BITSAT 2012

A computer based online test for admission to
Integrated First Degree Programmes of BITS, Pilani
at Pilani Campus, K.K.Birla Goa Campus & Hyderabad Campus

BITS Pilani
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Brochure

BITSAT-2012

A Computer Based Online Test for Admission to
Integrated First Degree programmes of BITS, Pilani, 2012-13

The Birla Institute of Technology and Science (BITS) Pilani is an all India 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 2012-13 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 – 2012', in short as **BITSAT-2012** hereafter in this document.

1. **Integrated First Degree Programmes to which admissions will be made on the basis of BITSAT-2012:**

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

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

   B.Pharm.(Hons.);

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

   M.Sc.(Tech.): General Studies, 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.

   Note: **All students admitted to M.Sc.(Hons.) programmes are given an option to work for a second degree for one of the B.E. (Hons.)/B.Pharm.(Hons.) programmes under the dual degree scheme, assignment being made by competition on their performance at BITS at the end of first year, separately in Pilani, Goa and Hyderabad campuses. Under this scheme, a student normally requires five years to complete both the degrees and is awarded both the degrees, namely M.Sc.(Hons.) and B.E.(Hons.)/B.Pharm.(Hons.)**

2. Eligibility:

For admission to any of the above Integrated First Degree Programmes, candidates should have passed the 12th class 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 75% marks in Physics, Chemistry and Mathematics subjects in 12th examination, at least 60% marks in each of the Physics, Chemistry, and Mathematics subjects and should have adequate proficiency in English.

Only Students who are appearing for 12th examination in 2012 or who have passed 12th Examination in 2011 are eligible to appear in the BITSAT-2012 test. If a candidate has taken more than one attempt in 12th class or its equivalent, only his latest performance is considered, provided this attempt has been for the full component of subjects/courses prescribed. Students who have passed 12th examination in 2010 or earlier are NOT eligible to appear in BITSAT-2012. Students who are presently studying in BITS at any of its campuses are not eligible to appear in BITSAT-2012

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-2012. However, their eligibility for admission is subject to fulfilling the requirement of minimum marks in 12th 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 2012 will be given direct admission to the program of their choice, irrespective of their BITSAT-2012 score as per the eligibility criteria mentioned above. Further details about this scheme will be available at BITS website by 20th May, 2012.

3. Details of BITSAT-2012:

'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 answers the questions on the computer 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-2012 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-2012 Test Format:

BITSAT-2012 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 (-1mark). No marks are awarded for questions not attempted. 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:

	Subject	No of questions
Part I	Physics	40
Part II	Chemistry	40
Part III	(a) English Proficiency	15
	(b) Logical Reasoning	10
Part IV	Mathematics	45
	Total:	**150**

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, and 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. 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.

Each candidate who registers for BITSAT-2012 will be instructed to download a 'Hall Ticket'. Candidates with the hall ticket only will be allowed inside the Test centers. All centers are closely monitored for security and candidates' identity and activities will be recorded using web cameras and/or closed circuit TV cameras. Candidate's finger print and photograph will be taken at the time of the test and will be matched at the time of admission. Anyone violating the rules of the test center will not be allowed to continue with the test and will automatically be disqualified.

Syllabus:

The BITSAT-2012 test will be conducted on the basis of NCERT syllabus for 11th and 12th class. The detailed syllabus is given in the Annexure. Candidates may refer to the NCERT textbooks for the contents. A sample test demonstrating the features of BITSAT 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-2012 will be eligible for admission only if he/she gets the required minimum marks in the Physics, Chemistry and Mathematics subjects of 12th examination as per the eligibility criteria described already. All candidates who have appeared in BITSAT-2012 and are interested in admission will be required to submit Admission application with 12th marks and preferences to different degree programmes offered, on or before 30th June 2012, the details of this will be available in the BITS website by 19th May 2012.

The merit position of such eligible candidates (i.e., those who have appeared in BITSAT-2012 and who have submitted the application for admission in the prescribed form with 12th marks, preferences and the required fees) will be prepared on the basis of their scores in BITSAT-2012. 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 12th examination will be considered for their separation.

6.   Test Centers for BITSAT-2012:

In order to facilitate a large number of students all over India to participate in this test, **apart from Pilani, Goa and Hyderabad** campuses of BITS 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 Campus of BITS	2. Goa Campus of BITS	3. Hyderabad Campus of BITS
4. Ahmedabad	5.Bangalore	6. Bhubaneswar
7. Chandigarh	8. Chennai	9. Coimbatore
10. Delhi	11. Gurgaon	12. Gwalior
13. Hyderabad City	14. Indore	15. Kolkatta
16. Lucknow	17. Mumbai	18. Nagpur
19. Noida	20. Visakhapatnam	21.Vijayawada
22. Guwahati	23. Varanasi	24. Patna
25. Roorkee	26 Trivandrum	27.Hubli
28. Surat	29.Pune	30.Amritsar
31. Dubai Campus of BITS (International center)		32. Jaipur

The candidate can choose the centers from within India or Dubai. If a candidate chooses centers within India, he/she will be asked to give three preferences and will be allotted one out of these three. **If a candidate chooses Dubai as a center he/she will not be asked for any other center preference and will be allotted Dubai center**.

The final list of centers in India and the operating days at each center in India and Dubai 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-2012	:	15th February 2012
Test center allotment and announcement to candidates	:	25th February 2012
Candidates to reserve Test dates	:	29th Feb. – 20th March 2012
Candidates to download the Hall tickets with instructions:		14th April – 30th April 2012
BITSAT Online tests	:	10th May – 9th June 2012
Candidates to apply for admission with 12th marks and Preferences to Degree programmes	:	19th May – 30th June 2012
Admit List and Wait List announcement	:	1st July 2012

8.   How to Apply:

Interested candidates should register their names for BITSAT-2012 by applying in the prescribed application form online.   Complete the application form online at *http://www.bitsadmission.com* and pay the prescribed fees. Also take the print out of the filled form for your future reference. If you make payment by Demand draft then a copy of the completed application form alongwith the prescribed fees of **Rs. 1700/- (Rs. 1200/- for female candidates)** should be sent to Admissions Officer, BITS, Pilani –   333 031**. If you are using a payment mode other than DD then the prescribed fee for BITSAT 2012 is Rs. 1600/- (Rs. 1100/- for female candidates).**

 If a candidate chooses Dubai as a test center the application fee for both male and female candidates will be same and will be US $ 50 (or Indian Rs. 2500/-). Details for payment of fees are available at the website while applying online.

Deadline to apply for BITSAT-2012 online along with the fee payment is 15th February 2012. If you are usind DD as the mode of payment then the DD along with a copy of application form must reach Admissions Office, BITS Pilani by 5.00 PM on 15st February 2012.

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 10th May – 9th June 2012.

9.   Procedure for Applying for admission:

In addition to applying and appearing for BITSAT-2012, candidates have to also apply for admission to BITS giving details of their 12th 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 19th May 2012. The completed form with the required application fee has to be submitted so as to reach the under-mentioned on or before 5.00 PM on 30th June 2012.

> **The Admissions Officer,**
> **BITS**
> **Pilani – 333 031**
> **Rajasthan**

10. Board codes

The codes for the name of the Board from which you have passed/ appearing in the 12th examination are as follows:

	Name of the Board and Examination	Board Code
i)	Central Board of Secondary Education - All India Senior School Certificate Examination	CBAT
ii)	Council for the Indian School Certificate Examination - Indian School Certificate (Year-12) Examination	ISCT
iii)	Board of Intermediate Education, Andhra Pradesh - Intermediate Examination	APBT
iv)	Assam Higher Secondary Education Council - Higher Secondary (+2) Examination	ASBT
v)	Bihar Intermediate Council, Bihar Intermediate Examination	BICT
vi)	Board of Secondary Education, Chhatisgarh - Higher Secondary School Certificate Examination	CGBT
vii)	Goa Board of Secondary and Higher Secondary Education - Higher Secondary School Certificate Examination	GDBT
viii)	Gujarat Secondary Education Board, Gujarat - Higher Secondary Certificate Examination (10+2 Pattern)	GJBT
ix)	Board of School Education, Haryana - Senior Secondary Certificate Examination	HRBT
x)	Himachal Pradesh Board of School Education - Senior Secondary (+2) examination	HPBT
xi)	The Jammu & Kashmir State Board of School Education - Higher Secondary Part II Examination, Jammu/Kashmir Region	JKBW
xii)	Jharkhand Intermediate Council, Jharkhand Intermediate Examination	JHCT
xiii)	Board of Pre-University Examination, Karnataka - Second Year Pre-University Examination	KART
xiv)	Board of Higher Secondary Examination, Kerala - Higher Secondary Examination	KERT
xv)	Board of Secondary Education, Madhya Pradesh - Higher Secondary School Certificate Examination (10+2)	MPBT
xvi)	Maharashtra State Board of Secondary and Higher Secondary Education - Higher Secondary Certificate Examination	MSBT
xvii)	Council of Secondary Education, Manipur – Higher Secondary	CHMT

Name of the Board and Examination	Board Code
Examination	
xviii) Meghalaya Board of School Education - Higher Secondary School Leaving Certificate Examination	MEGT
xix) Mizoram Board of School Education – Higher Secondary School Leaving Certificate Examination	MZBT
xx) Nagaland Board of School Education - Higher Secondary School Leaving Certificate Examination;	NAGT
xxi) Council of Higher Secondary Education, Orissa - Higher Secondary Examination	CHOT
xxii) Punjab School Education Board - Senior Secondary Certificate Examination (Part II)	PNBT
xxiii) Board of Secondary Education, Rajasthan - Senior Secondary Examination	RJBT
xxiv) Board of Higher Secondary Examination, Tamil Nadu - Higher Secondary Exam.	TNBT
xxv) Tripura Board of Secondary Education - Higher Secondary (+2 Stage) Examination	TRBT
xxvi) Board of Intermediate Examination, Uttaranchal - Intermediate Examination	UABT
xxvii) Board of Intermediate Examination, Uttar Pradesh - Intermediate Examination	UPBT
xxviii) West Bengal Council of Higher Secondary Examination - Higher Secondary Examination	WBBT
xxix) Foreign Qualifications	FORW
xxx) Any Other Board/ University (not covered above)	AOBW

Important Notes:

(ii) 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.

(iii) 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.

(iv) The Institute is planning to operate test centers in different cities other than Pilani, Goa and Hyderabad campuses of BITS as previously stated. The final list of centers and actual days of operation will be announced to candidates through the BITS website www.bitsadmission.com . 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 a situation arises. In such cases, those candidates allotted to these centers will be accommodated in alternate test centers including Pilani/Goa/Hyderabad campuses of BITS.

(v) While BITSAT-2012 tests are scheduled to be held during the period 10th May – 9th June 2012, some of the test centers may operate only for a limited duration during this period depending on the number of applications received. The final list of the centers will be announced at BITS website after all the applications are received.

(vi) The preferences that you give are only indicative and are to guide the Institute for deciding the number of centers. The Institute cannot guarantee that you will get your first preference. Further, if the Institute is unable to allot any center of your choice, you will be allotted a center either at Pilani or at Goa or at Hyderabad campuses of BITS. The exact center where you will be appearing for the test will be announced at BITS website www.bitsadmission.com . However, the Institute will try its best to accommodate all female candidates at their first preference of test centers.

(vii) Candidates who are allotted test centers in Pilani/Goa/Hyderabad campuses of BITS may be given accommodation on nominal charges in hostels.

(viii) The candidate must fully obey the rules of the test centers; otherwise he/she will be automatically debarred from the test.

(ix) **A candidate can apply online only once for BITSAT-2012. However, if a candidate discovers any mistake in the form submitted by him, he can apply online second time and send a letter to admission office BITS,Pilani mentioning the earlier application number which will be cancelled. In such cases, the second application has to be accompanied by a fresh application fee**.

(x) In addition to applying for and appearing in BITSAT-2012, candidates have to also apply for admission to BITS as per the 'Procedure for applying for Admission' outlined earlier. The prescribed application form for admission will be available at the BITS website, by 19th May 2012, for those who appear in BITSAT-2012. The completed form with the required application fee has to be submitted so as to reach the Admissions Office on or before 5.00 PM on 30th June 2012.

(xi) All information and communications regarding BITSAT-2012 and Admission to BITS are made available to the registered candidates on the BITS website www.bitsadmission.com. Candidates are advised to view the BITS website regularly for all related information on BITSAT and BITS Admissions.

(xii) In all matters in the conduct of BITSAT-2012, the decision of the Vice Chancellor of BITS will be final

(xiii) All disputes pertaining to BITSAT-2012 shall fall within the jurisdiction of Pilani only.

Syllabus for BITSAT-2012

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, Heat Transfer - Conduction, convection and radiation, thermal conductivity, Newton's law of cooling

11.4   Work, heat and first law of thermodynamics

11.5 2nd 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 empirical & 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 AB2 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: Radioactivity, Subatomic particles; Atomic number, isotopes and isobars, 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.

3. Chemical Bonding & Molecular Structure

3.1   Ionic Bond: Lattice Energy and Born-Haber cycle; Covalent character of ionic bonds and polar character of covalent bond

3.2   Molecular Structure: Lewis picture & resonance structures, VSEPR model & molecular shapes

3.3   Covalent Bond: Valence Bond Theory- Orbital overlap, Directionality of bonds & hybridization (s, p & d 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

4.4   Third Law: Introduction

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; solid solutions.

5.3   Physical Equilibrium: Equilibria involving physical changes (solid-liquid, liquid-gas, solid-gas), Surface chemistry, Adsorption, Physical and Chemical adsorption, Langmuir Isotherm, Colloids and emulsion, classification, preparation, uses.

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 ΔG and ΔG^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; EMF of Galvanic cells; Nernst equation; Factors affecting the electrode potential; Gibbs energy change and cell potential; Secondary cells; Fuel cells; Corrosion and its prevention.

6.2   Electrolytic Conduction: Electrolytic Conductance; Specific and molar conductivities; Kolhrausch's Law and its application, Faraday's laws of electrolysis; Coulometer; Electrode potential and electrolysis, Commercial production of the chemicals, NaOH, Na, Al, Cl_2 & F_2.

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.

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.

7.3 **Mechanism of Reaction:** Elementary reactions; Complex reactions; Reactions involving two/three steps only.

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_2CO_3, $NaHCO_3$, $NaOH$, 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, $Ca(OH)_2$, plaster of Paris, $MgSO_4$, $MgCl_2$, $CaCO_3$, and $CaSO_4$; 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, silicon tetrachloride, 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 $CuSO_4$, $K_2Cr_2O_7$, $KMnO_4$, Mercury halides; Silver nitrate and silver halides; Photography.

9.8 **f-Block elements:** Lanthanoids and actinoids; Oxidation states and chemical reactivity of lanthanoids compounds; Lanthanide contraction; Comparison of actinoids and lanthanoids.

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, carbanions, nucleophiles and electrophiles; types of organic 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. Uses and environmental effects; di, tri, tetrachloromethanes, iodoform, freon and DDT.

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 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 methods of preparation, 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, cellulose and glycogen.

13.3 Proteins: Amino acids; Peptide bond; Polypeptides; Primary structure of proteins; Simple idea of secondary , tertiary and quarternary 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 Vitamins: Classification, structure, functions in biosystems; Hormones

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; Preservatives, artificial sweetening agents, antioxidants, soaps and detergents.

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_2SO_4, Na_2SO_3, $Na_2S_2O_3$ and H_2S; Potassium permanganate in acidic, basic and neutral media; Titrations of oxalic acid, ferrous ammonium sulphate with $KMnO_4$, $K_2Cr_2O_7/Na_2S_2O_3$, $Cu(II)/Na_2S_2O_3$.

14.2 Qualitative analysis of Inorganic Salts: Principles in the determination of the cations Pb^{2+}, Cu^{2+}, As^{3+}, Mn^{2+}, Zn^{2+}, Co^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Mg^{2+}, NH_4^+, Fe^{3+}, Ni^{2+} and the anions CO_3^{2-}, S^{2-}, SO_4^{2-}, SO_3^{2-}, NO_2^-, NO_3^-, Cl^-, Br^-, I^-, PO_4^{3-}, CH_3COO^-, $C_2O_4^{2-}$.

14.3 Physical Chemistry Experiments: preparation and 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) $[Co(H_2O)_6]^{2+}$ 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_f 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; 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.

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;

Fundamental theorem of algebra.

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, Pascal's triangle

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, elementary row and column operations of matrices,

1.9　Sets, Relations and Functions, algebra of sets applications, equivalence relations, mappings, one-one, into and onto mappings, composition of mappings, binary operation, inverse of function, functions of real variables like polynomial, modulus, signum and greatest integer.

1.10　Mathematical Induction

1.11　Linear Inequalities, solution of linear inequalities in one and two variables.

2. Trigonometry

2.1　Measurement of angles in radians and degrees, positive and negative angles, 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　Co-ordinate axes and co-ordinate planes, distance between two points, section formula, 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, shortest distance between two lines.

4.3　Equation of a plane, distance of a point from a plane, condition for coplanarity of three lines, angles between two planes, angle between a line and a plane.

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, applications in finding areas under simple curves.

6.4   Application of definite integrals to the determination of areas of regions bounded by simple curves.

7. Ordinary Differential Equations

7.1   Order and degree of a differential equation, formulation of a differential equation whole general solution is given, variables separable method.

7.2   Solution of homogeneous differential equations of first order and first degree

7.3   Linear first order differential equations

8. Probability

8.1   Various terminology in probability, axiomatic and other approaches of probability, addition and multiplication rules of probability.

8.2   Conditional probability, total probability and Baye's theorem

8.3   Independent events

8.4   Discrete random variables and distributions with mean and variance.

9. Vectors

9.1   Direction ratio/cosines of vectors, addition of vectors, scalar multiplication, position vector of a point dividing a line segment in a given ratio.

9.2   Dot and cross products of two vectors, projection of a vector on a line.

9.3   Scalar triple products and their geometrical interpretations.

10. Statistics

10.1   Measures of dispersion

10.2   Measures of skewness and Central Tendency, Analysis of frequency distributions with equal means but different variances

11.Linear Programming

11.1   Various terminology and formulation of linear Programming

11.2   Solution of linear Programming using graphical method, feasible and infeasible regions, feasible and infeasible solutions, optimal feasible solutions (upto three nonitrivial constraints)