

SECONDARY EDUCATION CURRICULUM, 2076

CHEMISTRY SYLLABUS

GRADE 12 | Subject Code: Che. 302

■ COURSE OVERVIEW

Grade: 12

Subject Code: Che. 302

Credit Hours: 5 | Working Hours: 160

Structure: Theory (128 TH) + Practical/Project Work (32 TH)

Evaluation: External Examination (75 Marks) + Internal Assessment (25 Marks)

1. Level-Wise Competencies

- Think critically and creatively, communicate effectively in written and oral form and reason quantitatively.
- Apply appropriate principles, concepts, theories, laws, models and patterns to interpret findings, draw conclusions, make generalizations, and predict from chemical facts, observations, and experimental data.
- Correlate old principles, concepts, theories, laws, tools, techniques to modern, sustainable, and cost-effective skills, tools, and techniques in the development of scientific attitude.
- Apply principles and methods of science to develop scientific skills in industrial processes to produce various useful chemicals in daily life and service of mankind.
- Explain social, economic, environmental, and other implications of chemistry and appreciate advancement of chemistry as essential for national economy growth.
- Describe chemistry as a coherent and developing framework of knowledge based on fundamental theories of the physical world.
- Develop skills in safe handling of chemicals, taking into account physical/chemical properties, risks, and environmental hazards.

- Conduct research or innovative work under teacher guidance using acquired knowledge and skills.

2. Grade 12 Learning Outcomes & Scope of Contents

Content Area: General and Physical Chemistry

1. Volumetric Analysis (8 TH)

- 1.1 Define volumetric and gravimetric analysis.
- 1.2 Express solution concentration: Percentage, g/L, molarity, molality, normality, ppm, ppb.
- 1.3 Calculate equivalent weight of elements, acids, bases, salts, oxidizing and reducing agents; Relationship between equivalent weight, atomic weight, and valency.
- 1.4 Apply Law of Equivalence and Normality Equation ($N_1V_1 = N_2V_2$) in chemical calculations.
- 1.5 Define primary and secondary standard substances.
- 1.6 Explain acid-base and redox titrations with related numerical problems.

2. Ionic Equilibrium (10 TH)

- 2.1 Limitations of Arrhenius concepts; Bronsted-Lowry concepts, conjugate acid-base pairs; Lewis definition of acids and bases.
- 2.2 Ionization of weak electrolytes and Ostwald's dilution law.
- 2.3 Ionic product of water (K_w), pH and pOH calculations, dissociation constants (K_a , K_b), and pK_a/pK_b concepts.
- 2.4 Solubility product principle (K_{sp}), Common Ion Effect, and applications in precipitation reactions.
- 2.5 Buffer solutions (mechanism and applications); Indicators and choice of indicators in acid-base titration.
- 2.6 Differentiate salt types (simple, double, complex, acidic, basic, neutral) and explain Salt Hydrolysis.

3. Chemical Kinetics (7 TH)

- 3.1 Rate of reaction: Average and instantaneous rates; Rate law, rate equation, rate constant (units and significance).
- 3.2 Order and molecularity of reactions.
- 3.3 Integrated rate equation and half-life for zero and first-order reactions.
- 3.4 Collision theory, activation energy, and activated complex.
- 3.5 Factors affecting reaction rate: Concentration, temperature (Arrhenius equation), and catalysts (homogeneous, heterogeneous, enzyme catalysis).

4. Thermodynamics (8 TH)

- 4.1 Energy changes in reactions, internal energy, state functions, First Law of Thermodynamics.
- 4.2 Enthalpy and enthalpy changes (enthalpy of reaction, solution, formation, combustion); Endothermic/exothermic profile diagrams.
- 4.3 Laws of thermochemistry (Laplace law and Hess's law) with numerical problems.
- 4.4 Entropy, spontaneity, Second Law of Thermodynamics.
- 4.5 Standard Gibbs Free Energy change ($\Delta G = \Delta H - T\Delta S$) and prediction of spontaneity; Relationship between ΔG and equilibrium constant.

5. Electrochemistry (7 TH)

- 5.1 Standard electrode potential; Standard hydrogen electrode and calomel electrode.
- 5.2 Electrochemical series and its practical applications.
- 5.3 Voltaic cells (Zn-Cu cell, Ag-Cu cell); Standard cell potential (E°_{cell}).
- 5.4 Relationship between cell potential and Gibbs free energy change ($\Delta G = -nFE^\circ_{\text{cell}}$).
- 5.5 Commercial batteries, fuel cells (H_2/O_2), and lithium-ion rechargeable batteries.

Content Area: Inorganic Chemistry

6. Transition Metals (5 TH)

- 6.1 Characteristics and variable oxidation states of transition metals.

- 6.2 Complex ions, coordination complexes, and shapes of complex ions.
- 6.3 Crystal Field Theory (CFT) explanation of d-orbital splitting in octahedral complexes.
- 6.4 Reasons for color in transition metal compounds and catalytic properties.

7. Studies of Heavy Metals (15 TH)

- 7.1 Copper: Extraction from copper pyrites; Physical/chemical properties and uses; Chemistry of blue vitriol ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$), red oxide (Cu_2O), and black oxide (CuO).
- 7.2 Zinc: Extraction from zinc blende; Properties and uses; Chemistry of white vitriol ($\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$).
- 7.3 Mercury: Extraction from cinnabar; Properties; Chemistry of calomel (Hg_2Cl_2) and corrosive sublimate (HgCl_2).
- 7.4 Iron: Extraction; Manufacture of steel by Basic Oxygen Method and Open Hearth Process; Corrosion of iron and prevention.
- 7.5 Silver: Extraction by cyanide process; Preparation and uses of AgCl and AgNO_3 .

Content Area: Organic Chemistry

8. Haloalkanes (8 TH)

- 8.1 Nomenclature, isomerism, classification, and preparation of monohaloalkanes.
- 8.2 Nucleophilic substitution reactions: SN_1 and SN_2 mechanisms (basic concept).
- 8.3 Formation of alcohols, nitriles, amines, ethers, thioethers, carbylamines, nitrites, and nitroalkanes.
- 8.4 Elimination reactions (Saytzeff's rule), reduction, Wurtz reaction.
- 8.5 Trichloromethane (Chloroform): Preparation from ethanol/propanone; Chemical properties (oxidation, reduction, Ag powder, HNO_3 , KOH).

9. Haloarenes (3 TH)

- 9.1 Nomenclature, isomerism, and preparation of chlorobenzene.
- 9.2 Low reactivity of haloarenes vs. haloalkanes in nucleophilic substitution.
- 9.3 Chemical properties: Reduction, electrophilic substitution, Fittig and Wurtz-Fittig reactions, action with chloral (DDT formation).

10. Alcohols (7 TH)

- 10.1 Classification and distinction of 1°, 2°, 3° alcohols using Victor Meyer's Method.
- 10.2 Industrial preparation: Oxo process, hydroboration-oxidation, fermentation of sugar.
- 10.3 Concepts: Absolute alcohol, power alcohol, denatured alcohol, rectified spirit, alcoholic beverages.
- 10.4 Chemical properties: Reaction with HX, PX₃, PCl₅, SOCl₂, Na, dehydration, oxidation, catalytic dehydrogenation, esterification.

11. Phenols (4 TH)

- 11.1 Preparation from chlorobenzene, diazonium salts, and benzene sulphonic acid.
- 11.2 Acidic character of phenol compared to alcohol and water.
- 11.3 Reactions: NH₃, Zn, Na, diazonium chloride, phthalic anhydride, Kolbe's reaction, Reimer-Tiemann reaction, electrophilic substitutions.
- 11.4 Tests for phenol: FeCl₃ test, aqueous bromine test, Libermann test.

12. Ethers (2 TH)

- 12.1 Preparation via Williamson's synthesis; Physical properties.
- 12.2 Chemical properties of ethoxyethane with HI, Conc. HCl, Conc. H₂SO₄, air, and Cl₂.

13. Aldehydes and Ketones (10 TH)

- 13.1 Aliphatic: Preparation, structure of carbonyl group, distinction using 2,4-DNP, Tollen's reagent, Fehling's solution.
- 13.2 Reactions: Nucleophilic addition (HCN, NaHSO₃), ammonia derivatives, Aldol condensation, Cannizzaro's reaction, Clemmensen reduction, Wolff-Kishner reduction, Formalin uses.
- 13.3 Aromatic: Benzaldehyde preparation and reactions (Perkin condensation, Benzoin condensation, Cannizzaro reaction, electrophilic substitution).

14. Carboxylic Acids and Derivatives (9 TH)

- 14.1 Aliphatic & Aromatic Carboxylic Acids: Preparation, physical properties, Hell-Volhard-Zelinsky (HVZ) reaction, acidic strength factors, abnormal behavior of methanoic acid.
- 14.2 Acid Derivatives (Halides, Amides, Esters, Anhydrides): Preparation, relative reactivity, hydrolysis, ammonolysis, alcoholysis, reduction, Claisen condensation, Hofmann bromamide degradation, amphoteric nature of amides.

15. Nitro Compounds (3 TH)

- 15.1 Nitroalkanes: Preparation, reduction reactions.
- 15.2 Nitrobenzene: Preparation from benzene, reduction in neutral, acidic, and alkaline media, electrophilic substitution reactions.

16. Amines (7 TH)

- 16.1 Aliphatic Amines: Separation of 1°, 2°, 3° amines by Hoffmann's method; Basicity comparison; Nitrous acid test.
- 16.2 Aromatic Amine (Aniline): Preparation, basicity vs ammonia/aliphatic amines, alkylation, acylation, diazotization, carbylamine reaction, coupling reactions, electrophilic substitution.

17. Organometallic Compounds (2 TH)

- 17.1 Organolithium, organocopper, organocadmium compounds; Nature of Metal-Carbon bond.
- 17.2 Grignard Reagent: Preparation and reactions with H₂O, aldehydes, ketones, CO₂, HCN, RCN, esters, and acid chlorides.

Content Area: Applied Chemistry

18. Chemistry in the Service of Mankind (4 TH)

- 18.1 Polymers: Addition and condensation polymers, elastomers, synthetic polymers (polythene, PVC, Teflon, polystyrene, nylon, bakelite).
- 18.2 Dyes, Drugs (characteristics, classification, drug addiction risks), Pesticides (insecticides, herbicides, fungicides).

19. Cement (4 TH)

- 19.1 Raw materials, manufacturing steps, OPC and PPC cement, Portland cement process flow-sheet diagram, Cement Industry in Nepal.

20. Paper and Pulp (3 TH)

- 20.1 Raw materials, production stages, flow-sheet diagram, paper quality parameters.

21. Nuclear Chemistry and Radioactivity (2 TH)

- 21.1 Natural/artificial radioactivity, units, nuclear fission/fusion, nuclear power/weapons, industrial/medical uses, radiocarbon dating, hazards.

3. Grade 12 Practical Portion (32 Teaching Hours)

List of Experiments

- A. Recovery & Preparation: Blue vitriol crystals from $\text{CuSO}_4 + \text{NaCl}$ mixture; CaCO_3 from dolomite; Hydrated calcium sulphate from marble chips.
- B. Volumetric Analysis (Titration): Prepare primary standard Na_2CO_3 and standardize HCl ; Determine strength of unknown NaOH solution; Double titration of bench H_2SO_4 ; Standardization of KMnO_4 with oxalic acid (Redox titration).
- C. Organic Chemistry Experiments: Detection of N, S, X elements; Identification of functional groups ($-\text{OH}$, $-\text{COOH}$, $-\text{CHO}$, $-\text{CO}-$, $-\text{NH}_2$, $-\text{COO}-$); Tests for carbohydrates, proteins, fats, phenol.
- D. Thermochemistry: Enthalpy of neutralization of strong acid & strong base; Molar enthalpy change of NH_4Cl solution.
- E. Chemical Kinetics: Kinetics of reaction between $\text{Na}_2\text{S}_2\text{O}_3$ and HCl ; Kinetics of reaction between propanone and iodine.
- F. Salt Analysis: Complete qualitative analysis of acid and basic radicals in unknown inorganic salts.
- G. Applied & Analytical Chemistry: Paper chromatography separation of ink components; Titrimetric determination of acetic acid in vinegar; Preparation of Potash alum, Iodoform, Fehling's solution, Tollen's reagent; Isolation of hippuric acid from cow urine.

Sample Project Works (Grade 12)

- Environmental impact report on local industrial/vehicular pollution.
- Field visit/study report on paper manufacturing industry.
- Field visit/study report on cement production industry and setting duration tests.
- Thermal effect study on various synthetic plastics.
- Extraction of essential oils using Clevenger's apparatus.
- Soap preparation using coconut/vegetable oil.
- Casein content determination in various milk samples.
- Foaming capacity comparison of washing soaps and effect of Na_2CO_3 .
- Detection of food preservatives and pesticides in market produce.

