



## BITSAT-2009 Brochure

### A Computer Based Online Test for admission to Integrated First Degree programmes of BITS, Pilani; I Semester 2009-10

The Birla Institute of Technology and Science (BITS) Pilani is an Institution declared as Deemed to be University under Section 3 of the UGC Act. Admissions to all the Integrated First Degree programmes of BITS, Pilani, at Pilani campus, Goa campus, and Hyderabad Campus for the academic year 2009-10 will be made on the basis of a Computer based Online Test conducted by BITS, Pilani. This test will be referred to as 'BITS Admission test – 2009', in short as **BITSAT-2009** hereafter in this document.

#### 1. Integrated First Degree Programmes to which admissions will be made on the basis of BITSAT-2009:

##### (i) at BITS, Pilani – Pilani Campus:

**B.E.(Hons.):** Chemical; Civil; Computer Science; Electrical and Electronics; Electronics & Instrumentation; Mechanical;

**B.Pharm.(Hons.);**

**M.Sc.(Hons.):** Biological Sciences; Chemistry; Economics; Mathematics; Physics; and

**M.Sc.(Tech.):** General Studies; Engineering Technology; Finance; Information Systems.

##### (ii) at BITS, Pilani – Goa Campus:

**B.E.(Hons.):** Chemical; Computer Science; Electrical and Electronics; Electronics & Instrumentation; Mechanical;

**M.Sc.(Hons.):** Biological Sciences; Chemistry; Economics; Mathematics; Physics; and

**M.Sc.(Tech.):** Information Systems.

##### (iii) at BITS, Pilani – Hyderabad Campus :

**B.E.(Hons.):** Chemical; Civil; Computer Science; Electronics & Communication, Electrical and Electronics; Mechanical;

**B.Pharm.(Hons.);**

**M.Sc.(Hons.):** Biological Sciences; Chemistry; Economics; Mathematics; Physics; and

**M.Sc.(Tech.):** Information Systems.

All students admitted to M.Sc(Hons.) programmes will be given an opportunity to work under the dual degree scheme for one of the B.E. (Hons.)/B.Pharm.(Hons.) programmes, assignment being made by competition on their performance at BITS at the end of first year, separately in Pilani, Goa and Hyderabad campuses.

#### 2. Eligibility:

For admission to any of the above Integrated First Degree programmes Candidates should have passed the 12<sup>th</sup> examination of 10+2 system from a recognized Central or State board or its equivalent with Physics, Chemistry, and Mathematics. Further the candidate should have obtained a minimum of

aggregate 80% marks in Physics, Chemistry and Mathematics subjects in 12<sup>th</sup> examination, with at least 60% marks in each of the Physics, Chemistry, and Mathematics subjects and should have adequate proficiency in English.

**Students who are appearing for 12<sup>th</sup> examination in 2009 or who have passed 12<sup>th</sup> Examination in 2008 only are eligible to appear in the BITSAT-2009 test.** Students who have passed 12<sup>th</sup> examination in 2007 or earlier are NOT eligible to appear in BITSAT-2009. Students who are presently studying in BITS at any of its campuses are not eligible to appear in BITSAT-2009

Admissions will be made purely on merit. The merit position of the candidate for admission will be based on the score obtained by the candidate in the BITSAT-2009. However, their eligibility for admission is subject to fulfilling the requirement of minimum marks in 12<sup>th</sup> examination, as mentioned above.

**Direct Admission to Board Toppers:**

In the past, admission process of the Institute always ensured guaranteed admission to all the students who obtained first ranks in their respective board examinations. This has given a very vital input of highly meritorious students from all over India. First rank students of all the central and state boards in India for the year 2009 will be given direct admission to the program of their choice, irrespective of their BITSAT-2009 score as per the eligibility criteria mentioned above. Further details about this scheme will be available at BITS website by 20<sup>th</sup> May, 2009.

**3.Details of BITSAT-2009:**

‘Computer Based Online test’ means the candidate sits in front of a computer and the questions are presented on the computer monitor and the candidate submits the answers through the use of keyboard or mouse. Each computer is connected to a server, which prepares the question set and delivers it to the candidate on the computer. This is unlike the traditional paper-pencil based test, which is generally offered on a single day to all candidates. BITSAT-2009 will be offered over a period of time and the candidate can choose the center, the day and time of his/her convenience to take the test, as described in the later sections.

**BITSAT-2009 Test Format:**

BITSAT-2009 will be of total 3-hour duration (without break). The test consists of four parts:

- Part I : Physics
- Part II : Chemistry
- Part III : (a) English Proficiency and (b) Logical Reasoning
- Part IV : Mathematics

All questions are of objective type (multiple choice questions); each question with choice of four answers, only one being correct choice. Each correct answer fetches 3 marks, while each incorrect answer has a penalty of 1 mark. No marks are awarded for not attempted questions. While the candidate can skip a question, the computer will not allow the candidate to choose more than one option as correct answer.

There will be 150 questions in all. The number of questions in each part is as follows:

	<b>Subject</b>	<b>No of questions</b>
Part I	Physics	40

Part II	Chemistry	40
Part III	(a) English Proficiency	15
	(b) Logical Reasoning	10
Part IV	Mathematics	45
<b>Total:</b>		<b>150</b>

There is no time limit for individual parts of the test. The candidate can go back and change any of his/her answers among the 150 questions.

If a candidate answers all the 150 questions (without skipping any question), the candidate will have an option of attempting 12 (twelve) extra questions, if there is still time left. These extra questions will be from Physics, Chemistry, Mathematics only; four questions from each part. Further, once the candidate has opted for extra questions, he cannot go back for correction of any of the earlier answered 150 questions.

The questions are so designed that a good student will be able to answer 150 questions in 180 minutes. The extra questions (a maximum of 12) will give a chance to highly meritorious candidates to score higher. However, candidates should keep in mind the fact that there is negative marking for wrong answers and any attempt to answer the questions by pure guessing of the answers is not likely to have any advantage, but may result in a reduction in the total score.

The questions will be selected at random from a large question bank. Different candidates will get different question sets. An expert committee will ensure that the question sets are of comparable difficulty level, content, question type etc. In this matter, the decision of the expert committee will be final and binding on the candidate.

All the questions and instructions of the test will be in English only.

Each candidate who registers for BITSAT-2009 will be instructed to download a 'Hall Ticket'. Candidates with the hall ticket only will be allowed inside the test centers. Candidates should bring a pen for the purpose of rough work, signing etc. Blank sheets for rough work will be provided, if required. Calculators and logarithmic tables are not allowed in the test centers. Candidates are not allowed to bring any other personal belongings such as mobiles.

All centers are closely monitored for security and candidates' identity and activities will be recorded using web cameras and/or closed circuit TV cameras. Anyone violating the rules of the test center will not be allowed to continue with the test and will be automatically disqualified.

**Syllabus:**

The BITSAT-2009 test will be conducted on the basis of NCERT syllabus for 11<sup>th</sup> and 12<sup>th</sup> class. The detailed syllabus is given in the Annexure. Candidates may refer to the NCERT textbooks for the contents. A sample test will be made available to the registered candidates at the BITS website on which he/she can practice as many times as desired.

**4. BITSAT score report:**

At the completion of the test, the computer will announce the result to the candidate in terms of number of total correct answers and wrong answers, with the score. The candidate can also check and

print his score report at the BITS website after all the tests are completed. No student will be allowed to repeat the test in the same year.

#### 5. Merit List for Admission:

As explained earlier, a candidate who has appeared in BITSAT-2009 will be eligible for admission only if he/she gets the required minimum marks in the Physics, Chemistry and Mathematics subjects of 12<sup>th</sup> examination as per the eligibility criteria described already. All candidates who have appeared in BITSAT-2009 and are interested in admission will be required to submit Admission application with 12<sup>th</sup> marks and preferences to different degree programmes offered, on or before 30<sup>th</sup> June 2009.

The merit position of such eligible candidates (i.e., those who have appeared in BITSAT-2009 and have submitted the application for admission in the prescribed form with 12<sup>th</sup> marks, preferences and the required fees) will be prepared on the basis of their scores in BITSAT-2009. The cases of bracketing, if any, will be dealt with as described below.

When the score of two candidates are the same, first their scores obtained in Mathematics in BITSAT will be considered for separating them, If the tie still exists, then their scores in Physics in BITSAT will be considered for separating them. Further tie is eliminated using their scores in Chemistry. Finally, their PCM total marks in 12<sup>th</sup> examination will be considered for their separation.

#### 6. Test Centers for BITSAT-2009:

In order to facilitate a large number of students all over India to participate in this test, **apart from Pilani, Goa and Hyderabad** where it is expected that a large number of students will take the test, the Institute is also planning to offer the tests at dedicated test centers in several cities. The planned test centers are in the following cities.

- |                   |                |                             |
|-------------------|----------------|-----------------------------|
| 1. Pilani         | 2. Goa         | 3. Hyderabad City           |
| 4. Ahmedabad      | 5. Bangalore   | 6. Hyderabad Campus of BITS |
| 7. Chandigarh     | 8. Chennai     | 9. Bhubaneswar              |
| 10. Delhi         | 11. Gurgaon    | 12. Coimbatore              |
| 13. Indore        | 14. Kolkatta   | 15. Lucknow                 |
| 16. Mumbai        | 17. Nagpur     | 18. Noida                   |
| 19. Visakhapatnam | 20. Vijayawada |                             |

The final list of centers and the operating days at each center will depend on the number of applicants and their preferences and will be announced only after all the applications are received and candidates will be informed of the same through BITS website, so that the candidates can choose their date for the test as per their convenience and availability of slots in any of these centers.

#### 7. Important dates and deadlines:

Deadline to apply for BITSAT-2009	:	31 <sup>st</sup> January 2009
Test center allotment and announcement to candidates	:	by 15 <sup>th</sup> February 2009
Candidates to reserve Test dates	:	18 <sup>th</sup> Feb. – 10 <sup>th</sup> March 2009
Candidates to download the Hall tickets with instructions:	:	20 <sup>th</sup> – 31 <sup>st</sup> March 2009
BITSAT Online tests	:	9 <sup>th</sup> May – 12 <sup>th</sup> June 2009
Candidates to apply for admission with 12 <sup>th</sup> marks and	:	

preferences to Degree programmes : 20<sup>th</sup> May – 30<sup>th</sup> June 2009  
Admit List and Wait List announcement : 1<sup>st</sup> July 2009

## **8. How to Apply:**

Interested candidates should register their names for BITSAT-2009 by applying in the prescribed application form online. Complete the application form Online at <http://www.bitsadmission.com> and take the print out of the filled form. The completed application form alongwith the prescribed fees of Rs. 1000/- (Rs. 500/- for female candidates) should be sent to Admissions Officer, BITS, Pilani – 333 031. Details for payment of fees are available at the website while applying online.

**Special provision for Female candidates:** The BITSAT application fee for female candidates is Rs. 500/- only instead of Rs. 1000/-. Further, the Institute will try its best to accommodate all female candidates at their first preference of test centers.

Application form by can also be obtained by post from the Admissions Office, BITS, Pilani by sending a request on plain paper giving the candidate's name, and gender with complete postal address, accompanied by a crossed demand draft for Rs. 1100/- (Rs. 600/- for Female candidates). This amount includes the prescribed fees and Rs. 100/- towards postal and handling charges. The form will be sent by Speed Post / Registered Post. Requests by post will be accepted only till 21<sup>st</sup> January 2009. Demand drafts should be drawn in favour of '*Birla Institute of Technology & Science*' payable at State Bank of India, Pilani (code: 1976) Or State Bank of Bikaner & Jaipur, Pilani (Code: 10398) or UCO Bank, Vidya Vihar, Pilani (Code: 0150) Or ICICI Bank, Jhunjhunu (Code: 0799)

**Deadline to apply for BITSAT-2009 by submitting the completed form to the Admissions Office, BITS Pilani is 5.00 PM on 31<sup>st</sup> January 2009.**

Those who register for the test and reserve test dates have to download the 'Hall ticket', alongwith instructions, from BITS website as per the schedule given earlier. The tests will be conducted during 9<sup>th</sup> May – 12<sup>th</sup> June 2009.

### **Procedure for Applying for admission:**

In addition to applying for and appearing in BITSAT-2009, candidates have to also apply for admission to BITS giving details of their 12<sup>th</sup> marks and preferences to different degree programmes offered. The prescribed application form for admission, the detailed application procedure and the final list of Degree programmes offered will be available at the BITS website, by 20<sup>th</sup> May 2009. All the Candidates have to fill the form and a fee of Rs. 200/- has to be submitted with the form. The completed form with the required application fee of Rs. 200/- has to be submitted so as to reach the under-mentioned on or before 5.00 PM on 30<sup>th</sup> June 2009.

Completed application forms for BITSAT-2009 and for admission are to be sent by registered post/speedpost or personally submitted to the under-mentioned so as to reach him before the announced deadlines:

**The Admissions Officer,**

**BITS**

**Pilani – 333 031**

**Rajasthan**

**Important Note:**

- (i) The tests are generated from a large question bank and different candidates will get different question sets. An expert committee will ensure that the question sets are of comparable difficulty level, content, question type etc. In this matter, the decision of the expert committee will be final and binding on the candidate.
- (ii) The test assumes that the candidate has basic familiarity with computers, keyboard and mouse operation. It is the responsibility of the candidate to acquire these skills before appearing in the test and the Institute cannot take responsibility for the same.
- (iii) The Institute is planning to operate test centers in different cities other than Pilani and Goa as previously stated. The final list of centers and actual days of operation will be announced to candidates through the BITS website. The Institute cannot guarantee that test centers will be set up in all these cities. Further, the Institute reserves the right to cancel any test center if such situation arises. In such cases, those candidates allotted to these centers will be accommodated in alternate test centers including Pilani/Goa/Hyderabad.
- (iv) The candidate must fully obey the rules of the test centers; otherwise he/she will be automatically debarred from the test.
- (v) In all matters in the conduct of BITSAT-2009, the decision of the Vice Chancellor of BITS will be final.
- (vi) A candidate can submit only one filled form for BITSAT-2009. However, if a candidate discovers any mistake in the form submitted by him, he can submit a second application form duly completed before the last date, indicating on the top of the second application form that his first application form (giving its number) should be cancelled. In such cases, the second application has to be accompanied by a fresh application fee
- (vii) All disputes pertaining to BITSAT-2009 shall fall within the jurisdiction of Pilani only.

**Syllabus for BITSAT-2009****Part I: Physics****1. Units & Measurement**

- 1.1 Units (Different systems of units, SI units, fundamental and derived units)
- 1.2 Dimensional Analysis
- 1.3 Precision and significant figures
- 1.4 Fundamental measurements in Physics (Vernier calipers, screw gauge, Physical balance etc)

**2. Kinematics**

- 2.1 Properties of vectors
- 2.2 Position, velocity and acceleration vectors
- 2.3 Motion with constant acceleration
- 2.4 Projectile motion
- 2.5 Uniform circular motion
- 2.6 Relative motion

**3. Newton's Laws of Motion**

- 3.1 Newton's laws (free body diagram, resolution of forces)
- 3.2 Motion on an inclined plane
- 3.3 Motion of blocks with pulley systems
- 3.4 Circular motion – centripetal force
- 3.5 Inertial and non-inertial frames

**4. Impulse and Momentum**

- 4.1 Definition of impulse and momentum
- 4.2 Conservation of momentum
- 4.3 Collisions
- 4.4 Momentum of a system of particles
- 4.5 Center of mass

**5. Work and Energy**

- 5.1 Work done by a force
- 5.2 Kinetic energy and work-energy theorem
- 5.3 Power
- 5.4 Conservative forces and potential energy
- 5.5 Conservation of mechanical energy

**6. Rotational Motion**

- 6.1 Description of rotation (angular displacement, angular velocity and angular acceleration)
- 6.2 Rotational motion with constant angular acceleration

- 6.3 Moment of inertia, Parallel and perpendicular axes theorems, rotational kinetic energy
- 6.4 Torque and angular momentum
- 6.5 Conservation of angular momentum
- 6.6 Rolling motion

### **7. Gravitation**

- 7.1 Newton's law of gravitation
- 7.2 Gravitational potential energy, Escape velocity
- 7.3 Motion of planets – Kepler's laws, satellite motion

### **8. Mechanics of Solids and Fluids**

- 8.1 Elasticity
- 8.2 Pressure, density and Archimedes' principle
- 8.3 Viscosity and Surface Tension
- 8.4 Bernoulli's theorem

### **9. Oscillations**

- 9.1 Kinematics of simple harmonic motion
- 9.2 Spring mass system, simple and compound pendulum
- 9.3 Forced & damped oscillations, resonance

### **10. Waves**

- 10.1 Progressive sinusoidal waves
- 10.2 Standing waves in strings and pipes
- 10.3 Superposition of waves, beats
- 10.4 Doppler Effect

### **11. Heat and Thermodynamics**

- 11.1 Kinetic theory of gases
- 11.2 Thermal equilibrium and temperature
- 11.3 Specific heat
- 11.4 Work, heat and first law of thermodynamics
- 11.5 2<sup>nd</sup> law of thermodynamics, Carnot engine – Efficiency and Coefficient of performance

### **12. Electrostatics**

- 12.1 Coulomb's law
- 12.2 Electric field (discrete and continuous charge distributions)
- 12.3 Electrostatic potential and Electrostatic potential energy
- 12.4 Gauss' law and its applications
- 12.5 Electric dipole
- 12.6 Capacitance and dielectrics (parallel plate capacitor, capacitors in series and parallel)

### **13. Current Electricity**

- 13.1 Ohm's law, Joule heating

13.2 D.C circuits – Resistors and cells in series and parallel, Kirchoff's laws, potentiometer and Wheatstone bridge,

13.3 Electrical Resistance (Resistivity, origin and temperature dependence of resistivity).

#### **14. Magnetic Effect of Current**

14.1 Biot-Savart's law and its applications

14.2 Ampere's law and its applications

14.3 Lorentz force, force on current carrying conductors in a magnetic field

14.4 Magnetic moment of a current loop, torque on a current loop, Galvanometer and its conversion to voltmeter and ammeter

#### **15. Electromagnetic Induction**

15.1 Faraday's law, Lenz's law, eddy currents

15.2 Self and mutual inductance

15.3 Transformers and generators

15.4 Alternating current (peak and rms value)

15.5 AC circuits, LCR circuits

#### **16. Optics**

16.1 Laws of reflection and refraction

16.2 Lenses and mirrors

16.3 Optical instruments – telescope and microscope

16.4 Interference – Huygen's principle, Young's double slit experiment

16.5 Interference in thin films

16.6 Diffraction due to a single slit

16.7 Electromagnetic waves and their characteristics (only qualitative ideas), Electromagnetic spectrum

16.8 Polarization – states of polarization, Malus' law, Brewster's law

#### **17. Modern Physics**

17.1 Dual nature of light and matter – Photoelectric effect, De Broglie wavelength

17.2 Atomic models – Rutherford's experiment, Bohr's atomic model

17.3 Hydrogen atom spectrum

17.4 Radioactivity

17.5 Nuclear reactions : Fission and fusion, binding energy

### **Part II: Chemistry**

#### **1. States of Matter**

1.1 Measurement: Physical quantities and SI units, Dimensional analysis, Precision, Significant figures.

1.2 Chemical reactions: Laws of chemical combination, Dalton's atomic theory; Mole concept; Atomic, molecular and molar masses; Percentage composition & molecular formula; Balanced chemical equations & stoichiometry

1.3 Gaseous state: Gas Laws, Kinetic theory – Maxwell distribution of velocities, Average, root mean square and most probable velocities and relation to temperature, Diffusion; Deviation from ideal behaviour – Critical temperature, Liquefaction of gases, van der Waals equation.

1.4 Liquid state: Vapour pressure, surface tension, viscosity.

- 1.5 Solid state: Classification; Space lattices & crystal systems; Unit cell – Cubic & hexagonal systems; Close packing; Crystal structures: Simple AB and AB<sub>2</sub> type ionic crystals, covalent crystals – diamond & graphite, metals. Imperfections- Point defects, non-stoichiometric crystals; Electrical, magnetic and dielectric properties; Amorphous solids – qualitative description.

## 2. Atomic Structure

- 2.1 Introduction: Subatomic particles; Rutherford's picture of atom; Hydrogen atom spectrum and Bohr model.
- 2.2 Quantum mechanics: Wave-particle duality – de Broglie relation, Uncertainty principle; Hydrogen atom: Quantum numbers and wavefunctions, atomic orbitals and their shapes (s, p, and d), Spin quantum number.
- 2.3 Many electron atoms: Pauli exclusion principle; Aufbau principle and the electronic configuration of atoms, Hund's rule.
- 2.4 Periodicity: Periodic law and the modern periodic table; Types of elements: s, p, d, and f blocks; Periodic trends: ionization energy, atomic and ionic radii, electron affinity, electro negativity and valency.
- 2.5 Nucleus: Natural and artificial radioactivity; Nuclear reactions.

## 3. Chemical Bonding & Molecular Structure

- 3.1 Ionic Bond: Lattice Energy and Born-Haber cycle
- 3.2 Molecular Structure: Lewis picture & resonance structures, VSEPR model & molecular shapes
- 3.3 Covalent Bond: Valence Bond Theory- Orbital overlap, Directionality of bonds & hybridisation (s & p orbitals only), Resonance; Molecular orbital theory- Methodology, Orbital energy level diagram, Bond order, Magnetic properties for homonuclear diatomic species.
- 3.4 Metallic Bond: Qualitative description.
- 3.5 Intermolecular Forces: Polarity; Dipole moments; Hydrogen Bond.

## 4. Thermodynamics

- 4.1 Basic Concepts: Systems and surroundings; State functions; Intensive & Extensive Properties; Zeroth Law and Temperature
- 4.2 First Law of Thermodynamics: Work, internal energy, heat, enthalpy, heat capacities; Enthalpies of formation, phase transformation, ionization, electron gain; Thermochemistry; Hess's Law. Bond dissociation, combustion, atomization, sublimation, dilution
- 4.3 Second Law: Spontaneous and reversible processes; entropy; Gibbs free energy related to spontaneity and non-mechanical work; Standard free energies of formation, free energy change and chemical equilibrium; Third Law and Absolute Entropies.

## 5. Physical and Chemical Equilibria

- 5.1 Concentration Units: Mole Fraction, Molarity, and Molality
- 5.2 Solutions: Solubility of solids and gases in liquids, Vapour Pressure, Raoult's law, Relative lowering of vapour pressure, depression in freezing point; elevation in boiling point; osmotic pressure, determination of molecular mass.
- 5.3 Physical Equilibrium: Equilibria involving physical changes (solid-liquid, liquid-gas, solid-gas), Adsorption, Physical and Chemical adsorption, Langmuir Isotherm.
- 5.4 Chemical Equilibria: Equilibrium constants ( $K_p$ ,  $K_c$ ), Le-Chatelier's principle.
- 5.5 Ionic Equilibria: Strong and Weak electrolytes, Acids and Bases (Arrhenius, Lewis, Lowry and Bronsted) and their dissociation; Ionization of Water; pH; Buffer solutions; Acid-base titrations; Hydrolysis; Solubility Product of Sparingly Soluble Salts; Common Ion Effect.
- 5.6 Factors Affecting Equilibria: Concentration, Temperature, Pressure, Catalysts, Significance of  $\Delta G$  and  $\Delta G^0$  in Chemical Equilibria.

## 6. Electrochemistry

- 6.1 Redox Reactions: Oxidation-reduction reactions (electron transfer concept); Oxidation number; Balancing of redox reactions; Electrochemical cells and cell reactions; Electrode potentials; Idea of heterogeneous equilibria on the surface of the electrode; EMF of Galvanic cells; Nernst equation; Factors affecting the electrode potential; Gibbs energy change and cell potential; Concentration cells; Secondary cells; Fuel cells; Corrosion and its prevention.
- 6.2 Electrolytic Conduction: Electrolytic Conductance; Specific, equivalent and molar conductivities; Kohlrausch's Law and its application, Faraday's laws of electrolysis; Coulometer; Electrode potential and electrolysis, Commercial production of the chemicals, NaOH, Na, Al<sub>2</sub>Cl<sub>2</sub>, & F<sub>2</sub>

## 7. Chemical Kinetics

- 7.1 Aspects of Kinetics: Rate and Rate expression of a reaction; Rate constant; Order and molecularity of the reaction; Integrated rate expressions and half life for zero and first order reactions; Determination of rate constant and order of reaction
- 7.2 Factor Affecting the Rate of the Reactions: Concentration of the reactants, size of particles; Temperature dependence of rate constant; Activation energy; Catalysis, Surface catalysis, enzymes, zeolites; Factors affecting rate of collisions between molecules; Effect of light.
- 7.3 Mechanism of Reaction: Elementary reactions; Complex reactions; Reactions involving two/three steps only; Photochemical reactions; Concept of fast reactions.
- 7.4 Radioactive isotopes: Half-life period; Radiochemical dating.

## 8. Hydrogen and s-block elements

- 8.1 Hydrogen: Element: unique position in periodic table, occurrence, isotopes; Dihydrogen: preparation, properties, reactions, and uses; Molecular, saline, interstitial hydrides; Water: Properties; Structure and aggregation of water molecules; Heavy water; Hydrogen peroxide; Hydrogen as a fuel.
- 8.2 s-block elements: Abundance and occurrence; Anomalous properties of the first elements in each group; diagonal relationships.
- 8.3 Alkali metals: Lithium, sodium and potassium: occurrence, extraction, reactivity, and electrode potentials; Biological importance; Reactions with oxygen, hydrogen, halogens and liquid ammonia; Basic nature of oxides and hydroxides; Halides; Properties and uses of compounds such as NaCl, Na<sub>2</sub>CO<sub>3</sub>, NaHCO<sub>3</sub>, NaOH, KCl, and KOH.
- 8.4 Alkaline earth metals: Magnesium and calcium: Occurrence, extraction, reactivity and electrode potentials; Reactions with non-metals; Solubility and thermal stability of oxo salts; Biological importance; Properties and uses of important compounds such as CaO, Ca(OH)<sub>2</sub>, plaster of Paris, MgSO<sub>4</sub>, MgCl<sub>2</sub>, CaCO<sub>3</sub>, and CaSO<sub>4</sub>; Lime and limestone, cement.

## 9. p- d- and f-block elements

- 9.1 General: Abundance, distribution, physical and chemical properties, isolation and uses of elements; Trends in chemical reactivity of elements of a group;
- 9.2 Group 13 elements: Boron; Properties and uses of borax, boric acid, boron hydrides & halides. Reaction of aluminum with acids and alkalis;
- 9.3 Group 14 elements: Carbon: Uses, Allotropes (graphite, diamond, fullerenes), oxides, halides and sulphides, carbides; Silicon: Silica, silicates, silicone, Zeolites.
- 9.4 Group 15 elements: Dinitrogen; Reactivity and uses of nitrogen and its compounds; Industrial and biological nitrogen fixation; Ammonia: Haber's process, properties and reactions; Oxides of nitrogen and their structures; Ostwald's process of nitric acid production; Fertilizers – NPK type; Production of phosphorus; Allotropes of phosphorus; Preparation, structure and properties of hydrides, oxides, oxoacids and halides of phosphorus.
- 9.5 Group 16 elements: Isolation and chemical reactivity of dioxygen; Acidic, basic and amphoteric oxides; Preparation, structure and properties of ozone; Allotropes of sulphur; Production of sulphur and sulphuric acid; Structure and properties of oxides, oxoacids, hydrides and halides of sulphur.

- 9.6 Group 17 and group 18 elements: Structure and properties of hydrides, oxides, oxoacids of chlorine; Inter halogen compounds; Bleaching Powder; Preparation, structure and reactions of xenon fluorides, oxides, and oxoacids.
- 9.7 d-block elements: General trends in the chemistry of first row transition elements; Metallic character; Oxidation state; Ionic radii; Catalytic properties; Magnetic properties; Interstitial compounds; Occurrence and extraction of iron, copper, silver, zinc, and mercury; Alloy formation; Steel and some important alloys; preparation and properties of  $\text{CuSO}_4$ ,  $\text{K}_2\text{Cr}_2\text{O}_7$ ,  $\text{KMnO}_4$ , Mercury halides; Silver nitrate and silver halides; Photography.
- 9.8 f-block elements: Lanthanides and actinides; Oxidation states and chemical reactivity of lanthanide compounds; Lanthanide contraction; Comparison of actinides and lanthanides.
- 9.9 Coordination Compounds: Coordination number; Ligands; Werner's coordination theory; IUPAC nomenclature; Application and importance of coordination compounds (in qualitative analysis, extraction of metals and biological systems e.g. chlorophyll, vitamin B12, and hemoglobin); Bonding: Valence-bond approach, Crystal field theory (qualitative); Stability constants; Shapes, color and magnetic properties; Isomerism including stereoisomerisms; Organometallic compounds.

## 10. Principles of Organic Chemistry and Hydrocarbons

- 10.1 Classification: Based on functional groups, trivial and IUPAC nomenclature.
- 10.2 Electronic displacement in a covalent bond: Inductive, resonance effects, and hyperconjugation; free radicals; carbocations, carbanion, nucleophile and electrophile; types of reactions.
- 10.3 Alkanes and cycloalkanes: Structural isomerism and general properties.
- 10.4 Alkenes and alkynes: General methods of preparation and reactions, physical properties, electrophilic and free radical additions, acidic character of alkynes and (1,2 and 1,4) addition to dienes.
- 10.5 Aromatic hydrocarbons: Sources; Properties; Isomerism; Resonance delocalization; polynuclear hydrocarbons; mechanism of electrophilic substitution reaction, directive influence and effect of substituents on reactivity.
- 10.6 Haloalkanes and haloarenes: Physical properties, chemical reactions.
- 10.7 Petroleum: Composition and refining, uses of petrochemicals.

## 11. Stereochemistry

- 11.1 Introduction: Chiral molecules; Optical activity; Polarimetry; R,S and D,L configurations; Fischer projections; Enantiomerism; Racemates; Diastereomerism and meso structures.
- 11.2 Conformations: Ethane, propane, n-butane and cyclohexane conformations; Newman and sawhorse projections.
- 11.3 Geometrical isomerism in alkenes

## 12. Organic Compounds with Functional Groups Containing Oxygen and Nitrogen

- 12.1 General: Electronic structure, important methods of preparation, important reactions and physical properties of alcohols, phenols, ethers, aldehydes, ketones, carboxylic acids, nitro compounds, amines, diazonium salts, cyanides and isocyanides.
- 12.2 Specific: Effect of substituents on alpha-carbon on acid strength, comparative reactivity of acid derivatives, basic character of amines and their separation, importance of diazonium salts in synthetic organic chemistry

## 13. Biological , Industrial and Environmental chemistry

- 13.1 The Cell: Concept of cell and energy cycle.
- 13.2 Carbohydrates: Classification; Monosaccharides; Structures of pentoses and hexoses; Anomeric carbon; Mutarotation; Simple chemical reactions of glucose, Disaccharides: reducing and non-reducing sugars – sucrose, maltose and lactose; Polysaccharides: elementary idea of structures of starch and cellulose.
- 13.3 Proteins: Amino acids; Peptide bond; Polypeptides; Primary structure of proteins; Simple idea of secondary , tertiary and quaternary structures of proteins; Denaturation of proteins and enzymes.
- 13.4 Nucleic Acids: Types of nucleic acids; Primary building blocks of nucleic acids (chemical composition of DNA & RNA); Primary structure of DNA and its double helix; Replication; Transcription and protein synthesis; Genetic code.

- 13.5 Lipids, Hormones, Vitamins: Classification, structure, functions in biosystems.
- 13.6 Polymers: Classification of polymers; General methods of polymerization; Molecular mass of polymers; Biopolymers and biodegradable polymers; Free radical, cationic and anionic addition polymerizations; Copolymerization: Natural rubber; Vulcanization of rubber; Synthetic rubbers. Condensation polymers.
- 13.7 Pollution: Environmental pollutants; soil, water and air pollution; Chemical reactions in atmosphere; Smog; Major atmospheric pollutants; Acid rain; Ozone and its reactions; Depletion of ozone layer and its effects; Industrial air pollution; Green house effect and global warming; Green Chemistry.
- 13.8 Chemicals in medicine, health-care and food: Analgesics, Tranquilizers, antiseptics, disinfectants, anti-microbials, anti-fertility drugs, antihistamines, antibiotics, antacids; Cosmetics: Creams, perfumes, talcum powder, deodorants; Preservatives, artificial sweetening agents, antioxidants, and edible colours.
- 13.9 Other Industrial Chemicals: Dyes: Classification with examples – Indigo, methyl orange, aniline yellow, alizarin, malachite green; Advanced materials: Carbon fibers, ceramics, micro alloys; Detergents; Insect repellents, pheromones, sex attractants; Rocket Propellants.

#### 14. Theoretical Principles of Experimental Chemistry

- 14.1 Volumetric Analysis: Principles; Standard solutions of sodium carbonate and oxalic acid; Acid-base titrations; Redox reactions involving KI, H<sub>2</sub>SO<sub>4</sub>, Na<sub>2</sub>SO<sub>3</sub>, Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> and H<sub>2</sub>S; Potassium permanganate in acidic, basic and neutral media; Titrations of oxalic acid, ferrous ammonium sulphate with KMnO<sub>4</sub>, K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>/Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>, Cu(II)/Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>
- 14.2 Qualitative analysis of Inorganic Salts: Principles in the determination of the cations Pb<sup>2+</sup>, Cu<sup>2+</sup>, As<sup>3+</sup>, Mn<sup>2+</sup>, Zn<sup>2+</sup>, Co<sup>2+</sup>, Ca<sup>2+</sup>, Sr<sup>2+</sup>, Ba<sup>2+</sup>, Mg<sup>2+</sup>, NH<sub>4</sub><sup>+</sup>, Fe<sup>3+</sup>, Ni<sup>2+</sup> and the anions CO<sub>3</sub><sup>2-</sup>, S<sup>2-</sup>, SO<sub>4</sub><sup>2-</sup>, SO<sub>3</sub><sup>2-</sup>, NO<sub>2</sub><sup>-</sup>, NO<sub>3</sub><sup>-</sup>, Cl<sup>-</sup>, Br<sup>-</sup>, I<sup>-</sup>, PO<sub>4</sub><sup>3-</sup>, CH<sub>3</sub>COO<sup>-</sup>, C<sub>2</sub>O<sub>4</sub><sup>2-</sup>.
- 14.3 Physical Chemistry Experiments: crystallization of alum, copper sulphate, ferrous sulphate, double salt of alum and ferrous sulphate, potassium ferric sulphate; Temperature vs. solubility; pH measurements; Lyophilic and lyophobic sols; Dialysis; Role of emulsifying agents in emulsification. Equilibrium studies involving (i) ferric and thiocyanate ions (ii) [Co(H<sub>2</sub>O)<sub>6</sub>]<sup>2+</sup> and chloride ions; Enthalpy determination for (i) strong acid vs. strong base neutralization reaction (ii) hydrogen bonding interaction between acetone and chloroform; Rates of the reaction between (i) sodium thiosulphate and hydrochloric acid, (ii) potassium iodate and sodium sulphite (iii) iodide vs. hydrogen peroxide, concentration and temperature effects in these reactions;
- 14.4 Purification Methods: Filtration, crystallization, sublimation, distillation, differential extraction, and chromatography. Principles of melting point and boiling point determination; principles of paper chromatographic separation – R<sub>f</sub> values.
- 14.5 Qualitative Analysis of Organic Compounds: Detection of nitrogen, sulphur, phosphorous and halogens; Detection of carbohydrates, fats and proteins in foodstuff; Detection of alcoholic, phenolic, aldehydic, ketonic, carboxylic, amino groups and unsaturation.
- 14.6 Quantitative Analysis of Organic Compounds: Basic principles for the quantitative estimation of carbon, hydrogen, nitrogen, halogen, sulphur and phosphorous; Molecular mass determination by silver salt and chloroplatinate salt methods; Elementary idea of mass spectrometer for accurate molecular mass determination; Calculations of empirical and molecular formulae.
- 14.7 Principles of Organic Chemistry Experiments: Preparation of iodoform, acetanilide, p-nitro acetanilide, di-benzyl acetone, aniline yellow, beta-naphthol; Preparation of acetylene and study of its acidic character.

### Part III: (a) English Proficiency and (b) Logical Reasoning

#### (a) English Proficiency

This test is designed to assess the test takers' general proficiency in the use of English language as a means of self-expression in real life situations and specifically to test the test takers' knowledge of basic grammar, their vocabulary, their ability to read fast and comprehend, and also their ability to apply the elements of effective writing.

#### 1. Grammar

- 1.1 Agreement, Time and Tense, Parallel construction, Relative pronouns

- 1.2 Determiners, Prepositions, Modals, Adjectives
- 1.3 Voice, Transformation
- 1.4 Question tags, Phrasal verbs

## **2. Vocabulary**

- 2.1 Synonyms, Antonyms, Odd Word, One Word, Jumbled letters, Homophones, Spelling
- 2.2 Contextual meaning.
- 2.3 Analogy

## **3. Reading Comprehension**

- 3.1 Content/ideas
- 3.2 Vocabulary
- 3.3 Referents
- 3.4 Idioms/Phrases
- 3.5 Reconstruction (rewording)

## **4. Composition**

- 4.1 Rearrangement
- 4.2 Paragraph Unity
- 4.3 Linkers/Connectives

### **(b) Logical Reasoning**

The test is given to the candidates to judge their power of reasoning spread in verbal and nonverbal areas. The candidates should be able to think logically so that they perceive the data accurately, understand the relationships correctly, figure out the missing numbers or words, and to apply rules to new and different contexts. These indicators are measured through performance on such tasks as detecting missing links, following directions, classifying words, establishing sequences, and completing analogies.

## **5. Verbal Reasoning**

- 5.1 Analogy  
Analogy means correspondence. In the questions based on analogy, a particular relationship is given and another similar relationship has to be identified from the alternatives provided.
- 5.2 Classification  
Classification means to assort the items of a given group on the basis of certain common quality they possess and then spot the odd option out.
- 5.3 Series Completion  
Here series of numbers or letters are given and one is asked to either complete the series or find out the wrong part in the series.
- 5.4 Logical Deduction – Reading Passage  
Here a brief passage is given and based on the passage the candidate is required to identify the correct or incorrect logical conclusions.
- 5.5 Chart Logic  
Here a chart or a table is given that is partially filled in and asks to complete it in accordance with the information given either in the chart / table or in the question.

## **6. Nonverbal Reasoning**

- 6.1 Pattern Perception  
Here a certain pattern is given and generally a quarter is left blank. The candidate is required to identify the correct quarter from the given four alternatives.
- 6.2 Figure Formation and Analysis  
The candidate is required to analyze and form a figure from various given parts.
- 6.3 Paper Cutting  
It involves the analysis of a pattern that is formed when a folded piece of paper is cut into a definite design.
- 6.4 Figure Matrix  
In this more than one set of figures is given in the form of a matrix, all of them following the same rule. The candidate is required to follow the rule and identify the missing figure.
- 6.5 Rule Detection  
Here a particular rule is given and it is required to select from the given sets of figures, a set of figures, which obeys the rule and forms the correct series.

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## Part IV: Mathematics

### 1. Algebra

- 1.1 Complex numbers, addition, multiplication, conjugation, polar representation, properties of modulus and principal argument, triangle inequality, roots of complex numbers, geometric interpretations.
- 1.2 Theory of Quadratic equations, quadratic equations in real and complex number system and their solutions, relation between roots and coefficients, nature of roots, equations reducible to quadratic equations.
- 1.3 Arithmetic, geometric and harmonic progressions, arithmetic, geometric and harmonic means, arithmetico-geometric series, sums of finite arithmetic and geometric progressions, infinite geometric series, sums of squares and cubes of the first  $n$  natural numbers.
- 1.4 Logarithms and their properties.
- 1.5 Exponential series.
- 1.6 Permutations and combinations, Permutations as an arrangement and combination as selection, simple applications.
- 1.7 Binomial theorem for a positive integral index, properties of binomial coefficients.
- 1.8 Matrices and determinants of order two or three, properties and evaluation of determinants, addition and multiplication of matrices, adjoint and inverse of matrices, Solutions of simultaneous linear equations in two or three variables.
- 1.9 Sets, Relations and Functions, algebra of sets applications, equivalence relations, mappings, one-one, into and onto mappings, composition of mappings.
- 1.10 Mathematical Induction
- 1.11 Linear Inequalities, solution of linear inequalities in one and two variables.

### 2. Trigonometry

- 2.1 Trigonometric ratios, functions and identities.
- 2.2 Solution of trigonometric equations.
- 2.3 Properties of triangles and solutions of triangles
- 2.4 Inverse trigonometric functions
- 2.5 Heights and distances

### 3. Two-dimensional Coordinate Geometry

- 3.1 Cartesian coordinates, distance between two points, section formulae, shift of origin.
- 3.2 Straight lines and pair of straight lines: Equation of straight lines 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, concurrent lines.
- 3.3 Circles and family of circles : Equation of circle in various form, equation of tangent, normal & chords, parametric equations of a circle , intersection of a circle with a straight line or a circle, equation of circle through point of intersection of two circles, conditions for two intersecting circles to be orthogonal.
- 3.4 Conic sections : parabola, ellipse and hyperbola their eccentricity, directrices & foci, parametric forms, equations of tangent & normal, conditions for  $y=mx+c$  to be a tangent and point of tangency.

#### **4. Three dimensional Coordinate Geometry**

- 4.1 Direction cosines and direction ratios, equation of a straight line in space and skew lines.
- 4.2 Angle between two lines whose direction ratios are given
- 4.3 Equation of a plane, distance of a point from a plane, condition for coplanarity of three lines.

#### **5. Differential calculus**

- 5.1 Domain and range of a real valued function, Limits and Continuity of the sum, difference, product and quotient of two functions, Differentiability.
- 5.2 Derivative of different types of functions (polynomial, rational, trigonometric, inverse trigonometric, exponential, logarithmic, implicit functions), derivative of the sum, difference, product and quotient of two functions, chain rule.
- 5.3 Geometric interpretation of derivative, Tangents and Normals.
- 5.4 Increasing and decreasing functions, Maxima and minima of a function.
- 5.5 Rolle's Theorem, Mean Value Theorem and Intermediate Value Theorem.

#### **6. Integral calculus**

- 6.1 Integration as the inverse process of differentiation, indefinite integrals of standard functions.
- 6.2 Methods of integration: Integration by substitution, Integration by parts, integration by partial fractions, and integration by trigonometric identities.
- 6.3 Definite integrals and their properties, Fundamental Theorem of Integral Calculus and its applications.
- 6.4 Application of definite integrals to the determination of areas of regions bounded by simple curves.

#### **7. Ordinary Differential Equations**

- 7.1 Variables separable method.
- 7.2 Solution of homogeneous differential equations.
- 7.3 Linear first order differential equations

#### **8. Probability**

- 8.1 Addition and multiplication rules of probability.
- 8.2 Conditional probability
- 8.3 Independent events
- 8.4 Discrete random variables and distributions

#### **9. Vectors**

- 9.1 Addition of vectors, scalar multiplication.
- 9.2 Dot and cross products of two vectors.
- 9.3 Scalar triple products and their geometrical interpretations.

#### **10. Statistics**

- 10.1 Measures of dispersion
- 10.2 Measures of skewness and Central Tendency
- 11.Linear Programming**
- 11.1 Formulation of linear Programming
- 11.2 Solution of linear Programming, using graphical method.