જાહેરાત ક્રમાંક: ૩૬/૨૦૧૮-૧૯

ઉદ્યોગ અને ખાણ વિભાગના નિયંત્રણ હેઠળના ભૂસ્તરવિજ્ઞાન અને ખનિજ કમિશનરની કચેરી, ગુજરાત રાજ્ય હેઠળની ગુજરાત ખાણકામ સેવામાં,

મુખ્ય રસાયણશાસ્ત્રી (કેમીસ્ટ), વર્ગ-૧ માટે ની પ્રાથમિક કસોટીનો અભ્યાસક્રમ

ભાગ -૧

માધ્યમ:ગુજરાતી **કુલ ગુણ :૧૦૦**

૧	ભારતની ભૂગોળ - ભૌગોલિક, આર્થિક, સામાજિક, કુદરતી સંસાધન અને વસ્તી અંગેની બાબતો- ગુજરાતના ખાસ સંદર્ભ સાથે
૨	ભારતનો સાંસ્કૃતિક વારસો- સાહિત્ય, કલા, ધર્મ અને સ્થાપત્યો- ગુજરાતના ખાસ સંદર્ભ સાથે
૩	ભારતનો ઈતિહાસ- ગુજરાતના ખાસ સંદર્ભ સાથે
૪	ભારતની અર્થવ્યવસ્થા અને આયોજન
૫	ભારતીય રાજનીતિ અને ભારતનું બંધારણ: (૧) આમુખ (૨) મૂળભૂત અધિકારો અને ફરજો (૩) રાજ્યનીતિના માર્ગદર્શક સિદ્ધાંતો (૪) સંસદની રચના (૫) રાષ્ટ્રપતિની સત્તા (૬) રાજ્યપાલની સત્તા (૭) ન્યાયતંત્ર (૮) અનુસૂચિત જાતિ, અનુસૂચિત જનજાતિ અને સમાજના પછાત વર્ગો માટેની જોગવાઈઓ (૯) એટર્ની જનરલ (૧૦) નીતિ આયોગ (૧૧) પંચાયતી રાજ (૧૨) નાણા પંચ (૧૩) બંધારણીય તથા વૈધનિક સંસ્થાઓ- ભારતનું ચૂંટણી પંચ, સંઘ લોક સેવા આયોગ, રાજ્ય લોક સેવા આયોગ, કોમ્પ્ટ્રોલર એન્ડ ઓડિટર જનરલ; કેન્દ્રીય સતર્કતા આયોગ, લોકપાલ તથા લોકાયુક્ત અને કેન્દ્રીય માહિતી આયોગ
૬	સામાન્ય બૌદ્ધિક ક્ષમતા કસોટી
૭	સામાન્ય વિજ્ઞાન, પર્યાવરણ અને ઈન્ફર્મેશન એન્ડ કોમ્યુનિકેશન ટેકનોલોજી
૮	ખેલ જગત સહિત રોજબરોજના પ્રાદેશિક, રાષ્ટ્રીય અને આંતરરાષ્ટ્રીય મહત્વના બનાવો

Advt. No. 36/2018-19

Syllabus of Preliminary Test for the post of Chief Chemist, Class I, in the Gujarat Mining Service, Under the Commissionerate of Geology and Mining, Gujarat State

Part - 1

Medium:Gujarati **Total Marks- 100**

1	**Geography of India-Physical, Economic, Social, Natural Resources and population related topics- with special reference to Gujarat**
2	**Cultural heritage of India-Literature, Art, Religion and Architecture- with special reference to Gujarat**
3	**History of India with special reference to Gujarat**
4	**Indian Economy and Planning**
5	**Indian Polity and the Constitution of India:** **(1) Preamble** **(2) Fundamental Rights and Fundamental Duties** **(3) Directive Principles of State Policy** **(4) Composition of Parliament** **(5) Powers of the President of India** **(6) Powers of Governor** **(7) Judiciary** **(8) Provisions for Scheduled Castes, Scheduled Tribes and backward classes of the society** **(9) Attorney General** **(10) NITI Aayog** **(11) Panchayati Raj Institutions** **(12) Finance Commission** **(13) Constitutional and Statutory Bodies: Election Commission of India, Union Public Service Commission, State Public Service Commission, Comptroller and Auditor General; Central Vigilance Commission, Lokpal and Lokayukta, Central Information Commission**
6	**General Mental Ability**
7	**General Science, Environment and Information & Communication Technology**
8	**Daily events of Regional, National and International Importance including Sports**

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Part - 2

Marks – 200 **Questions - 200** **Medium - English**

1. Chemical periodicity

Periodic table, group trends and periodic trends in physical properties. 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, electron affinity 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, metallicnature, magnetic properties, catenation and catalytic properties, oxidation states, aqueous and redox chemistry in common oxidation states, properties and reactions of important compounds such hydrides, halides, oxides, oxy-acids, complex chemistry in respect of s-block and p-block elements.

2. 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. Schrodinger equation for the H-atom. Coordinate bonding: Werner theory of coordination compounds, double salts and complex salts, Lewis acidbase. Ambidentate and polydentate ligands, chelate complexes. IUPAC nomenclature

of coordination compounds. Coordination numbers, Geometrical isomerism. Stereoisomerism in square planar and octahedral complexes. Hydrogen bonding. Metallic bonding: qualitative idea of band theory, conducting, semi conducting and insulating properties.

3. Chemistry of coordination compounds

Isomerism, reactivity and stability: Determination of configuration of cis- and trans- isomers by chemical methods. Labile and inert complexes, substitution reaction on square planer complexes, trans effect. Stability constants of coordination compounds and their importance in inorganic analysis. Structure and bonding: Elementary Crystal Field Theory: splitting of do configurations in octahedral, square planar and tetrahedral fields, crystal field stabilization energy; pairing energy. Jahn- Teller distortion. Metal-ligand bonding, sigma and pi bonding in octahedral complexes and their effects on the oxidation states of transitional metals. Orbital and spin magnetic moments, spin only moments of and their correlation with effective magnetic moments, d-d transitions; LS coupling, spectroscopic ground states, selection rules for electronic spectral transitions; spectro-chemical series of ligands; charge transfer spectra .

4. Acid-Base reactions

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

5. Precipitation and Redox Reactions

Solubility product principle, common ion effect. Ion-electron method of balancing equation of redox reaction. Standard redox potentials, Nernst equation. Influence on complex formation, 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.

6. Organo metallic compounds

18-electron rule and its applications to carbonyls, nitrosyls, cyanides, and nature of bonding involved therein. Simple examples of metal-metal bonded compounds and metal clusters. Metal-olefin complexes: zeises salt, Ferrocene.

7. 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.

8. 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 alkalimetal borohydrides. Preparation, properties and technical applications of carbides and fluorocarbons. Silicones and structural principles of silicates.

9. Kinetic theory and the gaseous state:

Gaseous state: Gas laws, kinetic theory of gas, collision and gas pressure, derivation of gas laws from kinetic theory, average kinetic energy of translation, Boltzmann constant and 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 classical limit of molar heat capacity of gases.

10. 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 ideal behaviour; compressibility factor; Andrew's and Amagot's plots; van der Waals equation and its characteristic features. Existence of critical state.

Critical constants in terms of van der Waals constants. Law of corresponding state and significance of second virial coefficient. Boyle temperature. Intermolecular forces.

11. 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 a process. Chemical equilibrium: chemical equilibria of homogeneous and heterogeneous systems, derivation of expression of equilibrium constants, Le Chatelier's principle of dynamic equilibrium.

12. Thermodynamics and Equilibrium:

Chemical potential in terms of Gibb's free energy and other thermodynamic state functions and its variation with temperature and pressure. Gibbs-Duhem equation; fugacity of gases and fugacity coefficient. Thermodynamic conditions for equilibrium, degree of advancement. Van't Hoffs reaction isotherm. Equilibrium constant and standard Gibbs free energy change. Definitions of KP, KC and Kx; van't Hoffs reaction isobar and isochore. Le Chatelier's principle. Activity and activity coefficients of electrolyte / ion in solution. Debye-Huckel limiting law.

13. 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 and limitations. Strengths of acids and bases. Ionization of weak acids and bases in aqueous solutions, application of Ostwald's dilution law, ionization constants, ionic product of water, pH-scale, buffer solutions and their pH values, buffer actions & buffer capacity; hydrolysis of salts.

14. Solutions of non-electrolytes

Colligative properties of solution, Raoult's Law, relative lowering of vapor pressure, osmosis and osmotic pressure; elevation of boiling point and depression of freezing point of solvents.

15. Chemical kinetics and catalysis

Order and molecularity of reactions, rate laws and rate equations for first order and second order reactions; zero order reactions. Parallel and consecutive reactions. Determination of order of reactions. Temperature dependence of reaction rate, energy of activation. Enthalpy of activation, entropy of activation , effect of dielectric constant and ionic strength of reaction rate, kinetic isotope effect; collision theory & transition State Theory of reaction rate, Catalytic reactions.

16. Adsorption and Surface Chemistry

Physisorption & Chemisorption, adsorption isotherms, Freundlich and Langmuir adsorption isotherm, BET equation, surface area determination, heterogeneous catalysis; colloids, electrical double layer and colloid stability, electro-kinetic phenomenon; elementary ideas about soaps & detergents, micelles, emulsions.

17. 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 electrochemical cells, cell reactions, emf and change in free energy, 6.H and AS 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 of a solution. Potentiometric titrations: acid-base and redox, electro chemical power sources; primary, secondary and fuel Cells, corrosion and inhibition of corrosion.

18. Photochemistry

Frank-Condon principle and vibrational structure of electronic spectra. Bond dissociation and principle of determination of dissociation energy. Decay of excited states by radiative and non-radiative paths. Fluorescence and phosphorescence, Jablonsky diagram. Laws of photochemistry: Grotthus-Draper law, Stark- Einstein law of photochemical equivalence and Lambert-Beers law; quantum yield and its measurement for a photochemical process, actinometry. Photostationary state. Photosensitized reactions. Kinetics of HI decomposition, H2-Br2 reaction, dimerisation of anthracene.

19. Quantum Chemistry

Wave-particle duality, Photoelectric and Compton effects, de Broglie hypothesis. Eigenfunctions and eigenvalues. Uncertainty relation, Expectation value. Hermitian operator. Schrodinger time-independent equation: nature of the equation, acceptability conditions imposed on the wave functions and probability interpretations of wave function. Schrodinger equation for one-dimensional box and its solution. Comparison with free particle eigenfunctions and eigenvalues.

20. Basic principles and application of spectroscopy

Electromagnetic radiation, interaction with atoms and molecules and quantization of different forms of energies. Condition of resonance and energy of absorption for various types of spectra; origin of atomic spectra, spectra of hydrogen atoms, many electron atoms, spin and angular momentum. Rotational spectroscopy of diatomic molecules: rigid rotor model, selection rules, spectrum, characteristic features of spectral lines. Determination of bond length, effect of isotopic substitution. Vibrational spectroscopy of diatomic molecules: Simple Harmonic Oscillator model, selection rules, Raman Effect. Characteristic features and conditions of Raman activity with suitable illustrations. Rotational and vibrational Raman spectra. Mineral

Characterisation Studies: (i) Electron Probe Micro Analyser (ii) Laser Raman Spectroscopic Study

21. Theoretical basis of Quantitative inorganic analysis

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

22. Gravimetric Analysis

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

23. Sampling and treatment of samples for chemical analysis

Techniques of collection of Solids, liquids and gaseous samples, dissolution of solid samples, attack with water, acids, and alkalis, fusion with Na2CO3, NaOH, Na202, K2S207; Microwave assisted digestion techniques(Only elementary idea) Volumetric Analysis: Equivalent weights, different types of solutions, Normal solutions, Molar solutions, and molal solutions and their inter relations. Primary and secondary standard substances. principles of different type of titrations-i) acid-base titration, ii) redox titration, iii) complexometric titrations. Types of indicators - i) acid-base, ii) redox iii) metalion indicators. Principles in estimation of mixtures of NaHCO3 and Na2CO3 (by acidimetry); Principles of estimation of iron, copper, manganese, chromium (by redox titration).

24. Acid base titrations

Principles of titrimetric analysis, titration curves for strong acid-strong base, weak acidstrong base and weak base-strong acid titrations, poly protic acids, poly equivalent bases, determining the equivalence point-theory of acid base indicators, colour change range of indicator, selection of proper indicator.

25. Redox Titrations

Principles behind the lodometry, permaganometry, dichrometry, difference between iodometry and iodimetry.

26. 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 potentiometric measurements-determination of pH and fluoride. Redox and potentiometer titrations- Balancing redox reactions, calculation of the equilibrium constant of the reaction, titration curves, visual end point detection. Redox indicators-theory, working and choice. Potentiometric end point detection. Applications of redox titrations.

27. Complexometric titrations

Complex formation reactions, stability of complexes, stepwise formation constants, chelating agents, EDTA-acidic properties, complexes with 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 EDTA titrations-theory of common indicators, titration methods employing EDTA-direct, back and 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 a mixture,

titrations involving uni-dentate ligands-titration of chloride with Hg^{2+} and cyanide with Ag^{+}.

28. 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.

29. 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. Three different modes of AAS - Flame-MS, VGAAS, and GFAAS. Single beam and double beam AAS. Function of Halo Cathode Lamp (HCL) and Electrode Discharge Lamp (EDL). Different types of detectors used in MS. Different types of interferences-Matrix interferences, chemical interferences, Spectral interferences and background correction in AAS. Use of organic solvents. Quantitative techniques-calibration curve procedure and the standard addition technique. Typical commercial instruments for FP and MS. Applications. Qualitative and qualitative analysis. Relative detection abilities of atomic absorption and flame emission spectrometry.

30. X-ray methods of Analysis:

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

31. 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, different type of interferences- spectroscopic and non-spectroscopic interferences, isobaric and molecular interferences, applications.

32. 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.

33. Analysis of coal and coke

Types, composition, preparation of sample, proximate and ultimate anlaysis calorific value by bomb Calorimetry.

34. Fluid Inclusion Studies

35. Experimental Petrology Studies

36. Polynological Studies

37. Geo-Chemical Mapping

Electro chemistry**,** General Physical Chemistry**,** Inorganic Analytical Chemistry**,** Organic Analytical Chemistry, Reprographic Process

38. Classical Methods

Chemical Tests, Flame Test (Qualitative Methods), Gravimetric analysis, Volumetric Analysis (Quantitative Methods)

39. Differentiation and mixing

40. Fractionation

41. Petrology

42. Basics & Instrumentation

ICPMS (Inductive Coupled Plasma & Mass Spectrometry), XRF (X-Ray Fluroscence), AAS (Atomic Absorption Spectrophotometer), Coal & Lignite Analysis, Water & Environmental Samples

43. Current Trends and Recent Advancements in the field of Chief Chemist.