St. Xavier's College – Autonomous Mumbai

Syllabus for 1st Semester Course in CHEMISTRY(June 2014 onwards)

Contents: Theory Syllabus for Courses:

SYLLABUS UNDER AUTONOMY
CHEMISTRY

SEMESTER I **COURSE: S.CHE.1.01**

CONCEPTS OF PHYSICAL AND ANALYTICAL CHEMISTRY I [45 LECTURES]

LEARNING OBJECTIVES

1. To understand mole concept, concentration calculations and stoichiometric relations.
2. To apply inter – conversions to relate various concentration units.
3. To differentiate between primary and secondary standards.
4. To understand the importance of accuracy, precision, errors and its sources, presentation of experimental data and significant figures.
5. To understand the behaviour of fluids and study the physical phenomena involved.
6. To understand the statistical methods of representing experimental data.
7. To understand the kinetics of various order reactions and apply these concepts to various categories of catalysed reactions.

Unit I: Introduction to Analytical Chemistry and its interdisciplinary nature (15 L)

1.1: Chemical Calculations and Stoichiometry

1.1.1: Moleconcept, determination of molecular massby gram molecular volume relationship for chemicalreactions, problemsbased on mole concept.

1.1.2: Methods of expressing concentration of solutions: molarity, normality,molality,mole fraction,formality, dilution of solutions, inter-conversion between different concentration units, conceptof milliequivalents, millimoles, ppm and ppb.

1.1.3: Analysis of Commercial Samples: Calculation of concentration of commercial samples of acidsand bases like HCl, H_2SO_4, acetic acid and ammonia.

1.1.4: Gravimetric and Volumetric analysis: use of digital balance, calibration of glassware, pipette, burette and volumetric flask, primary and secondary standards.

1.1.5: Importance of accuracy, precision and sources of error in analyticalmeasurements, presentation of experimental data and results from the point of view of significant figures.

Unit II: Study of Fluids (15 L)

2.1:Behaviour of Real Gases (9 L)

2.1.1: Recapitulation of ideal behaviour of gases, deviations from ideal gas behaviour, compressibility factor - Z and its variation with pressure for different gases. Causes of deviation from ideal behaviour.

2.1.2: Van der Waal's equation of state, its derivation and application in explaining real gas behaviour(Mention of other equations of state: Berthelot, Dietrici).

2.1.3: Isotherms of real gases and their comparison with Van der Waal's isotherms, continuity of states,critical state, experimental determination of Pc, Tc and Vc,critical constant ofgas in terms of Van der Waal's constant.

2.2: Physical properties of Liquids (6 L)

2.2.1: Measurable physical properties of liquid such as vapour pressure, surface tension and viscosity.

2.2.2: Experimental determination of vapour pressure, surface tension and coefficient of viscosity (one method of each), effect of addition ofvarious solutes on surface tension and viscosity.

2.2.3: Temperature variation of viscosity of liquids and comparison with that of gases.

Unit III: Kinetics and Catalysis (15 L)

3.1: Kinetics (10 L)

3.1.1: Graphical representation of equations:Co-relation between mathematical functions and shapes of the graph, rules for drawing graph co-ordinates etc., equation of straight line, slope and intercept, plotting the graph from the data of chemical properties, determination of equation of line of best fit (method of averages and least squares) for y = mx only and problems.

3.1.2: Recapitulation of basic concepts**:** Rate law, specific rate constant, comparison between order and molecularity with examples, integrated rate equations for zero and firstorder reactionsand their half life (no derivations), numerical problemsexpected.

3.1.3: Second order reaction:Derivation of integrated rate equation (for equal and unequal concentration of reactants), characteristics of second order reactions with suitable examples, effectof temperature on rate of reaction (no derivation expected for Arrhenius equation).

3.2: Catalysis (5 L)

3.2.1: Catalyst and catalysis, positive and negative catalysis, type of catalysis,characteristics of catalytic reactions, promoters, catalytic poisoning,autocatalysis.

3.2.2: Activation energy and catalysis,theories ofcatalysis, active centre on catalyst surface, adsorption theory and catalytic activity **(theoretical aspect only).**

3.2.3: Acid – Base catalysis (**theoretical aspect only**) and its applications in industry.

3.2.4: Enzyme catalysis,mechanism of enzyme catalysis, characteristics ofenzyme catalysis, effect of temperature on enzyme catalysis (**qualitative approach only**), applications.

REFERENCES:

1. Principles of Physical Chemistry,4th edition by S.H. Marron and C.F.Pruton.
2. Textbook of Physical Chemistry, Samuel Glasstone.
3. Physical Chemistry, Ira Levine, 5th Edition, 2002 Tata McGraw Hill Publishing Co. Ltd. [Chapter 4,14].
4. Physical Chemistry, G.M. Barrow, 6th Edition, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
5. Physical Chemistry 9th Ed.,Atkins, P. W. & Paula, J. de Atkins Oxford UniversityPress2011.
6. University Chemistry, Bruce Mahan.
7. Textbook of Physical Chemistry, Sharma and Puri.
8. Fundamentals of analytical chemistry, 8th edition, Skoog, West, Holler and Crouch.
9. Physical Chemistry, 3rd Ed., Ball, D. W. Cengage India.2012.
10. *Physical Chemistry 4th Ed.,* Castellan, G. W. Narosa 2004.
11. *Chemical Kinetics*, J. LaidlerK. Pearson Education: New Delhi 2004.
12. Rogers, D. W. *Concise Physical Chemistry* Wiley 2010.

CIA I: Short answer questions and cross-word **20 MARKS**

CIA II: MCQ **20 MARKS**

Template of Question Paper

CONCEPTS OF PHYSICAL AND ANALYTICAL CHEMISTRY I COURSE: S.CHE.1.01

OBJECTIVES

UNIT	KNOWLEDGE	UNDERSTANDING	APPLICATION	TOTAL MARKS
I	4	4	12	20
II	6	8	6	20
III	3	7	10	20
TOTAL MARKS PER OBJECTIVE	13	19	28	60
% WEIGHTAGE	22	32	46	100

END SEMESTER PAPER PATTERN:

Total Marks: 60 **Maximum Time: 2 hours**

Total number of questions: 3 [all compulsory] of 20 marks each
1 question per unit.
Question set out of 30 marks[50% internal choice]
Sub questions will not exceed 5 marks.

SEMESTER I **COURSE: S.CHE.1.02**
FUNDAMENTALS OF INORGANIC AND ORGANIC CHEMISTRY I [45 LECTURES]

LEARNING OBJECTIVES

1. To reinforce the basics of Inorganic Chemistry with special reference to atomic structure, periodic table and periodicity of properties.
2. To study the chemistry of the 's' block elements with emphasis on physical and chemical properties.
3. To understand the anomalous behaviour of Lithium and Berylium and the diagonal relationship.
4. To study the trends of properties of the 'p' block elements.
5. To understand Group 18 elements.
6. To understand the principles and theory in Qualitative Analysis of a mixture of radicals especially when they interfere with each other in the detection.
7. To correctly name an organic compound using IUPAC nomenclature and to accurately represent an organic compound given a IUPAC name.
8. To introduce mechanism of organic reactions and to learn to classify reaction types and intermediates.
9. To investigate nucleophilic substitution as well as elimination reactions in detail including a comparative analysis.

UNIT I: Fundamentals of Inorganic Chemistry and Chemistry of s-block elements (15L)

1.1:Atomic Structure (3L)

Bohr's theory of Hydrogen atom, wave theory, Heisenberg's Uncertainty Principle, orbitals (shapes of s,p and d orbitals), quantum numbers.

1.2: Periodic Table and Periodicity of properties (3L)

Arrangement of elements in the long form of the periodic table, correlation of classification of elements into s, p, d and f-block on the basis of electronic configuration, Pauli's Exclusion Principle, Aufbau Principle and Hund's Rule of maximum multiplicity, anomalies in electronic configuration.

1.3: Periodic Properties (4L)

1.3.1: Atomic and ionic radii, ionization energy, electron affinity, effective nuclear charge and calculations using Slater's Rule, electronegativity and its determination using Mulliken's and Pauling's method (numerical problems expected), metallic and non-metallic character, oxidation states, melting / boiling points, colour, magnetic properties, polarizability.
1.3.2: Trends in the periodic table and applications in predicting and explaining chemical behaviour.

1.4: Chemistry of 's' block (Groups 1 and 2) (5L)

1.4.1: Position of elements in the periodic table, electronic configuration, trends in the properties with respect to family relationship, physical and chemical properties, ionization potential (charge to size ratio), electronegativity, polarizing power, oxidation state, hydration energy of ions.
1.4.2: Anamolous behaviour of Li and Be and diagonal relationship.

1.4.3: General methods of preparation of organolithium and organomagnesium compounds with applications.

UNIT II: Chemistry of 'p' block and Group 18 elements and theory of Qualitative Analysis **(15L)**

2.1: Chemistry of 'p' block elements **(4L)**

Position of elements in the periodic table, electronic configuration, trends in periodic properties with respect to family relationship, physical and chemical properties, ionization potential (charge to size ratio), electronegativity, oxidation state and metallic character.

2.2: Chemistry of Group 18 **(3L)**

History, peculiar properties of Helium, clathrate compounds, preparation of Xenon compounds.

2.3: Principles involved in Qualitative Analysis **(8L)**

2.3.1: Use of borax, sodium carbonate, cobalt nitrate, hydrogen sulphide and ammonium chloride in qualitative analysis.

2.3.2: Detection of the following acid radicals in presence of each other: carbonate, sulphite, chloride, bromide, iodide, nitrite and nitrate.

UNIT III: Fundamentals of Organic Chemistry **(15L)**

3.1: IUPAC nomenclature: ALIPHATIC system only (including cyclic systems) with multiple functional groups. **(2L)**

3.2: Geometry and structure of sp^3, sp^2 and sp hybridized carbon, nitrogen and oxygen atoms and some common functional groups eg. carbonyl and cyano. **(2L)**

3.3: Applications of electronic factors **(4L)**

3.3.1: Impact of inductive effect on pK_a and pK_b.

3.3.2: Resonance in organic compounds.

3.3.3: Hyperconjugation and effect on stability of carbocation and carbon radicals.

3.4: Reaction Mechanism **(7L)**

3.4.1: Introduction including bond fission, classification of reactions, reagents and intermediates .

3.4.2: Structure and stability of carbocations, carbanions and carbon radicals.

3.4.3: Mechanism of nucleophilic substitution, SN_1, SN_2 and SN_i. Effect of substrate, nucleophile, leaving group and solvent on rate of reaction.

3.4.4: Elimination Reactions E_1 and E_2.

3.4.5: Rearrangements of intermediates [hydride and methyl shift].

3.4.6: Elimination v/s Substitution, emphasis on factors that influence substitution / elimination.

REFERENCES:

1. Organic Chemistry, R.T. Morrison and R.N. Boyd, 6th Edition, Pearson Education.
2. Organic Chemistry, T.W.G. Solomon and C.B. Fryhle, 8th Edition, John Wiley & Sons.

3. Organic Chemistry, Paula Y. Bruice, Pearson Education, 2008.
4. Organic Chemistry, John McMurray
5. Organic Chemistry, L.G.Wade Jr.,
6. Concise Inorganic Chemistry, J.D. Lee, 5th edition, Oxford Press.
Advanced Inorganic Chemistry, Volume I, S.Prakash, G.D. Tuli, S.K.Basu, R.D.Madan.
7. Advanced Inorganic Chemistry, F. A. Cotton and G. Wilkinson, 3rd edition, 1977.
8. Inorganic Chemistry, James E. Huheey, 3rd edition, Harper & Row Publishers, Asia, Pte Ltd., 1983.
9. Inorganic Chemistry, D. F. Shriver, P. W. Atkins and C. H. Langford, 3rd edition, Oxford University Press,1999.
10. Theoretical Inorganic Chemistry, C. M. Day & J. Selbin, Affiliated East West Press Pvt. Ltd., 1985.
11. Advanced Inorganic Chemistry, Volume I and II, Bahl, Tuli and Anand.

CIA I: Objective and short answer questions **20 MARKS**

CIA II: MCQ **20 MARKS**

Template of Question Paper

FUNDAMENTALS OF INORGANIC AND ORGANIC CHEMISTRY I COURSE:S.CHE.1.02

OBJECTIVES

UNIT	KNOWLEDGE	UNDERSTANDING	APPLICATION	TOTAL MARKS
I	10	06	04	20
II	10	06	04	20
III	04	08	08	20
TOTAL MARKS PER OBJECTIVE	24	20	16	60
% WEIGHTAGE	40	33	27	100

END SEMESTER PAPER PATTERN:

Total Marks: 60 **Maximum Time: 2 hours**

Total number of questions: 3 [all compulsory] of 20 marks each
1 question per unit.
Question set out of 26-28 marks with internal choice.
Sub questions of 2-3 marks.

PRACTICAL CHEMISTRY **Course No. S.CHE.1.PR**

LEARNING OBJECTIVES:

1. **To learn to perform experiments that have specific aims with correct techniques.**
2. **To develop skills of observation, recording and analyzing data.**
3. **To learn to present the experimental work in a systematic manner.**

SEMESTER I : COURSE 1
Volumetric Estimations
Chemical Kinetics

SEMESTER I : COURSE 2
Organic Purification
Gravimetric Estimation

COURSE 1:

VOLUMETRIC ESTIMATIONS:
Determination of percentage composition of a mixture of Na_2CO_3 + $NaHCO_3$.
Determination of percentage composition of a mixture of Oxalic acid + Potassium oxalate.
Estimation of Fe^{2+} versus $K_2Cr_2O_7$ using an internal indicator (diphenylamine).

CHEMICAL KINETICS:
1. To investigate the hydrolysis of methyl acetate in HCl and identify the rate constant graphically as well as by calculations.
2. To identify the relative strength of HCl and H_2SO_4 using hydrolysis of methyl acetate.

COURSE 2:

ORGANIC PURIFICATION :
1. Organic compounds to be purified by crystallization using water and aqueous alcohol as solvent system , purity to be confirmed by melting point and the yield obtained to be calculated.
2. Determination of mixed melting point also to be included.

GRAVIMETRIC ESTIMATION:
1. To study the effect of heat on the following mixtures:
   a) NH_4Cl + $BaSO_4$ and b) Na_2CO_3 + $NaHCO_3$
   and to calculate the percentage composition of the mixture.
2. To determine the water of crystallization of hydrated salts

❖ **CIA AND END SEMESTER PRACTICAL EXAMINATION**

COURSE 1: Volumetric Estimations + Organic Purification
COURSE 2: Chemical Kinetics + Gravimetric Estimation

Journal: 5 marks per course.

CIA : 15 marks per course.

Duration: 3 periods to be conducted during regular practicals by the faculty-in-charge
CIA for each course will be an exercise to test a practical skill (Qualitative and Quantitative).

End Semester Examination: 30 marks per course. This includes a 5 mark written test based on the theory behind all the experiments conducted per course.

Duration: 3 hours. Students are to perform two experiments **(one per course).**

Batch Size: Maximum 20 students per batch.

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