়ের (Subject) নাম এবং কোড, রেজিস্ট্রেশন নম্বর, সেশন এবং রোল নম্বর লিখতে হবে।

উদাহরণ — যেমন Paper III-A (MCQ) এবং III-B (Descriptive)।

Subject Code : III A & B

Subject Name :

- পরীক্ষার্থীদের সবগুলি প্রশ্নের (MCQ) উত্তর দিতে হবে। প্রতিটি প্রশ্নে চারটি করে সম্ভাব্য উত্তর, যথাক্রমে (A), (B), (C) এবং (D) করে দেওয়া আছে। পরীক্ষার্থীকে তার উত্তরের স্বপক্ষে (A) / (B) / (C) / (D) সঠিক বিকল্পটিকে প্রশ্ন নম্বর উল্লেখসহ উত্তরপত্রে লিখতে হবে।

উদাহরণ — যদি 1 নম্বর প্রশ্নের সঠিক উত্তর A হয় তবে লিখতে হবে :

1. – A

- ভুল উত্তরের জন্য কোন নেগেটিভ মার্কিং নেই।

Paper Code : XI - A

Full Marks : 15

Time : Thirty Minutes

Choose the correct answer.

Each question carries 1 mark.

1. At $T \rightarrow \infty$ limit, the $\frac{n_1}{N}$ values for a two-level system approach to —

- (A) 0
- (B) 1/4
- (C) 1
- (D) 1/2

2. A catalyst accelerates the rate of a reaction by —

- (A) Decreasing energy of activation
- (B) Increasing Arrhenius's pre-exponential factor
- (C) Increasing both
- (D) Decreasing both

3. Rotational energy can be written as —

- (A) $2B(J+1)$
- (B) $\frac{h^2}{8\pi^2 IcJ(J+1)}$
- (C) $\frac{h^2}{8\pi^2 IJ(J+1)}$
- (D) $BhcJ(J+1)$

4. Which of the following(s) is/are characteristics of wave function ψ ?
- (A) ψ must be single valued
 - (B) ψ must be finite
 - (C) ψ must be continuous with continuous first derivative
 - (D) All of the above
5. Molar absorption coefficient depends on —
- (A) Path length of light
 - (B) Intensity of the light used
 - (C) Concentration of the same absorbing species
 - (D) Wave length of light used
6. Zeta potential or electrokinetic potential is dependent on —
- (A) Viscosity
 - (B) Dielectric constant
 - (C) Velocity of the colloidal particles when an electric field is applied
 - (D) All the above
7. Infrared (IR) spectroscopy is useful for determining certain aspects of structure of organic molecules because —
- (A) All molecular bonds absorb IR radiation
 - (B) IR peak intensities are related to molecular beam
 - (C) Most organic functional groups absorb in a characteristic region of the IR spectrum
 - (D) Vibrational transitions are correlated to spin-spin coupling

8. Frequency of gamma photon is greater than —
- (A) 10^{12} Hz
 - (B) 10^{15} Hz
 - (C) 10^{18} Hz
 - (D) 10^{21} Hz
9. The crystal structure which does not have any axis of rotational symmetry is —
- (A) Triclinic
 - (B) Orthorhombic
 - (C) Hexagonal
 - (D) Cubic
10. At most probable state of a system, the entropy of the system is —
- (A) Minimum
 - (B) Maximum
 - (C) Constant
 - (D) None of the above
11. Percentage of free space in a body centered cubic unit is —
- (A) 32%
 - (B) 34%
 - (C) 28%
 - (D) 20%

12. If $\log t_{1/2}$ vs initial concentration of reactant plot goes parallel to concentration axis then the order of the reaction will be —
- (A) First order
 - (B) Second order
 - (C) 3/2th order
 - (D) Zero order
13. Alum stops bleeding because —
- (A) The blood starts following in opposite direction
 - (B) The blood reacts and form a solid, which seals the blood vessels
 - (C) The blood is coagulated and thus the blood vessel is sealed
 - (D) Alum seals the blood vessel
14. The time independent Schrödinger's equation can be written as —
- (A) $\hat{H}\psi = E\psi$
 - (B) $\hat{H}\psi = (E - V)\psi$
 - (C) $\hat{H}\psi = (E + V)\psi$
 - (D) $\hat{H}\psi + E\psi = 0$
15. Among the singlet (S), doublet (D) and triplet (T) electronic states, phosphorescence involves transition between —
- (A) $S \rightarrow S$
 - (B) $S \rightarrow D$
 - (C) $D \rightarrow D$
 - (D) $T \rightarrow S$

2021

CHEMISTRY (Honours)

Paper Code : XI - B
[New Syllabus]

Full Marks : 50

Time : Two Hours Thirty Minutes

The figures in the margin indicate full marks.

Answer any five questions, taking at least two questions from each group.

Group - A

1. (a) Explain how Heisenberg's uncertainty principle implies the existence of zero-point energy of a harmonic oscillator.
(b) Obtain an eigen function of one-dimensional momentum operator with eigen value 2.
(c) Prove that the eigenvalues of a Hermitian operator are real.
(d) Show that $\Psi = \sin(n\pi x / L)$ is a solution of the time independent Schrödinger's equation for a free particle of mass m confined in a one-dimensional box of length L . 3+3+2+2
2. (a) Show that the de Broglie hypothesis leads to the quantization of angular momentum of an electron in a hydrogen atom.
(b) Find the expression of energy of a free particle of mass m confined in a one-dimensional box of length L .
(c) "If ϕ_1 and ϕ_2 are degenerate eigen function of a linear operator, \hat{A} , then a linear combination of the eigen functions is also an eigen function of the operator with the same eigen value" — Justify.
(d) Write down the Schrödinger equation for a particle of mass m which is considered to move in one dimension with zero potential energy. 3+3+3+1

3. (a) A catalyst influences the rate of a reaction not the position of equilibrium — Explain.
- (b) The first-order decomposition of H_2O_2 in a suitable medium is characterized by a rate-constant $3 \times 10^{-3} \text{ min}^{-1}$. Find the time to complete one-third of the reaction.
- (c) The rate of a reaction was found to be equal to its rate constant at any concentration of the reactant. What is the order of the reaction? Give an example of such reaction. 3+3+(2+2)
4. (a) "Zero-order reaction must be multistep and it goes to completion in a finite time" — Explain.
- (b) Using Lindemann mechanism show that a unimolecular gas phase reaction follows a 2nd order kinetics at low reactant — concentration.
- (c) The Arrhenius parameters for the thermal decomposition of $NOCl$, $2NOCl(g) \rightarrow 2NO(g) + Cl_2(g)$ are $A = 10^{13} \text{ mol}^{-1} \text{ s}^{-1}$, $E_a = 105 \text{ kJ mol}^{-1}$ and $RT = 2.5 \text{ kJ mol}^{-1}$. Calculate the enthalpy (in kJ mol^{-1}) of the activated complex. 3+4+3

Group - B

5. (a) Derive the expression for the internal energy in terms of partition function.
- (b) Derive Boltzmann's distribution formula for a non-degenerate system, using Stirling's approximation.
- (c) At 298.15K the vibrational energy levels of Iodine molecules have a constant difference of 214.6 cm^{-1} . Estimate the fraction of molecules in the first two energy levels. 3+4+3
6. (a) Deduce Langmuir's adsorption isotherm stating the assumptions involved.
- (b) Write down the Debye- T^3 law of lattice heat capacity of solids indicating the significance of the terms involved.
- (c) The surface tension of water follows a linear dependence on the concentration of a solute and is reduced to six unit at 0.02 (M) at 27°C . Calculate the Gibbs surface excess of the solution at 0.005 (M) concentration. 4+3+3

7. (a) A metal has a body centred cubic lattice and length of unit cell is 2.951 \AA , if the density of the metal be 9.95 g cm^{-3} . Calculate the atomic weight of the metal.
- (b) "Alum is used for cleaning the muddy water" — Justify.
- (c) State Lambert-Beers Law.
- (d) A substance in an aqueous solution at a concentration of 10^{-3} (M) absorbs 10% of an incident light in a path length of 1 cm. What concentration will be required to absorb 90% of the incident light for
- The same path length and
 - When the path length is 5mm? 3+3+1+3
8. (a) SO_2 has dipole moment of 1.6 D while CO_2 has zero dipole moment — Explain.
- (b) C-H stretching vibration in organic compound occur at 2900 cm^{-1} . At what wave number would C-D stretching vibration occur assuming the force constants for both the vibration to be the same?
- (c) State and explain Einstein's law of photochemical equivalence.
- (d) What do you mean by quantum efficiency of a photochemical reaction? 3+4+2+1
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