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| **1.** | **TOPIC 0 - INTRODUCTION TO CHEMISTRY AND INTEGRATED SCIENCE** |
|  | **Concept of Integrated Science (IA1.1)**Explanation of Science as an interrelated body of knowledgeCareers in science and technology. |

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| **2.** | **TOPIC 1 - ATOMIC STRUCTURE AND THE PERIODIC TABLE** |
|  | (a) | **Gross features of the atom (CA1A)**Short account of Dalton’s atomic theory and J. J. Thomson’s experiment should be given Outline description of Rutherford’s alpha particle scattering experiment to establish the structure of the atomTreatment should illustrate scientific method and development of a model |
|  | (b) | (i) | Atomic number/proton number; number of neutrons, isotopes; atomic mass (IA4.4) (CA1B)Definitions and representation in symbols of atoms and sub-atomic particlesAtomic mass as the weighted average mass of isotopesCalculation of relative mass of chlorine should be used as an example |
|  |  | (ii) | **Relative Atomic mass (Ar) based on Carbon-12 scale (IA4.4) (CA1B)**Relative atomic masses should be explained using the periodic tableCarbon-12 isotope should be mentioned as reference scale |
|  | (c) | **Electronic Energy levels (CA1D)** |
|  |  | (i) | **Arrangement of electrons in the main and sub-energy levels** |
|  |  | (ii) | **Orbitals** |
|  |  | (iii) | **Rules and principles for filling in electrons** |
|  |  | Experimental evidence and interpretation of line spectra (qualitative treatment only)Mention should be made of the arrangements of electrons in the main shells (K, L, M) as 2:8:18 Origin of s, p, d and f orbitals as sub-energy levels; shapes of s and p orbitals onlyAufbau Principle, Hund’s Rule of Maximum Multiplicity and Pauli Exclusion Principle Abbreviated and detailed electronic configuration in terms of s, p, and d orbitals from hydrogen to zinc  |
|  | (d) | **Periodicity of the elements (CA2A)** |
|  |  | (i) | Periodic Law |
|  |  | (ii) | **Trends in periodic properties: Down a group and across a period.**Electronic configurations leading to group and periodic classifications Periodic properties for the first 18 elements: atomic size, ionic size, ionization energy, electron affinitySimple discrepancies should be accounted for.  |
|  | (e) | **Classification (IA3.2)**Contribution of Mendeleev to classification |

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| **3.** | **TOPIC 2 - PARTICLES, BONDING AND STRUCTURE** |
|  | (a) | **Kinetic model of matter (CA5A)** |
|  |  | (i) | Postulates of the kinetic model of matter |
|  |  | (ii) | **The use of the kinetic model to explain the nature of solids, liquids and gases and the changes of state of matter**Changes of state of matter should be explained in terms of movement of particlesIt should be emphasized that randomness decreases (and orderliness increases) from gaseous state to liquid state and to solid stateIllustrations of changes of state using the different forms of water, iodine, sulphur, napthalene etcBrownian motion to be illustrated using any of the following experiments:Pollen grains/powdered sulphur in water (viewed under a microscope)Smoke in a glass container illuminated by a strong light from the sideA dusty room being swept and viewed from outside under sunlightDiffusion - demonstration could be given using the following:Diffusion of bromine/iodine/NO2 from a sealed tube into an empty tubeSpread of scent of ammonia in a room |
|  | (b) | **Liquids (CA5C)**Concept of vapour pressureLiquids as an intermediate state between gases and solids in the kinetic-molecular sense should be emphasizedSimple methods for determination of boiling pointsStandard boiling point |
|  | (c) | **Inter-atomic bonding (CA3A, CA3C, IA4.3)**Lewis dot structure for ionic and covalent compounds |
|  |  | (i) | Ionic bonding - factors influencing its formationFormation of stable compounds from ionsFactors should include: ionisation energy; electron affinity; electronegativity difference |
|  |  | (ii) | **Covalent bonding - factors influencing covalent bond formation**Co-ordinate bond as a type of covalent bondFactors should include: ionization energy; electron affinity and electronegativity difference |
|  |  | (iii) | Metallic Bonding - factors influencing its formationFactors should include: atomic radius, ionization potential, and number of valence electronsType of specific packing not required |

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|  | (d) | **Simple molecules and their shapes (CA3B) (CC1)**Models should be used where applicable:Linear: CO2; Non linear: H2O; Tetrahedral: CH4; Pyramidal: NH3The shapes of the following molecules should also be treated: H2 and O2 |
|  | (e) | **Intermolecular bonding (CA3D)** |
|  |  | **(i)** | **van der Waal’s forces;**Relative physical properties of polar and non-polar compoundsDescription of formation and nature should be treatedDipole-dipole and induced dipole forces should be treated under van der Waal’s forces. |
|  |  | (ii) | **Hydrogen bonding**Variation of the melting points and boiling points of noble gases, halogens and alkanes in a homologous series explained in term of van der Waal’s forces; and variation in the boiling points of H2O, H2S, H2Se, H2Te explained using hydrogen bonding |
|  | (f) | **Atoms, molecules and ions - particulate nature of matter (IA4.1)**Definition of particles and treatment of particles as building blocks of matter |
|  | (g) | **Comparison of all bond types (IA4.3) (CA3A) (CA3C) (CA3E) (CA5D)** |
|  |  | **(i)** | Properties of ionic compoundsTypical properties of ionic compounds using binary compounds which are largely ionic. e.g. melting points, boiling point and solubility in various solvents |
|  |  | **(ii)** | **Properties of covalent compounds**Typical properties compared with those of ionic compounds e.g. Melting point, boiling point, solubility in various solvents like water, hexane, ether |
|  |  | **(iii)** | Properties of metalsTypical properties including conductivity; malleability, ductility demonstrated using metals like Mg, Zn, Sn, Fe |
|  |  | **(iv)** | Solids: Types and StructuresIonic, metallic, covalent and molecular solids - comparison of their properties.Regular arrangement of ions, molecules and atoms in three dimensions in the solid state should be emphasizedKnowledge of specific packing arrangements not requiredMelting points as indicator of purity of solids |
|  |  | **(v)** | Structures, properties and uses of diamond and graphiteProperties and uses – dependent on structures |
|  | (h) | **Trends in periodic properties: Down a group and across a period (IA4.1) (CA2A)**Elements: metals and non-metals (1st to 20th elements in the periodic tablePeriodic properties for the first 18 elements: electronegativity, Progression from metallic to non-metallic character of elements, ionic to covalent bonding in compounds |
|  | (i) | Elements, compounds and mixtures (IA4.2)Differences between elements, compounds and mixtures |
|  | (j) | **IUPAC names of common compounds (IA4.3)** |

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| **4.** | TOPIC 3 - AMOUNT OF SUBSTANCE |
|  | (a) | Safety Precautions in the Laboratory (IA1.3)Safety measures taken in the laboratory and reasons for them. |
|  | (b) | Measurement (IA2.1) (IA2.2) (IA2.3) (CA4B) (CA13A)Basic quantities, derived quantities and their unitsBasic quantities and units of scientific measurement: Length (m), Mass (kg),Time (s), Temperature (K), Amount of substance (mol)Derived quantities and their units: Volume (m3), Density (kgm-3), Quantity of electricity (C), Potential difference (V)Measuring instrumentsIdentification and use of measuring instruments such as balances, stop watch, thermometer, measuring cylinder, pipette and burette to measure in various unitsNecessity for measurementSources of errorMass and volume measurementsMeasurement of density and relative densityExperiments to determine the density of equal volumes of water and salt solutionComparison of densities of water and salt solutionSimple experiments of density of regular and irregular objects |
|  | (c) | Amount of substance (IA4.5) (CA4B) (IA4.4) (CA1B)The mole as a unit of measurement of physical quantity/amount of substance; Avogadro’s Constant, (L=the number of atoms in 12.00g of 12C). Molar quantities and their usesMole of electrons; atoms, molecules, formula units etc.relative molecular mass (Mr) based on Carbon-12 scaleCalculation of formula mass and molar mass using relative atomic massesCalculation of amount of substance in moles given its mass |
|  | (d) | **Solutions (IA4.6) (CA4C) (CA13A)**Concept of solution as made up of solvent and solute |
|  |  | (i) | Concentration termsMass (g) or mole (mol) per unit volumeEmphasis on current IUPAC chemical terminology, symbols and conventions |
|  |  | (ii) | Standard solutionsPreparation of standard solution of NaOH, HCl, NaCl and sugarDilution of standard solutionsPreparation of some primary standard solutions using anhydrous Na2CO3, (COOH)2.2H2ODilution factor |

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|  | (e) | **The Gases (CA5B) (CC2)** |
|  |  | The Gas LawsCharles’; Boyle’s; Dalton’s; Graham’s; Avogadro’s laws and the ideal gas equation; Qualitative explanation of each of the gas laws using the kinetic modelMathematical relations of the gas laws and calculations based on the laws will be required. Molar volume of a gas =22.4dm3 at s.t.p. Derivation of the general gas law PV = K TStatement of Gay Lussac’s Law and calculations based on the law. |
|  | (f) | **Symbols, Formulae and Equations (CA4A) (CA4B)** |
|  |  | (i) | Chemical symbols |
|  |  | (ii) | **Empirical and molecular formulae**Relative formula mass and relative molecular mass |
|  |  | (iii) | **Chemical equations** |
|  |  | (iv) | Laws of Chemical combinationCalculations involving formulae and equations will be requiredMass and volume relationships in chemical reactions and the stoichiometry of reactionsExperimental illustrations of Law of conservation of mass, Law of constant composition, Law of multiple proportion. |
|  |  | (v) | **Mole Ratios**Use of mole ratios in determining stoichiometry of chemical reactionsSimple calculations to determine number of entities, amount of substance, mass, concentration, volume and other quantitiesStoichiometry of reactions such as evolution of gases |

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| **5.** | **TOPIC 4 - ENERGY CHANGES, RATES OF REACTION AND EQUILIBRIUM SYSTEMS** |
|  | (a) | **Energy changes in physical and chemical processes (CA6A)**Enthalpy, energy diagramsForms of energy, energy content, transfer of energy |
|  | (b) | Description, definition and illustrations of energy changes and effects (CA6B) (CA13A) (CC3)Exothermic and endothermic processes. Total energy of a system as the sum of various forms of energy e.g. kinetic, potential, electrical, heat, sound etcEnthalpy changes of the following: Formation, combustion, Solution, neutralizationPractical knowledge of the measurement of the heats of neutralisation and solution Uses of energy changes including energy content of foods and fuelsMeasurement of the enthalpy of combustion (in outline) by calorimetry |
|  | (c) | **Rate of reaction (CA9A) (CA13A)** |
|  |  | (i) | Factors affecting rates: physical states, concentration of reactants, temperature, catalysts and mediumDefinition of reaction rates For gaseous systems, pressure may be used as concentration term. Appropriate experimental demonstration for each factor is required |
|  |  | (ii) | Theory of reaction ratesCollision theory and activation energy theory to be treated qualitatively only. Factors influencing collisions: temperature and concentration. Effective collision. Activation energy. Energy profile showing activation energy and enthalpy changeDetermination of rates of reaction from concentration versus time curves |
|  | (d) | Equilibrium (CA9B) |
|  |  | (i) | General principlesReversible reactions i.e. dynamic equilibriumThe equilibrium constant K must be treated qualitativelyIt must be stressed that K for a system is constant at constant temperature |
|  |  | (ii) | Le Chatelier’s principlePrediction of the effects of external influence of concentration, temperature and pressure changes on equilibrium systems |

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| **6.** | **TOPIC 5 - ACIDS, BASES AND SALTS** |
|  | (a) | **Definitions of acids and bases (IA7.1) (CA7A)**Arrhenius concept of acids and basesDefinition of acids and bases in terms of Proton transfer (Bronsted- Lowry concept) |
|  | (b) | Physical and chemical properties of acids and bases (IA7.2) (IA7.4) (CA7B) (CC4A)Conductivities, taste etcEffects of acids and bases on indicators, metals and trioxocarbonate (IV) saltsPreparation of salts using the following methods: neutralization, acid + metalConcept of amphoterismBalanced chemical equations of all reactionsSimple chemical tests to classify chemical substances as acids, bases, or saltsMethods of preparation of simple salts |
|  | (c) | Acids, bases and salts as electrolytes (IA7.2) (CA7C)Electrolytes and non-electrolytes; strong and weak electrolytesEvidence from conductivity and enthalpy of neutralisation |
|  | (d) | **pH (IA7.2) (IA7.6) (CA7D) (CA13A)**Knowledge of pH scalepH as a measure of acidity and alkalinity**Determination of pH of a given solution:**The nature and use of the universal indicator and pH meterDetermination of pH value of various solutions by colorimetryDetermination of soil pH |
|  | (e) | Weak acids and weak bases (IA7.2) (IA7.4) (CA7E) (CC4A)Behaviour of acids and bases in water as example of equilibrium system Qualitative comparison of the conductances of molar solutions of strong and weak acids and basesMethods of preparation of simple salts: using acid + salt |
|  | (f) | Hydrolysis (IA7.2) (CA7F)Qualitative explanation of hydrolysis. Behavior of some salts (e.g. NH4C1, A1C13, Na2CO3, CH3COONa) in water as examples of equilibrium systems |
|  | (g) | Acid–base indicators (IA7.5) (CA7G)Indicators as weak organic acids or bases (organic dyes)Colour of indicator at any pH dependent on relative amounts of acid and base formsWorking pH ranges of methyl orange and phenolphthaleinDescription of the colours developed by phenolphthalein, litmus and methyl orange in dilute acids and dilute bases |

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|  | (h) | Acid-base titrations (CA7H) (CA13B)Correct use of relevant apparatus Knowledge of how acid-base indicators work in titrationsTitration involving weak acids versus strong bases, strong acids versus weak bases and strong acids versus strong bases using the appropriate indicators and their applications in quantitative determination; e.g. concentrations, purity, water of crystallisation and compositionThe use of standard solutions of acids and alkalis and the indicators methyl orange and phenolphthalein to determine the following: The concentrations of acid and alkaline solutions; The molar masses of acids and bases and water of crystallization; The solubility of acids and bases; The percentage purity of acids and bases. |
|  | (i) | Deliquescent, Efflorescent and hygroscopic substances (IA7.2) (CC4B)The use of deliquescent and hygroscopic substances as drying agents should be emphasized |

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| **7.** | **TOPIC 6 - SOLUBILITY AND QUALITATIVE ANALYSIS** |
|  | (a) | **General principles (CA8A)**Saturated and unsaturated solutionsSaturated solution as an equilibrium system Solubility expressed in mol dm-3 Solubility curves and their usesRelationship between solubility and crystallisationCrystallisation as a method of purification Solubility of sparingly soluble salts - complete dissociation of the portion that dissolves (Qualitative treatment only) |
|  | (b) | Practical application of solubility (IA7.4) (CA8B)Preparation of salts by precipitationGeneralisations of solubility of salts and their applications in qualitative analyses |
|  | (c) | Stoichiometry of chemical reactions (CA4A)Stoichiometry of such reactions as precipitation and analysis of chlorides |

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| **8.** | **TOPIC 7 - INTRODUCTION TO ORGANIC CHEMISTRY** |
|  | (a) | **Organic and Inorganic Compounds (IA13.1)**Classification of chemicals as organic and inorganicImportance of organic chemistry in industrialization |
|  | (b) | **Classification and Nomenclature (CA11A) (CC6G)** |
|  |  | (i) | **Root names** |
|  |  | (ii) | **Functional groups**Broad classification into straight chain, branched chain, aromatic and alicyclic compounds Systematic nomenclature of the following compounds: Alkanes, alkenes, alkynes and alkanolsRecognition of the structures of mono-, di- and triols |
|  | (c) | General Properties (CA11D) |
|  |  | (i) | Homologous seriesGradation in physical properties Effects on the physical properties by introduction of active groups into the inert alkane |
|  |  | (ii) | IsomerismExamples should be limited to compounds having maximum of five carbon atoms. Differences between structural and geometric/stereo isomerism |
|  | (d) | Alkanes (CA11E) |
|  |  | (i) | Sources and propertiesLaboratory and industrial preparations and other sourcesNomenclature and structure Reactivity: combustion, substitution reactions and cracking of large alkane molecules |
|  |  | (ii) | UsesImportance as fuels, as starting materials for synthesisUses of haloalkanes and pollution effects |
|  |  | (iii) | PetroleumCompositionFractional distillation and major productsCracking and reformingPetro-chemicals: Starting materials of organic synthesisQuality of petrol. Meaning of octane number |
|  | (e) | Alkenes (CA11F) (CA13C) |
|  |  | (i) | Sources and propertiesLaboratory preparation; Nomenclature and structure; Addition reactions with halogens, bromine water, hydrogen halides; Oxidation: Hydroxylation with aqueous KMnO4Characteristic test tube reactions of the alkenes |
|  |  | (ii) | Laboratory detectionUse of reaction with Br2/CC14 and KMnO4(aq) as means of characterising alkenes. |

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|  | (f) | Alkynes: Sources and Uses (CA11G) (CC6E)Nomenclature and structure: Industrial production of ethyne; Uses of ethyne.Alkynes – Chemical properties: tests to distinguish between alkanes, alkenes and alkynes |
|  | (g) | Benzene (CA11H) (CC6F) |
|  |  | (i) | Structure and physical properties |
|  |  | (ii) | Chemical propertiesResonance in benzeneStability leading to substitution reactionsHalogenations (mechanism not required)Addition reactions: hydrogenation and halogenationCompare reactions with those of alkenes |
|  |  | (iii) | Uses |

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| **9.** | **TOPIC 8 - REDOX REACTIONS** |
|  | (a) | **Oxidation and reduction processes (CA10A)**Oxidation and reduction in terms of(i) addition and removal of oxygen and hydrogen;(ii) loss and gain of electrons;(iii) change in oxidation numbers/states Oxidation numbers/states. |
|  | (b) | Oxidising and reducing agents (CA10B)Definition of oxidising and reducing agents in terms of:(i) addition and removal of oxygen and hydrogen;(ii) loss and gain of electrons;(iii) change in oxidation numbers/stateTests for oxidants and reductants |
|  | (c) | Redox equations (CA10C)Balancing redox equations by: (i) ion, electron or change in oxidation number/state method; (ii) half reactions and overall reactions IUPAC system required |
|  | (d) | **Stoichiometry of chemical reactions (CA4A)**1. displacement of metal ions
2. formation and reduction of metallic oxides
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|  | (e) | Effect of acids on metals (IA7.4) (CA7B)Preparation of salts using acid + metalEffects of acids and bases on metals |
|  | (e) | Electrochemical Cells (CA10D) |
|  |  | (i) | Standard Electrode Potential Drawing and writing of cell diagrams Standard hydrogen electrode: Meaning of standard electrode potential and its measurement Only metal/metal ion systems should be used |
|  |  | (ii) | E.M.F. of CellsElectrochemical cells as a combination of two half-cells.The meaning of the magnitude and sign of the emf |
|  |  | (iii) | Application of Electrochemical cellsDistinction between primary and secondary cells. Daniel cell, lead battery cell, dry cells, fuel cells and their use as generators of electrical energy from chemical reactions |

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|  | (f) | Electrolysis (CA10E) (CC5A)Mechanism of electrolysis: Compare with electrochemical cells |
|  |  | (i) | Principles of electrolysis |
|  |  | (ii) | Factors influencing discharge of speciesLimit electrolytes to molten PbBr2/NaCl, dilute NaCl solution, concentrated NaCl solution, CuSO4(aq); dilute H2SO4 (using platinum or graphite and copper electrodes). Section C: NaOH(aq) KI(aq) and CuCl2(aq)Faraday’s Laws: Simple calculations based on the relation F = Le = 96,500 C and mole ratios to determine mass, volume of gases, number of entities, charges etc. using half reactions and overall reactions |
|  |  | (iii) | Practical ApplicationsElectroplating, smelting of aluminium etc. |
|  | (g) | Corrosion of metals (IA12.1) (IA12.2) (CA10F)Corrosion treated as redox processRusting of iron and its economic cost Experiments to show that air and water are necessary for rusting.Experiments to show that salt, dilute acid, dilute base and heat affect the rate of rusting in ironMethods of preventing rusting: oiling/ greasing, painting, galvanizing, tin-coating, electroplating, cathode protection and keeping the metal dry. Effectiveness of the various methods of preventing rusting. Items in the home that undergo rusting Prevention based on relative magnitude of electrode potentials and preventive methods like galvanising, sacrificial cathodic protection and non-redox methodsMethods of preventing rusting: oiling/ greasing, painting, galvanizing, tin-coating, electroplating, cathode protection and keeping the metal dryEffectiveness of the various methods of preventing rusting. Items in the home that undergo rusting  |

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| **10.** | **TOPIC 9 - NUCLEAR CHEMISTRY (CA1C)** |
|  |  | (i) | **Types and nature of radiations** |
|  |  | (ii) | **Half life as a measure of the stability of the nucleus** |
|  |  | (iii) | **Nuclear reactions: Fission and Fusion in nuclear reactors** |
|  |  | (iv) | **Effects and application of radioactivity** |
|  |  | Distinction between ordinary reactions and nuclear reactionsCharges, relative mass and penetrating power of radiationsBalancing of simple nuclear equationsQualitative treatment (only) of half lifeNatural and artificial radioactivity. Detection of radiation by Geiger-Muller counterGeneration of electricity; atomic bombsCarbon dating (qualitative treatment only)Use of radioactivity in agriculture, medicine and industry |

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| **11.** | **TOPIC 10 - METALS AND THEIR COMPOUNDS** |
|  | (a) | Metals and non-metals - classification of materials (IA10.1)Classification of materials into metals, semi-metals (metalloids), and non-metalsPhysical properties of metals, semi-metals and non-metals under conductivity, luster, malleability, ductility, sonority, density, melting point and tensile strength. |
|  | (b) | Properties and uses of sodium and its compounds (CC8A)The compounds must be limited to NaC1, NaOH, Na2CO3, NaHCO3, NaNO3, Na2SO4 and NaC1O |
|  | (c) | **Properties and uses of calcium and its compounds (CC8B)**The compounds must be limited to CaCO3, CaO, CaSO4, CaC12, Ca(OH)2 |
|  | (d) | Reactivities of iron and aluminium with air, water and acids (CC8C) |
|  | (e) | Copper (CC8D) |
|  |  | (i) | Purification |
|  |  | (ii) | Chemical properties |
|  |  | (iii) | **Uses of copper and its compounds (IA10.2)**The compounds must be limited to CuSO4, CuO and CuC12 |
|  | (f) | **Elements of the first transition series (CA2C)**Their electronic configuration, physical properties and chemical reactivities of the elements and their compounds. Physical properties should include: physical states, metallic properties and magnetic properties. Other properties of the transition metals should include:  (i) Variable oxidation states;(ii) Formation of coloured compounds;(iii) Complex ion formation;(iv) Catalytic abilities |
|  | (g) | **Uses of metals (IA10.2)**Uses of the following elements: Al, Fe, AuApplication of semi-metals |
|  | (h) | **Alloys (IA10.3)**Examples of alloys and their constituent elements (steel, bronze, brass)Uses of alloysAdvantages of alloys in manufacture of certain household items |
|  | (i) | Qualitative Analysis of cations (CA13C)1. Characteristic tests of the following cations with dilute NaOH(aq) and NH3(aq): NH4+; Ca2+; Pb 2+; Cu2+, Fe2+; Fe3+; A13+; and Zn2+
2. Confirmatory tests for the above cations
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| **12.** | **TOPIC 11 - ALKANOLS, ALKANOIC ACIDS, ALKANOATES, SYNTHESIS AND ANALYSIS** |
|  | (a) | Nomenclature, classification and isomerism (IA13) (CA11A)Systematic nomenclature of the following compounds: alkanols, alkanoic acids, alkanoates (esters and salts) |
|  | (b) | Alkanols (CA11I) (CA13C) |
|  |  | (i) | Sources, nomenclature and structureLaboratory preparation including hydration of alkenes. Industrial and local production of ethanol including alcoholic beverages. Harmful impurities and methods of purification should be mentioned. |
|  |  | (ii) | ClassificationPrimary, secondary and tertiary alkanols |
|  |  | (iii) | Physical propertiesIncluding those due to intermolecular hydrogen bonding |
|  |  | (iv) | Chemical PropertiesCharacteristic test tube reactions of alkanolsReaction with: Na, alkanoic acids (esterification), conc. H2SO4 Oxidation by: KMnO4(aq), K2Cr2O7 (aq), I2/NaOH(aq) |
|  |  | (v) | Laboratory testCharacteristic test tube reactions of alkanols |
|  | (c) | Alkanoic Acids (CA11J) (CC6H) |
|  |  | (i) | Sources, nomenclature and structure Recognition of mono and dioic acids |
|  |  | (ii) | Physical propertiesIncluding those due to intermolecular hydrogen bonding. |
|  |  | (iii) | Chemical PropertiesAcid properties only: i.e. reactions with H2O, NaOH, NaHCO3 |
|  |  | (iv) | Laboratory testReaction with NaHCO3 |
|  |  | (v) | Uses and propertiesUses and properties of ethanoic and phenylmethanoic (benzoic) acids as examples of aliphatic and aromatic acids respectively |
|  | (d) | Alkanoates as derivatives of alkanoic acids (IA13.2) (CA11K) (CA13C) |
|  |  | (i) | Sources, nomenclature and structurePreparation of alkyl alkanoates (esters) from alkanoic acidsDifferences between neutralization and esterification. Equations representing neutralization and esterification reactions |
|  |  | (ii) | Physical properties |
|  |  | (iii) | Chemical PropertiesCharacteristic test-tube reactions of alkanoic acidsHydrolysis of esters (mechanism not required) |
|  | (e) | Separation and purification (CA11B) (CA13A)Methods to be discussed should include: distillation, crystallisation, drying, chromatographyFiltration, recrystallisation and melting point determination |
|  | (f) | Determination of empirical and molecular formulae and molecular structures of organic compounds (CA11C) |

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| **13.** | **TOPIC 12 - NON-METALS AND THEIR COMPOUNDS** |
|  | (a) | Oxygen (IA10.2) (CC7A) |
|  |  | (i) | Laboratory and Industrial preparation |
|  |  | (ii) | **Properties and uses** |
|  |  | (iii) | **Binary Compounds of oxygen: acidic oxides, basic oxides, amphoteric oxides and neutral oxides** |
|  | (b) | Water and solution (IA9) (CC7B)Test for water will be required |
|  |  | (i) | Composition of waterReference should be made to the electrolysis of acidulated water |
|  |  | (ii) | Physical and chemical properties of waterExperiments to determine/ demonstrate: (i) boiling point of water. (ii) the solvent action of water on a variety of substances. (iii) presence of dissolved substances (iv) polar nature of water. Uses of water |
|  |  | (iii) | Water as a solvent |
|  |  | (iv) | Hardness of water: causes and methods of removing itAdvantages and disadvantages of hard water and soft waterExperiments to compare the degree of hardness in different samples of waterCauses of hardness of water (Ca++, Mg++, Fe++ ions). Softening hard water (addition of washing soda, ion exchange, boiling and distillation) |
|  |  | (v) | Treatment of water for town supplySteps involved in the treatment of water for public consumption |
|  | (c) | Halogens (CA2B) (CC6C) |
|  |  | (i) | **Periodic gradation of elements in group i.e. the halogens: F2/Cl2/Br2/I2**Recognition of group variations noting any anomalies. Treatment should include the following:(i) physical states, melting and boiling points;(ii) redox properties of the elements: displacement reaction of one halogen by another.  |
|  |  | (ii) | Chlorine: Laboratory preparation, properties and reactions |
|  |  | (iii) | Properties of chlorine as a typical halogenProperties should include: (i) variable oxidation states; (ii) reaction with water and alkali (balanced equations required) |
|  |  | (iv) | Uses of halogen compoundsUses should include silver halide in photography and sodium oxochlorate (I) as a bleaching agent |
|  | (d) | Nitrogen (CC6D) |
|  |  | (i) | Preparation and propertiesBoth laboratory and industrial preparations from liquefied air are required. |
|  |  | (ii) | Uses of nitrogen (IA10.2) |
|  |  | (iii) | Compounds of nitrogen**(I) Ammonia – Industrial preparation and uses.** **(II) Trioxonitrate (V) acid - Laboratory preparation, reactions and uses.** **(III) Trioxonitrate (V) salts**Action of heat will be required |
|  | (e) | Sulphur (CC6E) |
|  |  | (i) | Allotropes and uses |
|  |  | (ii) | **Compounds of sulphur****Sulphides** **Trioxosulphate (IV) acid and its salts.** **Tetraoxosulphate (VI) acid - Industrial preparation, reactions and uses**For industrial preparation, only the Contact Process should be discussed |
|  | (f) | The noble gases – properties and uses (CC6F) |
|  | (g) | Preparation and properties of gases (IA7.2) (CA5B)Laboratory preparation of gases lighter than air (H2, NH3) and gases heavier than air (CO2, HCI and SO2) to illustrate the principles of purification and collection of gasesLaboratory preparation of ammoniaChemical properties of the gases mentioned above (i.e. H2, NH3, CO2, HCl and SO2).Test for hydrogen, carbon dioxide and ammonia gases |
|  | (h) | **Carbon (CC6A) (CC6B) (CC6C) (CC6D)** |
|  | (i) | **Coal** |
|  |  | (i) | Allotropes of carbon other than diamond and graphiteStructures, properties and usesThe uses of the allotropes should be correlated with their properties and structuresCombustion of allotropes |
|  |  | (ii) | **Coal****Different types**Different types should include anthracite, peat and lignite**Destructive distillation of coal and uses of the products** |
|  |  | (iii) | **Coke**Gasefication and usesManufacture of synthetic gas and uses |
|  |  | (iv) | Oxides of CarbonCarbon (IV) oxide: usesCarbon (II) oxide: properties and uses |
|  | (j) | Practicals - Qualitative Analysis of Anions (IA7.2) (CA13C) Characteristic reaction of dilute HCl on solids or aqueous solutions and conc. H2SO4 on solid samples of the following: C1-; SO32-; CO32-; NO3-; SO42-; Confirmatory tests for the above anions Comparative study of the halogens; displacement reactions. Characteristic test for the following gases: H2; NH3; CO2; HCl and SO2 |
|  | (k) | Rocks (IA4.6)Types, formation and characteristics of rocks (Formation of igneous, sedimentary and metamorphic rocks and their characteristicsWeathering of rocks (Physical, biological and chemical weathering of rocksExplanation of the effect of hydration, hydrolysis, carbonation and oxidation on rocks is required |

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| **14.** | **TOPIC 13 - POLYMERS AND BIOCHEMISTRY** |
|  | (a) | Fats and oils: Sources, physical and chemical properties (IA13) (CA11L)Alkanoates (esters) Saponification, hardening of oils. Detergents as soapless detergents. Comparison of soapless detergents with soapy detergents and their action on soft water and hard water |
|  | (b) | **Systematic nomenclature of amines (CA11A)** |
|  | (c) | **Amino acids (CA11M)**Difunctional nature of amino acid |
|  | (d) | Natural and synthetic polymers (CA11N) |
|  |  | (i) | DefinitionsPolymerisationAddition and condensation polymersPlastics and resinsThermoplastic and thermosetting polymers |
|  |  | (ii) | Important properties of polymers |
|  |  | (iii) | Natural polymers**Carbohydrates: formulae, properties and uses**Classification as monosaccharides, disaccharides and polysaccharides; reducing and non-reducing sugars using glucose, fructose, sucrose/maltose and starch/cellulose as examples. Hydrolysis of sucrose and starch**Proteins**As polymers of amino acid molecules linked by peptide or amide linkageHydrolysisUses in living systems |
|  |  | (iv) | Synthetic polymersClassification and preparation based on the monomers and co-polymers |
|  | (e) | Practicals – Qualitative Analysis (CA13C)Characteristic test tube reactions of the functional groups in the following simple organic compounds: Sugars (using Fehling’s and Benedict’s solutions only); starch (iodine test only) and proteins (using the Ninhydrin test, Xanthoproteic test, Biuret test and Millon’s test only). |

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| **15.** | **TOPIC 14 - CHEMISTRY, INDUSTRY AND THE ENVIRONMENT** |
|  | (a) | Chemistry in industry (CA12A)Natural resources in candidate’s own countryChemical industries in candidate’s own country and their corresponding raw materials. Distinction between fine and heavy chemicals.Factors that determine siting of chemical industries.Effect of industries on the community.  |
|  | (b) | Exploitation of minerals (IA11)Exploitation of the following minerals in Ghana: bauxite, diamond, gold, crude oil and kaolin.Negative impact of exploitation of minerals mentioned and how to minimize the effect. |
|  | (c) | (i) | Extraction of metals (CA12B)**Al and Fe****Au or Sn**Raw materials, processing, main products, byproducts, recyclingUses of the metals |
|  |  | (ii) | AlloysCommon alloys of Cu, A1, Pb, and Fe and their uses |
|  | (d) | Petrochemicals (IA13.3)Sources, application and effects of petrochemicals on the environment.The refinery of crude oil. Uses of petrochemical such as plastics, pharmaceuticals and agrochemicals. |

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|  | (e) | Pollution: air, water and soil pollution (IE2.1) (IE2.2) (IE2.3) (IE2.4) (IE2.5) (IE2.6) (CA12C)Sources, effects and controlGreenhouse effect and depletion of the ozone layer**Regions of atmosphere**Layers of the atmosphere: troposphere, stratosphere, mesosphere, and thermosphere. Description of the characteristics of each layer in terms of thickness, temperature, air quality and composition, pressure and support for human activities**Human activities and their effects on the atmosphere**Effects of human activities on the atmosphere: air transport, defence, industrialization and agriculture**Atmospheric pollutants**Sources and effects of the following major pollutants: oxides of lead, nitrogen and sulphur; ozone, halons (carbon and halogen compounds).**Greenhouse effect**Explanation of ‘greenhouse’ and its effect: Global warming and climate change. Possible factors to address the problem of global warming. Greenhouse gases e.g. carbon (IV)oxide and methane.**Ozone layer**Ozone layer and how it protects living organisms. Causes and effects of the depletion of the ozone layer. Sources and effects of CFCs on the ozone layer**Acid rain**Identification of acidic pollutants which cause acid rain. The effects of acid rain on the environment (damage to buildings, paints forests etc)Biodegradable and non-biodegradable pollutants |
|  | (f) | Biotechnology (CA12D)Food processing, fermentation including production of kenkey/gari, bread and alcoholic beverages e.g. Local gin |
|  | (g) | Hazardous Substances (IE6.4)Possible hazards that can occur in working environment e.g. dust, fumes, toxic substance, corrosive substances, fire, food contamination, harmful radiation (X-rays), poisonous substances from heated or frozen plasticsEffects of hazardous substances on human body, e.g. blindness, burns, nausea, vomiting, and allergies |
|  | (h) | **Endogenous Technology (IE9)**Explanation of endogenous technology.Effects of modern technology on the development of endogenous technology. Inter-dependence of science and technology. Distinction between science and technology. Significance of science and technology to the development of society. |
|  | (i) | **Small-scale industries (IE9.1)**Small scale industries: raw materials and equipmentScientific principles underlying the following small scale industries: soap production, salt making,palm oil production, bread making, and yogurt production |