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

    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।

Choose the correct answer.

Each question carries 1 mark.

1. At $T \to \infty$ limit, the $\dfrac{n_i}{N}$ 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) $\dfrac{h^2}{8\pi^2 IcJ(J+1)}$

    (C) $\dfrac{h^2}{8\pi^2 IJ(J+1)}$

    (D) $Bhc\ J(J + 1)$

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 → S

    (B) S → D

    (C) D → D

    (D) T → S

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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, $\widehat{A}$, 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 3×10^{-2} 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 $A = 10^{13}$mol^{-1}s^{-1}, $E_a = 105$ kJ mol^{-1} and RT=2.5 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 interms 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 aunit cell is 2.951Å, 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

   (i) The same path length and

   (ii) 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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