St. Xavier's College – Autonomous Mumbai

Syllabus for 2nd Semester Course in CHEMISTRY(June 2014 onwards)

Contents: Theory Syllabus for Courses:

SYLLABUS UNDER AUTONOMY
CHEMISTRY

SEMESTER II **COURSE: S.CHE.2.01**

CONCEPTS OF PHYSICAL AND ANALYTICAL *CHEMISTRY* II [45 LECTURES]

LEARNING OBJECTIVES

1. To study and understand the tenets of thermodynamics pertaining to First and Second Laws of thermodynamics.
2. To understand operation of Carnot cycle in order to determine thermodynamic efficiency.
3. Significance and mathematical definition of entropy.
4. To understand limitation of Second Law/ Necessity to introduce work functions A and G.
5. To correlate free energy change and spontaneity of a process.
6. To understand and be able to elucidate the difference between molecular and atomic spectra and understand various types of spectroscopy.
7. To understand the basic concepts involved in qualitative analysis and solve the numerical problems based on these concepts.
8. To understand the fundamentals involved in various titrimetric analysis.

Unit I: Chemical Thermodynamics (15 L)

1.1.1: Recapitulation of some important mathematical concepts: derivatives, rules of differentiation and partial differentiation, algebraic, logarithmic and exponential functions. Integration; rules of integration, algebraic and exponential functions. ***(Self Study)***

1.1.2: Intensive and extensive properties, state and path functions, isolated, closed and open systems, zeroth law of thermodynamics (definition only).

1.1.3: First Law of thermodynamics: Definition, relation and comparison between heat capacities, calculations of *q*, *w*, *E* and *H* for reversible, irreversible and free expansion of ideal gases under isothermal and adiabatic conditions, limitations of first law and need for introducing new functions. (numerical problems expected)

1.1.4: Second Law of thermodynamics: Carnot cycle, mechanical efficiency, entropy changes for system and surroundings for reversible and irreversible processes, entropy changes for an ideal gas in isothermal, isobaric and isochoric processes, entropy changes in chemical reactions, entropy changes accompanying state change, physical significance of entropy, need for introducing new functions. (numerical problems expected)

1.1.5: Free Energy Functions: Gibbs and Helmholtz energy; variation of *G* and *A* with *P*, *V* and *T*; Gibbs energy change and spontaneity, exergonic and endergonic reactions, Gibbs-Helmholtz equation, thermodynamic equation of state. (numerical problems expected)

Unit II: Introduction to Spectroscopy (15 L)

2.1.1: Physical quantities and their dimensions: International system of units, derived units, subsidiary units, prefixes for S.I. units, some important conversion factors.

2.1.2: Interaction of low energy radiation with matter: Electromagnetic spectrum, quantisation of energy, absorption of radiation, absorption process, absorbance, transmittance, Beer's law, absorption spectrum, atomic absorption, molecular absorption, limitations of Beer's Law, Beer - Lambert's Law and its applications.

2.1.3: Emission of electromagnetic radiation: Emission spectra, line spectra, band spectra, continuous spectra, effect of concentration on line and band spectrum, emission by fluorescence and phosphorescence (introduction only), electronic, vibrational and rotational energy levels and transitions in atoms and molecules.

2.1.4: Electronic Spectra and Molecular Structure: Kinds of transitions, significance and applications of various types of spectroscopies (qualitative discussion only).

Unit III: Analytical Chemistry (15 L)

3.1: Principles of Qualitative Analysis (9 L)

3.1.1: Buffer solutions: types of buffers, derivation of Henderson–Hesselbelch equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry (numerical problems expected).

3.1.2: Solubility product, factors affecting precipitation equilibria (solubility product) in qualitative analysis: common ion effect, pH, complexation, diverse ion effect, oxidation states (numerical problems expected).

3.2: Volumetric Analysis (6 L)

3.2.1: Classification of volumetric analysis (basic concepts only) (1 L)

3.2.2: Acid base (neutralisation) titrations: (1 L)

Theory of indicators, theory of acid base indicators, mixed and universal indicators, explaination of the shapes of neutralisation curves for strong acid - strong base, weak acid - strong base, weak base - strong acid, weak acid - weak base, choice of indicators (numerical problems expected).

3.2.3: Oxidation-Reduction Titration: (1 L)

Principle and only theoretical discussion (using suitable examples), detection of end points, numerical problems.

3.2.4: Complexometric Titration: (1 L)

Principle (using suitable examples), standardisation, detection of end point.

3.2.5: Iodometry and Iodimetry: (1 L)

General discussion, detection of end point, difference between iodometry and iodimetry.

3.2.6: Precipitation Titration: (1 L)

Principle and only theoretical discussion (using suitable examples), detection of end point.

REFERENCES:

1. Mathematical preparation for physical Chemistry By F. Daniel, Mc. Graw Hill publication.
2. University General Chemistry. By C.N. R. Rao Mc. Millan Publication.
3. Principles of Physical Chemistry. By Maron and Pruton 4th Ed. Oxford and IBH publication.
4. Physical Chemistry. By G.M. Barrow.
6. Peter, A. & Paula, J. de. *Physical Chemistry 9th Ed.,* Oxford University Press 2011.
7. Castellan, G. W. *Physical Chemistry 4th Ed.,* Narosa 2004.
8. Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall 2012.
9. McQuarrie, D. A. & Simon, J. D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.: New Delhi 2004.
10. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. *Commonly Asked Questions in Thermodynamics.* CRC Press: NY 2011.Page **19** of **80**
11. Levine, I .N. *Physical Chemistry 6th Ed.,*Tata Mc Graw Hill 2010.
12. Metz, C.R. *2000 solved problems in chemistry,* Schaum Series 2006.

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

CIA II: MCQ **20 MARKS**

Template of Question Paper

CONCEPTS OF PHYSICAL AND ANALYTICAL *CHEMISTRY* II **COURSE: S.CHE.2.01**

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 26-28 marks with internal choice.
Sub questions of 2-3 marks.

SEMESTER II **COURSE: S.CHE.2.02**

FUNDAMENTALS OF INORGANIC AND ORGANIC CHEMISTRY II [45 LECTURES]

LEARNING OBJECTIVES:

1. To understand some characteristic properties of elements of groups 13 to 17.
2. To study the chemistry of representative elements of groups 13 [aluminium] and 14 [silicon].
3. To understand some properties of a few selected compounds of groups 15,16 and 17.
4. To introduce manufacturing processes of bulk chemicals [ammonia and sulphuric acid].
5. To understand the concept of isomerism, and represent the structures of organic compounds
6. To study properties of unsaturated hydrocarbons.
7. To study the reactivity of various aliphatic organic compounds and their interconversions in 5 – 6 steps.

UNIT I: CHEMISTRY OF p-BLOCK ELEMENTS (15 L)

1.1: Group 13 **(3 L)**

1.1.1: Structures of electron-deficient compounds with reference to boron hydrides, inert pair effect.

1.1.2: Chemistry of Aluminium compounds – halides, oxides and alkyls.

1.2: Group 14 **(3L)**

1.2.1: Catenation and allotropy with special reference to carbon.

1.2.2: Chemistry of silicon, preparation and uses of silicones.

1.3: Groups 15 and 16 **(6L)**

1.3.1: Physical properties of hydrides of elements of groups 15 and 16 with respect to hydrogen bonding.

1.3.2: Manufacture of bulk chemicals - ammonia by Haber's process and sulphuric acid by Contact process [principles, reactions and flow chart expected].

1.4: Group 17 **(3L)**

1.4.1: Pseudohalogen chemistry with respect to comparison with halogens, preparation and uses- cyanogens, thiocyanogens and selenocyanogens.

UNIT II: STEREOCHEMISTRY AND HYDROCARBON CHEMISTRY (15L)

2.1: Stereochemistry

2.1.1: Isomerism: Types of isomerism; structural isomerism (chain , position and functional) and stereoisomerism. **(1L)**

2.1.2: Chirality: Configuration, chirality and enantiomers, stereogenic / chiral centre, asymmetric carbon atom, representation of configuration by flying wedge formula and projection formulae - Fischer, Newmann and Sawhorse. **(2L)**

2.1.3: Stereochemistry of carbon compounds with one and two similar and dissimilar asymmetric carbon atoms, enantiomers, diastereomers and racemic mixtures and their properties; threo, erythro and meso isomers. **(2L)**

2.1.4: Geometrical isomerism due to restricted rotation around carbon – carbon double bond and cycloalkanes [disubstituted 3- and 4-membered cycloalkanes], E-Z nomenclature. **(2L)**

2.1.5: Conformations; difference between conformation and configuration, conformations of ethane, propane and n-butane. **(2L)**

2.2: Hydrocarbon Chemistry

2.2.1: Alkanes - mechanism of halogenation. **(1L)**

2.2.2: Reactions of alkenes and cycloalkenes: hydrogenation, halogenation, addition of HX – Markovnikov and anti- Markovnikov additions with mechanism. **(2L)**

2.2.3: Reactions of alkadienes – Diels-Alder reaction and 1,2- and 1,4- addition of X_2 [mechanism is not expected] **(1L)**

2.2.4: Reactions of alkynes: hydration, addition of HX, selective hydrogenation to cis- and trans- alkenes, acidity of terminal alkynes, preparation of metal acetylides and their alkylation. **(2L)**

UNIT III: FUNCTIONAL GROUP CHEMISTRY (15 L)

3.1: Reactions of alkyl halides with: aqueous alkali, alcoholic alkali (dehydrohalogenation), potassium cyanide, conversion of alkyl cyanide further to primary amine and carboxylic acid, ammonia, silver salt of carboxylic acid, sodium alkoxide, Wurtz reaction. **(4L)**

3.2: Reactions of alcohols with sodium metal, dehydration, esterification, oxidation of primary, secondary and tertiary alcohols. **(2L)**

3.3: Reactions of aldehydes and ketones:

a) Addition to carbonyl compounds:
i) HCN and ii) $NaHSO_3$

b) Condensation reaction with hydroxylamine

c) Oxidation with acidic $K_2Cr_2O_7$ and PCC

d) Reduction of aldehydes and ketones:
i) catalytic reduction ii) Clemmensen reduction iii) reduction with $LiAlH_4$ and $NaBH_4$
iv) Wolff - Kishner reduction **(4L)**

3.4: Reactions of carboxylic acids: Formation of salt [comparative 'acidity'], anhydride, amide, acid halide, ester and alkane. **(2L)**

3.5: Reactions of amines: Acetylation of amines with acetic anhydride and acetyl chloride, action of nitrous acid on primary / secondary / tertiary amines, alkylation of primary / secondary / tertiary amines yielding quaternary ammonium salts. **(3L)**

Note : Each reaction should be studied with respect to compounds upto 6 carbon atoms. Based on these and the reactions of alkanes, alkenes and alkynes, multi-step synthesis of compounds having one functional group are expected, the number of carbon atoms in each being not more than six. No mechanisms are expected.

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.
7. Advanced Inorganic Chemistry, Volume I, S.Prakash, G.D. Tuli, S.K.Basu, R.D.Madan.
8. Advanced Inorganic Chemistry, F. A. Cotton and G. Wilkinson, 3rd edition, 1977.
9. Inorganic Chemistry, James E. Huheey, 3rd edition, Harper & Row Publishers, Asia, Pte Ltd., 1983.
10. Inorganic Chemistry, D. F. Shriver, P. W. Atkins and C. H. Langford, 3rd edition, Oxford University Press,1999.
11. Theoretical Inorganic Chemistry, C. M. Day & J. Selbin, Affiliated East West Press Pvt. Ltd., 1985.
12. 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 II **COURSE: S.CHE.2.02**

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.2.PR**

LEARNING OBJECTIVES:

1. **To learn to perform experiments that have specific aims with the 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 II: COURSE 3

Physico-Chemical Exercises
Commercial Analysis

SEMESTER II: COURSE 4

Organic Preparations
Semi-micro Inorganic Qualitative Analysis

COURSE 3:

VISCOMETRY:
To determine co-efficient of viscosity of some organic liquids.

STALAGMOMETRY:
Determination of Surface Tension of some organic liquids.

SEMI-MICRO INORGANIC QUALITATIVE ANALYSIS:
Inorganic mixtures containing four radicals, 2 cations and 2 anions.
Preliminary dry tests, preparation of solution for analysis and wet tests for confirmation of the presence of the radicals.

COURSE 4:

ORGANIC PREPARATIONS [including calculation of yield and melting point]:
i) Anhydride from Phthalic acid
ii) Hydrolysis of amides
iii) Bromination of acetanilide

COMMERCIAL ANALYSIS :
To determine the strength of commercial samples of antacid, vinegar, acetic acid and HCl [standard succinic acid solution to be prepared by the students to standardize the given NaOH solution].

CIA AND END SEMESTER PRACTICAL EXAMINATION

COURSE 3: Physico-Chemical Exercises + Commercial Analysis

COURSE 4: Organic Preparations +Semi-micro Inorganic Qualitative Analysis

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.

****
****