SEMESTER II

Paper 5-CHHT 203: Physical Chemistry- I

THEORY **Marks: 100**

Unit I: Gaseous state:

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure.

Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.

Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, *Z*, and its variation with pressure for different gases. Causes of deviation from ideal behaviour. van der Waals equation of state, its derivation and application in explaining real gas behaviour, mention of other equations of state (Berthelot, Dietrici); virial equation of state; van der Waals equation expressed in virial form and calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

Unit II: Liquid state:

Qualitative treatment of the structure of the liquid state; Radial distribution function; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases.

Qualitative discussion of structure of water.

Unit III: Solid state:

Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals. Glasses and liquid crystals.

Unit IV: Ionic equilibria:

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di- and tri-protic acids (exact treatment).

Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body.

Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid – base indicators; selection of indicators and their limitations.

Multistage equilibria in polyelectrolyte systems; hydrolysis and hydrolysis constants.

Recommended Texts:

1. Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry* 8th Ed., Oxford University Press (2006).
2. Ball, D. W. *Physical Chemistry* Thomson Press, India (2007).
3. Castellan, G. W. *Physical Chemistry* 4th Ed. Narosa (2004).
4. Mortimer, R. G. *Physical Chemistry* 3rd Ed. Elsevier: NOIDA, UP (2009).

Paper 6-CHHT 204: Analytical Methods in Chemical Analysis

THEORY **Marks: 100**

Unit I : Qualitative and Quantitative aspects of analysis:

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q, and T test, rejection of data, and confidence intervals.

Unit II: Optical methods of analysis:

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument;

Basic principle of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.

Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques.

Structural illustration through interpretation of data, Effect and importance of isotope substitution.

Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, Choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.

Unit III: Thermal method of analysis:

Theory of thermogravimetry (TG), basic principle of instrumentation.

Techniques for quantitative estimation of Ca and Mg from their mixture.

Unit IV: Electro analytical methods:

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence point. Techniques used for the determination of pK_a values.

Unit V: Separation Techniques:

Solvent extraction: Classification and principle and efficiency of the technique.

Mechanism of extraction: extraction by solvation and chelation.

Technique of extraction: batch, continuous and counter current extractions.

Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non aqueous media.

Chromatography: Classification and principle and efficiency of the technique.

Mechanism of separation: adsorption, partition & ion exchange.

Development of chromatograms: frontal, elution and displacement methods.

Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.

Stereo isomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of Enantiomeric composition using NMR, Chiral solvents and chiral shift reagents Chiral chromatographic techniques using chiral columns (GC and HPLC).

Role of computers in instrumental methods of analysis.

Recommended texts:

1. Vogel, Arthur I: *A Test book of Quantitative Inorganic Analysis* (Rev. by GH Jeffery and others) 5th Ed. The English Language Book Society of Longman
2. Willard, Hobert H. *et. al*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, Gary D; *Analytical Chemistry*, 6th Ed. New York- John Willy, 2004.
4. Harris, Daniel C: *Exploring Chemical Analysis*, 2nd Ed. New York, W.H. Freeman, 2001.
5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry* New Age, International Publisher, 2009.
6. SKoog, D.A. Holler F.J. and Nieman, T.A. *Principles of Instrumental Analysis*, Thomson Asia Pvt. Ltd. Singapore.
7. Mikes, O. & Chalmes, R.A. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood Ltd. London.
8. Ditts, R.V. *Analytical Chemistry – Methods of separation*.

Paper 7-LSPT 202-BIOLOGY-II

THEORY **Marks: 100**

Cell and Cellular Processes

Unit 1. Techniques in Biology (Ch 1 Sheeler) (12 Periods)

Principles of microscopy; Light Microscope; Phase contrast microscopy; Fluorescence microscopy; Confocal microscopy; Sample Preparation for light microscopy; Electron microscopy (EM)- Scanning EM and Scanning Transmission EM (STEM); Sample Preparation for electron microscopy; X-ray diffraction analysis

Unit 2. Cell as a unit of Life (Ch 6 Campbell) (10 Periods)

The Cell Theory; Prokaryotic and eukaryotic cells; Cell size and shape; Eukaryotic Cell components

Unit 3. Cell Organelles (Ch 15, 16, 17,18,19,20 Sheeler) (22 Periods)

- **Mitochondria:**
  Structure, marker enzymes, composition; mitochondrial biogenesis; Semiautonomous organelle; Symbiont hypothesis; Proteins synthesized within mitochondria; mitochondrial DNA

- **Chloroplast**
  Structure, marker enzymes, composition; semiautonomous nature, chloroplast DNA

- **ER, Golgi body & Lysosomes**
  Structures and roles. Signal peptide hypothesis, N-linked glycosylation, Role of golgi in O-linked glycosylation. Cell secretion, Lysosome formation.

- **Peroxisomes and Glyoxisomes:**
  Structures, composition, functions in animals and plants and biogenesis

- **Nucleus:**
  Nuclear Envelope- structure of nuclear pore complex; chromatin; molecular organization, DNA packaging in eukaryotes, euchromatin and heterochromatin, nucleolus and ribosome structure (brief).

Unit 4. Cell Membrane and Cell Wall (Ch 7 Campbell / Ch 15 Sheeler / Ch 3 Raven)

(8 Periods)

The functions of membranes; Models of membrane structure; The fluidity of membranes; Membrane proteins and their functions; Carbohydrates in the membrane; Faces of the membranes; Selective permeability of the membranes; Cell wall

Unit 5. Cell Cycle: Interphase, Mitosis and Meiosis (Ch 12, 13 Campbell) (8 Periods)

Role of Cell division; Overview of Cell cycle; Molecular controls; Meiosis

SUGGESTED BOOKS

1. Campbell, N.A. and Reece, J. B. (2008) Biology 8th edition, Pearson Benjamin Cummings, San Francisco.
2. Raven, P.H et al (2006) Biology 7th edition Tata McGrawHill Publications, New Delhi
3. Sheeler, P and Bianchi, D.E. (2006) Cell and Molecular Biology, 3rd edition, John Wiley & sons NY

Paper 8-PHCT 201: Physics-I

THEORY Marks: 100

Unit I :Mathematical Physics: Scalar and vector products, polar and axial vectors, triple and quadruple products.

Unit II:Vector calculus:

Scalar and vector fields, differentiation of a vector, gradient, divergence, curl and Δ operations and their meaning, idea of line, surface and volume integrals, Gauss and Stokes' theorem.

Unit III: Classical Mechanics:

Particle dynamics: Newton's laws of motion, conservation of linear momentum, centre of mass, conservative forces, work energy theorem, particle collision.

Rotational kinematics and dynamics: Rotational motion, forces and pseudo forces, torque and angular momentum, kinetic energy of rotation, rigid body rotation dynamics, moment of inertia, conservation of angular momentum, comparison of linear and angular momentum, motion of a top.

Oscillations: Linearity and superposition principle, free oscillation with one and two degrees of freedom, simple pendulum, combination of two simple harmonic motions.

Lissajous figures, free and damped vibrations, forced vibrations and resonance, Q factor, wave equation, travelling and standing waves, superposition of waves, phase and group velocity.

Unit IV :Wave optics: Interference, division of amplitudes, Young's double split, Fresnel's biprism, interference in thin films and wedged shaped films.

Fresnel diffraction: Diffraction at a single slit and a circular aperture, diffraction at a double split, plane transmission grating, resolving power of a telescope and a microscope, resolving and dispersive power of a plane diffraction grating.

Polarization: Polarization by reflection and refraction, Brewster's law, double refraction, nicol prism, quarter and half-wave plates, Production and analysis of circularly and elliptically polarized light.

Recommended Texts:

1. Spiegel, M. R. *Vector Analysis* Schaum's Outline Series. McGraw-Hill Book Co.: Singapore (1974)
2. Beiser, A. *Concepts of Modern Physics* McGraw-Hill Education (2002).
3. Resnick, R., Halliday, D. & Krane, K. S. Physics Vol. I and II 5th Ed. John Wiley & Sons (2004)
4. Serway, R. A. & Jewett, J. W. *Physics for Scientists and Engineers* 6th Ed.

Paper 5-CHHP 203: Physical Chemistry - I

PRACTICAL **Marks: 50**

(I) **Surface tension measurements** (use of organic solvents excluded).
   a) Determine the surface tension by (i) drop number (ii) drop weight method.
   b) Study the variation of surface tension of detergent solutions with concentration

(II) **Viscosity measurement using Ostwald's viscometer** (use of organic solvents

excluded).

(a) Study the effect of the addition of solutes such as (i) polymer (ii) ethanol (iii) sodium chloride on the viscosity of water at room temperature.

(b) Study the effect of variation of viscosity of an aqueous solution with the concentration of solute.

(III) **pH measurements**

b) Measurement of pH of different solutions using pH-meter.

c) Preparation of buffer solutions

(i) Sodium acetate-acetic acid

(ii) Ammonium chloride-ammonium hydroxide

Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

d) pH metric titrations of

(i) strong acid and strong base

(ii) weak acid and strong base

Any other experiment carried out in the class.

Paper 6-CHHP 204: Analytical Methods in Chemical Analysis

PRACTICAL Marks: 50

Separation Techniques

1. Chromatography:

(a) Separation of mixtures

(i) Paper chromatographic separation of Fe^{3+}, Al^{3+}, and Cr^{3+}

(ii) Separate and identify the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography.

Report the R_f values.

(b) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their R_f values.

(c) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC

2. Solvent Extractions:

(i) To separate a mixture of Ni^{2+} & Fe^{3+} by complexing with DMG and extracting

the Ni^{2+} DMG complex in chloroform, and determine its concentration with spectrophotometry.

(ii) Solvent extraction of zisconium with amberliti LA-1, separation from a mixture of irons and gallium.

3. Determine the pH of given aerated drinks fruit juices, shampoos and soaps.

4. Determination of Na, Ca, Li in cola drinks and fruit juices using fame photometric techniques.

5. Analysis of soil:

   (i) Determination of pH of soil.

   (ii) Total soluble salt

   (iii) Estimation of calcium, magnesium, phosphate, nitrate

6. Ion exchange:

   (i) Determination of exchange capacity of cation exchange resins and anion exchange resins.

   (ii) Separation of metal ions from their binary mixture.

   (iii) Separation of amino acids from organic acids by ion exchange chromatography.

7. Determination of pK_a values of indicator using spectrophotometry.

8. Structural characterization of compounds by Infra-Red spectroscopy.

9. Determination of dissolved oxygen in water.

10. Determination of chemical oxygen demand (COD).

11. Determination of Biological oxygen demand (BOD).

Paper 7- LSPP 202-BIOLOGY-II

PRACTICALS **Marks: 50**

1. To study prokaryotic cells (bacteria), viruses, eukaryotic cells with the help of light and electron micrographs.
2. Study of the photomicrographs of cell organelles
3. To study the structure of plant cell through temporary mounts.
4. To study the structure of animal cells by temporary mounts-squamous epithelial cell and nerve cell.
5. Preparation of temporary mounts of striated muscle fiber
6. To prepare temporary stained preparation of mitochondria from striated muscle cells /cheek epithelial cells using vital stain Janus green.
7. To prepare temporary stained squash from root tips of *Allium cepa* and to study the various stages of mitosis.
8. Study the effect of temperature, organic solvent on semi permeable membrane.
9. Demonstration of dialysis of starch and simple sugar.
10. Study of plasmolysis and deplasmolysis on *Rhoeo* leaf.
11. Measure the cell size (either length or breadth/diameter) by micrometry.
12. Study the structure of nuclear pore complex by photograph (from Gerald Karp)

Paper 8- PHCP 201-PHYSICS-I

PRACTICALS **Marks: 50**

Each student is expected to do at least 3 experiments each from Group A and Group B.

Group A experiments

A-1. Determination of spring constant of a spring by (i) static, and (ii) dynamic methods.

A-2. Study of damped harmonic oscillator- Q factor.

A-3. Determination of temperature coefficient of resistance using platinum resistance thermometer.

A-4. Study of thermal couple calibration and inversion temperature.

A-5. LCR study of resonance Q-factor.

A-6. Kator's pendulum- Bar pendulum.

Group B experiments

B-1. Determination of wavelength of light by Fresnel's biprism.

B-2. Determination of wavelength of sodium light by Newton's arrangement.

B-3. Determination of refractive index of tint glass using a spectrometer.

B-4. Determination of dispersive power of a glass prism using Cauchy's constant. Also determine the resolving power of a prism.

B-5. Determination of wavelength of sodium light using a plane transmission grating and resolving power of a diffraction grating.

B-6. Determination of specific rotation of cane sugar solution using a polarimeter.