UNIVERSITY OF KERALA

SYLLABUS OF COMPLEMENTARY CHEMISTRY

FOR PHYSICS MAJORS

2020 Admission onwards

SEMESTER	I
COURSE	1
COURSE NAME	THEORETICAL AND ANALYTICAL CHEMISTRY
COURSE CODE	CH1131.1
CREDIT	2
L-T-P	2-0-2
TOTAL HOURS	36

CO No.	**COURSE OUTCOME** ***Upon completion of this course, students,***	**Cognitive Level**
1	Discuss the rules for filling electrons in atomic orbitals	U
2	Correlate stability of atom with electronic configuration	U
3	Discuss theories of chemical bonding and their limitations	U
4	Predict geometry of molecules from the type of hybridisation	U,A
5	Recognise fundamentals of thermodynamics and the predict spontaneity of reactions	U,A
6	Derive thermodynamic properties of systems in equilibrium	A

7	Critically select suitable indicators for acid base and redox titrations	E,A
8	Appreciate the application of common ion effect and solubility product in precipitation and intergroup separation of cations	A
9	Discuss the basic principles of paper chromatography and thin layer chromatography	U
10	Solve numerical problems on bond order, molarity, normality and Lattice energy	A

R-Remember, U-Understand, A-Apply, E- Evaluate

MODULE I –PERIODIC CLASSIFICATION OF ELEMENTS (9hrs)

Quantum numbers and their significance,
Concept of orbitals. Orbital wise electron configuration, energy sequence rule – Pauli's principle, Hund's rule, stability of filled and half filled orbitals
Electronic configuration and classification of elements in to s,p,d and f blocks.
Periodic properties, Ionisation energy, Electronegativity and Electron affinity. Diagonal relationship.
Important characteristics of representative elements: valency, oxidation states, ionic and covalent bond formation
Important characteristics of transition elements : variable valency and oxidation states, formation of Complex compounds.

MODULE II - CHEMICAL BONDING (9hrs)

Energetic of bond formation – Types of Chemical bonds – Energetics of ionic bond formation – Lattice energy – Born Haber Cycle - Fajan's rules.
Polarity of covalent bond its relation with electronegativity
Electro negativity scales – Paulings and Mullikan's approaches, factors influencing polarity Dipole moment – its relation to geometry.
Hydrogen bond – inter and intra molecular – its consequences on boiling point,volatility and solubility.

Concept of Hybridisation– SP, SP^2, SP^3, dSP^2, dSP^3, SP^3d^2, and SP^3d^3 with examples
Explanation of bond angle in water and ammonia- VSEPR theory, geometry of molecules with bond pairs of electrons , bond pairs and lone pairs of electrons, limitations of VSEPR Theory.
A brief review of molecular orbital approach, LCAO method – bond order, bond distance and stability of O_2,O_2^{2+},O_2^{2-},NO,NO+,CO and HF.

MODULE–III: THERMODYNAMICS (9hrs)

First law of thermodynamics, mathematical form, intrinsic energy, enthalpy, reversible, process and maximum work, work of expansion of an ideal gas in reversible isothermal process.

Heat capacity of gases at constant volume and constant pressure, derivation of $C_P - C_V = R$.

Second law of thermodynamics, entropy and free energies

Significance of $\Delta G, \Delta H$ and available work

Criteria of equilibrium, and spontaneity on the basis of entropy and free energy – Gibbs-Helmholtz equation.

MODULE IV: ANALYTICAL PRINCIPLES (9 Hrs)

Analytical methods in Chemistry – Principles of volumetric analysis, primary standard, standard solution, Calculation of normality,molality and molarity of solutions

Theory of acid - base titrations: Strong acid-Strong Base, Strong acid-weak base, Weak acid Strong base and weak acid-strong base (Explanation with titration curves)

Redox titrations: Permanganometry-Fe2+ and KMnO4 and Dichrometry-Fe2+ and K2Cr2O7, Theory of acid – base and redox indicators.

Inorganic qualitative analysis, common ion effect- solubility product- precipitation and inter group separation of cations. Salting out process

Chromatography- principle and applications of paper and thin layer chromatography.

Text books/References

1. B.R Puri, L R Sharma K C Kalia, Principles of Inorganic Chemistry, Sobhanlal Nagin Chand&Co. New Delhi
2. Manas chanda,Atomic structure and Chemical bonding in molecular spectroscopy,Tata Mc Graw Hill
3. S Glasstone ,Thermodynamics for Chemists,Affiliated Eat West Publishers
4. J D Lee, Concise Inorganic Chemistry, ELBS
5. R P Rastogi and R R Misra, An Introduction to Thermodynamics
6. D.A Skoog, D M West, F J, Holler, S R Crouch, Fundamentals of Analytical Chemistry,8th Edn., Brookes/Cole, Thomson Learning,Inc, USA,2004
7. B K Sharma, Chromatography, Goel Publishing House, Meerut

UNIVERSITY OF KERALA
I Semester B.Sc Degree Examination Model Question Paper
Complementary Chemistry for Physics Major

Course code CH1131.1 Credit 2
THEORETICAL AND ANALYTICAL CHEMISTRY

(2020 admission onwards)

Time: Three Hours **Maximum Marks: 80**

SECTION A

*(Answer **all** questions. Each question carries **1** mark)*

1. Give the electronic configuration of Copper (atomic umber 29)
2. The quantum numbers n = 2 and l = 1 corresponds to which orbital?
3. What are the shapes of molecules with sp and sp^3 hybridization?
4. Calculate the bond order of H_2 molecule.
5. What do you mean by solubility product?
6. Give the mathematical expression for first law of thermodynamics.
7. What is the significance of entropy?
8. Define Molality.
9. Which indicator you suggest for the volumetric titration of NH_4OH by HCl?
10. Name a primary standard substance for estimation of NaOH.

SECTION B

*(Answer any **eight** questions. Each question carries 2 marks)*

11. Give one example each for the stability of Half filled and fully filled atomic orbitals.
12. Write down the MO configuration of O_2 molecule.
13. Define lattice energy.
14. What are the limitations of VSEPR Theory?
15. What are polar and non polar covalent bonds?

16. Mention the rules for adding electrons to molecular orbitals?

17. Explain redox titrations with an example.

18. How would you prepare 100ml of 0.05M Mohr's salt solution?

19. Why is methyl orange not a suitable indicator for the titration of weak acid with strong base?

20. What is the application of Gibbs Helmholts equation?

21. What is the principle of paper chromatography?

22. What is the theory of pH indicators?

(1x10=10 marks)

SECTION C

*(Answer any **six** questions. Each question carries 4 marks)*

23. Discuss the Born Haber cycle for the formation of NaCl.

24. Identify the hybridization in H_2O and NH_3. How will you account for the geometry of these molecules?

25. Give an account of acid base indicators.

26. Discuss the theory of Acid – Base indicators.

27. Explain the energetic of ionic bond formation.

28. Define hybridization. Mention the types of hybridization involved in SF6, PCl5, BF3.

29. Explain Born-Haber Cycle considering the formation of NaCl as an example.

30. Write a note on spontaneity of a chemical reaction.

31. Explain briefly the principle and application of thin layer chromatography.

(4x6=24 marks)

SECTION D

*(Answer any **two** questions. Each question carries 15 marks)*

32. (a) Discuss the basis of periodic classification into different blocks.

(b)What are quantum numbers? Give its significance.

(c) Explain various rules regarding electronic configuration. (5+5+5)

33. a) Define heat capacity of gases at constant temperature and pressure.

How are they related ?

b) What are the criteria for equilibrium? Discuss.

c) Discuss on the work of expansion of an ideal gas in reversible isothermal process. (5+5+5)

34. (a) Write a note on Hydrogen bonding and its consequences.

(b) How electronic configuration of molecules related to molecular behavior? Explain.

(c) Explain Fajan's Rule. (5+5+5)

35. (a) Discuss the titration curves for the titration of strong acid with strong base and weak acid with strong base.

(b) Explain the theory of redox indicators.

(c) Calculate the concentration in terms of normality and molarity of a solution of 8g of NaOH in 100 mL NaOH solution. (5+5+5)

(15x2=30 marks)

UNIVERSITY OF KERALA

SYLLABUS OF COMPLEMENTARY CHEMISTRY

FOR STUDENTS OF PHYSICS MAJORS

2020 Admission onwards

SEMESTER	**II**
COURSE	**2**
COURSE NAME	**PHYSICAL AND INDUSTRIAL CHEMISTRY**
COURSE CODE	**CH1231.1**
CREDIT	**2**

L-T-P	2-0-2
TOTAL HOURS	**36**

CO No.	COURSE OUTCOME *Upon completion of this course, students,*	Cognitive Level
1	Define enthalpies of formation, combustion, neutralization, solution and hydration reactions	R,U
2	Apply Hess's law for thermo chemical calculations	A
3	Predict the effect of temperature pressure and concentration on a system in equilibrium based on Le Chatelier principle	U
4	Classify acidic and basic compounds in accordance with different concepts.	U
5	Suggest method for determination of pH	A
6	Discuss petrochemicals and their applications	
7	Realise the depletion of petroleum products and the need for alternate sources of energy.	U
8	Recognise the necessity of sustainable development	U
9	Appreciate the role of solar energy in photosynthesis and discuss methods of solar energy harvesting	U
10	Become responsible in the consumption of natural resourses and avoid factors affecting the harmony of nature from the equilibrium concept.	A
11	Discuss and the Illustrate general methods and techniques in metallurgy	U,A
12	Predict methods of concentration, extraction metals from their ores	A
13	Discuss the applications of Van Arkel method and zone refining in metallurgy	U

R-Remember, U-Understand, A-Apply, E- Evaluate

MODULE I: THERMO CHEMISTRY (9hrs)

Enthalpies of formation, combustion, neutralization, solution and hydration.

Relation between heat of reaction at constant volume and constant pressure, variation of heat of reaction with temperature. Kirchoff's equation,

Hess's law as an application of First law of thermod ynamicsand its application Bond dissociation energies and bond energies of different types of bonds, their calculation and enthalpies of reaction. (Numerical problems to be worked out)

MODULE II : CHEMICAL AND IONIC EQUILIBRIUM (9 hrs)

Reversible reactions – K_P, K_C, and K_X and their inter relationships – Free energy change and chemical equilibrium (thermodynamic derivation) Influence of pressure and temperature on the following reactions.

(i) $N_2 + 3H_2 \rightleftharpoons 2NH_3$ (ii) $PCl_5 \rightleftharpoons PCl_3 + Cl_2$ (iii) $2SO_2 + O_2 \rightleftharpoons 2\,SO_3$

Le Chatelier's principle and the discussion of the above reactions on its basis.

Concepts of Acids and Bases, Arhenius, Lowry-Bronsted, and Lewis concepts.

HSAB Principle. Levelling effect.

pH and its determination by potentiometric method.

Buffer solutions – Henderson equation, Acidic and basic buffers-examples.

Hydrolysis of salts – degree of hydrolysis and hydrolytic constant,

Derivation of relation between Kw and Kh for salts of strong acid – weak base, weak acid - strong base and weak acid – weak base.

MODULE III : PETROCHEMICALS AND ALTERNATE SOURSES (9hrs)

Petrochemicals:Introduction,Natural gas-CNG,LNG and LPG.

Coal: classification based on carbon content- Carbonisation of coal

Crude oil: constitution and distillation, composition and uses of important Fractions

Ignition point, flash point and octane number-cracking

Usage and depletion of petroleum products.

Need for alternative fuel and Green Chemistry approaches for sustainable development:

Introduction, Solar energy harvesting- photosynthesis

Photo voltaic cell, conventional solar cells, nano structured solar cells,

Hydrogen as the future fuel

MODULE IV : METALLURGY (9 Hrs)

General principles of occurrence and extraction of metals

Concentration of ores- roasting, calcination and smelting

General Methods of extracting metal from concentrated ore, examples

Electro metallurgy-Metallurgy of Aluminium, Sodium-Pyrometallurgy

Refining of crude metals: Distillation, Liquation, electrolytic and zone refining

Chromatographic techniques and vapour phase refining (Mond's process and Van Arkel process)

Metallurgy of titanium, cobalt, nickel, thorium and uranium.

TEXT BOOKS /REFERENCES

1. B.R Puri, L R Sharma K C Kalia, Principles of Inorganic Chemistry , S. Chand & Co. New Delhi
2. B.R Puri, L R Sharma M S Pathania, Principles of Inorganic Chemistry , Vishal Publishing Co. New Delhi 2013
3. B K Sharma,H. Gaur, Industrial chemistry, Goel Publishing House, New Delhi
4. K S Tewari,N K Vishnoi, Organic Chemistry, 3rd Edn. Vikas Publishing House

UNIVERSITY OF KERALA
II Semester B.Sc Degree Examination Model Question Paper
Complementary Course for Physics Major

Course code CH 1231.1 Credit 2
PHYSICAL AND INDUSTRIAL CHEMISTRY

(2020 admission onwards)

Time: Three Hours **Maximum Marks: 80**

SECTION A

*(Answer **all** questions. Each question carries **1** mark)*

1. Write one example for an exothermic reaction
2. Name a natural way of harvesting solar energy.
3. Mention two different forms in which natural gas is available.
4. What do you mean by ionic product of water?
5. Semi conductor grade Silicon is made by the technique--------
6. Identify the Lewis acid (HCl, NaOH, ,BF3,NH3)
7. Name the chemicals which can form an acidic buffer.
8. What is meant by carbonization of coal?
7. Give one example each for a Proton donor and a proton acceptor.
8. Name an oxide ore and a sulphide ore
9. What is the advantage of photovoltaic cell?
10. What is the application of Van Arkel method?

SECTION B

*(Answer any **eight** questions. Each question carries 2 marks)*

11. One mole of an ideal gas at 25oc is allowed to expand isothermally and reversibly form a volume of 10 liters to 20 liters. Calculate the work done by the gas?
12. Give one application of first law of thermodynamics.
13. Write the relation between ΔG, ΔH and ΔS. What is the condition for spontaneity of a process?
14. Calculate the enthalpy of hydrogenation, C_2H_4 (g) + H_2(g) ⟶ C_2H_6 (g).
    Given that bond energy of H-H= 433kJ, C=C =615kJ and C-C= 347kJ and C-H = 413kJ.
15. What is bond dissociation energy?
16. What is isochoric process?
17. What are the characteristics of equilibrium constant?
18. What is enthalpy of hydration?
19. What is a reversible process? Give an example.
20. Define Lewis acid and base
21. What is ionic product of water.
22. What is the importance of pyrometallurgy?

SECTION C

*(Answer any **six** questions. Each question carries 4 marks)*

23. Calculate the bond energy of HBr bond,given that the enthalpy of formationof HBr is -36.2kJmol^{-1}. The bond energies of H-H and Br-BR bond are 431kJmol $^{-1}$ and 188kJmol^{-1} respectively.
24. Write a note on HSAB principle.
25. Differentiate between ignition point and flash point.
26. Discuss n Mond's process and Van Arkel method.
27. Write a note on nanostructured solar cells.
28. How will you differentiate between liquation and distillation processes in metallurgy?

29. Give an account of crude oil, its distillation products and theur applications.

30. Comment on the use of hydrogen as a future fuel.

31. What is smelting? Give an example

SECTION D

*(Answer any **two** questions. Each question carries 15 marks)*

32. a) Explain pH determination by potentiometric method
    (b) Differentiate between hard and soft acid
    (c) Write a note on leveling effect of solvents on acids. (5+5+5)

33. (a) Discuss the effect of pressure , temperature and concentration and mention the optimum conditios in the following reaction under equilibrium
    i) dissociation of PCl_5 into PCl_3 and Cl_2
    ii) formation of SO_3 from SO_2 and O_2
    (b) Illustrate the role roasting and calcinations in metallurgy. (5+5+5)

34. (a) Discuss on spontaneity or feasibility of a process.

    (b) State and explain Hesse's law.
    (c) When one mole of ethanol melts at its melting point, the entropy change is $29.4 JK^{-1} mol^{-1}$. If enthalpy of fusion of ethanol is 4.6 $kJmol^{-1}$, what is the melting point of ethanol?

35. (a) Discuss metallurgy of titanium
    (b) Compare between aluminothermy and hydrometallurgy.
    (c) Write notes on concentration of an oxide ore and a sulphide ore?

UNIVERSITY OF KERALA

SYLLABUS OF COMPLEMENTARY CHEMISTRY

FOR STUDENTS OF PHYSICS MAJORS

2020 Admission onwards

SEMESTER	**III**
COURSE	**3**
COURSE NAME	**PHYSICAL CHEMISTRY**

COURSE CODE	**CH1331.1**
CREDIT	**3**
L-T-P	**3-0-2**
TOTAL HOURS	**54**

CO No.	**COURSE OUTCOME** *Upon completion of this course, the students will:*	**Cognitive Level**
1	Discuss on electrochemical cells and emf measurements	U
2	Apply the principles of physical Chemistry in Catalysis and photochemistry	A
3	Draw unit cells and structure of crystals	U
4	Understand the effect of temperature on molecular velocities of gases	R
5	Calculate cell emf and electrode potentials	A
6	Construct electrochemical cells	A
7	Classify between Photochemical reactions	U
8	Relate electrolyte concentration with emf	E

R-Remember, U-Understand, A-Apply, E- Evaluate

MODULE 1: GASEOUS STATE 9HRS

Maxwell's distribution of molecular velocities (No derivation) average, most probable and rms velocities, collision number and collision frequency, mean free path, deviation of gases from ideal behaviour – Boyle temperature, derivation of vander waals constants and critical constants – Law of corresponding states – reduced equation of state, Joule Thomson effect, liquefaction of gases – Linde's and claude's processes

MODULE II – CRYSTALLINE STATE 9HRS

Isotropy and anisotropy – symmetry elements in crystals – the seven crystal systems. Miller indices, Bravais lattices, primitive, bcc and hcc of cubic crystals – Representation of lattice planes of simple cubic crystal - Density from cubic lattice

dimension – calculation of Avogadro number - Bragg equation, diffraction of Xrays by crystals – single crystal and powder method. Detailed study of structures of NaCI and KCl crystals.

MODULE III - ELECTRO CHEMISTRY 9HRS

Transport number – definition, determination by Hittorfs method and moving boundary method, application of conductance measurements. Conductometric titrations involving strong acid – strong base, strong acid – weak base, weak acid – strong base and weak acid – weak base.

EMF – Galvanic cells, measurement of emf, cell and electrode potential, IUPAC sign convention, Reference electrodes, SHE and calomel electrode, standard electrode potential, Nernst equation, anion and cation reversible electrodes, redox electrode with examples, quinhydrone electrode, glass electrode concentration cell without transference, potentiometric titration, Fuel cells – H_2 – O_2 and hydrocarbon – O_2 type.

MODULE IV – CATALYSIS AND PHOTOCHEMISTRY 9HRS

General Characteristics of catalytic reactions. Different types of catalysis – examples – theories of catalysis (Outline of intermediate compound formation theory and adsorption theory). Enzyme catalysis – Michaelis-Menten mechanism.

Photo Chemistry**:** - Laws of Photo Chemistry, Grothus – Drapter law, Beer Lambert's law, Einstein's laws, quantum yield, H_2 – Cl_2 reaction, H_2 – Br_2 reaction – Fluorescence and phosphorescence, chemiluminescence and photo sensitization.

MODULE – V: CHEMICAL KINETICS 9 HRS

Rates of reaction, various factors influencing rates of reactions – order and molecularity – Zero, first, second and third order reaction, derivation of integrated rate equation, fractional life time, units of rate constants, influence of temperature on reaction rates. Arrhenius equation, calculation of Arrhenius parameters – collision theory of reaction rates.

MODULE VI- GROUP THEORY 9 HRS

Group theory- elements of symmetry- proper and improper axis of symmetry- plane of symmetry-center of symmetry- identity elements, combination of symmetry elements- point group- C_{2v}, C_{3v} and D_{3h}- group multiplication table of C_{2v}- determination of point group of simple molecules like water, NH_3, BF_3

REFERENCES

1. B.R.Puri,L.R. Sharma and M.S.Pathania, Principles of Physical Chemistry, 46 th Edn Vishal Publishing Co. NewDelhi
2. J E Huheey, ,E A Keiter, R L Keiter, O K Medhi, Inorganic Chemistry, 4th Edn.Pearson
3. F A Cotton and Wilkinson,Advanced Inorganic Chemistry, John Wiley, New York
4. P L Soni, O P Dharmarsha,U N Dash,Textbook of Physical Chemistry, 23rd Edn, Sultan Chand & Sons, NewDelhi,2011
5. Gurudeep Raj ,Advanced physical chemistry
6. L V Azaroff, Introduction to solids
7. N B Hannay ,Solid state chemistry
8. F Daniel and R A Alberty ,Physical chemistry
9. A Salahuddin kunju and G krishnan Group theory and its applications in chemistry-

UNIVERSITY OF KERALA
III Semester B.Sc Degree Examination Model Question Paper
Complementary Course for Physics Major

Course Code CH1331.1 Credit 3
PHYSICAL CHEMISTRY

(2020 admission onwards)

Time: Three Hours **Maximum Marks: 80**

SECTION A

*(Answer **all** questions. Each question carries **1** mark)*

1. What is the ratio of observed molar volume to ideal molar volume is?
2. Define Boyle temperature?
3. How many unit cell are possible in cubic crystal?

4. Why amorphous solids are said to be isotropic?
5. In a Galvanic cell electron flows from …… to ……
6. What is the potential of SHE.
7. What is the quantum yield of H_2-Cl_2 reaction?
8. Define chemiluminescence
9. What is the order of the reaction with rate constant $2x10^{-2}$ $molL^{-1}s^{-1}$
10. NH_3 belongs to which point group?

SECTION B

*(Answer **any eight** questions. Each question carries **2** mark)*

11. Define critical temperature and explain its significance?
12. What is virial equation of states?
13. Explain the term Space lattice and Unit cell.
14. Both NaCl and KCl have fcc structures but Kcl behaves towards X-rays like simple cubic lattice. Why?
15. What is liquid junction potential? How can it be eliminated?
16. What are reference electrodes? Give their significance?
17. State Einstein's law of photochemical equivalence?
18. What is meant by chemiluminescence?
19. What is meant by autocatalysis?
20. Define order and molecularity of areaction?
21. A substance decomposes following first order kinetics. The half life period of a reaction is 35 minutes. What is the rate constant of the reaction?
22. What is meant by point group?

SECTION C

*(Answer **any six** questions. Each question carries **4** mark)*

23. What is the law of corresponding states? How is it derived from the vander waal's equation?
24. Calculate the constants a and b, if Tc=31^0C, Pc=72.8atm and R=0.082lit atm/K?
25. What are the Miller indices? How are they detrmined?
26. EMF of a standard Daniel Cell is 1.01832 V at 298K. Temperature coefficient of the cell is $-5x10^{-5}$V/K. Calculate ΔG, ΔH, and ΔS of the cell reaction?
27. Write a brief note on Calomel electrode?

28. State and explain Beer-Lambert's law? What are its limitations?
29. Explain pseudo order reactions with suitable examples?
30. Give the group multiplication table for C_{2V}
31. Explain the different symmetry elements?

SECTION D

*(Answer **any two** questions. Each question carries **15** mark)*

32. (i) Explain Linde's and Claude's method of liquefaction of gases?

    (ii)Do all gases obey gas laws? Discuss some experimental results to explain the deviation and point out the causes which account for this behavior?

    (iii) explain the terms: collision frequency and collision diameter.

33. (i) Derive Bragg's equation for the diffraction of of X-rays by crystal lattice? How is this equation used in elucidating the crystal structure?

    (ii) In fcc lattice of NaCl the distance between Na^+ and Cl^- ions is 281 pm and the density of NaCl is 2.165g/cm ^{3}. Compute Avogadro's no. from the given data. The molar mass of NaCl is 58.5g/mol.

    (iii) Assign the point groups of the molecule BF_3 and H_2O

34. (i) Write a brief note on fuel cells? (ii) State and explain Nernst equation (iii) Explain the principle of potentiometric titrations?
35. (i) What is catalysis? What are the general characteristics of catalyst? (ii) Derive an expression for rate constant of a first order reaction? (iii) Explain the influence of temperature on reaction rates?

UNIVERSITY OF KERALA

SYLLABUS OF COMPLEMENTARY CHEMISTRY

FOR STUDENTS OF PHYSICS MAJORS

2020 Admission onwards

SEMESTER	**IV**
COURSE	**3**
COURSE NAME	**SPECTROSCOPY AND ADVANCED MATERIALS**
COURSE CODE	**CH 1431.1**

CREDIT	**3**
L-T-P	**3-0-2**
TOTAL HOURS	**54**

CO No.	**COURSE OUTCOME** *Upon completion of this course, the students will:*	**Cognitive Level**
1	Discuss the principle and applications of rotational, vibrational, electronic and NMR spectroscopy.	U
2	Illustrate isomerism, geometry and bonding in co ordination complexes	A
3	Appreciate the use of co ordination compounds in qualitative and quantitative analysis	U
4	Solve numerical problems relating to nuclear chemistry	R
5	Appreciate the use of biodegradable polymers	A
6	Apply the importance energy and environment conservation	U
7	Get insight to the emerging area of nano and advanced materials	A

R-Remember, U-Understand, A-Apply, E- Evaluate

MODULE I - SPECTROSCOPY 9hrs

Regions of electromagnetic spectrum – different units to represent energy such as erg, joule, calorie, cm^{-1}, Hz and eV, their interconversions – interaction of radiation with matter, different types of energy levels of molecules – rotation, vibration and electronic levels. Rotation spectroscopy Microwave spectrum of diatomic molecules – expressions for rotational energy, selection rule – frequency separation and determination of bond length – vibrational spectrum – harmonic oscillator, equation for frequency of vibration, expression for vibrational energy, selection rule, frequency separation, calculations of force constant,

Electronic spectroscopy –types of transition and regions where they absorb.

MODULE II- SPECTROSCOPY- II 9 hrs

Raman spectroscopy – stokes and anti stokes lines, quantum theory of Raman spectrum – advantages and disadvantages of Raman spectrum, rotational Raman spectrum, selection rules and frequency separation. Vibrational Raman spectrum – Complementary with IR spectrum, mutual exclusion principle, NMR spectroscopy, principle of NMR spectroscopy, nuclear spin, interaction with external magnet, energy spacing, transition between nuclear energy levels in hydrogen nucleus, low resolutionspectrum, chemical shift, spin – spin coupling – fine structure spectrum, application to simple molecule

MODULE III COORDINATION CHEMISTRY 9 hrs

Double salts and complex salts, Werner's coordination theory, Types of ligands,
Chelating ligands- bidentate and polydentate- EDTA, Stability of chelates
Valence bond theory of bonding in octahedral and tetrahedral complexes, Drawbacks of valence bond theory
Crystal field theory of octahedral and tetrahedral complexes, examples
high and low spin complexes, magnetic properties ,applications of co ordination compound in qualitative and quantitative volumetric analysis.

MODULE IV – NUCLEAR CHEMISTRY 9 hrs

Nuclear Chemistry – stability of Nucleus – n/p ratio,radioactivity, artificial transmutation and artificial radio activity. Detection of radio activity by Wilson's cloud chamber and Geiger Muller Scintillation counter – units of radio activity – curie and rutherford – Radio Carbon dating , Rock dating, Neutron activation analysis Applications in agriculture and medicine. A brief study of pathological and genetic damage due to radiation , Dosimetry – Units – rad, gray and Roentgen. Fricke dosimeter and ceric sulphate dosimeter.

Mass defect, binding energy, atomic fission and fusion

MODULE V :CHEMISTRY OF NANO MATERIALS 9 hrs

Evolution of Nano science – Historical aspects – preparations containing nano gold in traditional medicine, Lycurgus cup – Faraday's divided metal etc.
Nanosystems in nature.
Preparation of Nano particles – Top – down approach and bottom – top approach, sol – gel synthesis, colloidal precipitations, Co- precipitation, combustion technique.

Properties of nano particles: optical, magnetic and mechanical properties.
Tools for measuring nano structure – XRD, Atomic force Microscopy (AFM), Scanning Tunneling Microscopy (STM), and Scanning Electron Microscopy (SEM) Transmission Electron Microscopy (TEM) . Applications of nano materials in electronics, robotics, computers, sensors, mobile electronic devices, Medical applications (use Au, Ag,ZnO and ZnO_2 as examples)

MODULE VI- ADVANCED MATERIALS 9hrs

Magnetic materials-classification- applications and examples
Piezo electric and pyroelectric materials, examples
Conducting polymers- polyacetylene- ploy anilines- synthesis- applications
Bio degradable polymers: PLA, PGA and PHBV
Polymeric sulphur nitrogen compounds $(SN)_x$ as one dimensional conductors.
Photoconducting polymers-examples-super conducting materials
Liquid crystals – mesomorphic state, types of liquid crystals, applications and examples.
Ceramics: Introduction, types of clay products, properties and applications

REFERENCE

1. C.N.Banwell, Fundamentals of molecular spectroscopy, Tata Mc GRaw Hill CO. Ltd.
2. B R Puri, L R Sharma and K C Kalia, Principles of Inorganic Chemistry, Mile stone Publishers. New Delhi
3. G M Barrow, Physical Chemistry,5th Edn.Tata Mc Graw HillEducation, NewDelhi,2006
4. J E Huheey, ,E A Keiter, R L Keiter, O K Medhi, Inorganic Chemistry, 4th Edn.Pearson
5. F A Cotton and Wilkinson,Advanced Inorganic Chemistry, John Wiley, New York
6. V R Gowarikar,Polymer Chemistry, New Age International (P) Ltd. New Delhi 2010
7. T Pradeep, A Text book of Nanoscience and Nanotechnology,Mc Graw Hill, New Delhi

UNIVERSITY OF KERALA
IV Semester B.Sc Degree Examination Model Question Paper
Complementary Course for Physics Major

Course code CH1431.1 Credit 3
SPECTROSCOPY AND ADVANCED MATERIALS

(2020 admission onwards)

Time: Three Hours **Maximum Marks: 80**

SECTION A

*(Answer **all** questions. Each question carries **1** mark*

1. Which of the following give pure rotational spectrum: H_2, N_2, CO_2, HCl?

2. What is Rayleigh scattering?
3. What is the selection rule for vibrational transition?
4. What is the condition for a molecule to be NMR active?
5. What is Wilkinson's catalyst?
6. What is nano shells?
7. Write an example for a chelate.
8. What are the ores of titanium?
9. Name the nano meterial used in semiconductors?
10. What are ferromagnetic materials?

SECTION B

*(Answer **any eight** questions. Each question carries **2** mark)*

11. What is Born Oppenheimer approximation?
12. The force constant of HF molecule is 970Nm-1. Calculate the fundamental vibrational frequency as well as the zero point energy?
13. What is Raman Effect? What is the cause of Raman effect?
14. Explain the terms shielding and deshielding with regard to NMR spectroscopy.
15. What is chemical shift?
16. Explain the effect of solvent in UV spectroscopy.
17. What is the difference between a double salt and a complex compound?
18. $[Fe(CN)_6]^{3-}$ paramagnetic. Why?
19. Give an example for artificial transmutation of elements
20. What is half life?
21. What is STM and its basic principle?
22. Explain the synthesis of polyaniline from aniline.

SECTION C

*(Answer **any Six** questions. Each question carries **4** mark)*

23. Why are anti-stokes lines intense than the stokes lines in the Raman spectrum?
24. Taking the example of HCl show how rotation of the molecule causes dipole moment fluctuations?
25. State and illustrate the Frank-Condon principle.
26. Define the terms: Bathochromic shift, Hypsochromic shift, hyperchromic shift, hypochromic shift.
27. Discuss Werner's theory of coordination compounds.
28. Explain the formation of low spin and high spin complexes with the help of crystal field theory.
29. Write a note on Geiger Muller counter.
30. Explain the properties of nano particles.
31. Give a short note on superconducting materials.

SECTION D

*(Answer **any two** questions. Each question carries **15** mark)*

32. (i) Derive an expression for allowed energies of rotational levels ina diatomic molecule.
    (ii) Show that for a rigid diatomic rotor the moment of inertia is given by $I= \mu r^2$.

    (iii) Discuss the quantum theory of Raman spectroscopy

33. (i) Explain the underlying principle in an NMR spectrum.
    (ii)What are the different kinds of protons indicated in an NMR spectrum. How do they produce their characteristics signals?

    (iii)How can the NMR method be used to distinguish between the structures of

    1-propanol and 2-propanol?

34. (i) Give an account of crystal field theory?
    (ii) What are applications of coordination compounds in qualitative analysis?

    (iii) Radio carbon in wood decays with a half life of 5770 years. What is the rate constant (in $year^{-1}$) for the decay? What fraction would remain after 11540 years?

35. (i) Explain the applications of nanomaterials in electronic and robotics.
    (ii) Explain working principle of SEM and TEM.

    (iii)Give a note radio active disintegration series.

UNIVERSITY OF KERALA
SYLLABUS OF LAB COURSE IN CHEMISTRY
FOR STUDENTS OF PHYSICS MAJORS

2020 Admission onwards

SEMESTER	**I,II,III &IV**
COURSE	**5**
COURSE TITLE	**COURSE V : LAB COURSE FOR PHYSICS**
COURSE CODE	**CH 1432.1**
CREDIT	**2**

L-T-P	**0-0-2**
TOTAL HOURS	**36**

CO No.	**COURSE OUTCOME** ***Upon completion of this course, the students***	**Cognitive Level**
1	Obey Lab safety instructions, develop qualities of punctuality, regularity and scientific attitude, out look and scientific temper (GOOD LAB PRACTICES)	E.U
2	Develop skill in safe handling of chemicals, take precaution against accidents and follow safety measures	A
3	Develop skill in observation , prediction and interpretation of reactions	U,A
4	Apply the principle of common ion effect and solubility product in the identification and separation of ions	A
5	Develop skill in weight calculation for preparing standard solutions	A
6	Perform volumetric titrations under acidimetry-alkalimetry, permanganometry, dichrometry, iodimetry-iodometry,cerimetry, argentometry and complexometry	A
7	Determine physical constants	A

I. REACTIONS OF THE FOLLOWING CATIONS:

Hg^{+}, Pb^{2+}, Ag^{+}, Hg^{2+}, Bi^{3+}, Cd^{2+}, As^{3+},b^{3+}, Sn^{2+}, Sn^{4+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Mn^{2+}, Zn^{2+}, Ni^{2+}, Cd^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Mg^{2+} and NH_4^{+}.

II. SYSTEMATIC ANALYSIS OF TWO CATIONS IN A MIXTURE

The cations must be provided in solutions. A student must analyze at least ten mixtures containing two cations each.

III. VOLUMETRIC ANALYSIS

A. Acidimetry and Alkalimetry

a. Preparation and standardization of 0.05N HCl using sodium carbonate as primary standard

b. Estimation of a strong base and a weak base using standardized HCl

c. Estimation of sodium hydroxide using (i)Std. oxalic acid and (ii) Std. HCl

d. Preparation and standardization of 0.05N NaOH using oxalic acid as primary standard

e. Estimation of a strong acids using standardized NaOH

f. Determination of sodium hydroxide, and sodium hydroxide and sodium carbonate in a mixture (indicator method)

B. Permanganometry

a. Standardisation of $KMnO_4$ by oxalic acid sodium oxalate and Mohr's salt

b. Estimation of oxalic acid / sodium oxalate

c. Estimation of Mohr's Salt.

d. Estimation of calcium

C. Dichrometry

a. Preparation of Std. $K_2Cr_2O_7$ and estimation of ferrous iron by external and internal indicators.

b. Estimation of ferric iron by reduction with stannous chloride (internal indicator).

D. Iodometry and Iodimetry

a. Standardization of sodium thiosulphate using std. potassium dichromate.

b. Estimation of copper in a solution

c. Estimation of iodine

E. Complexometric titrations

a. Standardisation of EDTA using std Mg^{2+} or Zn^{2+} ion solution

b. Estimation of any one metallic ion from Ca^{2+}, Mg^{2+}, Zn^{2+} or Ni^{2+}

A student has to carry out at least twelve experiments in this class.

IV. GRAVIMETRIC ANALYSIS

a. Estimation of water of hydration in barium chloride crystals.

b. Estimation of barium chloride solution.

V. DETERMINATION PHYSICAL CONSTANTS (NOT FOR ESE)

a. Determination of boiling points of common solvents (b.pt range 100^0C- 130^0C)
b. Determination of melting points of organic substances (m.pt range 100^0C- 130^0C)

SYLLABUS OF COMPLEMENTARY CHEMISTRY COURSES

FOR FIRST DEGREE PROGRAMME IN GEOLOGY

Complementary Courses -4 Total Credits – 14

(One Semester – 18Weeks

Semester	Hours/Week		No. of Credits	Course Code	Instructional Hours
	Thoery (L)	Lab (P)			
I	2		2	CH1131.2	2x18=36
		2	-		2x18=36
II	2		2	CH1231.2	2x18=36
		2	-		2x18=36
III	3		3	CH1331.2	3x18=54
		2	-		2x18=36
IV	3		3	CH1431.2	3x18=54
		2	4	CH1432.2	2x18=36