**Course title: Chemistry I**Full marks: 100 (80T + 20P)

Course No. : Sc. Ed. 416                                Pass marks: 28T + 8P

Nature of course: Theory (T) + Practical(P)    Periods/week: 6(T)x6(P)-3pds/day/week/gr

Level: B. Ed Four Year                                    Total periods: 150

Year: First                                                       Time : 55 minutes

**1. Course description**

This course is an introductory course designed for the students specializing Science Education and has two parts: theoretical and practical. The theoretical part consists of different units of general or physical chemistry, inorganic chemistry and organic chemistry – Structure of atom, Chemical bonding, Acids and Bases, Periodic table, Redox reactions, Metals and metallurgy, Principles qualitative analysis, Structure and properties of organic compounds, Alkanes, Alkenes, Alkynes, Aromatic hydrocarbons, Stereoisomerism, Solution, Chemical kinetics, Catalysis, Colloids, Chemical equilibrium, Ionic equilibrium. In practical part, the different experiments to be performed  are listed in practical course. The students are required to secure pass marks in theory as well as practical course separately.

**2. General Objectives**

The general objectives of this course are as follows:

* To provide students with the general knowledge and basic aspects of physical, organic and inorganic chemistry.
* To inculcate the knowledge and skills of chemistry through pedagogical learning experiences and practical activities.
* To provide the students with hands on and minds on experience on the chemistry process skills and tools.
* To interpret the nature and fundamentals of chemistry in science education.
* To enable students to prepare report on practical record file using appropriate methods and approaches.
* To provide students with an opportunity to understand inquiry based chemistry education with its application on various fields.

**3.**      **Specific Objectives and Contents**

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| **Specific Objectives** | **Contents** | **Periods** |
| * Explain Bohr's model of atom, its postulates and limitations * Explain Bohr's explanation of hydrogen spectrum. * Elaborate wave mechanical model of atom. * Describe dual nature of matter and de Broglie's equation. * Derive de Broglie's equation. * Explain Heisenberg's uncertainty principle. * Describe quantum numbers and their significances. * Draw energy profile diagram of multi-electron atom. * State and explain Pauli's exclusion principle, Hund's rule and aufbau principle. * Compare the stability of completely filled, half-filled and empty orbital. | **Unit I. Structure of atom**   * 1. Bohr's theory of atom.   2. Wave mechanical model of atom.   3. Mater waves.   4. de Broglie's equation.   5. Heisenberg's uncertainty principle   6. , Quantum numbers and their significance.   7. Pauli's exclusion principle.   8. Hund's rule of maximum multiplicity.   9. Aufbau principle and its limitations.   10. Energy level diagrams across d-block elements.   11. Stability of completely filled, half-filled and empty orbital. | **12** |
| .   * Define ionic bond and describe the covalent character in ionic compounds. * Describe bond moment and dipole moment and their effects on properties of the compounds. * Explain the characteristics of ionic compound. * Draw the structure of ionic compounds - NaCl, ZnS and CaF2. * Explain the characteristics of coordinate covalent bond. * Describe the directional characteristics of covalent bond. * State and describe resonance energy and hydrogen bonding. * Explain VSEPR-theory, hybridization and identify the shapes of molecules on basis of these theories. * Describe the molecular orbital theory. | **Unit II. Chemical bonding**   * Ionic bond. * Covalent character in ionic compounds. * Bond moment and dipole moments. * Characteristics of ionic compounds. * Structure of ionic compounds - NaCl, ZnS, CaF2. * Characteristics of coordinate covalent bond. * Directional characteristics of covalent bond. * Resonance energy. * Hybridization. * VSEPR theory. * Hydrogen bonding. * Molecular orbital theory. | **12** |
| * State and explain Arrhenius concept, Bronsted-Lowry concept and Lewis concept of acids and bases. * Describe the advantages and limitations of the different concepts of acids and bases. * Define hard and soft acids and bases and explain application of HSAB principle. * Explain the relative strength of acids and bases and the effect of substituent and solvents on them. | **Unit III. Acids and Bases**   * Arrhenius concept of acids and bases * Bronsted-Lowry concept of acids bases * Lewis concept of acids and bases. * Hard and soft acids and bases (HSAB) and application of HSAB principle. * Relative strength of acids and bases and the effect of substituent and solvents on them. | **8** |
| .   * Define Long form of periodic table and modern periodic law. * Explain the superiority and limitations of long form of periodic table. * Explain IUPAC classification of periodic table and its merits and demerits. * Describe the periodicity of s ,p, d and f-block elements. * Explain the different periodic properties and their periodic variations. | **Unit IV. Periodic Table**   * Long form of periodic table. * IUPAC classification of periodic table and its merits and demerits. * Periodicity of s, p, d and f-blocks elements. * Periodic properties - atomic, ionic and covalent radii (not necessary mathematical equations), ionization potential, electronegativity, electron affinity. | **10** |
| .   * Define and illustrate the oxidation - reduction reactions according to classical concept, electronic concept and oxidation number concept. * Define oxidation number and calculate the oxidation number of an atom in a molecule or an ion according to the rule of assigning O.N. * Balance the redox reactions by ion-electron transfer method and oxidation number method. * Define and describe redox titrations. | **Unit V. Redox reactions**   * Classical concept of oxidation and reduction reactions. * Electronic theory of oxidation and reduction. * Oxidation numbers. * Oxidation and Reduction on basis of oxidation number method. * Balancing of redox reactions by ion-electron transfer method and oxidation number method. * Redox titration. | **10** |
| * Differentiate metals, non-metals and metalloids. * Describe the general principles of metallurgy * Explain the general principles of metallurgy. * Describe the characteristics of IB and IIB of d-block elements. * Explain the metallurgy of copper and zinc with diagram and involved reactions. * Explain the general metallurgy of silver, gold, mercury and cadmium. * Explain the chemistry of copper sulphate, copper carbonate, silver nitrate and oxides and halides of Au, Zn, Hg and Cd. | **Unit VI. Metals and metallurgy**   * Metals, non-metals and metalloids. * General principles of metallurgy. * Characteristics of IB and IIB of d-block elements. * Metallurgy of copper, silver, gold, zinc, mercury and cadmium. * Chemistry of some selected compounds of copper, silver, gold, zinc, cadmium and mercury. | **12** |
| * Explain the principles of qualitative analysis and its applications. * Explain solubility product and solubility product principle. * Define common ion effect and explain its uses in qualitative analysis of inorganic salts. | **Unit VII. Principles of qualitative analysis**   * Solubility product. * Solubility product principle. * Common- ion effect and its applications in group separation in qualitative analysis of inorganic salts. | **4** |
| * Explain the different types of solution. * Express the different methods of concentrations of solutions. * Explain the colligative properties of solution. * Explain solubility and solubility curves and its applications or benefits. * Solve the numerical problems related with the concentration of solutions. | **Units VIII. Solution**   * Different kinds of solutions. * Concentration of solutions. * Colligative properties of solution. * Solubility and solubility curves. * Related Numerical. | **8** |
| * Define rate of reaction and instantaneous rate of reaction and their measurements and units. * Explain and differentiate molecularity and order of reaction. * Explain zero, first, second and third order reactions with examples. * Derive the integrated rate equations for zero and first order reactions. * Explain the factors affecting the rate of reactions.      Determine the order of reactions.       Explain the theories of reaction rate.       Solve numerical problems related with rate law and first order reaction rate equation. | **Unit IX. Chemical Kinetics**   * Rate of reactions and rate law. * Molecularity and order of reactions. * Zero, first, second and third order reactions. * Derivation of rate equations for zero and  first order reactions. * Related numerical problems. * Factors affecting the rate of reactions. * Theories of reaction rate. * Determination of order of reaction. | **10** |
| .   * Describe the general introduction of catalysis. * Explain the types of catalysis. * Explain the criteria and characteristics of catalysis. * Describe catalyst promoters, auto-catalyst, negative catalyst, catalyst poison. * Explain the theories of catalysis. | **Unit X. Catalysis**   * Introduction. * Types of catalysis. * Criteria and characteristics of catalysis. * Catalyst promoters, auto-catalysis, negative catalyst (inhibitor), catalyst poison. * Theories of catalysis. | **6** |
| * Describe the general introduction of colloids and its types. * Explain the classification of colloids on basis of solvent affinity. * Differentiate between lyophillic and lyopholic solutions. * Explain the properties of colloids. | **Unit XI. Colloids**   * Introduction. * Types of colloids. * Classification of colloids on basis of solvent affinity. * Preparation of colloids. * Properties of colloidal solutions. | **6** |
| * Describe the general introduction of chemical equilibrium. * Explain the characteristics of chemical equilibrium. * Explain the law of mass action. * Explain the characteristics and significance of equilibrium constant. * Explain Lechatelier's principle and its application. | **Unit XII. Chemical equilibrium**   * Introduction. * Characteristics of chemical equilibrium. * Law of Mass Action. * Characteristics and significance of equilibrium constant. * Lechatelier's principle and its applications. | **4** |
| .   * Describe strong electrolytes and weak electrolytes. * Explain auto-ionization of water and ionic product of water. * Explain Ostwald's dilution law. * Explain the relative strength of acids and bases. * Describe PH and PHscale. * Solve numerical problems related to PH of solutions. * Explain buffer solution and buffer action.            Differentiate acidic buffer and basic buffer.           Select the indicators in acid-base titrations. | **Unit XIII. Ionic equilibrium**   * Strong and weak electrolytes. * Auto-ionization of water. * Ostwald's dilution law. * Relative strength of acids and bases. * PH and PH scale. * Related numerical problems. * Buffer solution and buffer action. * Acidic buffer and basic buffer. * Selection of Indicators in acid-base titrations. | **6** |
| * Define atomic orbital, hybrid orbital. * Describe polarity of bonds, hydrogen bonding and their effects on properties of compounds – melting point and boiling point, solubility. * Explain acidity and basicity of organic compounds. * State inductive effect, electrometric effect, mesomeric effect, resonance and hyperconjugation and their effects on organic reactions. * State steric effect and its effect on reactivity of organic compounds. | **Unit XVI. Structure and properties of organic compounds**   * Atomics orbital, hybrid orbital. * Polarity of bonds. * Hydrogen bonding. * Melting point and boiling point. * Acidity and basicity. * Inductive effect. * Electromeric effect. * Mesomeric effect, resonance and Hyperconjugation. * Steric effect. | **5** |
| * Describe the general introduction of alkanes including IUPAC nomenclature and isomerism. * Explain the structure of alkanes on basis of hybridization. * Draw Fischer projection formula and Newman projection formula of alkenes. * Explain the conformations of ethane, propane, n-butane and their conformational analysis with energy - profile diagram. * Describe physical properties of alkenes. * Explain the industrial source and general preparation of alkanes. * Describe the important reactions of alkanes- halogenations, combustion and pyrolysis. * Explain the free radical substitution reactions - mechanism and orientation of halogenations of alkanes. * Explain the relative reactivity of alkanes, ease of abstraction of hydrogen. * Explain the stability of alkyl free radicals, reactivity and selectivity. * Draw an energy -profile diagram of halogenations of alkanes. | **Unit XV.  Alkanes**   * Introduction. * Structure. * Fischer projection formula. * Newman projection formula. * Conformation of ethane, propane and n-butane. * Physical properties. * Industrial source. * Preparation from alkenes, alkynes, alkyl halides, Grignard reagents, Wurtz synthesis,   Kolbe's synthesis, Corey-house synthesis. * Reactions: Halogenations - * Substitution reactions, mechanism of halogenations, orientation of halogenations, relative reactivity of alkanes towards halogenations, ease of abstraction of hydrogen, structure and stability of free radicals, reactivity and selectivity. * Combustion. * Pyrolysis. * Energy profile diagram of halogenations of alkanes. | **9** |
| * Describe the general introduction of alkenes. * Explain the structure of alkenes according to hybridization and its geometrical isomerism. * Describe the physical properties of alkenes. * Explain the industrial sources and general properties of alkenes –dehydrohalogenation and dehydration of alcohols. * Explain elimination reaction and its type E1and E2 reactions including kinetics, mechanism, orientation, stereochemistry and reactivity. * Explain the important reactions of alkenes - hydrogenation, hydrohalogenation, addition of hydrogen bromide (peroxide effect), addition of water, addition of sulfuric acid, addition of halogens, oxymercuration-demercuration, hydroboration- oxidation, ozonolysis, and hydroxylation. * Explain mechanism, orientation and reactivity of electrophilic addition reactions. * Explain mechanism and orientation of free radical addition reactions. * Distinguish alkanes, alkenes and alkynes. | **Unit XVI, Alkenes**   * Introduction. * Structure and geometrical isomerism. * Physical properties. * Industrial source. * Preparation- * Dehydrohalogenation of alkyl halides, dehydration of alcohols. * Reactions: hydrogenation, hydrohalogenation, addition of hydrogen bromide and peroxide effect, addition of sulfuric acid, addition of water, addition of halogen, oxymercuration -demercuration, hydroboration -oxidation * Mechanism and orientation of freeradical addition. * Ozonolysis. * Hydroxylation. * Analysis of alkenes. | **10** |
| * Describe the general introduction of alkynes, including types and isomerism. * Explain the structure of alkynes on basis of Hybridization. * Describe the physical properties of alkynes. * Explain the industrial source and preparation of alkynes. * Explain the important reactions of alkynes –addition of H2, X2, H2O, HCN. * Explain and compare the acidity of alkynes with alkanes and alkenes. * Explain the reaction of metal acetylides. * Explain polymerization of acetylene. * Identity on alkynes. | **Unit XVII. Alkynes**   * Introduction. * Structure. * Physical properties. * Industrial sources of acetylene. * Preparation of alkynes. * Reactions –Addition of hydrogen, halogen, water, HCN, Acidity of alkynes. * Reactions of metal acetylides. * Polymerization. * Test reactions of alkynes. | **4** |
| * Describe the general introduction of aromatic hydrocarbons. * Draw and explain Kekule's structure, resonance structure and molecular orbital structure of benzene. * Explain the aromaticity and Huckel’s rule. * Describe the physical properties of benzene. * Describe the preparation of benzene –from acetylene, benzoic acid, phenol and chlorobenzene. * Explain the important reactions of benzene –halogenations, nitration, sulphonation, Friedel –crafts alkylation, Friedel –crafts acylation, addition of hydrogen, and addition of halogens.            Explain the mechanism and orientation of electrophilic substitution reactions. | **Unit XVIII. Aromatic hydrocarbon**   * Introduction. * Structure –Kekule's structure, resonance structure and molecular orbital structure of benzene. * Aromaticity and Hukel’s rule. * Preparation from acetylene, phenol, benzoic acid, chlorobenzene. * Reactions –Halogenations, Nitration, sulphonation, Friedel-crafts alkylation, Friedel-Crafts acylation, Addition of hydrogen, Addition of halogens.           Mechanism and orientation of electrophilic substitution reactions. | **8** |
| .   * Describe the general introduction of stereoisomerism. * Explain the optical activity and plane polarized light. * Explain the optical isomerism and the criteria of compounds to show optical isomerism. * Define and differentiate enantiomers and diastereoisomers. * Explain the optical isomerism of lactic acid and tartaric acid. * Describe the resolution of racemic mixtures. * Explain the sequence rule and apply to identify R and S –configuration. | **Unit XIX. Stereoisomerism**   * Introduction. * Optical activity: Plane polarized light. * Optical isomerism. * Enantiomers and Diastereomers. * Optical isomerism of lactic acid and tartaric acid. * Resolution of racemic mixtures. * Sequence rule and R and S configuration. | **6** |

**Part II: Practical Activities**

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| --- | --- |
| * Develop observational, manipulative, calculative and inference drawing skills. * Carry out the given experiments efficiently and correctly. * Maintain record base of the performed experiments. | * To analyze the given inorganic salt mixture containing two cations and two anions (at least five mixture). * To prepare primary standard solutions- N/10 oxalic acid solution, N/10 KMnO4 solution, N/10 K2Cr2O7 solution. * To determine the equivalent weight of oxalic acid volumetrically. * To prepare decinormal solution of potassium permanganate and standardize it with the given standard oxalic acid solution. * To estimate the amount of CaCO3 in a sample of marble. * To determine the heat capacity of a calorimeter. * To determine the heat of neutralization of hydrochloric acid with sodium hydroxide. * To standardize the given sodium thiosulphate solution with the help of standard potassium permanganate solution. * To standardize the given sodium thiosulphate solution with the help of standard potassium dichromate solution. * To estimate the amount of sulphuric acid and oxalic acid in grams/liter in the given mixture solution. * To estimate the components of a mixture of sodium hydroxide and sodium carbonate solution by the change of indicators. * To study the kinetics of acid catalyzed hydrolysis of methyl acetate at laboratory temperature. * To identify the functional group present in the given organic compounds (at least 5 samples). |

***Note: Chemistry practical class should be conducted three periods continuously in a day and two days a week.***

**4.**      **Instructional Techniques**

         Lecture

         Discussion

         Demonstration

         Project

         Problem solving

         Collaborative methods

         Concept mapping

**5.**      **Evaluation**

**Theory part**

Annual examination will be held by the Office of the Controller of Examinations at the end of the academic session for which 80 percent of total marks will be allocated. The number and types of questions are given below:

|  |  |  |  |
| --- | --- | --- | --- |
| **Types of questions** | **Total questions**  **to be asked** | **Number of questions**  **to be answered and marks allocated** | **Total marks** |
| Group A: Multiple choice items | 14 questions | 14x 1 mark | 14 |
| Group B: Short answer questions | 6 with 2 or questions | 6 x 7 | 42 |
| Group C: Long answer questions | 2 with 1 or question | 2 x 12 marks | 24 |
|  |  | Total | 80 Marks |

**Practical Part**

The marks allocated to practical part are given in the following table.

|  |  |  |  |
| --- | --- | --- | --- |
| **Examination** | **Area of examination** | **Marks** | **Total** |
| Internal | Regularity | 1 | 4 |
| Regular practical performance | 1.5 |
| Record Book | 1.5 |
| External | Experiment | 12 | 16 |
| Viva | 4 |

**Recommended Books:**

Bahl  Arun, Bahl B.S., Tuli G.D. Essentials of Physical Chemistry, S. Chand and Com.Ltd (Units I,II,V,XIV to XIX)

Prakash Satya, Tuli G.D., Basu S.K., Mohan R.D. Advanced Inorganic Chemistry, S. Chand and Com.Ltd(Units I toVII)

Bahl Arun, Bahl B.S. A Text Book of Organic Chemistry, S. Chand and Com. Ltd. (Units VIII to XIII)

Dhoubhadel S.P., Pradhan K.P., Joshi S.M. Practical Chemistry Guide.

Pandit, C.N., R.R. Subedi & Prakash Tiwari (2071), A Text Book of Chemistry for B.Ed., Cambridge Pubication, Kath., Nepal.