



**VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY
JNANASAGARA CAMPUS, BALLARI-583105**

Department of Studies in Chemistry

IV Semester Syllabus

Bachelor of Science

With effect from 2022-23 and onwards

Semester-IV

DSC 4: Inorganic and Physical Chemistry

Course Title: Inorganic and Physical Chemistry	Course code: 21BSC4C4CHL
Total Contact Hours: 56	Course Credits: 4
Internal Assessment Marks: 40 Marks	Duration of SEE: 2 Hrs
Semester End Examination Marks: 60 Marks	

Course Outcomes (CO's):

1. Different types of bonding in molecules/compounds/ions
2. The structures of molecules/compounds/ions based on different models/theories
3. Properties of compounds based on bonding and structure
4. The fundamentals of thermodynamics including the laws, the concept of entropy and free energy functions and their applications.
5. The concepts of surface chemistry, catalysis and their applications.
6. The theoretical and experimental aspects of chemical kinetics including basic theories of reaction rates and methods of determining order.
7. Electrochemistry dealing with electrolytes in solution. Conductance measurements and applications. Concept of ionic mobility and their determination

At the end of the course, students will be able to:

1. Predict the nature of the bond formed between different elements
2. Identify the possible type of arrangements of ions in ionic compounds
3. Write Born - Haber cycle for different ionic compounds
4. Relate different energy parameters like, lattice energy, entropy, enthalpy and solvation energy in the dissolution of ionic solids
5. Explain covalent nature in ionic compounds
6. Write the M.O. energy diagrams for simple molecules
7. Differentiate bonding in metals from their compounds
8. Learn important laws of thermodynamics and their applications to various thermodynamic systems
9. Understand adsorption processes and their mechanisms and the function and purpose of a catalyst
10. Apply adsorption as a versatile method for waste water purification.
11. Understand the concept of rate of a chemical reaction, integrated rate equations, energy of activation and determination of order of a reaction based on experimental data
12. Know different types of electrolytes, usefulness of conductance and ionic mobility measurements
13. Determine the transport numbers

DSC 4: Inorganic and Physical Chemistry

Unit	Description	Hours
1	Structure and Bonding -I The ionic bond: Structures of ionic solids Radius ratio rules, Calculation of some limiting radius ratio values, Coordination number 3 (planar triangle), Coordination number 4 (tetrahedral and square planar), Coordination number 6 (octahedral), Close packing. 3hrs	10hrs

	<p>Classification of ionic structures: Ionic compounds of the type AX (ZnS, NaCl, CsCl) Ionic compounds of the type AX₂ (Calcium fluoride (fluorite) and Rutile structure Layer structures CdI₂ , Cadmium iodide structure Limitations of radius ratio concept 2</p> <p>Hrs Lattice energy and Born-Haber cycle, Derivation of Born-Lande equation and its drawbacks, Kapustinskii equation, solvation energy and solubility of ionic solids, polarizing power and polarizability, Fajan's rules with applications. Numerical problems 4 hrs</p>	
2	<p>Covalent bond: Valence bond theory, The Lewis theory, The octet rule, Exceptions to the octet rule, Sidgwick- Powell theory. Valence shell electron pair repulsion (VSEPR) theory, Effect of lone pairs, electronegativity, isoelectronic principle, Examples using VSEPR theory: BF₃ and BF₄⁻, NH₃ and NH₄⁺, H₂O, PCl₅, ClF₃, SF₄, I₃⁻ and I₃⁺, SF₆, and IF₇. Limitations of VSEPR. 6 hrs</p> <p>Structure and Bonding -II Concept of resonance, resonance energy, hybridisation, types of hybridization, sp, sp², sp³ dsp² dsp³, d²sp³, sp³d² with one example each, and energetics of hybridization. Bent's rule, Limitations of Valence Bond Theory. 4 hrs</p>	10 hrs
3	<p>Molecular Orbital theory: LCAO concept: s-s, s-p, p-p, p-d and d-combinations of orbitals, bonding, nonbonding and antibonding molecular orbitals, non-bonding combinations of orbitals, Rules for linear combination of atomic orbitals Examples of molecular orbital treatment for homonuclear diatomic molecules H₂ molecule, H⁺², He₂ molecule, He^{+ 2} molecule ion, Li₂ molecule, Be₂ molecule B₂ molecule, C₂ molecule, N₂ molecule, N²⁺, O₂ molecule, O₂⁻ and O₂²⁻. M.O. energy diagrams of heteronuclear diatomic molecules with examples (NO, NO⁺, CO and HCl). Calculation of bond order, relationship between bond order, bond energy and bond length, magnetic properties based on MOT. 8 hrs</p> <p>Metallic Bonding: General properties of metals : Conductivity, Lustre, Malleability and cohesive force Crystal structures of metals and Bond lengths Theories of bonding in metals: Free electron theory, Valence bond theory, Molecular orbital or band theory of solids Prediction of conducting properties of conductors. insulators and semiconductors, extrinsic and intrinsic semiconductors using M.O. theory. 4 hrs</p>	12hrs
4	<p>First Law of Thermodynamics : Thermodynamic Processes, Reversible and Irreversible Processes, Nature of Heat and Work, Internal Energy, First Law of Thermodynamics, Enthalpy of a System, Work done in isothermal and adiabatic expansion of an ideal gas, Numerical problems, Joule - Thomson Expansion, Relation between Joule-Thomson coefficient and other thermodynamic parameters. Second law of Thermodynamics Concept of entropy, thermodynamic scale of temperature, Statements of the Second Law of Thermodynamics, molecular and statistical interpretation of entropy, Calculation of entropy change for reversible and irreversible processes, Free Energy Functions: Gibbs and Helmholtz energy, Variation of S, G, A with T, V and P, Numerical problems, Free energy change and spontaneity, Gibbs-Helmholtz equation. Third Law of Thermodynamics Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules. 8 hrs</p> <p>Surface Chemistry: Adsorption Types of adsorption isotherms. Freundlich adsorption isotherm (only equation), its limitations. Langmuir adsorption isotherm (derivation to be done) and BET equation (derivation not included). Catalysis Types of Catalysis and theories with examples</p>	12hrs

	(intermediate compound theory and adsorption theory), Theory of acid base catalysis, Michaelis-Menten mechanism. Heterogeneous catalysis: surface reactions, unimolecular, bimolecular surface reactions. Autocatalysis with examples. Applications: Design process to removal of toxic compounds from industrial wastewater and treatment of portable water requirements. 4hrs	
5	<p>Chemical Kinetics: Differential and integrated form of rate expressions up to second order reactions, Derivation of expression of rate constant of second order reaction ($a=b$ and $a \neq b$), Problems on rate constant ($a=b$), Methods of determination of order of a reaction, temperature dependence of reaction rates; Arrhenius equation, activation energy, Numerical problems on Arrhenius equation in calculating energy of activation and rate constants. Collision theory of reaction rates, Lindemann's mechanism, qualitative treatment of the theory of absolute reaction rates. Experimental determination of kinetics of (i) inversion of cane sugar by polarimetric method (ii) spectrophotometric method for the reaction between potassium persulphate and potassium iodide. 6 hrs</p> <p>Electrochemistry – I Arrhenius theory of electrolytic dissociation. Merits and Demerits, Conductance, Specific conductance, equivalent and molar conductivity and their variation with dilution. Molar conductivity at infinite dilution. Numerical problems. Kohlrausch's law of independent migration of ions and its applications, Debye-Hückel-Onsager equation. Ionic mobilities and their determinations, transference numbers and their relation to ionic mobility's, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts (iv) conductometric titrations (acid base titrations only) and (v) Hydrolysis constants of salts. Numerical problems. 6 hrs</p>	12hrs
<p>References:</p> <ol style="list-style-type: none"> 1. Peter Atkins & Julio De Paula, Physical Chemistry, 9th Ed., Oxford University Press, 2010 2. G W Castellan, Physical Chemistry, 4th Ed., Narosa, 2004 3. R G Mortimer, Physical Chemistry 3rd Ed., Elsevier: Noida, UP, 2009 4. B R Puri, L R Sharma and M S Pathania, Principles of Physical Chemistry, Vishal Publishing Co. , 2016 5. B S Bahl, G D Tuli and Arun Bahl, Essentials of Physical chemistry, S Chand & Company Ltd., 2000. 6. A S Negi and S C Anand, A textbook of Physical Chemistry, New Age International Publishers., 3rd Edn., 2022 7. B N Bajpai, Advanced Physical chemistry, S Chand and Company ltd., 1992/2015 8. R L Madan, Chemistry for Degree Students, Semester I, II, III and IV, S Chand and Company Ltd. 2018/2022 9. P L Soni, O P Dharmarha and U N Dash, Textbook of Physical Chemistry, Sultan Chand and Sons., 2022 		

Date

Course Coordinator

Subject Committee Chairperson

DSC 04: Inorganic and Physical Chemistry Practicals

Course Title: Inorganic and Physical Chemistry Practicals	Course code: 21BSC4C4CHP
Total Contact Hours: 4 hrs	Course Credits: 2
Internal Assessment Marks: 25 marks	Duration of SEE: 3 Hrs
Semester End Examination Marks: 25 marks	

Course Outcomes (CO's):

1. Analytical skills in detecting the constituents present in unknown samples by systematically carrying out the qualitative analysis.
2. The methods of determining rates of chemical reactions.
3. Designing electrochemical cells and making measurements related to it.
4. Determination of physical characteristics of electrolytes using conductivity measurements in solution.
5. Adsorption phenomenon, mechanism and basic models to explain adsorption.
6. Simple techniques like conductometry to obtain physicochemical parameters of electrolytes.

At the end of the course, students will be able to:

1. Understand the chemical reactions involved in the detection of cations and anions.
2. Explain basic principles involved in classification of ions into groups in semi-micro qualitative analysis of salt mixture
3. Carryout the separation of cations into groups and understand the concept of common ion effect.
4. Understand the choice of group reagents used in the analysis.
5. Analyse a simple inorganic salt mixture containing two anions and cations
6. Use instruments like conductivity meter to obtain various physicochemical parameters.
7. Apply the theory about chemical kinetics and determine the velocity constants of various reactions.
8. Learn about the reaction mechanisms.
9. Interpret the behaviour of interfaces, the phenomena of physisorption and chemisorptions and their applications in chemical and industrial processes.
10. Learn to fit experimental data with theoretical models and interpret the data

DSC 04: Inorganic and Physical Chemistry Practicals

Sl No	List of Experiments	Hours
Part A- Inorganic Chemistry Practicals		
1	Qualitative semi-micro analysis of mixtures containing 2 anions and 2 cations. Emphasis should be given to the understanding of different reactions. The following cations and anions are suggested. Cations: NH_4^+ , Pb^{2+} , Bi^{3+} , Cu^{2+} , Al^{3+} , Fe^{3+} , Co^{2+} , Cr^{3+} , Ni^{2+} , Zn^{2+} , Mn^{2+} , Ba^{2+} , Ca^{2+} , Sr^{2+} , Mg^{2+} , Na^+ , K^+ and Li^+ . Anions: CO_3^{2-} , CH_3COO^- , Cl^- , Br^- , I^- , NO_3^- , BO_3^{3-} , SO_4^{2-} , $\text{C}_2\text{O}_4^{2-}$ and PO_4^{3-} . Spot tests and flame tests to be carried out wherever possible.	28 hrs
Part B- Physical Chemistry Practicals		

1	Determination of the enthalpy of neutralization of a strong acid with strong base.	28 hrs
2	Verification of Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.	
3	The study of kinetics of potassium persulphate and potassium iodide volumetrically	
4	Determination of velocity constant for acid catalyzed hydrolysis of methyl acetate.	
5	Determination of velocity constant for the saponification of ethyl acetate (a = b) volumetrically. Determination of equivalent conductivity of strong electrolyte and verification of DHO equation.	
7	Determination of dissociation constant of weak acid by conductivity method	
8	Conductometric titration of strong acid and strong base.	
9	Conductometric titration of weak acid and strong base	
10	Determination of the hydrolysis constant of aniline hydrochloride conductometrically.	
11	Determination of solubility product of sparingly soluble salt conductometrically.	
<p>References:</p> <ol style="list-style-type: none"> 1. Vogel's Qualitative analysis, Revised by G. Svehla, Pearson education, 2002 2. J B Yadav, Advanced Physical Chemistry, Krishna Prakashan Media (P) Ltd, Meerut, 2014. 3. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi, 2011. 4. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York, 2003. 5. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York, 2003. 		

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