Chemistry (Theory)

Total: 6 hours /week
Lecture: 4 hours/week
Tutorial: 0 hour/week
Practical: 0 hours/week
Lab: 2 hours/week

Course Description
This course is an introductory course designed for the students specializing in Health Science 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 the practical part, the different experiments to be performed are listed in the practical course. The students are required to secure pass marks in theory as well as practical course separately. Emphasis is given to the principles related to chemistry within everyday life and to the application of chemistry in health science.

Course Objectives:
The general objectives of this course are as follows:

- Provide students with general knowledge and basic aspects of physical, organic, and inorganic chemistry.
- Inculcate the knowledge and skills of chemistry through learning experience and practical activities.
- Provide students with an opportunity to understand enquiry-based chemistry with its application in various fields.
- Prepare report on practical record file using appropriate methods and approaches.
- Provide students with hands on and mind on experience chemistry processes, skills and tools.
- Interpret the nature and fundamentals of chemistry in health science.
- Assist the students to know about the importance of chemistry and their role in body mechanism.
- Familiar with the sources, effects, chemicals present in the atmosphere and control measures of environmental pollution.

Unit 1: Physical and General Chemistry **60hrs**
1.1. Introduction to Chemistry (foundation and fundamentals) **4 hrs**

- General introduction to chemistry.
- Importance and scope of chemistry.
- Element and compound.
- Atoms, Molecules, Symbol and Formula (Molecular formula, empirical formula)
- Radical and percentage composition from molecular formula.
- Chemical equation, reactant and product.
- Significance and limitations of chemical equations.
- Types of chemical reactions (seven-types) with examples.
- Balancing a chemical equation by:

• Hit and trial method
• Partial equation method (To build up concept only: reactions involving nitric acid)

1.2. Stoichiometry **5 hrs**

- Dalton's atomic theory
- Atomic weight, atomic mass unit(amu) and gram atomic weight
- Molecular weight and gram molecular weight
- Laws of stoichiometry (statement and example only, no numerical calculations)
- Avogadro's hypothesis. (Deduce relation between molecular mass and VD)
- Mole concept, Mole in the term of mass, volume and no. of atoms/molecules.
- Relationships based upon chemical equation.
- Mass – mass relationship, mass – volume relationship, volume – volume relationship.
- Limiting reagent.
- Simple Calculation of related numerical problems.

1.3. Atomic Structure **4 hrs**

- Sub-atomic particles (Charge and mass)
- Rutherford's nuclear model of atom
- Bohr's atomic model
- Bohr's explanation of hydrogen spectrum
- Aufbau's principle
- Hund's rule.
- Atomic number, mass number, Isotopes and isobars.

1.4. Classification of elements and their periodic properties **5 hrs**

- Modern periodic law and modern periodic table.
- Classification of elements into different groups, periods and blocks.
- Nuclear charge and effective nuclear charge.
- Periodicity and periodic trend of periodic properties of elements (general trend only):
- Atomic radii (ionic and covalent)
- Ionization potential
- Electron affinity
- Electronegativity

1.5. Chemical bonding **3 hrs**

- Electronic theory of valency
- Types of chemical bond and their properties: Electrovalent, Covalent, Co-ordinate covalent Polarity in covalent bond, Hydrogen bond and its consequences, (solubility, viscosity and boiling point)

1.6. States of matter - Gaseous state **4 hrs**

- Kinetic theory of gases. (Postulates only)
- Boyle's law & Charles' law (with graphical representation)
- Ideal gas equation.
- Dalton's law of partial pressure
- Graham's law of diffusion.
- Simple numerical calculations

1.7. States of matter - Liquid state **6 hrs**

- Physical Properties of liquids: evaporation and condensation
- Vapour pressure and boiling point.
- Surface tension and viscosity.
- Rault's law
- Solution (Unsaturated, saturated and supersaturated solution)
- True solution, solubility, solubility curve
- Henry's law

- Osmosis, osmotic pressure, isotonic, hypotonic and hypertonic solution
- Biological importance of osmosis.
- Colloids; lypophilic and lypophobic colloids,
- Tyndal effect
- Brownian movement (simple concepts)
- Coagulation
- Electrophoresis
- Dialysis emulsion, gels, and gelation
- Application of colloids in medical field and in daily life.

1.8. States of matter - Solid state **1 hrs**

- Types of solids; amorphous and crystalline solids, Efflorescent, deliquescent and hygroscopic solids
- Crystallization and water of crystallization. Molecular crystal, Covalent crystal, Ionic crystal

1.9. Oxidation and Reduction **4 hrs**

- Classical concept of oxidation and reduction.
- Electronic concept of oxidation and reduction.
- Oxidant and reductant and oxidation number
- Examples of redox reaction.
- Balancing the chemical equation by oxidation number method and ion electron method.

1.10. Acid, Base and Salt **3 hrs**

- Arrhenius theory of acid base, Bronsted-Lowery (conjugate acid-base pair) theory and Lewis concept
- Salts and their types.
- Antacids and anta bases and their medical uses.

1.11. Electro Chemistry **5 hrs**

- Electrolytes, non-electrolytes, strong and weak electrolytes.
- Arrhenius theory of ionization.
- Faradays' laws of electrolysis.
- Electrolysis of water, Ionic product of water, PH, POH, Buffer solution
- Importance of PH and buffer in human body.
- Simple numerical problems based on Faradays' laws only

1.12. Volumetric analysis **5 hrs**

- Equivalent and gram equivalent weight of Element, Determination of equivalent weight of metal by hydrogen displacement method
- Acid, base, and salt Titration
- Acidimetry, alkalimetry, end point, indicator, primary and secondary standard substance
- Ways of expressing concentration of solution in terms of Normality, Molarity, molality % by mass, % by volume, parts per million (ppm), Normality factor
- pH changes in acid base titration and choice of indicator
- Calculations to prepare different concentrations of solutions.

1.13. Chemical Thermodynamics **4 hrs**

- Introduction
- Enthalpy and enthalpy change, exothermic and endothermic reactions, heat of combustion and its application, heat of formation, heat of neutralization and heat of solution, bond energy.
- First law of thermodynamics

- Hess's law

1.14. Chemical Kinetics **7 hrs**

- Rate of reaction; average and instant rate of reaction
- Law of mass action and rate equation (Rate law)
- Order and molecularity of reaction
- Zero, First and second order reactions
- Factors affecting rate of reaction
- Collision Theory
- Energy profile diagram for endothermic and exothermic reactions
- Chemical Equilibria and Le-Chateliers' Principle
- Catalysis; Enzyme catalysis, characteristics of enzyme catalysis, promoter, autocatalysis, negative catalysis, catalytic poisoning

Unit 2: Inorganic Chemistry and Environmental Chemistry **35hrs**

2.1. Hydrogen, Oxygen and Water **7 hrs**

- Hydrogen: Isotops of hydrogen, ortho and para hydrogen, Chemical comparison of atomic and molecular
- Hydrogen Oxygen: Types of oxides (acidic, basic, amphoteric, peroxide and mixed oxide), Medical application of oxygen and hydrogen peroxide.
- Water: Introduction of soft and hard water.
- The process of removal of hardness-Boiling,
- Clark's process, using washing soda, permutit process
- Quality of drinking water
- Solvent property of water

2.2. Nitrogen **3 hrs**

- Laboratory preparation and manufacture (Haber's process) of ammonia.[figure and description not required]
- Physical and chemical properties of ammonia (action with metals, Nessle';s reagent, ammonia as a Lewis base,basic nature)
- Uses of ammonia

2.3. Carbon **2 hrs**

- Allotropes of carbon
- Laboratory preparation of carbon monoxide. [figure and description not required]
- Chemical properties in reaction (with O2, Cl2, Ni, NaOH, and hemoglobin)

2.4. Phosphorous **2 hrs**

- Occurrence of phosphorous in animal bones, ATP and ADP.
- Properties of white phosphorous –reactions with O2, with Cl2, caustic alkali.
- Uses of phosphorous.

2.5. Sulphur **5 hrs**

- Laboratory preparation of SO2[figure and description not required]
- Chemical properties of SO2 (action with lime water, sodium carbonate, oxidizing and reducing properties,
- bleaching properties)

- Laboratory preparation of H_2S. [figure and description not required]
- Reducing properties and action with cations.

2.6. Halogens **4 hrs**

- Laboratory preparation of Cl_2, Br_2 and I_2 [figure and description not required]
- Compare the chemical properties of halogens-
- Oxidizing action, bleaching action, in reaction with H_2, with slaked lime, and with organic compounds.
- Uses of Cl_2

2.7. Metals, metallurgy and minerals **3 hrs**

- Difference between minerals and ores, flux and slag, calcination and roasting.
- Sources of the following minerals- Na, K, Ca, Mg, Fe, Zn, Ni, Cobalt.
- Biological importance and effects due to their deficiency

2.8. Metallic Compounds **4 hrs**

- Preparation, properties and uses of$HgCl_2$, Hg_2Cl_2, Plaster of Paris, Epsom salt, Bleaching powder, Cu_2O,$AgNO_3$, $AuCl_3$, $ZnCl_2.2H_2O$

2.9. Pollution **5 hrs**

- The sources and adverse effects due to the following air pollutants- CO_2, SO_2, O_3, H_2S,CO, hydrocarbon, lead, cadmium dust, CFC, oxides of nitrogen.
- Air pollution and its effects on:
- Human health, material sand climate, Greenhouse effect,
- Ozone layer depletion
- Acid rain and its adverse effects.
- Water pollution and its effects.
- Nuclear and pesticide pollution.

Unit 3: Organic Chemistry **45Hours**

3.1. An introduction to Organic compounds **8 hrs**

- Organic chemistry as a separate branch, Reason for large number of organic compounds.
- Difference between organic and inorganic compounds.
- Sources of organic compound
- Functional group and Homologous series
- IUPAC system of Nomenclature of aliphatic compounds containing functional and polyfunctional groups.
- Structural isomerism in organic compounds.
- Free radical, Carbocation and carbanion.
- Inductive effect (+I and –I effect), Significance of inductive effect
- Electrophiles and Nucleophiles.
- Hybridization (sp, sp^2 and sp^3) and Resonance
- Importance of organic chemistry in medical field

- Structure and uses of simple drugs: Antipyretics, antiseptics, analgesics, antibiotic, antimalarials, tranquilizers, germicides, and fungicides.

3.2. Hydrocarbons **6 hrs**

- Saturated and unsaturated hydrocarbons
- Preparation of ethene from ethanol.
- Chemical properties and uses of alkenes.
- Markovnikov's rule and anti-Markovnikov's rule
- Preparation of ethyne from calcium carbide.
- Chemical properties–Combustion, hydrogenation, catalytic hydration, with Br2 solution, with Na, polymerization
- Uses of hydrocarbons

3.3. Alkyl Halides **5 hrs**

- General method of preparation and chemical properties of monohaloalkanes
- Substitution reaction; SN1 & SN2(basic concept only)
- Elimination reaction (dehydrohalogenation-Saytzeff's rule)
- Laboratory preparation of chloroform.
- Chemical properties of chloroform
- Iodoform test
- Uses of chloroform.

3.4. Alcohol **4 hrs**

- Classification and distinction between primary, secondary and tertiary alcohols.
- Fermentation of ethyl alcohol
- Physical and chemical properties of ethyl alcohol (oxidation with sodium, bleaching powder, oxygen, sulphuric acid, phosphorius halides, CH3COOH,)

3.5. Aldehyde and Ketones **5 hrs**

- General methods of preparation of aldehydes and ketone: and chemical properties (NH2OH, NH2CONH2, C6H5NHNH2, NH2NH2, NaHSO3; 2,4-DNP, Formaline, Oxidation of ammonia)
- Uses

3.6. Carboxylic acid **2 hrs**

- Preparation of carboxylic acid from alcohol, aldehyde and alkyl benzene.
- Physical and Chemical properties (acidic character, NaHSOCl2, NH3,C2H5OH, P2O5)
- Uses

3.7. Ethers **2 hrs**

- Laboratory preparation from ethanol.
- Physical properties.
- Chemical properties with-Combustion
- Hydrolysis

- Reaction with excess HI and PCl5.
- Uses in medicine

3.8. An introduction to Aromatic Compounds and Benzene **2 hrs**

- Introduction
- Aromatic compound.
- Characteristics of aromatic compounds.
- Kekule's structure of benzene
- Preparation of benzene, physical and chemical properties (halogenation, nitration, sulfonation, Freidel Craft's reaction)
- Uses

3.9. Phenol **2 hrs**

- Introduction
- Preparation of phenol.
- Physical and Chemical properties (action with zinc dust, NaOH, NH3, PCl5, Kolbe's reaction, Condensation with formaldehyde)

3.10. Nitrobenzene **2 hrs**

- Introduction
- Laboratory preparation of nitrobenzene.
- Physical properties
- Reduction reaction of Nitrobenzene in different medium.
- Uses in everyday life.

3.11. Aniline **2 hrs**

- Introduction
- Laboratory preparation of pure aniline
- Physical and Chemical properties- basic nature, alkylation, acylation, sulfonation, halogenation, nitration
- Uses

3.12. Biomolecules **5 hrs**

- **Carbohydrate:**
    - Definition and classification,
    - Structure (Linear /Cyclic) of glucose,
    - Functions of Carbohydrates
- **Protein:**
    - Amino acid and Peptide bond
    - Essential and non-essential amino acid
    - Denaturation of protein
    - Functions of Protein
    - Enzymes (Definition and importance)
- **Lipid:**

- Introduction of lipid, fat and oil and their natural sources.
- Hydrolysis
- Functions of fat and oil

- **Vitamins and coenzymes:**
  - Introduction
  - Fat soluble and insoluble vitamins
  - Importance and function

Reference Books

- Jha, J.S.,&Gugliani, S.K.,A Textbook of Chemistry. Seirya Publication.Current edition.
- Sthapit,M.&Pradhananga, R.R.,Fundamentals of Chemistry (vol. I&II). Taleju Prakashar.Currentedition.
- A text book Chemistry, Surya Publication.
- Pandit, C.N. Dr., Subedi, R.R. and Tiwari, Prakash; A Textbook of Chemistry; K.P. Publication, Dillibazar, Kathmandu.
- Textbook of Chemistry, Akshav Publication.

Final written exam marking scheme

Unit	1	2	3	Total
Unit hours	60	35	45	140
Marks	34	20	26	80

Chemistry (Practical)

Practical: 70Hrs

- Procedural rules and guidelines of the chemistry lab.
- Proper handling of equipment.
- Lab safety measures.
- Documentation procedures for laboratory work.
- The correct operation of the Bunsen burner.
- Parts of the Bunsen burner.
- Differentset Oxidizing and non-oxidizing flames.
- Demostrate methods of filtration.
- Chloride ion, sulphate ion and nitrate ion test.
- Nature of mixtures and components.
- Principles and processes of sublimation.
- Principles and process of precipitation.
- The distillation process.
- Crystallization point and crystallization process.
- Acid base reactions.
- process of evaporation.
- Set up the apparatus and prepare hydrogen, nitrogen, ammonia and carbon dioxide gas at lab.
- Chemicals used in gas experimentation.
- Test the physical andchemical properties of selected gases
- The operation of a chemical balance scale.
- Calculation of equivalent weights.
- Determine the equivalent weight of metal by hydrogen displacement method.
- Process of titration.
- Perform acid base titration.
- Preparation of solutions of various strengths.
- Calculation of strengths of unknown solutions in termsof normality, molality, molarity, grams/liter, and percentage.
- Detection of nitrogen, sulphur, halogens
- The identification of acetate, formate, formaldehyde,oxalate, oxalic acid, glycerol, acetone, ethyl alcohol, acetic acid, formicacid.
- Perform chemical tests.