Syllabus for Geologist/Scientific Officer Exam.

Geology Paper I : - 70 Marks

Section A: Geomorphology and Remote Sensing.

Basic principles. Weathering and soils, Mass wasting. Influence of climate on processes. Concept of erosion cycles. Geomorphology of fluvial tracts, arid zones, coastal regions, 'Karst' landscapes and glaciated ranges. Geomorphic mapping, slope analysis and drainage basin analysis. Applications of geomorphology in mineral prospecting, civil engineering, hydrology and environmental studies. Topographical maps. Geomorphology of India.

Concepts and principles of aerial photography and photogrammetry, satellite remote sensing — data products and their interpretation. Digital image processing. Remote sensing in landform and land use mapping, structural mapping, hydrogeological studies and mineral exploration. Global and Indian Space Missions. Geographic Information System (GIS) — principles and applications.

Section B: Structural Geology

Principles of geological mapping and map reading, projection diagrams. Stress-strain relationships of elastic, plastic and viscous materials. Measurement of strain in deformed rocks. Behaviour of minerals and rocks under deformation conditions. Structural analysis of folds, cleavages, lineations, joints and faults. Superposed deformation. Mechanism of folding and faulting. Time-relationship between crystallization and deformation. Unconformities and basement-cover relations. structural behaviour of igneous rocks, diapirs and salt domes. Introduction to petrofabrics.

Section C: Geotectonics

Earth and the solar system, Meteorites and other extra-terrestrial materials, Planetary evolution of the earth and its internal structure. Heterogeneity of the earth's crust. Major tectonic features of the Oceanic and Continental crust. Continental drift — geological and geophysical evidence, mechanics, objections, present status. Gravity and magnetic anomalies at Mid-ocean ridges, deep sea trenches, continental shield areas and mountain chains. Palaeomagnetism. Seafloor spreading and Plate Tectonics. Island arcs, Oceanic islands and

volcanic arcs. Isostasy, orogeny and epeirogeny. Seismic belts of the earth. Seismicity and plate movements. Geodynamics of the Indian plate.

Section D: Stratigraphy

Nomenclature and the modern stratigraphic code. Radioisotopes and measuring geological time. Geological time-scale. Stratigraphic procedures of correlation of unfossiliferous rocks. Precambrian stratigraphy of India. Stratigraphy of the Palaeozoic, Mesozoic and Cenozoic formations of India. Gondwana system and Gondwanaland. Rise of the Himalaya and evolution of Siwalik basin. Deccan Volcanics. Quaternary Stratigraphy. Rock record, palaeoclimates and palaeogeography.

Section E: Palaeontology

Fossil record and geological time-scale. Morphology and time-ranges of fossil groups. Evolutionary changes in molluscs and mammals in geological time. Principles of evolution. Use of species and genera of foraminifera and echinodermata in biostratigraphic correlation. Siwalik vertebrate fauna and Gondwana flora, evidence of life in Precambrian times, different microfossil groups and their distribution in India.

Geology Paper II : - 60 Marks

Section A: Mineralogy

Physical, chemical and crystallographic characteristics of common rock forming silicate mineral groups. Structural classification of silicates. Common minerals of igneous and metamorphic rocks. Minerals of the carbonate, phosphate, sulphide and halide groups.

Optical properties of common rock forming silicate minerals, uniaxial and biaxial minerals. Extinction angles, pleochroism, birefringenece of minerals and their relation with mineral composition. Twinned crystals. Dispersion. The U-stage.

Section B: Igneous and Metamorphic Petrology

Forms, textures and structures of igneous rocks. Silicate melt equilibria, binary and pernery phase diagrams. Petrology and geotectonic evolution of granites, basalts, andesites and alkaline rocks. Petrology of gabbros, kimberlites, anorthosites and carbonatites. Origin of primary basic magmas.

Textures and structures of metamorphic rocks. Regional and contact metamorphism of pelitic and impure calcareous rocks. Mineral assemblages and

P/T conditions. Experimental and thermodynamic appraisal of metamorphic reactions. Characteristics of different grades and facies of metamorphism. Metasomatism and granitization, migmatites. Plate tectonics and metamorphic zones. Paired metamorphic belts.

Section C: Sedimentology

Provenance and diagenesis of sediments. Sedimentary textures. Framework matrix and cement of terrigenous sediments. Definition, measurement and interpretation of grain size. Elements of hydraulics. Primary structures, palaeocurrent analysis. Biogenic and chemical sedimentary structures. Sedimentary environment and facies. Facies modelling for marine, non-marine and mixed sediments. Tectonics and sedimentation. Classification and definition of sedimentary basins, Sedimentary basins of India. Cyclic sediments. Seismic and sequence stratigraphy. Purpose and scope of basin analysis. Structure contours and isopach maps.

Section D: Geochemistry

Earth in relation to the solar system and universe, cosmic abundance of elements. Composition of the planets and meteorites. Structure and composition of earth and distribution of elements. Trace elements. Elementary crystal chemistry and thermodynamics. Introduction to isotope geochemistry. Geochemistry of hydrosphere, biosphere and atmosphere. Geochemical cycle and principles of geochemical prospecting.

Section E: Environmental Geology

Concepts and principles. Natural hazards — preventive/precautionary measures — floods, landslides, earthquakes, river and coastal erosion. Impact assessment of anthropogenic activities such as urbanization, open cast mining and quarrying, river-valley projects, disposal of industrial and radio-active waste, excess withdrawal of ground water, use of fertilizers, dumping of ores, mine waste and fly-ash. Organic and inorganic contamination of ground water and their remedial measures. Soil degradation and remedial measures. Environment protection — legislative measures in India.

Geology Paper III : - 70 Marks

Section A: Indian mineral deposits and mineral economics

Occurrence and distribution in India of metalliferous deposits — base metals, iron, manganese, aluminium, chromium, nickel, gold, silver, molybdenum. Indian deposits of non-metals — mica, asbestos, barytes, gypsum, graphite, apatite and beryl. Gemstones, refractory minerals, abrasives and minerals used in glass, fertilizer, paint, ceramic and cement industries. Building stones. Phosphorite deposits. Placer deposits, rare earth minerals.

Strategic, critical and essential minerals. India's status in mineral production. Changing patterns of mineral consumption. National Mineral Policy. Mineral Concession Rules. Marine mineral resources and Law of Sea.

Section B: Ore genesis

Ore deposits and ore minerals. Magmatic processes of mineralisation. Porphyry, skarn and hydrothermal mineralisation. Fluid inclusion studies. Mineralisation associated with — (i) ultramafic, mafic and acidic rocks, (ii) greenstone belts, (iii) komatiites, anorthosites and kimberlites and (iv) submarine volcanism. Magma-related mineralisation through geological time. Stratiform and stratabound ores. Ores and metamorphism — cause and effect relations.

Section C: Mineral exploration

Methods of surface and subsurface exploration, prospecting for economic minerals — drilling, sampling and assaying. Geophysical techniques — gravity, electrical, magnetic, airborne and seismic. Geomorphological and remote sensing techniques. Geobotanical and geochemical methods. Borehole logging and surveys for deviation.

Section D: Geology of fuels

Definition, origin of coal. Stratigraphy of coal measures. Fundamentals of coal petrology, peat, lignite, bituminous and anthracite coal. Microscopic constituents of coal. Industrial application of coal petrology. Indian coal deposits. Diagenesis of organic materials.

Origin, migration and entrapment of natural hydorcarbons. Characters of source and reservoir rocks. Structural, stratigraphic and mixed traps. Techniques of exploration. Geographical and geological distributions of onshore and offshore petroliferous basins of India.

Mineralogy and geochemistry of radioactive minerals. Instrumental techniques of detection and measurement of radioactivity. Radioactive methods for prospecting and assaying of mineral deposits. Distribution of radioactive minerals in India. Radioactive methods in petroleum exploration — well logging techniques. Nuclear waste disposal — geological constraints.

Section E: Engineering geology

Mechanical properties of rocks and soils. Geological investigations for river valley projects — Dams and reservoirs; tunnels — types, methods and problems. Bridges — types and foundation problems. Shoreline engineering. Landslides — classification, causes, prevention and rehabilitation. Concrete aggregates — sources, alkali-aggregate reaction. Aseismic designing — seismicity in India and earthquake-resistant structures. Problems of groundwater in engineering projects. Geotechnical case studies of major projects in India.

Syllabus for Chemist Officer Exam.

PAPER-I (Inorganic Chemistry): - 60 Marks

Atomic structure:

Electromagnetic spectrum, black body radiation and Planck's hypothesis, photoelectric effect, Borh's quantum theory of hydrogen atom. Dual character of electron, de-Broglies relationship, Davisson and German experiment. Heisenbergs uncertainty Principle. Time independent Schrodingers equation for hydrogen like atom-Physical significance of the terms involved in the equation. Significance of Ψ and conditions for its acceptability. Normalization and orthogonality of wave function and angular wave function, their significance, quantum numbers, shapes of orbitals and their labeling, aufbau principle, Paulies exclusion principle, Hund's rule, electronic configuration of atoms and monoatomic ions.

Chemical periodicity:

Classification of elements on the basis of electronic configuration.Modern IUPAC Periodic table.General characteristic of s, p, d and f block elements.Effective nuclear charges, screening effects, atomic radii, ionic radii, covalent radii.Ionization potential, electronaffinity and electro-negativity.Group trends and periodic trends in these properties in respect of s-, p- and d-block elements. General trends of variation of electronic configuration, elemental forms, metallic nature, magnetic properties, catenation and catalytic properties, oxidation states, aqueous and redox chemistry in common oxidationstates, properties and reactions of important compounds such hydrides, halides, oxides, oxy-acids, complex chemistry in respect of s-block and p-block elements.

Chemical Bonding and structure:

Ionic bonding: Size effects, radius ratio rules and their limitations. Packing of ions in crystals, lattice energy, Born- lande equation and its applications, Born-Haber cycle and its applications.Solvation energy, polarizing power and polarizability, ionic potential, Fazan's rules.Defects in solids. Covalent bonding: Lewis structures, formal charge. Valence Bond Theory, Molecular orbital Theory, hybridizations, VSEPR theory. Partial ionic Character of covalent bonds, bond moment, dipole moment and electro negativity differences.Concept of resonance, resonance energy, resonance structures. Coordinate bonding: Werner theory of coordination compounds, double salts and complex salts, Lewis acid-base. Ambidentate and polydentate ligands, chelate complexes.IUPAC nomenclature of coordination compounds. Coordination numbers, Geometrical isomerism.

Acid-Base reactions

Acid-Base concept: Arrhenius concept, theory of solvent system, Bronsted-Lowry'sconcept, relative strength of acids, Pauling rules. Lewis concept. Acidbase equilibria in aqueous solution and pH. Acid-base neutralisation curves; indicator, choice of indicators.

Precipitation and Redox Reactions:

Solubility product principle, common ion effect.Ion-electron method of balancing equationof re reaction.Standard redox potentials, Nernst equation. Influence on complexformation, precipitation and change of pH on redox potentials; formal potential.Feasibility of a redox titration, redox potential at the equivalence point, redox indicators.

Redox potential diagram of common elements and their applications. Disproportionation and comproportionation reactions.

Nuclear chemistry:

Radioactive decay - General characteristics, decay kinetics, parent -daughter decaygrowth relationships, determination of half-lives, Nuclear models -shell model, liquiddrop model, Fermi gas model, Collective model and optical model. Nuclear stability.Decay theories. Nuclear reactions- fission, fusion and spallation reactions. Definition

of curie and related calculations, preparation of artificial radionuclides by bombardment,radiochemical separation techniques.

s-Block Elements :

Hydride, hydration energies, solvation and complexation tendencies of alkali and alkaline-earth metals, principle of metallurgical extraction, Chemistry of Li and Be, their anomalous behaviour and diagonal relationships, alkyls and aryls.

p-Block Elements :

Comparative study of group 13 & 14 elements with respect to periodic properties.Compounds such as hydrides, halides, oxides and oxyacids; diagonal relationship; preparation, properties, bonding and structure of diborane, borazine and alkalimetalborohydrides. Preparation, properties and technical applications of carbides and fluorocarbons. Silicones and structural principles of silicates.

Chemistry of d- and f- block elements:

General comparison of 3d, 4d and 5d elements in term of electronic configuration, elementalforms, metallic nature, atomization energy, oxidation states, redox properties,coordination chemistry, spectral and magnetic properties. f-block elements: electronicconfiguration, ionization energies, oxidation states, variation in atomic and ionic (3+) radii, magnetic and spectral properties of lanthanides, comparison between lanthanideand actinides, separation of lanthanides (by ion-exchange method). Chemistry ofsome representative compounds: $K_2Cr_2O_7$, $KMnO_4$, $K_4[Fe(CN)_6]$, $K_2[Ni(CN)_4]$,H_2PtCl_6, $Na_2[Fe(CN)_5NO]$.

PAPER-II (Physical Chemistry) : 60 Marks

Kinetic theory and the gaseous state:

Gaseous state: Gas laws, kinetic theory of gas, collision and gas pressure, derivationof gas laws from kinetic theory, average kinetic energy of translation, Boltzmann constantand absolute scale of temperature. Maxwell's distribution of speeds. Kinetic energy distribution, calculations of average, root mean square

and most probable velocities. Principle of equipartition of energy and its application to calculate the classicallimit of molar heat capacity of gases.

Collision of gas molecules, Real gases:
Collision diameter; collision number and mean free path; frequency of binary collisions;wall collision and rate of effusion.Real gases, Deviation of gases from idealbehaviour; compressibility factor; Andrew's and Amagot's plots; van der Waals equationand its characteristic features.Existence of critical state.Critical constants interms of van der Waals constants.Law of corresponding state and significance of second virial coefficient. Boyle temperature. Intermolecular forces.

Liquid state: physical properties of liquids and their measurements: surface tensionand viscosity

Solids: Nature of solid state, law of constancy of angles, concept of unit cell, different crystal system, Bravais lattices, law of rational indices, Miller indices, symmetry elementsin crystals. X-ray diffraction, Bragg's law, Laue's method, powder method,radius ratio and packing in crystals.

Thermodynamics:
Definition of thermodynamic terms.Thermodynamic functions and their differentials. Zeroth law, First law and Second law of thermodynamics.Cyclic, reversible and irreversibleprocesses. Internal energy (U) and enthalpy (H); relation between Cp and Cv,calculation of w, q, ΔU and ΔH for expansion of ideal gas under isothermal and adiabatic conditions for reversible and irreversible processes including free expansion.Joule-Thomson Coefficient and inversion temperature.Application of First law of thermodynamics.

Application of Second law of thermodynamics.
Carnot cycle and its efficiency, Gibbs function (G) and Helmholtz function (A), Gibbs-Helmholtz equation, criteria for thermodynamic equilibrium and spontaneity of aprocess. Chemical equilibrium: chemical equilibria of homogeneous and heterogeneoussystems, derivation of expression of equilibrium constants, Le Chatelier's principle of dynamic equilibrium.

Thermodynamics and Equilibrium:
Chemical potential in terms of Gibb's free energy and other thermodynamic state functionsand its variation with temperature and pressure. Gibbs-Duhem equation; fugacity of gases and fugacity coefficient. Thermodynamic conditions for equilibrium, degreeof advancement. Van't Hoff's reaction isotherm. Equilibrium constant and standard Gibbs free energy change.Definitions of K_P, K_C and K_x; van't Hoff's reaction isobarand isochore. Le Chatelier's principle. Activity and activity coefficients of electrolyte /ion in solution. Debye-Huckel limiting law.

Acids-bases and solvents:
Modern aspects of acids and bases: Arrhenius theory, theory of solvent system, Bronsted and Lowry's concept, Lewis concept with typical examples, applications andlimitations. Strengths of acids and bases. Ionization of weak acids and bases in aqueoussolutions, application of Ostwald's dilution law, ionization

constants, ionic productof water, pH-scale, buffer solutions and their pH values, buffer actions & buffer capacity;hydrolysis of salts.

Solutions of non-electrolytes: Colligative properties of solution, Raoult's Law, relativelowering of vapor pressure, osmosis and osmotic pressure; elevation of boilingpoint and depression of freezing point of solvents.

Chemical kinetics and catalysis:
Order and molecularity of reactions, rate laws and rate equations for first order andsecond order reactions; zero order reactions.Parallel and consecutive reactions.Determination of order of reactions.Temperature dependence of reaction rate, energyof activation. Enthalpy of activation, entropy of activation , effect of dielectric constant and ionic strength of reaction rate, kinetic isotope effect; collision theory & transitionState Theory of reaction rate, Catalytic reactions.

Electrochemistry:
Conductance: cell constant, specific conductance and molar conductance. Kohlrausch's law of independent migration of ions, ion conductance and ionic mobility. Equivalent and molar conductance at infinite dilution. Ostwald's dilution law. Debye-Huckel theory. Application of conductance measurement. Conductometric titrations. Determination of transport number by moving boundary method. Types of electro chemical cells, cell reactions, emf and change in free energy, ΔH and ΔS of cell reactions. Nernst equation. Standard cells. Half-cells/electrodes, different types of electrodes. Standard electrode potential and principles of its determination. Types of concentration cells. Liquid junction potential. Glass electrode and determination of pH ofa solution. Potentiometric titrations: acid-base and redox, electro chemical power sources;primary, secondary and fuel Cells, corrosion and inhibition of corrosion.

Photochemistry :
Frank-Condon principle and vibrational structure of electronic spectra.Bond dissociationand principle of determination of dissociation energy. Decay of excited states byradiative and non-radiative paths. Fluorescence and phosphorescence, Jablonsky diagram. Laws of photochemistry: Grotthus-Draper law, Stark-Einstein law of photochemicalequivalence and Lambert-Beer's law; quantum yield and its measurement for a photochemical process, actinometry. Photostationary state. Photosensitized reactions. Kinetics of HI decomposition, H_2-Br_2 reaction, dimerisation of anthracene.

Basic principles and application of spectroscopy:
Electromagnetic radiation, interaction with atoms and molecules and quantization ofdifferent forms of energies.Condition of resonance and energy of absorption for varioustypes of spectra; origin of atomic spectra, spectra of hydrogen atoms, many electronatoms, spin and angular momentum. Rotational spectroscopy of diatomic molecules: rigid rotor model, selection rules, spectrum, characteristic features of spectrallines. Determination of bond length, effect of isotopic substitution. Vibrational spectroscopyof diatomic molecules: Simple Harmonic Oscillator model, selection rules,Raman Effect. Characteristic

features and conditions of Raman activity with suitableillustrations. Rotational and vibrational Raman spectra.

UV Spectra: Electronic transition ($\sigma-\sigma^*$, $n-\sigma^*$, $\pi-\pi^*$ and $n-\pi^*$), relative positions of λmax considering conjugative effect, steric effect, solvent effect, red shift(bathochromic shift), blue shift (hypsochromicshift), hyperchromic effect, hypochromic effect (typical examples). IR Spectra: Modes of molecular vibrations, application ofHooke's law, characteristic stretching frequencies of O-H, N-H, C-H, C-D, C=C, C=N,C=O functions; factors effecting stretching frequencies

PMR Spectra: Nuclear spin, NMR active nuclei, principle of proton magnetic resonance,equivalent and non-equivalent protons, chemical shift ?), shielding / deshielding of protons, up-field and down-field shifts. NMR peak area, diamagnetic anisotropy, relative peak positions of different kinds of protons, substituted benzenes.

PAPER-III: 80 Marks

PART-A (Analytical Chemistry): 40 Marks

Theoretical basis of Quantitative inorganic analysis:

Law of mass action, chemical and ionic equilibrium, solubility, Solubility product and commonion effect, effect of temperature upon the solubility of precipitates, the ionic product ofwater, pH, effect of temperature on pH, Salt hydrolysis, hydrolysis constant, degree ofhydrolysis, buffer solutions, different types of buffers and Henderson's equation.

Gravimetric Analysis:

General principles, stoichiometry, calculation of results from gravimetric data.Properties of precipitates.Nucleation and crystal growth, factors influencing completionof precipitation.Co-precipitation and post-precipitation, purification and washing ofprecipitates. Precipitation from homogeneous solution, a few common gravimetric determinations-chloride as silver chloride, sulphate as barium sulphate, aluminum asthe oxinate and nickel as dimethyl glyoximate.

Sampling and treatment of samples for chemical analysis:

Techniques of collection of Solids, liquids and gaseous samples, dissolution of solidsamples, attack with water, acids, and alkalis, fusion with Na_2CO_3, NaOH, Na_2O_2,$K_2S_2O_7$; Microwave assisted digestion techniques(Only elementary idea)

Volumetric Analysis:

Equivalent weights, different types of solutions, Normal solutions, Molar solutions, andmolal solutions and their inter relations. Primary and secondary standard substances.principles of different type of titrations- i) acid-base titration, ii) redox titration, iii) complexometrictitrations. Types of indicators - i) acid-base, ii) redox iii) metal-ion indicators.

Principles in estimation of mixtures of $NaHCO_3$ and Na_2CO_3 (by acidimetry);Principles of estimation of iron, copper, manganese, chromium (by redox titration);

Acid base titrations: Principles of titrimetric analysis, titration curves for strong acidstrongbase, weak acid-strong base and weak base-strong acid titrations, poly proticacids, poly equivalent bases, determi... the equivalence point-theory of acid base indicators, colour change range of indicator, selection of proper indicator.

Redox Titrations: Principles behind the Iodometry, permaganometry, dichrometry, difference between iodometry and iodimetry.

Potentiometry: Fundamentals of potentiometry. indicator and ion-selective electrodes. Membrane electrodes. Glass electrode for pH measurement, glass electrodes for cations other than protons. Liquid membrane electrodes, solid state ion selective detectors and biochemical electrodes. Applications of potentiometry. Direct potentiometricmeasurements-determination of pH and fluoride. Redox and potentiometertitrations- Balancing redox reactions, calculation of the equilibrium constant of thereaction, titration curves, visual end point detection. Redox indicators-theory, workingand choice.Potentiometric end point detection.Applications of redox titrations.

Complexometric titrations: Complex formation reactions, stability of complexes,stepwise formation constants, chelating agents, EDTA-acidic properties, complexeswith metal ions, equilibrium calculations involving EDTA, conditional formation constants,derivation of EDTA titration curves, effect of other complexing agents, factors affecting the shape of titration curves-completeness of reaction, indicators for EDTAtitrations-theory of common indicators, titration methods employing EDTA-direct, backand displacement titrations, indirect determinations, titration of mixtures, selectivity,masking and de-masking agents, typical applications of EDTA titrations-hardness of water, magnesium and aluminium in antacids, magnesium, manganese and zinc in amixture, titrations involving uni-dentate ligands-titration of chloride with Hg^{2+} andcyanide with Ag^{+}.

Chromatographic methods of analysis:
Basic principles and classification of chromatography. Importance of column chromatography and thin layer chromatography; Theory and principles of High Performance Liquid Chromatography (HPLC) and Gas Liquid Chromatography (GLC). Ion-exchange chromatography.

UV-Visible Spectroscopy:
Basic Principles of UV-Vis spectrophotometer. Lambert -Beer's Law and its limitations.Instrumentation consisting of source, monochromator, grating and detector. Spectrophotometric determination.

Flame photometry and Atomic absorption spectrometry:
Emission spectra Vs absorption spectra. Basic Principles and theory of flame photometry. Applications of Flame photometers.Basic Principles and theory of AAS.Threedifferent modes of AAS - Flame-AAS, VGAAS, and GFAAS. Single beam and doublebeam AAS. Function of Halo Cathode Lamp (HCL) and Electrode Discharge Lamp

). Different types of detectors used in AAS. Different types of interferences-Matrix interferences, ch. .nical interferences, Spectral interferences and backgroundcorrection in AAS.Use of organic solvents.Quantitative techniques-calibration curveprocedure and the standard addition technique. Typical commercial instruments for FP and AAS. Applications.Qualitative and quantitative analysis.Relative detection abilitiesof atomic absorption and flame emission spectrometry.

X-ray methods of Analysis:

Introduction , theory of X-ray generation, , X-ray spectroscopy, , X-ray diffraction andX-ray fluorescence methods, Braggs law, instrumentation , dispersion by crystals,applications. Preparation of pallets, glass beads, quantitative and quantitative measurement.

Inductively coupled plasma spectroscopy:

Theory and Principles, plasma generation, utility of peristaltic pump, sampler – skimmer systems, ion lens, quadrupole mass analyzer, dynode /solid state Detector, differenttype of interferences- spectroscopic and non-spectroscopic interferences, isobaricand molecular interferences, applications.

Analysis of Minerals, Ores and Alloys:

Analysis of Minerals and Ores- estimation of (i) $CaCO_3$, $MgCO_3$ in dolomite (ii)Fe_2O_3, Al_2O_3, and TiO_2 in Bauxite.(iii) MnO and MnO_2 in Pyrolusite.

Analysis of Metal and Alloys: (i) Cu and Zn in Brass (ii) Cu, Zn, Fe, Mn, Al and Ni in

Bronze (iii) Cr, Mn, Ni, and P in Steel (iv) Pb, Sb, Sn in type metal.

Analysis of coal and coke-Types, composition, preparation of sample, proximate andultimate anlaysis calorific value by bomb Calorimetry.

PART-B (Organic Chemistry): 40 Marks

Basic organic chemistry:

Inductive effect, resonance and resonance energy.Homolytic and heterolytic bondbreaking, electrophiles and nucleophiles; carbocations, carbanions and radicals (stabilityand reactivity). Alkanes, alkenes and alkynes: Synthesis and chemical reactivityof alkanes, mechanism of free-radical halogenation of alkanes. General methods of synthesis, electrophilic addition reactions and polymerization reaction (definition andexamples only) of alkenes. General methods of synthesis, acidity, hydration and substitutionreactions of alkynes.

Organometallic compounds:

Grignard reagents - preparations and reactions, application of Grignard reagents inorganic synthesis. Organic compounds containing nitrogen: aromatic nitro compounds- reduction under different conditions. Methods of synthesis of aliphatic amines,Heinsberg's method of amine separation, Hofmann degradation, Gabriel's phthalimide synthesis, distinction of primary, secondary and tertiary amines; methods of synthesisof aromatic amines, basicity of aliphatic and aromatic amines. Sandmeyerreactions;synthetic applications of benzene diazonium salts.

Bonding and physical properties:

Valence bond theory: concept of hybridisation, resonance (including hyperconjugation),orbital picture bonding sp^3, sp^2, sp: C-C, C-N & C-O system).Inductiveeffect, bond polarization and bond polarizability, steric effect, steric inhibition of resonance.MO theory: sketch and energy levels of MOs of i) acyclic p orbital system ii)cyclic p orbital system, iii) neutral system. Frost diagram, Huckel's rules for aromaticity & antiaromaticity; homoaromaticity. Physical properties: bond distance, bond angles, mp/bp & dipole moment in terms of structure and bonding. Heat of hydrogenation and heat of combustion.

Organic Spectroscopy:

Infrared spectroscopy: Units of frequency wave length and wave number, molecularvibrations, factors influencing vibrational frequencies, the IR spectrometer, characteristicfrequencies of organic molecules and interpretation of spectra.

Ultraviolet spectroscopy: Introduction, absorption laws, measurement of the spectrum, chromophores, definitions, applications of UV spectroscopy to Conjugateddines, trienes, unsaturated carbonyl compounds and aromatic compounds.

Nuclear Magnetic Resonance Spectroscopy: (Proton and Carbon -13 NMR) Themeasurement of spectra, the chemical shift: the intensity of NMR signals and integrationfactors affecting the chemical shifts: spin-spin coupling to 13C IH-IH firstorder coupling: some simple IH-IH splitting patterns: the magnitude of IH-IH couplingconstants.

Mass spectroscopy: Basic Principles: instrumentation: the mass spectrometer, isotope abundances; the molecular ion, meta stable ions.