Candidates have to choose any one of the following papers for admission to the Integrated Ph D Programme (Biological / Chemical / Physical / Mathematical Sciences), depending on their choice of the programmes.

1. Biological Sciences
2. Chemical Sciences
3. Physical Sciences
4. Mathematical Sciences

BIOLOGICAL SCIENCES

Biological Sciences question paper will be fully of objective type. There will be negative marking for wrong answer.

SYLLABUS

General Biology

Taxonomy and physiology, Pro-and eukaryotic organisms; cell organelles and their function; multicellular organisation; energy transformations; internal transport systems of plants; respiration; regulation of body fluids and excretory mechanisms; cellular reproduction; Mendolian genetics and heredity; biology of populations and communities; evolution; genesis and diversity of organisms; animal behaviour; plant and animal diseases.

Basics of Biochemistry, Biophysics, Molecular Biology

Buffers; trace elements in biological systems; enzymes and proteins; vitamins; biological oxidations, carbohydrates and lipids and their metabolisms; digestion and absorption; detoxifying mechanisms; plant and animal hormones and their action, neuromuscular systems, nucleic acids, nature of gene and its function, Genetic code, synthesis of nucleic acids and proteins.

Structure of biomolecules; intra and intermolecular forces; thermodynamics and kinetics of biological systems, principles of x-ray diffraction, IR and UV spectroscopy and hydrodynamic techniques.

Microbiology and Cell Biology

Classes of microorganisms and their characterization, nutrient requirements for growth; laboratory techniques in microbiology, pathogenic microorganisms and disease; applied microbiology; viruses, Microbial genetics.

Cell theory : Cell architecture; methods of cell fractionation; cell division; types of chromosome structure; biochemical genetics-inborn errors of metabolisms; viruses and fungi; principles of processes of development.

MODEL QUESTIONS

1. The fluctuation test carriesout by Luria and Delbruck showed that

   (A) Mutations are sponteneous

   (B) Mutations are induced by the virus upon exposure

   (C) Bacteria fluctuate between sensitivity and resistance

   (D) Viruses are living entities

2. In a test of an *Aa* heterozygous parent with an *aa* homozygous parent what are the number of classes of genotypes exoected in the progency ?

   (A) 2

   (B) 1

   (C) 3

   (D) 4

3. Attenuation in bacterial operon regulation at the transcription level depends on

   (A) Operator sequence

   (B) tRNA structure

   (C) Special sigma factors

   (D) Charged tRNA levels

4. Codon-anticodon interaction occurs primarily through

   (A) Hydrogen bonds

   (B) Covelant bonds

   (C) Phosphodiester bonds

   (D) Disulfide linkages

5. Among angiosperms, dicots are distinguished by their :

   (A) netted leaf venetion

   (B) Single embryonic leaf

   (C) Scattered vascular bundles in the stem

   (D) Flower parts in multiples of three

6. The distribution and abundance of fungi is usually measured in terms of

   (A) Number of individuals per unit area or volume of habitat

   (B) Surface area per unit area or volume of habitat

   (C) Height of an individual

   (D) Mass per unit area or volume of habitat

7. Maximal quantity of progesterone is produced by

(A) Corpus luteum

(B) Placenta

(C) Foetal adrevals

(D) Corpus luteum during pregnancy

8. In C4 plants (e.g. maize) the initial carbon dioxide fixation occurs in leaf mesophyll cells containing chloroplasts. This reaction involves the enzyme.

(A) Ribulous 1,5 bisphophate carboxylase

(B) Pyruvate carboxulase

(C) Phosphoenol Pyruvate carboxulase

(D) Malate enzyme

9. In an enzyme assay in which the substrate concentration, [S] is much lower than K_m, the rate of the enzyme catalized reaction

(A) approaches V_{max}

(B) shows zero order kinetics

(C) is proportional to [S]

(D) is independent of enzyme concentration

SUGGESTED READING

1. Stryer L, Biochemistry, published by W.H. Freeman and company.
2. Madigan MT, Martinko JM & Parker J. BROCK Biology of microorganisms; published by Prentice Hall Internation Inc.

   OR

   Pelczar MJ, Chan ECS, Krieg NR. Microbilogy. Published by McGraw Hill
3. Odum EP, Fundamentals of Ecology.

CHEMICAL SCIENCES

Chemical Sciences question paper will consist of multiple choice question for 100 marks from Chemistry, Physics and Mathematics with greater emphasis on Chemistry. There will be negative marking for wrong answer.

SYLLABUS

General and Inorganic Chemistry

Valency, Equivalent weight, periodic classification of elements, Atomic structure, Isotopes, Raidoactivity, Electronegativity, Hybridisation, Oxidation states. Compounds of Main Group elements; preparation, structures and Reactivity.

Transition metals; Electronic structure, magnetic and spectral properties of metal complexes. Stability, structure and reactivity of coordination compounds.

Main Ores and Minerals, Principles of exatraction of metals like Cu, Au, Na, Zn, Mg, and Al. Iron and Steel manufacture. Common chemical processes used in industry.

Analytical Chemistry

Principles of Analytical Chemistry, Qualitative analysis and quantitative estimation of elements and groups.

Physical Chemistry

The laws of Thermodynamics, Thermodynamic functions, Kinetic theory of gases, Specific heats, Adiabatic and isothermal processes, Liquids, The solid state, x-ray Diffraction, Mixtures and solutions, colligative properties, chemical Equilibrium, phase rule. Thermochemistry, Electrochemistry, Reaction Kinetics. Surface and Colloid Chemistry. Catalysis, use of catalysts in important industrial processes. ***Mathematics and Physics essential for Physical Chemistry.***

Organic Chemistry

Geometric and optical isomerism in organic molecules. Preparation and reactions of alkanes, alkenes, alkynes, alcohols, alky halides, amines, ethers and carbonyl compounds.

Aromatic ring systems, aromatic animes and nitro derivatives, phenols, Heterocyclinc systems, Carbohydrates, Oils, Fats, Soaps and detergents, Aminoacids, Proteins, enzymes, dyes, drugs, synthetic and natural polymers.

Basic reaction mechanisms : SN1, SN2, E1 and E2 reactions, Free radical reactions, Markownikoff rule, Electrophilic aromatic substitution.

Synthetic uses of Grignard reactions, reactions involving acetoacetic ester and malonic ester.

MODEL QUESTIONS

1. The pH of 10^{-10} molar solution of HCI is :

   (a) 10 (b) 7 (c) 4 (d) 1

2. The molecular weight of $MgCl_2$ determined from elevation of boiling point experiment is (atomic masses of Mg and Cl are 24 and 35.5 respectively):

   (a) 47.5 (b) 95.0 (c) 63.4 (d) 31.7

3. The maximum number of electrons in an atom that can posses a principal quantum number of 4 is :

   (a) 8 (b) 14 (c) 18 (d) 32

4. Condition under which aldol condensation is carried out is :

   (a) acidic (b) basic (c) neutral (d) pyrolytic

5. Enolisation involves :

   (a) resonance (b) complexation (c) tautomerisation (d) aromatisation

6. There is 32% of adenine in the DNA of sea urchins. The percentage of quanine is

   (A) 32 (B) 68 (C) 36 (D) 18

7. The angle between the vectors **l+j** and **j+k** is

   (a) 30° (B) 45° (C) 60° (D) 90°

8. You are given the periodic function y=5 cos (x/2). Its frequency is

   (A) 2p (B) 1/2p (C) 4p (D) 1/4p

9. A 220 V alternating current source is connected across a 2mF capacitor. If the frequency of the source is 50 Hz, the current through the capacitor is approximately equal to

   (A) 140.0A (B) 14.0A (C) 1.4A (D) 0.14A

10. A soap film has an index of refraction of 1.333. The smallest thickness of this film which gives an interference maximum when light of wavelength 500nm is incident normally on it, is

    (A) 47nm (B) 94nm (C) 188nm (D) 375nm

PHYSICAL SCIENCES

Physical Sciences question paper will consist of multiple choice question for 100 marks. There will be negative marking for wrong answer.

SYLLABUS

Mechanics

Newtonian mechanics of a system of particles. Conservation of energy and momentum, collisions, simple harmonic motion, static equilibrium of a rigid body, rotational dynamics, angular momentum, gravitation, Kepler's laws.

Properties of Matter

Stress and strain, elastic properties of solids, elastic modulii; Hydrostatics, elements of fluid mechanics, surface, tension and viscosity.

Wave Motion

Wave propagation, phase and group velocities, standing waves, Fourier analysis, sound as elastic waves, interference and diffraction of sound waves, Doppler effect.

Thermal Physics

Kinetic theory of gases, the Maxwell-Boltzmann distribution, thermal properties of ideal and real gases, liquids and solids, laws of thermodynamics, entropy, reversible and irreversible processes, Carnot cycle, heat engines, changes of phase, blackbody radiation, the Stefan-Boltzmann law, Planck's law.

Electromagnetism, Electronics and Optics

Electric field and potential, Gauss law, Laplace and Poisson equations, electrostatic equilibrium, capacitance, dielectrics, electrostatic energy;

The magnetic field, magnetic forces on moving changes and current carrying wires, the Biot-Savart law, electromagnetic induction and Faraday's law, magnetic susceptibility and permeability, direct and alternating current circuits, Maxwell's equations, electromagnetic waves;

Semiconductors junctions, principles of rectification and amplification.

Reflection, refraction and polarisation of light, ray optics, thin lenses, aberrations, interference and diffraction of light, optical instruments.

Modern Physics

Frames of reference, time dilation and length contraction, simultaneity, the Lorentz transformation, relativistic energy and momentum, mass-energy relation;

The photoelectric effect, the Compton effect, atomic spectra, wave-particle dualism, the wave function and its interpretation, the uncertainty principle, the Schrodinger equation.

Atomic structure, the Pauli exclusion principle, periodic classification of elements, spin of electrons, the Zeeman effect; generation and diffraction of x-rays, radioactivity, nucleus-constituents, binding, nuclear reactions, fission and fusion, nuclear reactors, particle accelerators, cosmic rays.

Experiments and Measurements

Errors in measurement, accuracy, measurements of length, mass and charge of small and large objects, fundamental constants. Basic knowledge of scientific instruments and their working.

Mathematical Physics

Theory of Systems of linear Equation, Linear algebra and matrices.
Series and their convergence.

Limits and continuity, differentiation and integration, Taylor's expansion, L'Hospital rule, maxima, minima.
Analytical geometry of curves and surfaces.
Ordinary (first and second order) differential equations.
Complex numbers, roots of complex numbers, trigonometric identities, Argand's diagram.
Vector addition and products, gradient, divergence and curl, Gauss and Stokes theorems.
Probability, basic laws of probability, mean, standard deviation.

MODEL QUESTIONS

1. A heavy ball tied to a string spins around the circle. While the ball is spinning, the length of the string is slowly halved. The angular frequency of rotation of the ball is
   a) halved
   b) doubled
   c) quadrupled
   d) unchanged

2. Unpolarized light passes through three polarizing filters. The axis of the second one is at an angle of $+30^0$ with respect to the first, and the axis of the third is at an angle $+30^0$ with respect to the second. The fraction of the original intensity that energes from the third polarizer is
   a) 9/32
   b) 3/8
   c) 2/9
   d) 1/8

3. Two large metal spheres, A and B are near each other. The electrostatic force between them is attractive. Of the three possibilities :
   i) the two spheres are oppositely charged
   ii) one sphere is charged and the other is uncharged
   iii) both spheres are uncharged
      a) only case i) is possible.
      b) Cases i) and ii) are possible, but not iii).
      c) All three cases are possible.
      d) It depends on the size of the spheres compared to their separation.

4. A resistor inductor, and a capacitor are connected in series to an ac voltage source $\mathbf{U}(t) = V \cos [2\pi\nu t]$. . The peak voltages across the three elements are $V_{R,}$ V_L and V_C respectively. Then
   a) $V_{R,}$ V_L and V_C must be less than V.
   b) $V_{R,}$ must be less than V, *but* V_L and V_C need not.
   c) At any instant, the voltage across the resistor and the voltage from the source must have the same sign.
   d) At any instant, the voltage across the resistor must be smaller in magnitude than the voltage from the source.

5. Two spheres of radius r1 and r2 and at temperatures T1 and T2, are placed in vacuum. The first sphere is a blockbody. The second sphere may absorb more heat from the first than it radiates out if

a) T1 = T2, but r1 is sufficiently large compared r2.
b) T1 = T2, but the second sphere is painted, with a colour matching the peak of the radiation from the first.
c) T1 > T2
d) None of the above.

MATHEMATICAL SCIENCES

Mathematical Sciences question paper will consist of multiple choice questions for 100 marks from mathematics. There will be negative marking for wrong answer.

SYLLABUS

1. Algebra :

Theory of Equations :
Relations between roots and Coefficients, Newton's identities, Rolle's theorem, Reciprocal Equations, Des Cartes, Rule of Signs, Cubic and quartic equations, Complex numbers and De Moivre's Theorem.
Determinants :
Cofactors, Properties of determinants, Solution of a Linear System, Cramer's Rule.
Inequalities :
AM-GM inequality, Cauchy-Schwarz inequality.
Set Theory :
Relations, Functions, Cardinality.
Algebraic Structures :
Binary Operations, Groups, Rings: Definitions, Examples and Elementary Theorems.
Vector Spaces :
Subspaces, Linear Independence, Bases, Dimension, Linear Transformations, Matrices, Rank, Nullity, Eigen values and Eigen vectors.

2. Geometry :

Two-dimensional Coordinate Geometry :
Conics and their equations in Cartesian and Polar Coordinates, Ellipse, Parabola and Hyperbola.
Three-dimensional Co-ordinate Geometry :
Planes, Lines, Spheres and Cones.

3. Vector Algebra and Vector Calculus :
Vectors, addition, Scalar multiplication, Dot Product, Cross Product, Triple Product, Equations to the Line and the Plane. Grad, Divergence and Curl, Vector Integration, Green's Gauss' and Stokes' Theorems.

4. Calculus and Analysis
Real Number System, Sequence and Series. Continuity, Differentiability, Mean Value Theorems, Indeterminate Value Theorem, L'Hospital Rule, Tangents and Normals, Maxima and Minima, Riemann Integration, Multiple Integrals, Partial differentiations, Lengths, areas and volumes by integration.

5. Differential Equations :
First Order ODE; Method of Separation of Variables; Exact equations; Euler's equation; Orthogonal Family of curves, Second Order Linear ODE : Variation of Parameters.

MODEL QUESTIONS

Four possible answers are provided for each question.
Select the correct answer by making (√) against (A), (B), (C) or (D).

1. Let ρ be a non-trivial relation on a set X. If ρ is symmetric and antisymmetric then ρ is

   (A) reflexive, (B) transitive, (C) an equivalence relation, (D) the diagonal relation.

2. The set $\{5, 15, 25, 35\}$ is a group under multiplication modulo 40. The identity element of this group is

   (A) 5, (B) 15, (C) 25, (D) 35.

3. Let $\mathbb{Z}_n$ be the additive group of integers modulo n. The number of homomorphisms from $\mathbb{Z}_n$ to itself is

   (A) 0, (B) 1, (C) n, (D) n^2.

4. Let $v = (1, 1)$ and $w = (1, -1) \in \mathbb{R}^2$. Then a vector $u = (a, b) \in \mathbb{R}^2$ is in the $\mathbb{R}$-linear span of v and w

   (A) only when $a = b$, (B) always, (C) for exactly one value of (a, b), (D) for at most finitely many values of (a, b).

5. Let A be a 3×3 real matrix. Suppose $A^4 = 0$. Then A has

   (A) exactly two distinct real eigenvalues, (B) exactly one non-zero real eigenvalue, (C) exactly 3 distinct real eigenvalues, (D) no non-zero real eigenvalue.

6. Let a, b, c, d be real numbers and let $f : \mathbb{C} \to \mathbb{C}$ be the map defined by $f(x + iy) := (ax + by) + i(cx + dy)$. Then f is linear over $\mathbb{C}$ if and only if

   (A) $(a, b) = (d, c)$, (B) $(a, b) = (d, -c)$, (C) $(a, b) = (-d, c)$, (D) $(a, b) = (-d, -c)$.

7. The function $f : \mathbb{R} \to \mathbb{R}$ defined by $f(x) = \max\{1 - |x|, 0\}$ is differentiable

   (A) at all points, (B) at all except one point, (C) at all except three points, (D) nowhere.

8. Let $f : [0, 1] \to \mathbb{R}$ be a continuous function with $f(0) = f(1)$. If f is differentiable on $(0, 1)$ and the derivative f' is continuous on $(0, 1)$ then f' is

   (A) strictly positive in $(0, 1)$, (B) strictly negative in $(0, 1)$, (C) identically zero in $(0, 1)$, (D) zero at some point in $(0, 1)$.

9. A unit normal vector to the curve $\mathbf{C} := \{(x, x^2) : x \in \mathbb{R}\}$ in the plane $\mathbb{R}^2$ at the point $(0, 0)$ is given by

   (A) $(0, -1)$, (B) $(-1, 0)$, (C) $(\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}})$, (D) $(1, 0)$.

10. The differential equation $\dfrac{d^2y}{d^2x} + 4\dfrac{dy}{dx} + 4y = 0$ has general solution of the form:

    (A) $A\cos 2x + B\sin 2x$, (B) $Ae^{-2x} + Bxe^{-2x}$, (C) $Ae^{2x} + Bxe^{2x}$, (D) $Ae^{2x} + Be^{-2x}$.

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