Allied Chemistry-I (for Bot and Zoo)

(Subject code:18UCHA11)

Semester: I Allied: A1 Credits: 4 Hours/W: 4

Objectives:

- To know the structure and properties of compounds
- To understand the concepts of redox system and types of reactions
- To identify the intermolecular forces in different molecules.
- To Study the chemistry of carbon and nitrogen compounds
- To know the synthesis of important amino acids.

Outcome: Students Can

- Identify bonding and structure of organic and inorganic compounds
- Familiar with the acid-base concepts and their applications
- Understand the role of hydrogen bonding and other molecular forces through different applications
- Get the knowledge of different functionalities and their properties
- Assimilate the importance of proteins and amino acids in biological systems.

Unit I: Chemical Bonding 12 hrs

Self Study: Atomic number, mass number, isotopes, electronic configuration of atoms and ions.

1.1.1. Valency and valence electrons

1.2 Electronic theory of valency

1.2.1 Electrovalency- conditions favouring electrovalency-illustration

1.3.2 Electrovalent compounds and their properties

1.4.1 covalency- conditions favouring covalency-illustration

1.4.2 Covalent compounds and their properties

1.5 Coordinate covalency-conditions favouring formation of the bond-illustration

1.6 Transition from electrovalency to covalency

1.6.1 polarisation and polarizability

1.6.2 Fajan's rules-statement and illustration

1.7 Atomic orbitals-Definition-charge cloud interpretation-shapes of s,p and d orbitals

1.8 Overlapping of atomic orbitals-conditions for overlap-types(s-s, s-p, and p-p) with illustrations-sigma and pi overlaps

1.9 hybridisation sp^3 in CH_4, sp^2 in BF_3 and sp in $BeCl_2$.

1.1o Geometry of H_2O and NH_3 molecules-VSEPR theory.

Unit II: Redox systems and analytical chemistry-I **12 hrs**

Self Study: oxidation, reduction, acids and bases.

2.1 Redox systems

2.1.1 Redox reactions in terms of electron transfer

2.2 Oxidation number

2.2.1 Definition

2.2.2 Rules for assigning oxidation number

2.2.3 Calculation of oxidation number

2.2.4 Redox processes in terms of oxidation number

2.2.5 Advantages and disadvantages of the concept

2.3 Acids and bases

2.3.1 Arrhenius concept –illustration

2.3.2 Lowry-Bronsted concept-conjugate acid and conjugate base

2.4 Types of reactions relevant to qualitative analysis

2.4.1 Displacement reaction

2.4.2 Decomposition

2.4.3 Double decomposition

2.4.4 Hydrolysis

2.4.5 Redox reactions

2.4.6 Complex formation (it it compound or complex formations, clarification required)

2.5 Interfering anions and their elimination

2.6 Group reagents and analytical group classification

2.7 Explanation and application of the following principles in qualitative analysis

2.7.1 Solubility and solubility product

2.7.2 Common ion effect

2.7.3 pH

2.7.4 Buffer solutions

UNIT III: Intermolecular forces and properties of liquids **12 hrs**

Self-Study: pure covalent bonds with examples, electro negativity, conductors, insulators, boiling point, melting point

3.1 Polar and non-polar molecules

3.2 Dipole-dipole (Debye) forces, dipole-induced dipole (Keesom) forces, Induced dipole-Induced dipole (London) forces.

3.3 Repulsive forces

3.4 Resultant intermolecular energies

3.5 Hydrogen bonding-Nature of hydrogen bonding-conditions favouring hydrogen bonding-Types of hydrogen bonding-illustrations-impact of hydrogen bonding on melting points, boiling points and solubility.

3.6 Electrolysis

3.6.1 What is electrolysis-strong and weak electrolytes

3.6.2 Mechanism of electrolysis

3.6.3 Electrical units-coulomb, Amphere, Ohm and Volt, defiitop and sympols, usage.

3.6.4 Faradays laws of electrolysis and their importance

3.7 Conductance of electrolytes (conductance can be defined here and 3.7.1 can be removed)

3.7.2 Specific conductance and molar conductance-Units

3.7.3 Variation of equivalent conductance with concentrations

UNIT IV: Aldehydes, Ketones, Acids and Amides **12 hrs**

Self Study: aliphatic compounds, aromatic compounds, Functional group of aldehydes, ketones and amides

4.1 Aliphatic aldehydes and ketones-Nomenclature-General reactions- Formaldehyde- a comparison with other aldehydes of the series.

4.2 Aromatic aldehydes-Reactions of benzaldehyde-benzaldehyde compared with acetaldehyde

4.3 Aromatic ketones-Aceton, acetophenone and benzophenone-distiction

4.4 Aliphatic saturated monocarboxylic acids-Nomenclature, general reactions-comparison of formic acid with other acids of the series.

4.5 Aromatic saturated monocarboxylic acids-distinction between benzoic acid and acetic acid

4.6 Aliphatic amides-nomenclature, general reactions

4.7 Aromatic amides-Distinction between benzaldehyde (benzamide ??) and acetamide.

UNIT V: Amines, Amino acids and Proteins **12 hrs**

Self Study: Functionalities of amino acids and amines, Functionalities of proteins (nitrogen containing compounds)

5.1 Aliphatic monoamines

5.1.1 Nomenclature and classification-Primary, secondary and tertiary amines

5.1.2 General reactions

5.2 Aromatic amine-Aniline

5.2.1 Reactions of aniline

5.2.2 Distinction between aniline and ethylamine

5.3 Amino acids-classification-zwitter ions-isoelectric point-preparation and properties of glycine and alanine

5.4 Proteins-introduction-peptides and polypeptides-partial hydrolysis and terminal residue analysis in the determination of structure of peptides.

NOTE : Course materials will be supplied to the students**.**

Allied Chemistry Practical-I (For BOT and ZOO)

Inorganic qualitative analysis

(Subject code: 18UCHAP11)

Semester : I Allied : AP1 Credit :1 Hours/w :2

Qualitative analysis of a simple salt containing one anion and one cation

Anions : Carbonate, Borate, Fluoride, Oxalate and Phosphate

Cations : Lead, Bismuth, Copper, Cadmium, Cobalt, Nickel, Manganese, Zinc, Barium, Strontium and Ammonium

Note: Laboratory manual will be supplied.

Allied Chemistry-II (for Bot and Zoo)

(Subject code:18UCHA21)

Semester: II Allied: A2 Credits : 4 Hours/W :4

Objectives:

- To understand and correctly use terminology in thermodynamics.
- To describe the composition and properties of colloidal dispersions and surface phenomena
- To distinguish between monosaccharides, disaccharides, and polysaccharides
- To study the special arrangement of atoms in a molecule and know how role of hetero atoms in organic compounds
- To understand the basic concepts of quantitative analysis

Outcome: Students Can

- Explain fundamental thermodynamic properties
- List and explain several technological applications of colloids
- Summarize the roles carbohydrates, alkaloids and terpenoids play in biological systems.
- Figure out how many stereoisomers a compound has, and synthesis of a few heterocyclic molecules.
- Prepare standard solutions and standardize an unknown solution.

Unit-I : Thermodynamics **12 hrs**

Self study: ideal gas, ideal gas equation, homogeneous reactions and heterogeneous reactions, heat.

1.1 Introduction
1.2 Basic terminology and functional concepts
1.2.1 System, boundary and surrounding
1.2.2 Types of systems: open, closed and isolated
1.2.3 Properties of a system: extensive and intensive
1.2.4 State of a system and state variables (or state functions)
1.2.5 Thermodynamic equilibrium
1.2.6 Process and types: Isothermal, adiabatic, isochoric, isobaric, cyclic, reversible, and irreversible- comparison between isothermal and adiabatic processes, reversible and irreversible processes.
1.2.7 Internal energy as a state function- components of internal energy
1.2.8 Work: Thermodynamic concept-types of work
1.2.9 Heat : Thermodynamic concept
1.2.10 Heat and work as path functions

1.3 First law of thermodynamics
1.3.1 Statement of the law of conservation of energy
1.3.2 Mathematical expression of the law
1.4 Application of the law
1.4.1 Heat capacity, specific heat capacity and molar heat capacity of a system
1.4.2 Relation between molar heat capacities of gases
1.5 Enthalpy and enthalpy change
1.5.1 Enthalpy as a state function
1.5.2 Relation between ΔH and ΔE
1.5.3 Enthalpies of reaction, formation and combustion-Definition and illustration- standard state.
1.5.4 Calculation of enthalpy change using Hess law
1.5.5 Bond enthalpies and bond dissociation enthalpies-Definition and illustration using CH_4 as example (Numerical problems not expected)
1.5.6 Spontaneous (natural) process
1.5.7 Entropy-it's meaning of disorder
1.5.8 Gibb's free energy-its meaning as available energy
1.5.9 Criteria for spontaneity

UNIT : II Surface chemistry and Colloidal Chemistry 12 hrs

Self study: Adsorbent, adsorbate, molecular interactions.

2.1 Adsorption chemistry-introduction-definition-distinction from adsorption

2.2 Adsorption and adsorbate-definition and explanation

2.3 Chromatography-introduction

2.3.1 Adsorption chromatography-column chromatography, TLC

2.3.2 Partition chromatography-ascending chromatography

2.3.3 R_f value and its significance

2.3.4 Ion exchange chromatography-gas liquid chromatography (GLC), high pressure liquid chromatography

2.4 introduction-true solution, coarse suspension, colloidal solution

2.4.1 Types of colloidal systems

2.4.2 Classification of colloids-Lyophilic and lyophobic sols-a comparison

2.4.3 Stability of colloids-origin of charge-electrical double layer-salvation

2.4.4 Electrical properties-electrophoresis and electro-osmosis

2.4.5 Gels- gelation-classification-properties of gels-hydration, swelling or inhibition, syneresis and thixotropy

2.4.6 Emulsions-types of emulsion-identification of emulsion-dilution test, dye test, spreading test, viscosity and electrical conductivity-de-emulsification

2.4.7 Application of colloid in food, medicine, industry, purification of water, artificial rain, blue colour of the sky and cleaning action of soap.

UNIT : III Carbohydrates, Alkaloids and Terpenoids 12 hrs

Self study: Examples for food contains carbohydrates

3.1 Introduction

3.1.1 Monosaccharide

3.1.2 Reactions of glucose

3.1.3 Open chain structure and ring structure of glucose (elucidation not expected)

3.1.4 Epimers, mutarotation

3.1.5 Interconversion of glucose into fructose and vice versa

3.2 Disaccharides

3.2.1 Reactions and structure of sucrose (elucidation nor expected)

3.2.2 Structure of maltose and lactose (elucidation not expected)

3.3 Polysaccharide

3.3.1 Starch- amylase and amyl pectin-type of glycosidic linkage

3.3.2 Reaction of starch-action of heat-, hydrolysis and with iodine

3.4 Alkaloids

3.4.1 Definition, classification, (based on structure) occurrence and extraction

3.4.2 General methods of identification-functional nature of oxygen-functional nature of nitrogen-unsaturation-exhaustive methylation

3.4.3 Structure of conine

3.5 Terpenoids

3.5.1 Introduction, classification of terpenoids-Isoprene rule

3.5.2 Structure of citral (synthesis not included)

UNIT : IV Stereoisomerism and Heterocyclic compounds 12 hrs

Self study: Isomers, cyclic compounds, practice to draw the structure of simple molecules like H_2O, NH_3 etc.

4.1 Optical isomerism

4.1.1 Plane polarized light

4.1.2 Optical activity

4.1.3 Asymmetric carbon-chirality

4.1.4 Elements of symmetry-plane of symmetry- axis of symmetry-centre of symmetry-dissymmetric

4.1.5 Van't Hoff-le Bel theory

4.1.6 Optical isomerism of tartaric acid

4.1.7 Racemization

4.1.8 Resolution of racemic-mixture-biochemical method, chemical method and chromatographic method

4.2 Geometrical isomerism

4.2.1 Cause for geometrical isomerism

4.2.2 Illustration of compounds containing C-C double bond

4.3 Heterocyclic compounds

4.3.1 Pyrrole

4.3.2 Introduction-aromatic character

4.3.3 Basic and acidic character of pyrrole

4.4 Pyridine

4.4.1 Electronic interpretation of electron-rich centers

4.4.2 Reaction of pyridine

4.5 Quinoline

4.5.1 Skaraup synthesis

4.5.2 Reactions of quinoline

UNIT : V Analytical Chemistry-II 12 hrs

Self study: Solvent, solute, solution, saturated solution, unsaturated solution, equivalent weight.

5.1 Methods of expressing concentration of solution

5.1.1 Normality

5.1.2 Molarity

5.1.3 Molality

5.1.4 Mole fraction

5.1.5 Equivalent weight of acids, bases, oxidizing agent and reducing agent

5.2 Standard solution-Definition and examples

5.2.1 Primary standard

5.2.2 Secondary standard

5.2.3 Preparation of standard solution

5.3 Principles underlying the following types of titration

5.3.1 Acid-base titration-theory of indicator – why do we use different indicators?

5.3.2 Permanganometry

5.3.3 Dichrometry

5.3.4 Iodometry and Iodimetry

5.3.5 EDTA-complexometry

Note: Course materials will be supplied to the students.

Allied Chemistry Practical-II (For Bot and Zoo)

Inorganic Volumetric Estimations

(Subject Code : 18UCHAP21)

Semester : II **Allied AP2** **Credit : 1** **Hours/W : 2**

S.NO	Estimation	Link	Standard
1	Strong acid	Weak base/ Strong base	Strong acid
2	Strong acid	Strong base	Weak acid
3	Strong base	Strong acid	Weak base
4	Oxalic acid	Potassium permanganate	Oxalic acid
5	Ferrous sulphate	Potassium permanganate	Ferrous ammonium sulphate
6	Potassium dichromate	Ferrous sulphate	Potassium dichromate
7	Ferrous ammonium sulphate	Potassium dichromate	Ferrous sulphate
8	Potassium permanganate	Sodium thiosulphate	Potassium dichromate
9	Magnesium sulphate	EDTA	Zinc sulphate
10	Zinc sulphate	EDTA	Magnesium sulphate

Note: Laboratory manual is supplied.

ALLIED CHEMISTRY 1 (FOR PHYSICS)

SUBJECT CODE:18UCHA31

Semester: III **Core : 1** **Credits : 4** **Hours / W : 4**

OUTCOMES:

- Understanding atomic structure and periodicity
- Appreciating the mystery of existence of atoms together in molecular form
- Enjoying the regularity in solids

- Understanding acids and bases and redox process
- Application of learnt knowledge in practical experiments.

UNIT 1 ATOMIC STRUCTURE AND PERIODIC TABLE 12 hrs

ATOMIC STRUCTURE

1.1 Bohr model of atom
1.2 Atomic spectrum of hydrogen and Bohr theory
1.3 Refinement of the Bohr theory
1.4 Duel nature of electrons - particles or waves
1.5 Quantum numbers and its significance
1.6 Uncertainty principle
1.7 Paul's exclusion principle, Hund's rule
1.8 Periodic table
1.9 Modern periodic table
1.10 Long form of periodic table
1.11 Division of elements into s,p,d and f blocks
1.12 Bohr's aufbau principle- electronic configuration of ground state of atoms up to K(Z=19)
1.13 Trends in atomic properties - Ionization energy, successive ionization energy , electron affinity, electro negativity Pauling, Mulliken and Allred Rochow's scale

UNIT II STRUCTURAL AND CHEMICAL BONDING 12 hrs

2.1 Types of chemical bond
2.2 Electrovalent bond (conditions for formation and associated properties)
2.3 Covalent bond (conditions for formation and associated properties)
2.4 Coordinate covalent bond
2.5 Orbital overlap- s-s, s-p, p-p overlap
2.6 Sigma and pi bond - formation of N_2 and O_2 properties
2.7 Polar and non-polar molecules
2.8 Dipole moment and its applications
2.9 VSPER theory - application to CH_4 , NH_3 and H_2O
2.10 Molecular orbital theory, bonding, antibonding and non-bonding orbitals
2.11 MO diagrams for H_2 , He_2 and O_2 - bond order

UNIT III SOLID STATE AND ENERGETICS 12 hrs

3.1 Macroscopic properties of solids
3.2 Types of characteristics of crystals
3.3 Covalent solids- structure and properties of diamond and graphite

3.4 Ionic crystals solid- NaCl
3.5 Metallic crystals
3.6 Molecular crystals- intermolecular forces
3.7 Metals- free electron theory and bond theory of metallic bond
3.8 Superconductors
3.9 Lattice energy
3.10 Born-Haber cycle
3.11 Law of conversation of energy
3.12 Enthalpy of reactions
3.13 Entropy and Gibbs energy
3.14 Relationship between Gibbs energy and equilibrium

UNIT IV ACID, BASES AND REDOX PROCESSES 12 hrs

4.1 Concept of acids and bases
4.2 Arrhenius concept
4.3 Bronsted- Lowry concept - conjugate acids and bases
4.4 Lewis concept
4.5 Effect of solvents and substituents on relative strengths of acids and bases
4.6 Hydrolysis
4.7 Ionization of water
4.8 pH scale - definition of pOH , pK_a, pK_b - simple numerical problems
4.9 Buffer solution
4.10 Redox processes
4.11 Electronic concept of oxidation and reduction
4.12 Oxidation number- rules
4.13 Calculation of oxidation number of elements in neutral molecules and in ions
4.14 Oxidizing agent and reducing agent
4.15 Balancing ionic equation by oxidation number method

UNIT V PRACTICAL CHEMISTRY-1 12 hrs

5.1 Introduction - acquaintance with chemical laboratory - laboratory equipments - solid reagents, liquid reagents and test papers -laboratory instructions and some don’ts - Bunsen burner (self study)
5.2 Chemistry involved in the analysis of anion and cations
5.3 Dry tests (action of heat, flame test, filter ash test)
5.4 Wet test (with acids , with Na_2CO_3 extract)
5.5 Elimination of interfering anions and preparation of original solutions
5.6 Classification of cations into analytical groups

5.7 Condition for precipitation, application of solubility product and common ion effect in qualitative analysis
5.8 Cleaning
5.9 Soap - reaction with acids and hard water - effect of high temperature
5.10 Chemistry of cleaning - soap micelle - cleaning action of soap
5.11 Dry cleaning - general rules for stain removal - chemicals used for spots and stains from fabrics
5.12 Synthetic detergent and their advantages over soap
5.13 Safety in laboratory
5.14 General safety measures (safety equipment, safety notices, personal protection, dangers to avoid)
5.15 Chemical hazards (corrosive, irritant substances, toxic compounds, flammable explosives)
5.16 Physical hazards (fire, pressure) - fire extinguisher
5.17 Spillage and waste disposal
5.18 First aid (immediate assistance, burns, eye injuries, bleeding, toxic materials) - first aid kit

Note: Course materials will be supplied to the students

ALLIED CHEMISTRY PRACTICAL – I (FOR PHYSICS)
Inorganic qualitative analysis
(Subject Code: 18UCHAP31)

Semester:III **Allied: AP3** **Credit: 1** **Hours/W : 2**

Qualitative analysis of a simple salt containing one anion and one cation

ANIONS: Carbonate, Borate, Fluoride, Oxalate and Phosphate

CATIONS: Lead, Bismuth, Copper, Cadmium, Cobalt, Nickel, Manganese, Zinc, Barium, Strontium and Ammonium

Note: Laboratory manual is supplied

ALLIED CHEMISTRY II (FOR PHYSICS)

SUBJECT CODE: 18UCHA41

Semester : IV **Core : 1** **Credits : 4** **Hours / W : 4**

OUTCOME:

- Learning nomenclature of organic compounds
- Development of knowledge in the area of electromotive force
- Understanding various processes involved in metallurgy
- Knowing application of chemistry in industries
- Development in practical knowledge

UNIT I NOMENCLATURE AND ISOMERISM OF ORGANIC COMPOUNDS 12 hrs

1.1 Nomenclature of organic compounds

1.1.1 Alkane, alkene, alkyne, cycloalkane and alkyl groups

1.1.2 IUPAC names of alcohols, acids, aldehyde and ketones

1.2 Hybridization

1.2.1 Need for the concept of hybridization

1.2.2 sp, sp^2 and sp^3 hybridization with suitable examples

1.3 Isomerism in organic compounds

1.3.1 Structural isomerism- types with example

1.3.2 Stereoisomerism - conformational, geometrical and optical isomerism

1.3.3 Geometrical isomerism - cis and trans nomenclature

1.3.4 Optical isomerism- elemental of symmetry -chirality -optical activity-enantiomers,

diastereomers, mesomer and racemic mixture -optical activity exhibited by lactic acid and tartaric acid

UNIT II ELECTROMOTIVE FORCE 12 hrs

2.1 Introduction

2.2 Requirements of an electrochemical change

2.3 Electrochemical cells - difference between electrolytic and galvanic cells

2.4 Salt bridge

2.5 Electrode potential and standard electrode potential

2.6 Electrochemical series and applications-Anamoly examples such as Al and Fe can be explained,

2.7 Conventions used in electrode representation and in cell representation

2.8 Types of electrodes - description of hydrogen, calomel and glass electrodes -Nernst equation

2.9 Weston cadmium cell

2.10 Experimental determination of a cell emf and determination of electrode potential - simple calculations

2.11 Potentiometric titrations and their advantages- principle and method of acid - base, redox and precipitation titrations

2.12 Determination of pH using hydrogen, glass and quinhydrone electrodes

UNIT III METALLURGICAL PRINCIPLES AND POLYMERS 12 hrs

3.1 Minerals and ores

3.2 Native, sulphide, oxide, carbonate, halide and sulphate ores

3.3 Metallurgy -extraction metals

3.4 Concentration of ores -hand picking, gravity separation, magnetic separation, froth flotation processes and leaching

3.5 Calcination and roasting

3.6 Purification of metals - electrolysis and zone refining method

3.7 Polymers-classification

3.8 Properties of polymers

3.9 Mechanical, physical, thermal, optical, electrical and chemical properties

3.10 Preparation and uses of thermoplastics- polyethylene and PVC

3.11 Preparation and uses of thermosetting plastics - nylon, epoxy resins, bakelite

3.12 Rubber and uses of rubber

3.13 Vulcanization

3.14 Bio-polmers

(A topic on **Conducting polymers** and its application in electronic industry will be beneficial to the students)

UNIT IV INDUSTRIAL CHEMISTRY AND MAGNETO CHEMISTRY 12 hrs

4.1 Silicones - preparation, properties and uses

4.2 Manufacture and types of glass

4.3 Cement - composition, manufacture and setting of cement

4.4 Fuel gases - manufacture, composition and uses of producer gas, water gas, LPG and bio gas

4.5 Softening of water: Ion exchange, electro dialysis and reverses osmosis methods

4.6 Volume, mass and molar susceptibility

4.7 Diamagnetism and temperature independent paramagnetism

4.8 Temperature dependent paramagetism

4.9 Ferro and antiferromagnetism

4.10 Measurements of magnetic susceptibility

4.11 Applications of magnetic susceptibility studies

(Concepts of thermodynamics and crystal structures can be included for Physics students)

UNIT V PRACTICAL CHEMISTRY-II AND SOLVENT EXTRACTION 12 hrs

5.1 Introduction -definition of various terms (titrations, volumetric analysis, titrant indicator, end point -requirements of the reaction selected for the titration -commom types of titration

5.2 Law of equivalence- equivalent weight of acids, bases, oxidizing agents, reducing agents and salts - calculation of molecular weights and equivalent weights

5.3 Requirements of a primary standard

5.4 Secondary standards

5.5 Numerical problems in the preparation of solutions

5.6 Law of normalities- preparation of HCl, H_2SO_4,HNO_3(approximately 0.1N) from standard acids

5.7 Principles behind

5.7.1 Acid base titration - pH verses volume curves, choice of indicates form different acid base titrations

5.7.2 Permanganimetry

5.7.3 Dichrometry-diphenylamine and potassium ferricyanide as indicators

5.7.4 Iodimetry- Preparation of iodine and starch solutions - starch as indicators

5.7.5 Iodometry- role of $KMnO_4$ and $K_2Cr_2O_7$

5.7.6 Solution- Nernst distribution law and solvent extraction -numerical problems

Note: Course materials will be supplied to the students

ALLIED CHEMISTRY PRACTICAL – II (FOR PHYSICS)
Inorganic qualitative analysis
(Subject Code: 18UCHAP41)

Semester: IV **Allied: AP4** **Credit: 1** **Hours/W: 2**

S. No	Estimation	Link	Standard
1	Strong Acid	Weak Base/Strong Base	Strong Base
2	Strong Acid	Strong Base	Weak Acid
3	Strong Base	Strong Acid	Weak Base
4	Oxalic acid	Potassium Permanganate	Oxalic acid
5	Ferrous Sulphate	Potassium Permanganate	Ferrous Ammonium Sulphate
6	Potassium dichromate	Ferrous Sulphate	Potassium dichromate
7	Ferrous Ammonium Sulphate	Potassium dichromate	Ferrous Sulphate
8	Potassium Permanganate	Sodium thiosulphate	Potassium dichromate
9	Magnesium Sulphate	EDTA	Zinc Sulphate
10	Zinc Sulphate	EDTA	Magnesium Sulphate

Note: Laboratory manual is supplied