

NATIONAL ENTRANCE SCREENING TEST 2014

# NEST 2014

INFORMATION BROCHURE  
&  
SYLLABUS

Entrance Test for Admission to

National Institute of Science Education and Research  
(**NISER**) Bhubaneswar

and

University of Mumbai - Department of Atomic Energy  
Centre for Excellence in Basic Sciences  
(**UM-DAE CBS**) Mumbai

Academic Session 2014-15



## Introduction to NEST 2014

The National Entrance Screening Test or NEST is a compulsory test for admission to the 5-year Integrated MSc programme in basic sciences - Biology, Chemistry, Mathematics and Physics - at National Institute of Science Education and Research (NISER), Bhubaneswar and University of Mumbai - Department of Atomic Energy Center for Excellence in Basic Sciences (UM-DAE CBS), Mumbai. Both NISER and CBS are autonomous institutions established by Department of Atomic Energy (DAE), Government of India, in 2007.

These institutes have started with the mandate to provide high quality teaching in basic sciences by a faculty of distinguished scientists embedded in a vibrant research environment and to create a national pool of scientists ready to take up research challenges in the frontiers of basic and applied sciences. The Integrated MSc programme at these institutes follows a semester-based course structure and continuous assessment within a flexible and innovative academic curriculum, exposing the students to research early in their programme. The placements of the graduated students from NISER and CBS provide testimony of success to this initiative.

NISER and CBS are both residential institute equipped with state-of-art teaching and research laboratories, modern computational facilities and computer centres and excellent libraries. All the students are accommodated at in-campus hostels, for both girls and boys, and are provided with an environment conducive to science education and research.

All the candidates admitted to 5-year Integrated MSc programme at NISER and CBS are eligible for INSPIRE, Govt. of India, scholarship of ₹5,000 per month and ₹20,000 per year for carrying out summer projects.

Besides, top performers at NISER and CBS, securing overall grades above certain threshold at the end of final semester, will be eligible to appear directly for the interview for admission to BARC Training School.

The details of the Integrated MSc programme, courses, research activities, facilities and faculty profile at NISER and CBS can be found on their respective websites ([www.niser.ac.in](http://www.niser.ac.in) and [www.cbs.ac.in](http://www.cbs.ac.in)).

Integrated Science Education and Research Center (ISERC), Visva Bharati, is also participating in NEST 2014 and will admit students for its Integrated MSc course from the Merit List of NEST 2014. The eligibility criteria are the same as that for NISER/ CBS and the students admitted to ISERC are also eligible for INSPIRE scholarship. For the details of ISERC's vision and programme, check its website at [www.visva-bharati.ac.in](http://www.visva-bharati.ac.in) .

## Eligibility criteria for admission

**Educational qualification:** Candidates seeking admission to NISER and UM-DAE CBS for the academic session 2014-15 should be from science stream (having any combination of Biology/ Chemistry/ Mathematics/ Physics) at class XII and must write the NEST 2014 examination. Candidates who have passed class XII examination or equivalent from any recognised Board in India in 2012 or 2013 or are appearing in 2014 can appear in NEST 2014 examination. Admission will be offered strictly on the basis of Merit List of NEST 2014. Candidates securing at least 60% marks in aggregate or equivalent grade in class XII examination will be eligible for admission to NISER and CBS. However, there is no restriction for appearing for NEST. For candidates belonging to scheduled caste (SC), scheduled tribe (ST) and physical disabilities (PD) categories, the minimum requirement of marks is 55% in aggregate. Where only letter grades are available, a certificate from the Board specifying equivalent percentage marks is required. In the absence of such a certificate, the decision of the Admissions Committee of the concerned Institution will be final.

**Age limit:** General and OBC category candidates born on or after July 22, 1994 are eligible to apply. The age limit is relaxed by 5 years for SC / ST / Physically Disabled (PD) candidates.

*Necessary certificates supporting eligibility criteria have to be furnished at the time of admission.*

*Please note that the offer of admission is subject to verification of all original certificates at the time of counselling.*

### **Number of seats & reservation**

For academic session 2014-15, the total number of seats at NISER, CBS and ISERC is 100, 35 and 21 respectively. The number of seats reserved for SC, ST, OBC/Non-Creamy-Layer and PD is according to the Government of India norm. To claim seats under reserved category, relevant documents must be furnished at the time of admission. For the details of reserved seats and category certificates refer to the websites of the participating Institutions.

### **NEST 2014 examination**

The NEST 2014 will be conducted at 45 major towns and cities all over India on **May 31, 2014, (Saturday) 10:00am – 1:00pm**. Based on the performance in NEST 2014, a common Merit List of the candidates will be prepared and posted on NEST 2014 website on **June 20, 2014**. The successful candidates will be called for counselling and admission will be strictly according to the Merit List until all the seats are filled. Separate merit list for different category candidates will be made available before counselling.

**Examination centres:** A list of NEST examination centres is given in annexure-1. Candidates must choose 2 (two) centres in order of their preference while filling up of application form. Every effort will be made to allot the centre of first preference. Please note that *ultimately the allotment of an examination centre by the Chief Coordinator has to be regarded as final and request for change of centre will, in general, not be entertained*. The centre (venue) address will be mentioned in the NEST admit card.

**Examination rules:** Candidates must reach the test center at least half an hour before the start of the examination. The exam will start at 10:00 am. Candidates will not be allowed to enter the examination hall after 10:30 am. The earliest a candidate can leave the examination hall is 11:00 am. Use of log tables and calculators in the examination hall is not allowed. Candidates must bring their own pen, pencils (HB), eraser and sharpener. Exchange/sharing of these items with other candidates is strictly prohibited. Candidates **MUST** bring their Admit Card and their school photo Identity Card or any photo ID issued by Government agencies to the examination hall. Any candidate found adopting unfair means will be expelled from the examination hall without warning.

**Question type:** The question paper will consist of 5 (five) sections of objective (MCQ) type questions. Section 1 is compulsory for all candidates and will have questions on general science to test candidates' awareness towards basic scientific facts as well as their abilities of comprehension and reasoning. There will be no negative marking in general section. Sections 2 through 5 will contain subject specific questions from Biology, Chemistry, Mathematics and Physics. Candidates are required to answer questions from any three of these four sections. The questions are designed to test candidates' subject comprehension and analytic ability. In the subject sections, there will be negative marking for incorrect answers. Some questions may have one or more correct answers for which marks can only be earned by marking all correct answers and no wrong answer. For NEST question papers of last few years, refer to the NEST 2014 website.

Language of the question paper will be English only.

**Answering questions:** The answers to each question are to be marked on an OMR (Optical Mark Recognition) sheet. Details of how to answer on OMR sheet will be given in question paper and OMR sheet.

**Syllabus:** The syllabus for NEST 2014 primarily follows the NCERT/ CBSE science syllabus of class XI-XII. The detailed syllabus for NEST examination is provided separately. There is, however, no specific syllabus for the general section. This section tests candidate's familiarity with, but not detailed understanding of, major historical milestones in subjects like astronomy, biology, chemistry, mathematics, physics, computer science and environmental science. Questions will be designed to test analytic abilities and comprehension of scientific passages. Some of the questions in this section may require knowledge of class X mathematics.

**Note:** Previous NEST question papers (2007...2013) are available in NEST website.

### How to apply

To apply for NEST 2014, candidates can fill-up application form either online (preferable) or offline. Details of on-line and off-line applications are given in a separate sheet. Off-line application is to be filled on a prescribed form. The form along with this brochure will be mailed to the candidate on request. The request for the application form must reach the NEST office on or before February 20, 2014. **Please note that photocopies of prescribed form should not be used for filling off-line applications. Such applications will summarily be rejected.**

The address for postal communications is given under “*Address for correspondence*” – next page.

**Application Fee:** The application fee for the male candidates of General/OBC category is ₹700. The application fee for SC/ST/PD and all female candidates is ₹350. The fee can be paid either by Demand Draft or Electronic Transfer. For offline applications, please add ₹50 as postal charges to the application fees mentioned above.

- **Demand Draft:** DD for required amount may be made from any bank and should be drawn in favour of NISER NEST and payable at Bhubaneswar. Candidate must write her/his name and application number on the back of the DD. The DD has to be sent preferably by speed post at the address given below and must reach NEST office along with the application form on or before March 08, 2014.
- **Electronic Transfer (NEFT):** The candidate may transfer the required amount of fees electronically to NEST 2014 account from any bank. A form (challan) for electronic money transfer is enclosed in the postal application kit and it is downloadable for online applicants (after login). The challan contains a/c number & IFS code necessary for making the transfer. Applicant must fill other required information. The Unique Transaction Reference (UTR) must be filled in appropriate place in the application form. The NEFT challan (*Part-C*) should be sent to NEST office by speed post along with the application form.

Additionally, NEST cell is planning to make provision for payment gateway for online applicants. If implemented, it will appear as an extra mode of online payment.

***Please refer to the instruction sheet or ‘How to apply’ tab in NEST website for details.***

**Note:**

Money should be transferred from a branch of a bank. Money transferred directly from individual accounts through personal net-banking will be considered **invalid** and NEST 2014 is not liable to return such money.

***Applications incomplete in any respect or not accompanied by requisite fee will not be accepted.***

**Admit card:** The admit card for NEST 2014 will be available for downloading / dispatch from **April 08, 2014**. Admit cards will not be dispatched for online applicants. They must download their admit cards from NEST website (after login). Admit cards will be sent by post to the mailing address of the offline candidates. It is, therefore, important that the postal address with pin code in offline paper application form be clearly and correctly written. Please note that *NEST office will not be responsible if admit card fails to reach the candidate in time because of postal delay or incorrect mailing address*. In case the admit card is not received by May 01, 2014, the NEST office at the address given below must be notified. It may be possible to re-send the admit card but only electronically if email address of the candidate is provided. Safe-keeping of the admit card is strongly advised because the successful candidates have to produce the admit card in original during the counselling and admission.

### **Address for correspondence**

The request for paper application form, completed paper application form, Demand Draft and any NEST 2014 related queries by postal mail must be sent at

**The Chief Coordinator, NEST 2014,  
NISER, Institute of Physics Campus,  
Sachivalaya Marg, Sainik School (PO),  
Bhubaneswar – 751 005, Odisha.**

For any queries requiring quicker response, contact at

Phone: 0674-2304036 (Mon-Fri, 09:30-17:00)  
Email: nest@nestexam.in

The official website of NEST 2014 is: [www.nestexam.in](http://www.nestexam.in)

## Important Dates

- Start of Online / Offline application for NEST 2014: **January 07, 2014**
- Last date for receiving request for Offline application form: **February 20, 2014**
- Closing of Online / Offline application: **March 08, 2014**
- Download / Dispatch of Admit Card begins: **April 08, 2014**
- NEST 2014 examination: **May 31, 2014 (Saturday) 10:00am – 1:00pm**
- Announcement of results in NEST website: **June 20, 2014**

## Important things to remember

- ❖ Candidates must reach the examination venue at least half an hour (30 minutes) before the start of the examination.
- ❖ Candidates will not be allowed to enter the examination hall half an hour (30 minutes) after the start of the examination, i.e. 10:30 am.
- ❖ Candidates will be allowed to leave the examination hall only after one hour from the start of the examination, i.e. 11:00 am.
- ❖ Use of log tables and calculators in the examination hall are not allowed. Candidates must bring their own pen, pencil, eraser and other stationaries.
- ❖ Candidates **MUST** bring their Admit Card and their school Identity Card in the examination hall.

## Check-list for online/offline applications

- ✓ Name and mailing address with pin-code are entered/clearly written and legible
- ✓ Correct e-mail address is provided
- ✓ Passport size photograph is uploaded properly/pasted in correct place
- ✓ Signature is uploaded properly/signed at proper place
- ✓ Name of issuing Bank and DD number is entered/clearly written in proper place
- ✓ Name & application number written on the backside of the DD or on NEFT challan as the case may be
- ✓ Two examination centres are chosen according to preference.

***If any of the above is found missing, the application will be considered incomplete and will be rejected.***

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**List of NEST 2014 Test Centres with centre codes**

<b>Test Centre</b>	<b>Code</b>	<b>Test Centre</b>	<b>Code</b>
Agartala (TR)	<b>01</b>	Kochi (KL)	<b>24</b>
Ahmedabad (GJ)	<b>02</b>	Kolkata-North (WB)	<b>25</b>
Allahabad (UP)	<b>03</b>	Kolkata-South (WB)	<b>26</b>
Balasore (OD)	<b>04</b>	Lucknow (UP)	<b>27</b>
Belgaum (KA)	<b>05</b>	Madurai (TN)	<b>28</b>
Bengaluru (KA)	<b>06</b>	Mangalore (KA)	<b>29</b>
Berhampur (OD)	<b>07</b>	Mumbai (MH)	<b>30</b>
Bhopal (MP)	<b>08</b>	Nagpur (MH)	<b>31</b>
Bhubaneswar (OD)	<b>09</b>	Patna (BR)	<b>32</b>
Burdwan (WB)	<b>10</b>	Pune (MH)	<b>33</b>
Calicut (KL)	<b>11</b>	Raipur (CG)	<b>34</b>
Chandigarh (CH)	<b>12</b>	Ranchi (JH)	<b>35</b>
Chennai (TN)	<b>13</b>	Sambalpur (OD)	<b>36</b>
Cuttack (OD)	<b>14</b>	Shillong (ML)	<b>37</b>
Dehradun (UT)	<b>15</b>	Shimla (HP)	<b>38</b>
Delhi-East (DL)	<b>16</b>	Silchar (AS)	<b>39</b>
Delhi-North (DL)	<b>17</b>	Siliguri (WB)	<b>40</b>
Delhi-South (DL)	<b>18</b>	Srinagar (JK)	<b>41</b>
Guwahati (AS)	<b>19</b>	Thiruvananthapuram (KL)	<b>42</b>
Hyderabad (AP)	<b>20</b>	Udaipur (RJ)	<b>43</b>
Indore (MP)	<b>21</b>	Varanasi (UP)	<b>44</b>
Jaipur (RJ)	<b>22</b>	Visakhapatnam (AP)	<b>45</b>
Jammu (JK)	<b>23</b>	-	-

## SYLLABUS FOR NEST-2014

### **General:**

There is no specific syllabus for the General section. This section aims to test the candidate's general ability to comprehend qualitative and quantitative aspects of a given scientific passage and interpretation of graphs of simple systems. This will be done by giving a passage on some scientific topic and questions based on the concepts elaborated in the passage will be asked. Questions are designed to test the candidate's familiarity with (and not a detailed understanding of) major historical milestones in mathematics, physics, chemistry, biology, astronomy, computer science and environment. There will be some questions designed to test the grasp of mathematics up to 10<sup>th</sup> standard and application capabilities of the same to simple problems.

### **Biology**

#### ***Cell Biology***

Cell theory and cells as unit of life. Tools and techniques of cell studies - use of microscope and calibration (microscopy), elements of microscope. Biomembranes - transport mechanism, cellular respiration. Cell organelles - structure and functions. Discovery and structure of DNA, processes of replication, transcription, genetic code and translation. Principles of the basic techniques in molecular biology.

#### ***Anatomy and Physiology***

Digestive System - Modes of nutrition. Structure of alimentary canal and associated glands, digestive enzymes and gastrointestinal hormones. Absorption of products of digestion, peristalsis, balanced diet.

Respiratory System - Gaseous exchange in animals. Structure of respiratory organs, mechanism of breathing, gaseous transport, tissue respiration.

Circulatory System - Open and closed systems. Functions of blood and lymph. Microscopic structure of blood and blood vessels. Structures and working of heart. Distribution of arteries and veins. Circulation of blood coagulation. Blood groups.

Excretory System - Elimination of nitrogenous waste. Osmoconformers and osmoregulators. Structure and function of kidney tubules. Arrangement of excretory organs.

Nervous System - General account of brain, spinal cord and nerves. Reflex actions (simple and conditioned). Sense organs (eye and ear).

Reproductive System --- Sexual and asexual reproduction. General arrangement and functions of reproductive organs.

Developmental Biology --- Basic features of development in animals. Types of eggs, fertilization, cleavage, blastula. Stem cells- definition, types, uses, advantages and disadvantages, induced pluripotent stem cells.

Diversity of Animal Life --- Principles of classification, binomial nomenclature. General classification of animal phyla up to classes (invertebrates) and upto sub-classes/ order (vertebrates), General characters of fishes, amphibians, reptiles, birds and mammals.

Genetics and Evolution --- Fundamentals of genetics and evolution. Human genetics - human chromosomes, sex-determination, sex-linked inheritance. Evidences and theories of organic evolution. Organization of the hereditary material in chromosomes. Equational division. Reduction division. Mitosis and meiosis compared and contrasted. Significance of meiosis. Mendel's laws of inheritance. Discovery of linkage, sex-linked inheritance. Crossing-over, stage

at which crossing-over occurs. Neurospora genetics. Mutation - discovery, types of Mutation and Mutations in diploids. Role of mutations in evolution. Elaboration of Mendel's laws of inheritance. Monohybrid or Dihybrid crosses.

Immunology- Basics of immune mechanisms and diseases- active and passive immunity, T and B cell responses, antigen presentation, principles of vaccination, monoclonal antibodies and their uses, immunology of AIDS.

Enzymes- catalysis, kinetics, activation energy, competitive and non-competitive inhibition.

### ***Ecology***

Physical and biological factors influencing organisms. Food chains, pyramids of numbers and biomass. Biological equilibrium. Interspecific associations.

### ***Botany***

Anatomy and Physiology of Plants - Meristems. Plant growth and development. Internal and external regulators of growth and development in plant. Internal structure of root, stem, secondary growth and leaves. Xylem and Phloem - their cell elements and functions. Internal structure of dicot and monocot leaves. Photosynthesis - history, importance, factors and mechanism, stomatal mechanism, transpiration and respiration. Comparative study of dicot and monocot anatomy. Absorption and cell-water relations, transport of water and minerals, turgor and turgor movements. Significance of life-cycles with special reference to alternation of generations as exemplified in Funaria, Selaginella and Pinus (no structural details).

Systematics - Principles of classical and new systematics. Binomial nomenclature. Familiarity with taxa.

### ***Humans and Environment***

Soil, rainfall and temperature with reference to natural resources. Our natural resources - their uses and abuses. Environmental pollution and preventive measures.

## **Chemistry**

### ***Physical Chemistry***

Measurements in chemistry - SI units for fundamental quantities, significant figures, significant figures in calculations

General topics - Concept of atoms and molecules. Dalton's atomic theory. Mole concept. Chemical formulae. Balanced chemical equations. Calculations (based on mole concept) involving common oxidation-reduction, neutralisation and displacement reactions. Concentration in terms of mole fraction, molarity, molality and normality.

Gaseous and liquid states - Absolute scale of temperature. ideal gas equation. Deviation from ideality, van der Waals equation. Kinetic theory of gases, average, root mean square and most probable velocities and their relation with temperature. Law of partial pressures. Vapour pressure. Diffusion of gases.

Atomic structure and chemical bonding - Bohr model, spectrum of hydrogen atom, quantum numbers. Wave- particle duality, de Broglie hypothesis. Uncertainty principle. Qualitative quantum mechanical picture of hydrogen atom, shapes of s, p and d orbitals. Electronic configurations of elements (up to atomic number 36). Aufbau principle. Pauli's exclusion principle and Hund's rule. Orbital overlap and covalent bond. Hybridisation involving s, p and d orbitals only. Orbital energy diagrams for homonuclear diatomic species. Hydrogen bond. Polarity in molecules, dipole moment (qualitative aspects only). VSEPR model and shapes of molecules (linear, angular, triangular, square planar, pyramidal, square pyramidal, trigonal

bipyramidal, tetrahedral and octahedral).

Energetics - First law of thermodynamics. Internal energy, work and heat, pressure-volume work. Enthalpy, Hess's law. Heat of reaction, fusion and vapourization. Second law of thermodynamics. Entropy. Free energy. Criterion of spontaneity.

Chemical equilibrium - Law of mass action. Equilibrium constant. Le Chatelier's principle (effect of concentration, temperature and pressure). Significance of  $\Delta G$  and  $\Delta G^\circ$  in chemical equilibrium. Solubility product, common ion effect, pH and buffer solutions. Acids and bases (Bronsted and Lewis concepts). Hydrolysis of salts.

Electrochemistry - Electrochemical cells and cell reactions. Standard electrode potentials. Nernst equation and its relation to  $\Delta G$ . Electrochemical series, emf of galvanic cells. Faraday's laws of electrolysis. Electrolytic conductance, specific, equivalent and molar conductivity, Kohlrausch's law. Concentration cells.

Chemical kinetics - Rates of chemical reactions. Order of reactions. Rate constant. First order reactions. Temperature dependence of rate constant (Arrhenius equation).

Solid state - Classification of solids. Crystalline state, seven crystal systems (cell parameters  $a$ ,  $b$ ,  $c$ ,  $\alpha$ ,  $\beta$ ,  $\gamma$ ), close packed structure of solids (cubic), packing in fcc, bcc and hcp lattices. Nearest neighbours, ionic radii. Simple ionic compounds, point defects.

Solutions - Raoult's law. Molecular weight determination from lowering of vapour pressure, elevation of boiling point and depression of freezing point.

Nuclear chemistry - Radioactivity. Isotopes and isobars. Properties of alpha, beta and gamma rays. Kinetics of radioactive decay (decay series excluded), carbon dating. Stability of nuclei with respect to proton-neutron ratio. Brief discussion on fission and fusion reactions.

### ***Inorganic Chemistry***

Study of different groups in periodic table -

Group 1A (Preparation, properties and reactions of alkali metals, with emphasis on chemistry of  $Na$  and  $K$  and their compounds - oxides, peroxides, hydroxides, carbonates, bicarbonates, chlorides and sulphates)

Group 2A (preparation, properties and reactions alkaline earth metals with emphasis on  $Mg$  and  $Ca$  and their compounds such as oxides, peroxides, hydroxides, carbonates, bicarbonates, chlorides and sulphates)

Group 3A (chemistry of Boron and its compounds – diborane)

Group 8A (preparation, properties and reactions inert gases with emphasis on chemistry of Xenon)

Group 7A (halogen chemistry with special emphasis on chemistry of chlorine)

Study of nonmetals -  $C$ ,  $S$ ,  $N$ ,  $P$  (especially oxides and oxyacids compounds of these elements, in addition phosphines for  $P$ , ammonia for  $N$ ) and  $O$  (peroxide and ozone),  $Si$  (silicones and silicates). (Allotropes of  $C$ ,  $S$ ,  $N$  should be covered.)

Transition elements (3d series) - Definition, general characteristics, variable oxidation states and their stabilities, colour (excluding the details of electronic transitions) and calculation of spin-only magnetic moment.

Coordination compounds - nomenclature of mononuclear coordination compounds. cis-trans and ionisation isomerisms, hybridization and geometries of mononuclear coordination compounds (linear, tetrahedral, square planar and octahedral).

Metals and metallurgy - General methods involving chemical principles. General operation stages involved in metallurgical operation. Metallurgy of *p*-block element (emphasis on *Al*). Metallurgy of *Fe*-triad (*Fe*, *Co*, And *Ni* with more emphasis on *Fe* metallurgy). Metallurgy of coinage metals (*Cu*, *Ag* with more emphasis on *Cu*).

### **Organic Chemistry**

Concepts - Hybridisation of carbon. Sigma and pi-bonds. Shapes of simple organic molecules. Structural and geometrical isomerism. Optical isomerism of compounds containing up to two asymmetric centres, (*R*, *S* and *E*, *Z* nomenclature excluded). IUPAC nomenclature of simple organic compounds (only hydrocarbons, mono- functional and bi-functional compounds). Conformations of ethane and butane (Newman projections). Resonance and hyperconjugation. Keto-enol tautomerism. Determination of empirical and molecular formulae of simple compounds (only combustion method). Hydrogen bonds - definition and their effects on physical properties of alcohols and carboxylic acids. Inductive and resonance effects on acidity and basicity of organic acids and bases. Polarity and inductive effects in alkyl halides. Reactive intermediates produced during homolytic and heterolytic bond cleavage. Formation, structure and stability of carbocations, carbanions and free radicals.

Preparation, properties and reactions of alkanes - Homologous series, physical properties of alkanes (melting points, boiling points and density). Combustion and halogenation of alkanes. Preparation of alkanes by Wurtz reaction and decarboxylation reactions. Preparation, properties and reactions of alkenes and alkynes - physical properties of alkenes and alkynes (boiling points, density and dipole moments). Acidity of alkynes. Acid catalysed hydration of alkenes and alkynes (excluding the stereochemistry of addition and elimination). Reactions of alkenes with  $KMnO_4$  and ozone. Reduction of alkenes and alkynes. Preparation of alkenes and alkynes by elimination reactions. Electrophilic addition reactions of alkenes with  $X_2$ ,  $HX$ ,  $HOX$  and  $H_2O$  ( $X$ =halogen). Addition reactions of alkynes; Metal acetylides.

Reactions of benzene - Structure and aromaticity. Electrophilic substitution reactions - halogenation, nitration, sulphonation, Friedel-Crafts alkylation and acylation. Effect of *o*-, *m*- and *p*- directing groups in monosubstituted benzenes.

Phenols - Acidity, electrophilic substitution reactions (halogenation, nitration and sulphonation). Reimer-Tiemann reaction, Kolbe reaction.

Characteristic reactions of the following (including those mentioned above)

Alkyl halides - rearrangement reactions of alkyl carbocation, Grignard reactions, nucleophilic substitution reactions Alcohols - esterification, dehydration and oxidation, reaction with sodium, phosphorus halides,  $ZnCl_2$ / concentrated  $HCl$ , conversion of alcohols into aldehydes and ketones. Ethers - Preparation by Williamson's Synthesis. Aldehydes and Ketones - oxidation, reduction, oxime and hydrazone formation. aldol condensation, Perkin reaction. Cannizzaro reaction. Haloform reaction and nucleophilic addition reactions (Grignard addition). Carboxylic acids - formation of esters, acid chlorides and amides, ester hydrolysis. Amines - basicity of substituted anilines and aliphatic amines, preparation from nitro compounds, reaction with nitrous acid, azo coupling reaction of diazonium salts of aromatic amines, Sandmeyer and related reactions of diazonium salts. carbylamine reaction. Haloarenes - nucleophilic aromatic substitution in haloarenes and substituted haloarenes (excluding Benzyne mechanism and *Cine* substitution).

Carbohydrate - Classification. mono- and di- saccharides (glucose and sucrose). Oxidation, reduction, glycoside formation and hydrolysis of sucrose.

Amino acids and peptides - General structure (only primary structure for peptides) and physical properties. Some examples for separation of amino acid mixture using physical properties.

## **Mathematics**

### ***Algebra***

Algebra of complex numbers, addition, multiplication, conjugation, polar representation, properties of modulus and principal argument, triangle inequality, cube roots of unity, geometric interpretations.

Quadratic equations with real coefficients, relations between roots and coefficients, formation of quadratic equations with given roots, symmetric functions of roots.

Arithmetic, geometric and harmonic progressions, arithmetic, geometric and harmonic means, sums of finite arithmetic and geometric progressions, infinite geometric series, sums of squares and cubes of the first  $n$  natural numbers.

Logarithms and their properties.

Permutations and combinations, Binomial theorem for positive integral index, properties of binomial coefficients. Matrices as a rectangular array of real numbers, equality of matrices, addition, multiplication by a scalar and product of matrices, transpose of a matrix, determinant of a square matrix of order up to three, inverse of a square matrix of order up to three, properties of these matrix operations, diagonal, symmetric and skew-symmetric matrices and their properties, solutions of simultaneous linear equations in two or three variables.

Addition and multiplication rules of probability, conditional probability, Bayes Theorem, independence of events, computation of probability of events using permutations and combinations.

### ***Trigonometry***

Trigonometric functions, their periodicity and graphs, addition and subtraction formulae, formulae involving multiple and sub-multiple angles, general solution of trigonometric equations.

Relations between sides and angles of a triangle, sine rule, cosine rule, half-angle formula and the area of a triangle, inverse trigonometric functions (principal value only).

### ***Analytical geometry***

Two dimensions - Cartesian coordinates, distance between two points, section formulae, shift of origin. Equation of a straight line in various forms, angle between two lines, distance of a point from a line. Lines through the point of intersection of two given lines, equation of the bisector of the angle between two lines, concurrency of lines. Centroid, orthocentre, incentre and circumcentre of a triangle.

Equation of a circle in various forms, equations of tangent, normal and chord. Parametric equations of a circle, intersection of a circle with a straight line or a circle, equation of a circle through the points of intersection of two circles and those of a circle and a straight line.

Equations of a parabola, ellipse and hyperbola in standard form, their foci, directrices and eccentricity, parametric equations, equations of tangent and normal. Locus Problems.

Three dimensions - Direction cosines and direction ratios, equation of a straight line in space, equation of a plane, distance of a point from a plane.

### ***Differential calculus***

Real valued functions of a real variable, into, onto and one-to-one functions, sum, difference, product and quotient of two functions, composite functions, absolute value, polynomial, rational, trigonometric, exponential and logarithmic functions.

Limit and continuity of a function, limit and continuity of the sum, difference, product and quotient of two functions, L'Hospital rule for evaluation of limits of functions.

Even and odd functions, inverse of a function, continuity of composite functions, intermediate value property of continuous functions. Derivative of a function, derivative of the sum, difference, product and quotient of two functions, chain rule, derivatives of polynomial, rational, trigonometric, inverse trigonometric, exponential and logarithmic functions.

Derivatives of implicit functions, derivatives up to order two, geometrical interpretation of the derivative, tangents and normals, increasing and decreasing functions, maximum and minimum values of a function, Rolle's Theorem and Lagrange's Mean Value Theorem.

### ***Integral calculus***

Integration as the inverse process of differentiation, indefinite integrals of standard functions, definite integrals and their properties, Fundamental Theorem of Integral Calculus.

Integration by parts, integration by the methods of substitution and partial fractions, application of definite integrals to the determination of areas involving simple curves.

Formation of ordinary differential equations, solution of homogeneous differential equations, separation of variables method, linear first order differential equations.

### ***Vectors***

Addition of vectors, scalar multiplication, dot and cross products, scalar triple products and their geometrical interpretations.

## **Physics**

### ***General***

Units and dimensions, dimensional analysis. least count, significant figures. Methods of measurement (Direct, Indirect, Null) and measurement of length, time, mass, temperature, potential difference, current and resistance.

Design of some simple experiments. Identification of independent, dependent and control variables. Identification of sample size, range and interval. Identification of appropriate measurement techniques and instruments.

Graphical representation, interpretation and analysis of data. Errors in the measurements and error analysis.

### ***Mechanics***

Kinematics in one and two dimensions (Cartesian coordinates only), projectiles. Uniform circular motion. Relative velocity. Newton's laws of motion. Inertial and uniformly accelerated frames of reference. Static and dynamic friction. Kinetic and potential energy. Work and power. Conservation of linear momentum and mechanical energy.

Systems of particles. Centre of mass and its motion. Impulse. Elastic and inelastic collisions.

Law of gravitation. Gravitational potential and field. Acceleration due to gravity. Motion of planets and satellites in circular orbits. Escape velocity.

Rigid body, moment of inertia, parallel and perpendicular axes theorems, moment of inertia of uniform bodies with simple geometrical shapes. Angular momentum, Torque. Conservation

of angular momentum. Dynamics of rigid bodies with fixed axis of rotation. Rolling without slipping of rings, cylinders and spheres. Equilibrium of rigid bodies. Collision of point masses with rigid bodies.

Linear and angular simple harmonic motions. Hooke's law, Young's modulus.

Pressure in a fluid. Pascal's law. Buoyancy. Surface energy and surface tension, capillary rise. Viscosity - Stoke's and Poiseuille's law, Terminal velocity. Streamline flow, equation of continuity. Bernoulli's theorem.

Plane wave motion, longitudinal and transverse waves, superposition of waves. Progressive and stationary waves. Vibration of strings and air columns. Resonance. Beats. Speed of sound in gases. Doppler effect (in sound).

### ***Thermal physics***

Thermal expansion of solids, liquids and gases. Calorimetry, latent heat. Heat conduction in one dimension. Elementary concepts of convection and radiation. Newton's law of cooling. Ideal gas laws. Specific heats ( $C_V$  and  $C_P$  for monoatomic and diatomic gases). Isothermal and adiabatic processes, bulk modulus of gases. Equivalence of heat and work. First and second law of thermodynamics and its applications (only for ideal gases). Entropy. Blackbody radiation - absorptive and emissive powers. Kirchhoff's law. Wien's displacement law, Stefan's law.

### ***Electricity and magnetism***

Coulomb's law. Electric field and potential. Electrical potential energy of a system of point charges and of electrical dipoles in a uniform electrostatic field; Electric field lines. Flux of electric field. Gauss's law and its application in simple cases, such as to find field due to infinitely long straight wire. uniformly charged infinite plane sheet and uniformly charged thin spherical shell.

Capacitance - Calculation of capacitance with and without dielectrics. Capacitors in series and parallel. Energy stored in a capacitor.

Electric current. Ohm's law. Series and parallel arrangements of resistances and cells. Kirchhoff's laws and simple applications; Heating effect of current.

Biot-Savart's law and Ampere's law. Magnetic field near a current carrying straight wire, along the axis of a circular coil and inside a long straight solenoid. Force on a moving charge and on a current carrying wire in a uniform magnetic field.

Magnetic moment of a current loop. Effect of a uniform magnetic field on a current loop. Moving coil galvanometer, voltmeter, ammeter and their conversions.

Electromagnetic induction - Faraday's law, Lenz's law. Self and mutual inductance. RC, LR and LC circuits with and A.C. Sources.

### ***Optics***

Rectilinear propagation of light. Reflection and refraction at plane and spherical surfaces, Deviation and dispersion of light by a prism. Thin lenses. Combination of mirrors and thin lenses. Magnification.

Wave nature of light - Huygen's principle, interference limited to Young's double slit experiment. Elementary idea of diffraction - Rayleigh criterion. Elementary idea of polarization - Brewster's law and the law of Malus.

### ***Modern physics***

Atomic nucleus. Alpha, beta and gamma radiations. Law of radioactive decay. Decay constant. Half-life and mean life. Binding energy and its calculation. Fission and fusion processes. Energy calculation in these processes.

Photoelectric effect. Bohr's theory of hydrogen like atoms. Characteristic and continuous X-rays, Moseley's law. de Broglie wavelength of matter waves. Heisenberg's uncertainty principle.

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