

SYLLABUS

For

B. Sc. 3-Year (General) Degree

Course in Chemistry

(Effective from 2005-2006 Session)



**THE UNIVERSITY OF BURDWAN
RAJBATI, BURDWAN 713 104
WEST BENGAL, INDIA**

THE UNIVERSITY OF BURDWAN

Syllabus for 3-Year Degree Course in Chemistry (General)
(Effective from 2005-2006/2006-2007)

Category A: For students with honours in subjects other than chemistry

Total Marks: 200 (theoretical) + 100 (Practical) = 300

Category B: For pass course students only

Total Marks: 300 (theoretical) + 100 (Practical) = 400

PART I

Theoretical		Marks
Paper I:	Group A: General principles	50
	Group B: Organic	50
Total:		100

Practical 20

Examination will be conducted by the college and marks will be kept for final addition with the Practical Examination of **Part II**.

PART II

Paper II:	Group A: Inorganic	50
	Group B: Physical	50

Total: 100

Practical		Marks
Paper III:	Qualitative (Inorganic + Organic)	65
	Laboratory Note Book	05
	Viva-Voce	10

PART III

For pass course (Category B) students only

Theoretical		Marks
Paper IV:	Chemistry (General)	65
Practical		
Paper V:	Inorganic Quantitative	35
Total:		100

PART I

Paper I

Group A
General Principles

Full Marks: 50

1. Atomic Structure

Bohr's theory: energy and radius calculations for H-like atoms, quantum numbers, Pauli exclusion principle, qualitative introduction of orbitals, shapes of orbitals, electron distribution of elements - Aufbau principle and Hund's rule

2. Radio Activity

Disintegration rate and rate constant, idea of disintegration series, artificial transmutation and artificial radioactivity (introduction only), uses and abuses of radioactivity.

3. Periodic Table

Periodic classification of elements on the basis of electron distribution, s-, p- and d-block elements, connection among valencies, electron distribution and positions of the elements in the long form of the periodic table

4. General Properties of Atoms and Molecules

Electronegativity of atoms and polarity of bonds, variation with position in the periodic table, ionization potential, electron affinity, bond lengths, bond angles and qualitative description of shapes of some simple molecules like CO_2 , SO_2 , H_2O , NH_3 , CH_4 , C_2H_4 , C_2H_2 , C_6H_6

5. Oxidation and Reduction

Electronic concepts, oxidation number, ion-electron method of balancing equations

6. Valence

Electrovalence and covalence, properties associated with these valencies, Fajan's rules, hydrogen bond: intra- and intermolecular, bond strength

7. Chemical Equilibrium

Reversible and irreversible reactions, laws of mass action, equilibrium constant and its determination, equilibrium in homogeneous liquid and gaseous systems, K_p and K_c – their interrelation, Le Chatelier principle

8. Common Ion Effect and Solubility Product

Applications in analytical chemistry

9. Acids and Bases, Buffers

Strengths of acids and bases, ionic product of water, salt hydrolysis, pH and its calorimetric determination, Ostwald dilution law, Henderson equation, neutralization and acid-base indicators, buffers

10. Reaction Intermediates and Reagent

Homolytic and heterolytic cleavage, carbocation, carbanion, free radical, nucleophile, electrophile

11. Elementary Stereochemistry

Optical isomerism, concept of chirality, enantiomers and diastereomers, geometrical isomerism, examples from organic molecules and inorganic complexes

Group B
Organic Chemistry

Full Marks: 50

The processes such as fractional distillation, steam distillation, refluxing, sublimation and other laboratory techniques should be discussed during the preparation of individual compounds.

1. Chemistry of functional groups including reactions, simple valence bond structure and uses, IUPAC nomenclature
2. (a) Simple ideas of organic reaction mechanism, classification of reaction type and reagent type
(b) Simple concept of inductive effect, hyperconjugation, resonance. Alkanes – free radical substitution reaction, alkenes – electrophilic addition reaction, Markwonikoff's rule, peroxide effect, alkenes upto four carbon atoms
3. Halogen derivatives of alkanes, nucleophilic substitution and elimination reaction
4. Primary, secondary and tertiary monohydric alcohols, ethers, carbonyl compounds (aldehydes and ketones) - nucleophilic addition reaction, monocarboxylic acids and their derivatives, acid chlorides, anhydrides, esters and amides
5. Amines - 1°, 2°, 3° and 4°, Kjeldahl's and Duma's methods and principles only. Estimation of nitrogen by Kjeldahl's salts. Unsaturated alcohol: allyl alcohol, unsaturated aldehyde: acrolein, unsaturated acid: acrylic acid, unsaturated ester: methyl acrylate
6. Ethylene glycol, pinacol and glycerol, Pinacol-pinacolone rearrangement
7. Carbohydrates: glucose, fructose and their simple bond structures (mention of ring structure and mutarotation)
8. (a) Lactic acid and tartaric acid
(b) Fumaric acid and maleic acid
(c) Di- and tribasic acids: oxalic, malonic, succinic acids, malic and citric acids
9. Ethyl malonate, ethyl acetoacetate and their synthetic applications
10. Grignard reagents and its application in synthesis of ketones, secondary and tertiary alcohols, acids
11. Modern concept of structure of benzene: Mechanism of aromatic electrophilic substitution reaction, toluene, xylene, halogen derivatives of benzene, benzyl chloride, benzoyl chloride, benzotrichloride
12. (a) Nitrobenzene, dinitrobenzene
(b) Aniline, methyl and dimethyl aniline, benzyl amine
(c) Preparation of benzene diazonium chloride and reactions
13. Phenols, benzyl alcohol, benzaldehyde, acetophenone, benzophenone
14. Benzoic acid and its chloride, anhydride, amide and esters, phenyl acetic acid
15. Salicylic acid, cinnamic acid, sulphanilic acid, phenyl hydrazine, TNT, nitrophenols and picric acid.

PART II

Paper II

Full Marks: 50

Group A
Inorganic Chemistry1. **Coordination Chemistry**

Double and complex salts, Werner's theory, ligands, coordination number

2. A comparative study of the elements belonging to a particular group to be made in brief on the basis of their electron distribution and position in the periodic table. Structures (excluding stereochemistry) and properties of important compounds mentioned to be explained.

Group I: Hydrogen – isotopes and binary hydrides, lithium and its similarities and differences from other alkali metals, diagonal relationship with magnesium, lithium aluminium hydride, Cu, Ag, Au, principles of Ag and Au isolation

Group IIA: Calcium, strontium and barium, hydrolith, calcium cyanamide

Group IIB: Zinc, cadmium and mercury

Group IIIA: Diborane, boron trifluoride, sodium borohydride

Group IVA: Carbon, silicon, tin and lead, principle of isolation of lead, carbide, silicon carbide, silica, sodium silicate. Silica gel, hydrofluorosilicic acid, silicon tetra chloride, glass

Group VA: Nitrogen, phosphorus, arsenic, antimony and bismuth, hydrazine, hydrazoic acid, hydroxyl amine, hyponitrous acid, phosphorus oxyacids (H_3PO_2 , H_3PO_3 , H_3PO_4 , $\text{H}_4\text{P}_2\text{O}_7$ and HPO_3)

Group VIA: Oxygen and sulphur, composition and structure of ozone, oxyacids of sulphur (H_2SO_3 , H_2SO_4 , $\text{H}_2\text{S}_2\text{O}_3$, $\text{H}_2\text{S}_2\text{O}_8$), persulphate

Group VIIA: Fluorine, chlorine, bromine and iodine, oxides and oxyacids of chlorine

Group 0: Rare gases (isolation and uses) with special reference to general fluorides (structure)

3. **Transition Metals**

Group VIB and **Group VIIB:** Chromium, manganese, K_2CrO_4 , $\text{K}_2\text{Cr}_2\text{O}_7$, CrO_2Cl_2 , KMnO_4

Group VIII: Iron, cobalt and nickel, principles of isolation of Ni (excluding details), composition and uses of alloys, steels

Group B
Physical Chemistry

Full Marks: 50

1. **Kinetic Theory of Gases**

Ideal gas equation, derivation from gas laws, van der Waal's equation, continuity of state, critical constants, specific heats and specific ratios. Laws of partial pressures, vapour density and density method of determination of molecular weights, limiting density, abnormal vapour density

2. **Thermodynamics**

First law, reversible and irreversible work, criteria of perfect gas, isothermal and adiabatic expansions, Joule-Thompson effect (derivation excluded)

Thermochemistry: Hess's law and its application

Second law and its elementary interpretation, free energy and entropy

3. Dilute Solutions

Raoult's law of vapour pressure and colligative properties: osmosis, lowering of freezing point, elevation of boiling point, experimental methods of determination of molecular weights of substances in dilute solutions, Van't Hoff 'i' factor and abnormal behaviour of electrolytic solutions

4. Electrochemistry

Electrolytic conduction, transport number (experimental determination excluded), velocity of ions: specific, equivalent and molar conductances, determination of equivalent conductivity of solutions, Kohlrausch's law, strong and weak electrolytes

5. Chemical Kinetics

Order and molecularity of reactions, first and second order reactions, average life period, concept of Arrhenius activation energy

6. Equilibrium in Liquid Mixtures

Steam distillation, Henry's law, Nernst distribution law

7. Catalysis

Catalysis, autocatalysis, catalyst poisons, promoters, elementary treatment of mechanism of catalysts

8. Colloidal State

General classification, general methods of preparation of lyophobic colloids and general properties of colloids, ideas of coagulation, peptization, protective colloids, dialysis, gold number, isoelectric point, Brownian motion

Practical

Paper III

Full Marks: 65

Inorganic Qualitative

Detection of three radicals by analysis of mixture containing not more than three radicals from the following list (insoluble salts excluded)

Silver, lead, mercury, bismuth, copper, cadmium, arsenic, antimony, tin, iron, aluminium, chromium, zinc, manganese, cobalt, nickel, calcium, strontium, barium, magnesium, sodium, potassium, ammonium and their oxides, hydroxides, chlorides, bromides, iodides, sulphates, sulphites, sulphides, thiosulphates, chromates, phosphates, nitrites, nitrates and borates

Organic Qualitative

Detection of elements (N, S, Cl) and any one of the following groups in organic compounds (solid only): $-NH_2$, $-NO_2$, $-CONH_2$, $-OH$, $>C=O$, $-CHO$, $-COOH$

Marks distribution in Inorganic

- | | |
|--|---|
| 1. Physical characteristics | 1 |
| 2. Preliminary tests for basic radicals: | 4 |
| (i) Dry test heating | |
| (ii) Flame test | |

(iii) Borax bead test	
3. Special test for basic radicals: Mn, Cr, Fe, Co, Ni, Cu etc	2
4. Preliminary test for acid radicals:	4
(i) Dil. H_2SO_4	
(ii) Conc. H_2SO_4	
(iii) Conc. $\text{H}_2\text{SO}_4 + \text{MnO}_2$	
(iv) Conc. $\text{H}_2\text{SO}_4 + \text{Cu}$ turnings	
5. Tests for interfering acid radicals: Special test for S^{2-}	4
6. Solubility Tests	3
7. Wet and confirmatory tests for acid radicals: solution preparation, confirmation	4
8. Wet tests for basic radicals: preparation and confirmation	10
9. Conclusion	3

Marks distribution in Organic

1. Physical characteristics	2
2. Detection of elements	6
3. Solubility test and conclusion from solubility test	4
4. Functional group (presence or absence)	14
5. Confirmation	2
6. Conclusion	2

PART III

Paper IV

Full Marks: 65

Chemistry (General)

1. Analytical Chemistry:

- (a) Accuracy and precision in analysis, types of errors, data analysis and curve fitting (linear $Y = mX + C$ type), numerical problems, mean, mode and variant
- (b) Principles of acid-base titration, use of indicators and indicator constant, titration of $\text{Na}_2\text{CO}_3 + \text{NaHCO}_3$ mixture vs HCl using different indicators, estimation of mixture of strong and weak acids, qualitative discussion of salt hydrolysis (no derivation)
- (c) Single electrode potential and emf of a chemical cell, principles of redox titration, use of redox potentials, iodometry, iodimetry, use of $\text{K}_2\text{Cr}_2\text{O}_7$ and KMnO_4 as oxidant (acid, neutral and alkaline media)

2. Soil Chemistry

The composition of soil, sandy clay, shalky, loamy soils, common plant food like nitrate, phosphate and potash and their analysis, pest and its control by natural and synthetic using pesticides

3. Chemistry of Selected Biomolecules

Structural aspects (excluding elucidation and stereochemistry, unless specified) and important function of d/l-sucrose and polysaccharides (starch and cellulose), amino acids (classification, essential amino acids like glycine, alanine, methionine and tryptophan with d/l), proteins (special reference to the peptide bond, action of haemoglobin, idea of

denaturation of proteins, classification and functions of enzymes in general), pyrrole, pyridine, pyrimidine and purine, nucleic acids (DNA and RNA), nucleotide and nucleoside, antipyretics and analgesics like paracetamol and aspirin, sulpha-drug like sulphadiazine, antibiotics like penicillin and chloramphenicol, antiamoebic like metronidazole

4. **Macromolecular Chemistry**

Introduction, definition of macromolecules, natural and synthetic polymers, monomers, polymers, degree of polymerization, simple idea of polymer structure: homopolymer (linear, branched, cross-linked) and copolymer (random, block, graft), polymerization reaction step (growth, addition, ring opening), importance of polymers both natural and synthetic

Number and weight average molecular weights of polymers – significance, structure and use of natural rubber, synthetic rubber (neoprene), synthetic fibres (Nylon 66, poly ester), plastics like polyethylene and PVC, macromolecules and environment

Notes: Duration of the examination hall will be three hours. From each group 5 questions are to be set. Candidates will have to answer any five questions ($5 \times 13 = 65$), taking at least two from each group.

Practical

Paper V

Full Marks: 35

Inorganic Quantitative

- Titration of $\text{Na}_2\text{CO}_3 + \text{NaHCO}_3$ mixture vs HCl using phenolphthalein and methyl orange indicators
- To find the total hardness of water by EDTA titration
- To find the pH of an unknown solution by comparing colour of a series of (HCl solutions + 1 drop of methyl orange) and a similar series of (NaOH solutions + 1 drop of phenolphthalein)
- Estimation of saponification equivalent of a supplied ester/oil
- Titration of ferrous iron by $\text{KMnO}_4/\text{K}_2\text{Cr}_2\text{O}_7$
- Titration of ferric iron by $\text{KMnO}_4/\text{K}_2\text{Cr}_2\text{O}_7$ using SnCl_2 reduction

Notes: Duration of the examination will be 3 hours (for any one of the above experiments). Marks will be divided as follows: Experiment = 25 (Theory = 5, Presentation = 5, Correct calculation = 5, Quality of results = 10), Viva-voce = 5, Note book = 5

Accurate weighing by the students should be avoided. Standard solutions will be supplied. Teachers need not disclose exact strengths of supplied solution to students, but encourage them to perform required calculations by assuming a factor in each case. Examiners will set more than one experiments in the examination and students will perform one drawing card. Properly signed laboratory note book should be a must for the examinee to the practical laboratory where examination will be conducted.