# MAR IVANIOS COLLEGE (AUTONOMOUS)
# THIRUVANANTHAPURAM
# (Affiliated to the University of Kerala)

**First Degree Programme in Chemistry**

**UNDER CHOICE BASED CREDIT AND SEMESTER SYSTEM**

## CHEMISTRY COMPLEMENTARY COURSES

**SCHEME AND SYLLABI**

**2018**

## General Instructions to Complementary courses

Each Complementary Course has 4 theory courses and 4 practical courses. The Hour allotments and Credits for all are given in the table.

**B Sc Chemistry Complementary Courses -4; Total Credits – 14**

**One Semester – 18 Weeks**

| Instructional Hours | Course code* | Number Of Credits | Hours per week | | Semester |
|---|---|---|---|---|---|
| | | | Lab | Theory | |
| 2×18 = 36<br>2×18 = 36 | AUCH131<br>.2d | 2 | 2 | 2 | 1 |
| 2×18 = 36<br>2×18 = 36 | AUCH231<br>.2d | 2 | 2 | 2 | 2 |
| 3×18 = 54<br>2×18 = 36 | AUCH331<br>.2d | 3 | 2 | 3 | 3 |
| 3×18 =54<br>2×18 = 36 | AUCH431<br>.2d | 3 | 2 | 3 | 4 |
| | AUCH432.2d PI | 4 | | | |

## GENERAL ASPECTS OF EVALUATION

### MODE OF EVALUATION-COMMON TO CORE, ELECTIVE, COMPLEMENTARY AND FOUNDATION COURSES

Evaluation of each course shall involve Continuous Evaluation (CE) with 20 marks and End Semester evaluation (ESE) with 80 marks .

## CONTINUOUS EVALUATION FOR LECTURE COURSE

The Continuous evaluation will have 20 marks and will be done continuously during the semester. CE components are

Attendance for lecture and laboratory sessions (to be noted separately where both lecture and laboratory hours have been specified within a course);

(i) Assignment /seminar and

(ii) Test

The weightage is shown in Table I.1. There will be two class tests for which, the better of the two grades obtained will form part of CE. Seminar for each course to be organized by the course teacher and assessed along with a group of teachers in the Department. The topic selection by the student for assignments/seminar will be with the approval of the course teacher.

| **No** | **Marks** | **Component** |
|---|---|---|
| 1 | 5 | Attendance |
| 2 | 5 | Assignment / Seminar |
| 3 | 10 | Tests |
| | 20 | Total |

## QUESTION PAPER PATTERN FOR CONTINOUS EVALUATION TEST

1. The theory examination has a duration of 3 hours
2. Each question paper has three parts: A, B , C

3. Part A contains ten questions. Each question carries1mark. The questions may be in the forms – one word/one sentence.

4. Part B contains twelve questions. Out of these twelve questions, the students have to answer 8 questions. Each question carries 2 marks. Each answer should contain four points. (Short Answer type ).

5. Part C contains nine questions of which the candidate has to answer 6 questions. Each question carries 4 marks. The answer must contain 8 points (Short Essay type). Part D contains four questions of which the candidate has to answer 2 questions. Each question carries 15 marks (Long essay type)

Question paper should contain 20 % hard, 60 % medium and 20 % easy questions.

| **Question Paper Pattern for Test** | | |
|---|---|---|
| *Marks* | *Type of Question* | *Question No* |
| 1X10=10 | All / one word/one sentence | Part A: 1-10 |
| 8 X2=16 | 8 out of 12; Short Answer | Part B: 11-22 |
| 4 X6= 24 | 6 out of 9; Short Essay | Part C: 23-31 |
| 2×15=30 | 2 out of 4; Long Essay | Part D:32-35 |
| 80 marks | | TOTAL |

**CONTINUOUS EVALUATION FOR LABORATORY COURSES**

The Continuous evaluation will have 20 marks. The ESE of laboratory courses will be done only in the IV semester. But the corresponding CE are calculated from all the semesters in which there is attendance for laboratory sessions.

| **No** | **Marks** | **Component** |
|---|---|---|

| | | |
|---|---|---|
| 1 | 5 | Attendance |
| 2 | 5 | Lab test |
| 3 | 5 | Record |
| 4 | 5 | Punctuality |
| | 20 | Total |

## I. 2. 1. EVALUATION OF THE RECORD

On completion of each experiment, a report should be presented to the course teacher as soon as the experiment is over. It should be recorded in a bound note -book and not on sheets of paper. The experimental description should include aim, principle, materials/apparatus required/used, method/procedures, and tables of data collected, equations, calculations, graphs, and other diagrams etc. as necessary and final results. Careless experimentation and tendency to cause accidents due to ignoring safety precautions will be considered as demerits.

| **CE for Laboratory Record** | | |
|---|---|---|
| **Marks** | **Sub Component** | **No** |
| All four sub-components present & satisfactory 5<br>Only three : 4<br>Only two : 3<br>Only one : 2 | Punctual submission and Neat presentation | **1** |
| | Record of more than 90 % experiments in the syllabus | **2** |
| | Calculations and absence of errors/mistakes | **3** |

| | | |
|---|---|---|
| | Accuracy of the result | **4** |

**During ESE external examiner has to verify the Lab report of experiments certified by the tutor and HOD. The scheme of examination for lab exams may be framed by the Board of examiners.**

**END SEMESTER QUESTION PAPER PATTERN & GUIDELINE FOR QUESTION PAPER SETTERS**

1. The theory examination has a duration of 3 hours
2. Each question paper has four parts: A, B, C and D
3. Part A contains ten questions. Each question carries1 mark. The questions may be in the forms – one word/one sentence.
4. Part B contains twelve questions. Out of these twelve questions, the students have to answer eight questions. Each question carries 2 marks. Each answer should contain four points. (Short Answer type).
5. Part C contains nine questions of which the candidate has to answer six questions. Each question carries 4 marks. The answer must contain 8 points (Short Essay type).
6. Part D contains four questions of which the candidate has to answer two. Each question carries 15marks. Essay type question. Each question carries two or three subdivisions (10+5) or (5+5+5) pattern.
7. The total weightage for the entire questions to be answered is 80 marks.
8. Question paper should contain 20% hard, 60% medium and 20% easy questions.
9. Question paper setter shall submit a detailed scheme of evaluation along with question paper.

| **Question Paper Pattern for Test** | | |
|---|---|---|
| *Marks* | *Type of Question* | *Question No* |

| | | |
|---|---|---|
| 1x10=10 | 10 one word/one sentence | Part A: 1-10 |
| 2x8=16 | 8 out of 12; Short Answer | Part B: 11-22 |
| 4x6=24 | 6 out of 9; Short Essay | Part C: 23-31 |
| 2x15=30 | 2 out of 4; Essay | Part D: 32-35 |
| Total = 80 marks | | |

# Complementary courses offered to Physics Majors

**SYLLABUS OF COMPLEMENTARY COURSE**
**(For students of Physics Majors)**

| Instructional Hours | Title of Course | Course* | Number Of Credits | Hours\ Week Theory | Lab | Sem |
|---|---|---|---|---|---|---|
| 2×18 = 36<br>2×18 = 36 | | AUCH131 .2d | 2 | 2 | 2 | 1 |
| 2×18 = 36<br>2×18 = 36 | | AUCH231 .2d | 2 | 2 | 2 | 2 |
| 3×18 = 54<br>2×18 = 36 | | AUCH331 .2d | 3 | 3 | 2 | 3 |
| 3×18 =54<br>2×18 = 36 | | AUCH431 .2d<br><br>AUCH43.2d PI | 3<br><br>4 | 3 | 2 | 4<br><br>4 |

**B.Sc Complementary Course**
**(For students of Physics majors)**
**SEMESTER I**
**Complementary Course N o.: 1**
**THEORETICAL CHEMISTRY**

| **AUCH 131.2d –Theoretical Chemistry** | |
|---|---|
| **Total Teaching Hours for Semester : 36** | **No of Lecture Hours/Week: 2** |
| **Max Marks: 80** | **Credit-2** |
| **Course Outcomes** | |
| **CO1: To learn about the structure of atom**<br>**CO2: To know the types of chemical bonds in compounds**<br>**CO3: To appreciate the energetics of the reaction**<br>**CO4: To understand the concept of radioactivity and nuclear chemistry**<br>**CO5: To make students capable of understanding the analytical principles in chemistry** | |

**L–T-P- 2-0-2** **Total Hour: 36**

**Module I – Atomic Structure** **(9 hrs)**

Introduction to the structure of atom - Dual nature of electron - de Broglie equation - matter waves and electromagnetic waves - experimental verification of de Broglie relation - Heisenberg's uncertainty principle - expression and significance. Wave mechanical concept of the atom - Schrodinger equation (no derivation) - Charge cloud and probability concepts - orbitals, radial and angular probability distribution curves, shapes of orbitals. Four quantum numbers and their significances. Orbital wise electron configuration, energy sequence rule – Pauli's principle, Hund's rule, stability of filled and half-filled orbitals.

**Module II - Chemical Bonding** **(9 hrs)**

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 – Pauling's and Mullikan's approaches, factors influencing polarity, dipole moment – its relation to geometry. Hydrogen bond – intermolecular and intramolecular– its consequences on boiling point – volatility and solubility. Hydrogen bonding in DNA.

Hybridisation and structure of molecules – sp, $sp^2$, $sp^3$, $dsp^2$, $dsp^3$, $sp^3d^2$, and $sp^3d^3$ hybridisation with examples. Explanation of bond angle in water and ammonia VSEPR theory, geometry of molecules with bond pairs of electrons only, geometry of molecules containing bond pairs and lone pairs of electrons, limitations. 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 - Radioactivity (9 hrs)**

Radioactive equilibrium (qualitative idea only) 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 the biological effects of radiation such as pathological and genetic damage, Dosimetry – Units – rad, gray and roentgen. Fricke dosimeter and ceric sulphate dosimeter. Nuclear Chemistry – stability of Nucleus – n/p ratio, artificial transmutation and radio activity, mass defect, binding energy, atomic fission and fusion.

**Module IV- Analytical Principles (9 hrs)**

Analytical methods in Chemistry – principles of volumetric analysis, primary standard, standard solution, normality and molarity, theory of acid - base titration, permanganometric and dichrometric titration, theory of acid – base and redox indicators.

Inorganic qualitative analysis, common ion effect - solubility product - precipitation of cations – Chromatography - principle and applications of column, paper and thin layer chromatography.

Evaluation of analytical data – accuracy and precision, classification of errors. Detection and correction of determinate errors, standard deviation, variance and coefficient of variation.

Introduction to Lab safety-regulatory requirements-labels, material safety.Knowledge of hazard warning information and symbols.

**Text books**

1. B. R. Puri, L. R. Sharma, *Principles of Inorganic Chemistry*, 6th Edition, 1976.
2. V. K. Ahluwalia, *Environmental Chemistry*, 2nd Edition, New Delhi, 2016.

**Reference books**

1. Manas Chanda, *Atomic Structure and Chemical Bond: Including Molecular Spectroscopy*, Vol. 1, 1981.

2. A. I. Vogel, *A Text Book of Quantitative Inorganic Analysis*, 3rd Edition, London, Longmans, 1961.
3. A. I. Vogel, *A Text book of Qualitative Analysis*, 3rd Edition, London, Longman; 1966.
4. A. K. De, *Environmental Chemistry*, 6th Edition, New Age International, New Delhi 2003.
5. S. K. Banerji, Environmental Chemistry. 1st Edition, Prentice-Hall of India, 1993.
6. H. H. Fawcett, W.S. Wood, *Safety and Accident Prevention in Chemical Operations*, 2nd Edition, Wiley-Interscience, New York, 1982.
7. Young, Jay A., ed., *Improving Safety in the Chemical Laboratory*, John Wiley & Sons, Inc., New York, 1987.
8. Satya Prakash, R.D. Madan, Modern Inorganic Chemistry, S Chand & Co Ltd, New Delhi, 1987.

**First semester B.Sc Degree Examination**

**Model question paper**

**Complimentary course for Physics**

**AUCH131.2d:THEORETICAL CHEMISTRY**

**(2017 admission onwards)**

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

## SECTION A

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

1. Write the electronic configuration of Chromium?
2. Name the principle according to which an orbital can accommodate only two electrons?
3. What is the shape of $IF_7$ molecule?
4. Write the hybridization of Boron in $BF_3$?
5. What is the bond order of $O_2^+$ ?
6. Emission of ------ from a radioactive element does not bring any change in charge or mass.
7. What is the base of radiocarbon dating.

8. What is the result of the beta emission of group 15 element?

9. A useful indicator for the titration of acetic acid versus sodium hydroxide is --------.

10. Calculate the normality of 10% NaOH solution. **(10×1=10 marks)**

## SECTION B

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

11. State Hund's rule.

12. Give the general equation for the frequency of the lines in the Balmer series for hydrogen?

13. Write the Schrodinger wave equation and explain the terms?

14. $NH_3$ and $CH_4$ have $SP^3$ hybridization. Shapes of these molecules are different. Why?

15. Distinguish between intermolecular and intramolecular hydrogen bonding?

16. The bond energy of $NO^+$ is larger than that of NO. Why?

17. Define Soddy's group displacement law?

18. The half life period of $Ra^{226}$ is 1620 years. Calculate the value of K for its decomposition in $years^{-1}$?

19. What are beta rays? Which element is formed when beta particle is emitted from Cl-38?

20. Phenolphthalein is not suitable for the titration of strong acid X weak base. Why?

21. How would you prepare 100ml of 0.05M Mohr's slat solution?

22. What are primary standards? Give two examples. **(8×2=16 marks)**

## SECTION C

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

23. Why is Bohr model of atom considered inadequate?

24. Explain hydrogen spectrum?

25. Explain why $CO_2$ and $CCl_4$ molecules are non polar but $CHCl_3$ molecule is polar?

26. Explain the shape of $SF_6$ molecule.

27. Water exists as liquid at room temperature while $H_2S$ is a gas at the same temperature. Account for the reason.

28. Explain neutron activation analysis and its application?

29. Write a note on (i) Geiger-Muller counter and (ii) Wilson cloud Chamber.

30. Explain the principle and application of paper chromatography?

31. Explain the theory of redox indicators. **(6×4=24 marks)**

## SECTION D

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

32. What are the postulates of M.O.T. Compare bonding molecular orbital and antibonding molecular orbital.

33. (i) Write a short note on Born- Haber cycle?

(ii) Draw and explain the MO diagram for $O_2$ molecule.

(iii) Describe the different approaches of electronegativity?

34. (i) Derive an equation for the decay constant of a radioactive material.

(ii) If at the end of 67.5 years only 3.125% of a radioactive material remains without decay. What is the half life of the decay?

(iii) Give an example each for proton, neutron and deuteron induced reactions.

35. (i) what are acid base indicators?

(ii) explain the use of indicators in acid base titrations.

(iii)Discuss the titration curves for the titration of strong acid – strong base and weak acid –strong base? **(15×2=30 marks)**

**SYLLABUS OF COMPLEMENTARY COURSE**
**(For students of Physics majors)**
**SEMESTER II**
**PHYSICAL CHEMISTRY-I**
**Complementary Course No.- 2**
**Course Code- AUCH 231 .2d Credit – 2**

**L-T-P 2-0-2** **Total Hours - 36**

**Course Outcomes (CO)**

| **AUCH 231.2d –Physical Chemistry 1** | |
|---|---|
| **Total Teaching Hours for Semester :36** | **No of Lecture Hours/Week :2** |
| **Max Marks :80** | **Credit-2** |
| **Course Outcomes** | |
| **CO1: Familiarize with laws of thermodynamics**<br>**CO2: Understands the enthalpies of reaction**<br>**CO3: Learns the principles and applications of chemical and ionic equilibria** | |

**Module I – Thermodynamics** **(9 hrs)**

Basic concepts- system, surroundings, types of systems. Extensive and intensive properties, macroscopic properties. State functions and path functions. Types of Processes, Zeroth law of thermodynamics Definition of internal energy and enthalpy. Heat capacities at constant volume (Cv) and at constant pressure (Cp), relationship between Cp and Cv. First law and its mathematical statement. 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 II - Thermochemistry (9 hrs)**

Standard states and enthalpies of formation, combustion, neutralization, solution and hydration. Integral and differential enthalpies of solution. Relation between heat of reaction at constant volume and constant pressure, variation of heat of reaction with temperature. Kirchhoff's equation, Hess's law and application – bond dissociation energies and bond energies of different types of bonds, their calculation and enthalpies of reaction.

**Module III – Chemical Equilibrium (9 hrs)**

Reversible reactions – KP, KC, and KX and their inter relationships – Free energy change and chemical equilibrium (thermodynamic derivation) – van't Hoff reaction isotherm and isochore - influence of pressure and temperature on the following reactions.
(i) $N_2 + 3H_2 \rightarrow 2NH_3$ (ii) $PCl_5 \rightarrow PCl_3 + Cl_2$ (iii) $2SO_2 + O_2 \rightarrow 2SO_3$
Le Chatelier's principle and the discussion of the above reactions on its basis. Clausius – Clapeyron equation and its applications.

**Module IV– Ionic Equilibrium (9 hrs)**

Concepts of Acids and Bases, ionization of weak electrolytes. Influence of solvent on acid strength – levelling effect - pH and its determination of potentiometric method. Buffer solutions and calculations of their pH. Henderson equation. Hydrolysis of salt – 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.

**Text books**


1. Puri, Sharma, Pathania, *Principles of Physical Chemistry*,
2. Gurudeep Raj, *Advanced Physical Chemistry*,


**References**


1. S. Glasstone, *Thermodynamics for Chemists*
2. Glasstone, Lewis, *Elements of Physical Chemistry*
3. K. L. Kapoor, *A Text book of Physical Chemistry*


**Second semester B.Sc Degree Examination Model question paper**

**Complimentary course for Physics Majors**

**Semester II Complementary Course No.- 2**

**Course Code-AUCH231 .2d**

**PHYSICAL CHEMISTRY- I**

**(2017 Admission onwards)**

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

## SECTION A

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

1. What is a reversible process?
2. Write the first law of thermodynamics.
3. What is an isochoric process?
4. What is standard enthalpy of formation?
5. Write one example for an exothermic reaction.
6. What is enthalpy of hydration?
7. What is rate constant?
8. What is the significance of $\Delta G$?
9. What is common ion effect?
10. What is the $P^H$ of 0.01M HCl? **(10×1=10 marks)**

## SECTION B

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

11. One mole of an ideal gas at 25$^oC$ is allowed to expand isothermally and reversibly form a volume of 10 liters to 20 liters. Calculate the work done by the gas?
12. State the first law of thermodynamics. What are its limitations?
13. Write the relation between $\Delta G$, $\Delta H$ and $\Delta S$. What is the condition for spontaneity of a process?
14. Calculate the enthalpy of hydrogenation, $C_2H_4$ (g) + $H_2$(g) $\rightarrow$ $C_2H_6$ (g). Given that bond energy of H-H= 433kJ, C=C =615kJ and C-C= 347kJ and C-H = 413kJ.
15. Define Enthalpy of formation.
16. What is bond dissociation energy?

17. State Le Chatlier principle.

18. What is isochoric process?

19. What are the characteristics of equilibrium constant?

20. Define Lewis acid and base.

21. What is meant by levelling effect?

22. What is ionic product of water? **(2×8=16 marks)**

## SECTION C

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

23. What do you understand by heat capacity of a system? Show from thermodynamic considerations that Cp - Cv = R.

24. Derive Gibb's Helmohtz equation.

25. In a certain process 675 J of heat is absorbed by a system while 290 J of work is done on the system. What is the change in internal energy for the system?

26. State and explain Hess's law.

27. Derive relation between heat of reaction at constant volume and constant pressure.

28. Calculate the equilibrium constant for a reaction at 25 $^0$C. $\Delta G^0$=20 kcal.

29. Predict the effect of pressure on the dissociation of $PCl_5$.

30. What is meant by Buffer solution? Give an example of acidic and basic buffer solution? Explain its mechanism?

31. Write Henderson equation. What is its significance? **(6×4=24 marks)**

## SECTION D

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

32. (i) Derive an expression for work done in the reversible isothermal isothermal expansion of an ideal gas. (ii) Define

    (a) Work function

    (b) Gibbs free energy function

    (c) Entropy

    (d) Internal energy

33. (i) State Kirchhoff's equation. Indicate how it can be used to evaluate ΔH of a reaction
from heat capacity data of reactants and products.

(ii) Calculate the heat of formation of $CO_2$. Given that CO (g)+$H_2O$ (l) ---❼ $CO_2$ (g) $H_2$(g); ΔH=0.7 kcal. Heat of formation of $H_2O$ (l) and CO (g) are -68.3 and -26.4 $kcalmol^{-1}$ respectively.

34. (i) Derive van't Hoff equation.

(ii) Derive relation between Kp and Kc.

(iii) The equilibrium constant of a reaction doubles on raising the temperature from 25 $^0$C to 35 $^0$C. Calculate $\Delta H^0$ of the reaction?

35. (i) Define pH of a solution. Calculate the pH of 0.2M acetic acid in 0.5M sodium acetate at 298K. Dissociation constant of acetic acid at 298K is 1.8 $x10^{-5}$?

(ii) Write a note on salt hydrolysis?

**(15×2=30 marks)**

**SYLLABUS OF COMPLEMENTARY COUSRSE**
**SEMESTER III**
**(For students of Physics Majors)**

| **AUCH 331.2d – PHYSICAL CHEMISTRY- II** | |
|---|---|
| **Total Teaching Hours for Semester : 54** | **No of Lecture Hours/Week: 3** |
| **Max Marks: 80** | **Credit-3** |
| **Course Outcomes** | |
| *** To learn about the basic concepts in gaseous chemistry**<br>*** To understand, and compare the structure of crystalline, amorphous solids and liquid crystals**<br>***To study about the basic theoretical principles electrochemical processes and fuel cells**<br>*** To study the basic principles of spectroscopy**<br>*** About the rate of the reactions and factors affecting the Arrhenius parameters**<br>*** Based on the physical state of the dispersion medium and of the dispersed phase and colloids** | |

**Course-3 Credit-3Course Code –**

**L-T-P 3-0-2** **54Hrs**

**Module 1- Gaseous State** **(9 hrs)**

Ideal gas equation, Behaviour of real gases, Deviation from ideal behaviour, Compressibility factor, Boyle temperature - van der Waal's equation of state – derivation, Collision frequency, Collision number, Collision diameter and mean free path (No derivation).

Types of molecular velocities, most probable, root mean square and average velocities, their inter relations, Maxwell Boltzmann distribution of molecular velocities (No derivation), Critical constants and their experimental determination, relation between critical constants and van der Waals 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** **(9 hrs)**

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 X-rays by crystals – single crystal and powder method. Detailed study of structures of NaCl and KCl crystals.

**Module III - Electrochemistry (9 hrs)**

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. Lithium ion battery.

**Module IV - Spectroscopy-I (9 hrs)**

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 transitions and regions of absorption.

**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 for zero, first and second order reactions, 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 - Colloidal State (9 hrs)**

Kinetic, optical and electrical properties of colloids – Ultra microscope – determination of Avogadro number by Brownian movement – Electrical double layer and zeta potential. Gels – inhibition and syneresis. Micelles, critical micelle concentration, sedimentation and streaming potentials. Application of colloids. Cottrell precipitator – purification of water, coagulation, reverse osmosis, electro dialysis.

**Text books**

1. Puri, Sharma, Pathania, *Principles of Physical Chemistry*,

2. Gurudeep Raj, *Advanced Physical Chemistry*

**References**


1. P. W. Atkins, *Physical Chemistry*
2. F. Daniel, R.A. Alberty, *Physical Chemistry*
3. L .V. Azaroff, *Introduction to Solids*
4. N. B. Hannay, *Solid State Chemistry*


**Third Semester B.Sc Degree Examination**

**Complementary Course for Physics**

**Model Question Paper**
**AUCH 331 .2d: PHYSICAL CHEMISTRY- II**
**(2017 Admission Onwards)**

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

**SECTION A**

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

1. State the reduced equation of state
2. Define most probable velocity.
3. How many unit cells 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 order of the reaction with rate constant $2x10^{-2}$ $molL^{-1}s^{-1}$
8. The unit of second order rate constant is…..
9. Define rate law.
10. Give the selection rule for rotational spectrum **(10×1=10 marks)**

**SECTION B**

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

11. Define critical constants.
12. Explain collision number, collision frequency and mean free path
13. Why do real gases deviate from ideal behaviour?
14. Explain the term Space lattice and Unit cell.

15. Define Miller indices.
16. What are reference electrodes? Give their significance?
17. How many fundamental vibrations are expected for $CO_2$ and water?
18. Explain electromagnetic spectrum
19. What is the requirement for a molecule to be IR active?
20. Define order and molecularity of a reaction?
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 are the factors affecting the rate of a reaction? **(8×2=16 marks)**

## 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=$31^0$C, Pc=72.8atm and R=0.082lit atm/K?
25. Explain the symmetry elements in crystals
26. Derive Bragg's equation.
27. Write a brief note on Calomel electrode?
28. EMF of a standard Daniel Cell is 1.01832 V at 298 K. Temperature coefficient of the cell is 5 x $10^{-5}$ V/K. Calculate ΔG, ΔH, and ΔS of the cell reaction?
29. Discuss briefly the principle of IR spectroscopy.
30. Write a note on pure rotational spectrum.
31. Derive an expression for the rate constant of a first order reaction. **(6×4=24 marks)**

## SECTION D

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

32. (i) Explain Linde's and Claude's method of liquefaction of gases?
    (ii) What is Joule Thomson effect? How is it useful for the liquefaction of gases.
    (iii) Explain the terms: collision frequency and collision diameter.
33. (i) Explain (a) the rotating crystal method and (b) powder method for the determination of 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.
34. (i) Write a brief note on fuel cells? (ii) State and explain Nernst equation
    (iii) Explain the principle of potentiometric titrations?
35. (i) The rate of a reaction triples when the temperature changes from 20 $^o$C to 50 $^o$C. Calculate the energy of activation for such a reaction. (R=8.314 $JK^{-1}mol^{-1}$).
    (ii) Derive an expression for rate constant of a second order reaction?
    (iii) Explain the influence of temperature on reaction rates? **(15×2=30 marks)**

**B. Sc. Complementary Course**
**(For Physics Majors)**
**SEMESTER IV Course No.4 Credit-3**

| **AUCH 431 .2d – SPECTROSCOPY AND MATERIAL CHEMISTRY** | |
|---|---|
| **Total Teaching Hours for Semester : 54** | **No of Lecture Hours/Week: 3** |
| **Max Marks: 80** | **Credit-3** |
| **Course Outcomes** | |
| *** Enable to understand Raman and NMR spectroscopy**<br>*** Learn more about the types of Catalyst, chemical Reactions and photochemistry**<br>*** The students will acquire knowledge of theories of coordination chemistry and its applications**<br>*** To study the processes of mineral dressing, metal extraction and refining**<br>*** Basic knowledge of nanoparticles , historical aspects and applications**<br>*** Advanced techniques for materials characterization are exposed, magnetic materials and their applications** | |

**Module I - 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 resolution spectrum, chemical shift, spin – spin coupling – fine structure spectrum, application to simple molecule.

**Module II – Catalysis and Photochemistry (9 hrs)**

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 III - Coordination Chemistry (9 hrs)**

Types of ligands, Werner's Coordination theory, 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, application in qualitative and quantitative analysis.

**Module IV – Metallurgy (9 hrs)**

General principles of occurrence and extraction of metals – purification, roasting, calcination and smelting, reduction to metal, different method with examples, refining of metals- electrolytic and zone refining. Van – Arkel method. Metallurgy of Titanium, Cobalt, Nickel, Thorium and Uranium.

**Module V - Chemistry of Nanomaterials (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.
Applications of nano materials in electronics, robotics, computers, sensors, mobile electronic devices, Medical applications (use Au, Ag, ZnO and ZnO as examples)

**Module VI- Advanced Materials and Characterisation (9 hrs)**

Magnetic materials-classification-applications- conducting polymers- polyacetylene-ployanilines- synthesis- applications- photoconducting polymers-examples-super conducting materials - Liquid crystals – mesomorphic state, types of liquid crystals applications and examples.

Tools for measuring nano structure – Powder XRD, Atomic force Microscopy, Scanning Tunnelling Microscopy, and Scanning Electron Microscopy, Transmission Electron Microscopy.

**Textbooks**

1. Puri, Sharma, Kalia *Inorganic Chemistry*
2. Chatwal R. Gurdeep, Sham K. Anand *Spectroscopy (Atomic and Molecular*)

**References**

2. C. N. Banwell, *Fundamental of Molecular Spectroscopy*
3. Manas Chandra, *Atomic Structure and Chemical Bonding in Molecular Spectroscopy*
4. James E Huheey, *Inorganic Chemistry*
5. S. F. A. Kettle, *Coordination Chemistry*
6. T. Pradeep, *NANO: The Essentials*
7. Charles Kittel, *Introduction to Solid State Physics*

**Fourth Semester B.Sc Degree Examination**
**Complementary Course for Physics**

**Model Question Paper**

**AUCH 431 .2d: Spectroscopy and Material Chemistry**
**(2017 Admission onwards)**

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

**SECTION A**

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

1. What is mutual exclusion principle?
2. What is Rayleigh scattering?
3. What are the characteristics of a catalytic reaction?
4. What is the condition for a molecule to be NMR active?
5. What are amphidentate ligands
6. What is nano shells?
7. Write an example for a chelate.
8. What are the ores of titanium?
9. Name the nano meterials used in semiconductors?
10. Define conduction polymers

**SECTION B**

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

11. What is Born Oppenheimer approximation?
12. Explain photsensitisation.
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. Discuss van-Arkel method of refining of metals.
17. What is the difference between a double salt and a complex compound?
18. $[Fe(CN)_6]^{3-}$ paramagnetic. Why?
19. Explain Van Arkel method of refining of metals.
20. What is froth flotation?
21. What are STM and its basic principle?
22. Explain the synthesis of polyaniline from aniline.

## SECTION C

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

23. Why are anti-stokes lines intense than the stokes lines in the Raman spectrum?
24. Write a note on fluorescence, phosphorescence and chemiluminescence.
25. State and illustrate the Frank-Condon principle.
26. Define the terms: Bathochromic, Hypsochromic, Hyperchromic, Hypochromic shifts.
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. Outline the principles involving electrolytic refining.
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** marks)*

32. (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) Discuss the quantum theory of Raman spectroscopy
33. (i) Explain intermediate compound formation theory and adsorption theory of catalysis.
    (ii) Explain the kinetics of $H_2$-$Cl_2$ reaction.

(iii) Write short notes on laws of photochemistry

34. (i) Give an account of crystal field theory?
    (ii) What are applications of coordination compounds in qualitative analysis?
    (iii) What are the postulate of valence bond theory
35. (i) Explain the applications of nanomaterials in electronic and robotics.
    (ii) Explain working principle of SEM and TEM.
    (iii) Give a note on types of liquid crystals.

## SYLLABUS FOR LABORATORY COURSES FOR B.Sc COMPLEMENTARY CHEMISTRY

**Course V Course Code: AUCH 43.2d PI Credit 4**

**For Physics Majors -Semesters 1, 2, 3 & 4**

Reactions and identification of cations : $Hg^{+}$ , $Pb^{2+}$, $Ag^{+}$ , $Hg^{2+}$, $Bi^{3+}$, $Cd^{2+}$, $As^{3+}$, $Sb^{3+}$, $Sn^{2+}$, $Sn^{4+}$, $Fe^{3+}$, $Al^{3+}$, $Cr^{3+}$, $Mn^{2+}$, $Zn^{2+}$, $Ni^{2+}$, $Cd^{2+}$, $Ba^{2+}$, $Sr^{2+}$, $Ca^{2+}$, $Mg^{2+}$ and $NH_4^{+}$

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

**Volumetric analysis- one burette method only**

### A. Acidimetry and Alkalimetry

a. Preparation and standardization of decinormal HCl using sodium carbonate

as primary standard

b. (Estimation of a strong base and a weak base using standardized HCl)
Estimation of sodium hydroxide using (i)Std. oxalic acid and (ii) Std. HCl

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

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

e. Estimation of a strong acid using standardized NaOH.

**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**

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

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

**D. Iodometry and Iodimetry**

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

h. Estimation of copper in a solution

i. Estimation of iodine

E. **Complexometric titrations**

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

k. 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.

**Physical Chemistry Experiments**

1. Conductometric titrations- HCl Vs NaOH

2. Potentiometric titrations- Ferrous iron Vs Dichromate

This laboratory based course reinforces the qualitative and quantitative chemical analysis that the student has learned in the $1^{st}$, $2^{nd}$, $3^{rd}$ and $4^{th}$ semesters.

# Complementary Chemistry offered to Botany Majors

# Complementary Chemistry offered to Botany Majors

Each Complementary Course has 4 theory courses and 4 practical courses. The Hour allotments and Credits for all are given in the table.

**Complementary Courses -4 Total Credits – 14**

**One Semester – 18 Weeks**

| Sem | Hours/Week Theory | Lab | Number of Credits | Course | Title of Course | Instructional Hours |
|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 2 | AUCH131 .2a | | 2×18 = 36<br>2×18 = 36 |
| 2 | 2 | 2 | 2 | AUCH 231 .2a | | 2×18 = 36<br>2×18 = 36 |
| 3 | 3 | 2 | 3 | AUCH 331 .2a | | 3×18 = 54<br>2×18 = 36 |
| 4 | 3 | 2 | 3<br>4 | AUCH 431 .2a<br>AUCH 432 .2a PI | | 3×18 =54<br>2×18 = 36 |

**GENERAL ASPECTS OF EVALUATION**

**MODE OF EVALUATION-COMMON TO CORE , ELECTIVE,COMPLEMENTARY AND FOUNDATION COURSES**

Evaluation of each course shall involve Continuous Evaluation (CE) with 20 marks and End

Semester evaluation (ESE) with 80 marks .

**CONTINUOUS EVALUATION FOR LECTURE COURSE**

The Continuous evaluation will have 20 marks and will be done continuously during the semester. CE components are

Attendance for lecture and laboratory sessions (to be noted separately where both lecture and laboratory hours have been specified within a course);

(iii) Assignment /seminar and

(iv) Test

The weightage is shown in Table I.1. There will be two class tests for which, the better of the two grades obtained will form part of CE. Seminar for each course to be organized by the course teacher and assessed along with a group of teachers in the Department. The topic selection by the student for assignments/seminar will be with the approval of the course teacher.

| **No** | **Marks** | **Component** |
|---|---|---|
| 1 | 5 | Attendance |
| 2 | 5 | Assignment / Seminar |
| 3 | 10 | Tests |
| | 20 | Total |

**QUESTION PAPER PATTERN FOR CONTINOUS EVALUATION TEST**

6. The theory examination has a duration of 3 hours

7. Each question paper has three parts: A, B , C

8. Part A contains ten questions. Each question carries1mark. The questions may be in the forms – one word/one sentence.

9. Part B contains twelve questions. Out of these twelve questions, the students have to answer 8 questions. Each question carries 2 marks. Each answer should contain four points. (Short Answer type ).

10. Part C contains nine questions of which the candidate has to answer 6 questions. Each question carries 4 marks. The answer must contain 8 points (Short Essay type). Part D contains four questions of which the candidate has to answer 2 questions. Each question carries 15 marks.(Long essay type)

Question paper should contain 20% hard, 60% medium and 20% easy questions.

| **Question Paper Pattern for Test** | | |
|---|---|---|
| *Marks* | *Type of Question* | *Question No* |
| 1X10=10 | All / one word/one sentence | Part A: 1-10 |
| 8 X2=16 | 8 out of 12; Short Answer | Part B: 11-22 |
| 4 X6= 24 | 6 out of 9; Short Essay | Part C: 23-31 |
| 2×15=30 | 2 out of 4; Long Essay | Part D:32-35 |
| 80 marks | | TOTAL |

## CONTINUOUS EVALUATION FOR LABORATORY COURSES

The Continuous evaluation will have 20 marks. The ESE of laboratory courses will be done only in the IV semester. But the corresponding CE are calculated from all the semesters in which there is attendance for laboratory sessions.

| **No** | **Marks** | **Component** |
|---|---|---|
| 1 | 5 | Attendance |
| 2 | 5 | Lab test |
| 3 | 5 | Record |
| 4 | 5 | Punctuality |
| | 20 | Total |

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## I. 2. 1. EVALUATION OF THE RECORD

On completion of each experiment, a report should be presented to the course teacher as soon as the experiment is over. It should be recorded in a bound note -book and not on sheets of paper. The experimental description should include aim, principle, materials/apparatus required/used, method/procedures, and tables of data collected, equations, calculations, graphs, and other diagrams etc. as necessary and final results. Careless experimentation and tendency to cause accidents due to ignoring safety precautions will be considered as demerits.

| **CE for Laboratory Record** | | |
|---|---|---|
| **Marks** | **Sub Component** | **No** |
| All four sub-components present & satisfactory 5<br>Only three : 4<br>Only two : 3<br>Only one : 2 | Punctual submission and Neat presentation | **1** |
| | Record of more than 90% experiments in the syllabus | **2** |
| | Calculations and absence of errors/mistakes | **3** |
| | Accuracy of the result | **4** |

**During ESE external examiner has to verify the Lab report of experiments certified by the tutor and HOD. The scheme of examination for lab exams may be framed by the Board of examiners.**

## END SEMESTER QUESTION PAPER PATTERN & GUIDELINE FOR QUESTION PAPER SETTERS

10. The theory examination has a duration of 3 hours
11. Each question paper has four parts: A, B, C and D
12. Part A contains ten questions. Each question carries1mark. The questions may be in the forms – one word/one sentence.

13. Part B contains twelve questions. Out of these twelve questions, the students have to answer eight questions. Each question carries 2 marks. Each answer should contain four points. (Short Answer type).

14. Part C contains nine questions of which the candidate has to answer six questions.

Each question carries 4 marks. The answer must contain 8 points (Short Essay type).

15. Part D contains four questions of which the candidate has to answer two. Each

question carries 15marks.Essay type question. Each question carries two or three sub divisions (10+5) or (5+5+5) pattern.

16. The total weightage for the entire questions to be answered is 80 marks.

17. Question paper should contain 20% hard, 60% medium and 20% easy questions.

18. Question paper setter shall submit a detailed scheme of evaluation along with question paper.

| **Question Paper Pattern for Test** | | |
|---|---|---|
| *Marks* | *Type of Question* | *Question No* |
| 1x10=10 | 10 one word/one sentence | Part A: 1-10 |
| 2x8=16 | 8 out of 12; Short Answer | Part B: 11-22 |
| 4x6=24 | 6 out of 9; Short Essay | Part C: 23-31 |
| 2x15=30 | 2 out of 4; Essay | Part D: 32-35 |

**SYLLABUS FOR B.Sc. COMPLEMENTARY COURSE**
**(For Botany Majors)**

**SEMESTER 1 Complementary Course 1 Credit-2**
**(From 2017 admission onwards)**
**Course Code-AUCH 131.2a-Theoretical Chemistry**

| | |
|---|---|
| **Total Teaching Hours for Semester : 36** | **No of Lecture Hours/Week: 2** |
| **Max Marks: 80** | **Credit-2** |
| **Course Outcomes** | |
| **CO1: To develop the ability to understand the basic concepts of chemistry**<br>**CO2: To familiarise analytical principles of chemistry**<br>**CO3: To develop skills in the proper handling**<br>**CO4: To acquire the importance of environmental chemistry** | |

**L-T-P 2-0-2** **Total: 36 Hours**

**Module I – Atomic Structure** **(9 hrs)**

Atomic spectrum of hydrogen - different series, Rydberg equation, Bohr theory – postulates – statement of Bohr energy equation – derivation of spectral frequency from Bohr equation. Schrodinger wave equation (mention only, no derivation), concept of orbitals, the four quantum numbers and their significances.Orbitalwise electronic configuration, energy sequence rule – Pauli's principle, Hund's rule, Stability of filled and half-filled orbitals.

**Module II – Chemical Bonding** **(9 hrs)**

Energetics of bond formation – Born-Haber cycle.Hybridisation and structure of molecules – sp, $sp^2$, $sp^3$, $dsp^2$, $dsp^3$, $sp^3d^2$ and $sp^3d^3$ hybridisation with examples.Explanation of bond angle in water and ammonia.VSEPR theory with regular and irregular geometry. Hydrogen bond – intermolecular and intramolecular – its consequences on boiling point – volatility and solubility. Partial covalent character of the ionic bond – Fajan'srules. 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, $NO^+$.

**Module III – Analytical Principles and Safety measures in Laboratory (9 hrs)**

Principles of volumetric analysis – primary standard – standard solutions normality and molarity, theory of acid-base titrations, permanganometric and dichrometric titrations, iodometry andcomplexometric titrations. Theory of acid-base indicators – Redox indicators. Beer- Lambert law- Principles of colorimetry – Estimation of Iron.

Introduction to Lab safety-regulatory requirements-labels, material safety.Knowledge of hazard warning information and symbols. Explosive compounds(idea), potentially dangerous mixtures- Fire hazards(idea about flammable solvents, ignition sources used in laboratories, metal hydrides). Emergency procedures in chemical splashes to skin and eyes, burns and electric shock.

**Module IV – Environmental Chemistry (9 hrs)**

Different layers of atmosphere. Air pollution:Ozone layer depletion, ozone hole, protection of ozone umbrella –Particulates, Acid rain, Greenhouse effect, Smog –classic and photochemical smog- management of air pollution.

Water pollution: Causes- Heat, industrial waste, sewage water, detergents, agricultural pollutants - treatment of industrial waste water-Activated charcoal, Synthetic resin, reverse osmosis and electro dialysis - Quality of drinking water - Indian standard and W H O standard - Dissolved oxygen - BOD, COD.

Soil pollution - Pesticides, Fertilizers, Industrial waste, plastics - Control of pollution-E-waste-Disposal of plastic waste.

**Text books**


1. B. R. Puri, L. R. Sharma, *Principles of Inorganic Chemistry*, 6th Edition, 1976.
2. V. K. Ahluwalia, *Environmental Chemistry*, 2nd Edition, New Delhi, 2016.


**Reference books**


1. Manas Chanda, *Atomic Structure and Chemical Bond: Including Molecular Spectroscopy*, Vol. 1, 1981.
2. A. I. Vogel, *A Text Book of Quantitative Inorganic Analysis*, 3rd Edition, London, Longmans, 1961.
3. A. I. Vogel, *A Text book of Qualitative Analysis*,3rdEdition, London, Longman; 1966.
4. A. K. De, *Environmental Chemistry*, 6thEdition, New Age International, New Delhi 2003.
5. S. K. Banerji, Environmental Chemistry. 1st Edition, Prentice-Hall of India, 1993.
6. H.H. Fawcett, W.S. Wood, *Safety and Accident Prevention in Chemical Operations*, 2nd Edition, Wiley-Interscience, New York, 1982.
7. Young, Jay A., ed., *Improving Safety in the Chemical Laboratory*, John Wiley & Sons,

Inc., New York, 1987.

8. Satya Prakash, R.D. Madan, Modern Inorganic Chemistry, S Chand & Co Ltd, New Delhi, 1987.

# Mar Ivanios College (Autonomous)

**B.Sc. COMPLEMENTARY COURSE**
**(For Botany Majors)**
**SEMESTER 1 Complementary Course 1 Credit-2**
**(From 2017 admission onwards)**
**Course Code-AUCH 131.2a-Theoretical Chemistry**
**Model Question Paper**

**Time: 3 hrs** **Max marks: 80**

**Section A**

***(Answer all questions. Each question carries one 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 sp3 hybridization?
4. Calculate the bond order of H2 molecule.
5. Give the structure of XeO3.
6. What is Lattice Energy?
7. What is meant by primary standards?
8. Define Molality.
9. What is the optimum value of DO for good water quality?
10. What is meant by BOD? **(10×1=10 marks)**

**Section-B**

***(Answer any 8 questions. Each question carries two marks)***

11. What is Bohr Bury's rule?
12. Write down the Schrodinger Equation and explain the terms involved.
13. Explain the failures of Bohr's theory?
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. What are dichrometric titrations?
18. How would you prepare 100ml of 0.05M Mohr's salt solution?
19. Methyl orange is not a suitable indicator for the titration of weak acid with strong base. Why?

20. Which are green house gases? Mention their sources.
21. What is reverse osmosis? How it is useful in the purification of waste water?
22. What are chief factors responsible for water pollution? **(8×2=16 marks)**

## Section-C

***(Answer any 6 questions from the following. Each question carries four marks. )***

23. If the energy difference between two electronic states of hydrogen atom is 214.68 $KJmol^{-1}$. What will be the frequency of light emitted when the electrons jump from the higher to the lower level?
24. Explain the stability of half filled and completely filled orbitals.
25. Give an account of permanganometric titrations.
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 $SF_6$, $PCl_5$, $BF_3$.
29. Explain Born-Haber Cycle considering the formation of NaCl as an example.
30. Write a note on agricultural pollution.
31. Explain briefly the different methods for the treatment of industrial waste water.

**(6×4=24 marks)**

## Section-D

***(Answer any 2 questions from the following. Each question carries 15 marks.)***

32. (a) Discuss Bohr Theory, highlighting its merits and demerits.
    (b) What are quantum numbers? Give its significance.
    (c) Explain various rules regarding electronic configuration.

33. (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) Explain Beer's Law, Lambert's Law and Beer – Lambert Law.

34 (a) Write a note on Hydrogen bonding and its consequences.
    (b) How electronic configuration of molecules related to molecular behaviour? Explain.
    (c) Explain Fajan's Rule.

35 (a) Discuss the formation and importance of ozone layer.
    (b) What is meant by pollution and pollutants? Explain the classification of air Pollutants?
    (c) What are the sources of important air pollutants? **(15×2=30 marks)**

**(For Botany Majors)**
**SEMESTER I1 Complementary Course II**
**Course Code-AUCH 231.2a-Inorganic Chemistry**

| AUCH 231.2a –Inorganic Chemistry | |
|---|---|
| **Total Teaching Hours for Semester : 36** | **No of Lecture Hours/Week: 2** |
| **Max Marks: 80** | **Credit-2** |
| **Course Outcomes** | |
| **CO1: To introduce preparation and properties of organometallic compounds**<br>**CO2: To learn the fundamentals of spectroscopy**<br>**CO3: To have a basic understanding about the classification and nomenclature of coordination chemistry**<br>**CO4: To make students capable of understanding the properties of dilute solutions** | |

**L-T-P 2-0-2** **Total: 36 hrs**

**Module I - Organometallics** **(9 hrs)**

Definition and classification, Organometallic compounds of Mg, Sn, Li, Hg, Fe - synthesis, applications. Biological and environmental aspects of organometallic compounds – Organometallic compounds in medicines – organomercury, organoboron, organosilicon and organo arsenic compounds – outline of preparation and uses. Antitumour drugs, Silylated derivatives of bioactive organic compounds in agriculture and horticulture. Environmental aspects of Organometallic compounds.

**Module II - Spectroscopy – I** **(9 hrs)**

Regions of electromagnetic spectrum - interaction of radiation with matter – Different types of energy levels in molecules – rotation, vibration and electronic levels. Various types of molecular spectra – Microwave spectroscopy – spectra of diatomic molecules – Expression for rotational energy - selection rule – frequency separation, Infra-red spectra – equation for frequency of vibration – expression for vibrational energy. Selection rule, calculation of force constant.

**Module III - Coordination Chemistry (9 hrs)**

Nomenclature, Coordination number and geometry - chelates – isomerism – structural and stereo isomerism valence bond theory of bonding in octahedral and tetrahedral complexes – drawbacks of valence bond theory – high and low spin complexes – colour and magnetic properties of transition metal complexes. Application of metal complexes in qualitative and quantitative analysis.

**Module IV –Dilute solutions (9 hrs)**

Molarity, molality and molefraction - Colligative property – relative lowering of vapour pressure – elevation in boiling point – depression in freezing point – osmotic pressure – experimental determination of osmotic pressure – Isotonic solution – reverse osmosis - abnormal molecular mass - van't Hoff factor.

**Textbooks**


1. G. Aruldhas, *Molecular Structure and Spectroscopy*, Prentice-Hall of India Pvt. Limited, 2004.
2. B. R. Puri, L. R. Sharma, *Principles of Inorganic Chemistry*, 6th Edition, 1976.


**Reference books**


1. R. Gopalan, V. *Ramalingam, Concise Coordination Chemistry*, Vikas Publications, India, 2008.
2. R.C. Mehrotra, *Organometallic Chemistry: A Unified Approach*, New Age International Publications, New Delhi, 1991.


**Mar Ivanios College (Autonomous)**

**Model Question Paper of BSc Chemistry Programme**
**(2017 Admission onwards)**
**Complementary Course for Botany majors**
**SEMESTER II Course Code: AUCH 231.2a**
**INORGANIC CHEMISTRY**

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

**Section A**

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

1. Give the structure of Zeise's salt.
2. Write any one of the preparation methods of organolithium compounds.
3. What is ferrocene? How is it synthesized?
4. What is the selection rule in rotational spectrum?
5. What is the condition for a molecule to be IR active?

6. Write the IUPAC name of $K_3[Co(NO_2)_4Cl_2]$
7. What are low spin complexes?
8. What do you mean by chelate?
9. What is molality?
10. What are isotonic solutions?

**(10×1=marks)**

## Section-B

***(Answer any 8 questions from the following. Each question carries two marks)***

11. What is reformatsky reaction?
12. What is cisplatin? Give its significance.
13. How are organomercurials prepared?
14. Explain electromagnetic spectrum.
15. HCl is microwave active,but $H_2$ is not.Why?
16. The force constant of CO is 1840 $cm^{-1}$. Calculate the vibrational frequency in $cm^{-1}$. (Atomic mass $C^{12}$ = 19.9 x $10^{-27}$ kg, $O^{16}$ = 26.6 x $10^{-27}$ kg.)
17. Write the postulates of Werner's Coordination Theory.
18. What are poly dentate ligands? Give an example.
19. Explain the colours of transition metal complexes.
20. A solution containing 7g of a non volatile solute in 250g of water boils at 373.26 K. Find the molecular mass of the solute.(Kb for water is 0.52K/m)
21. Explain reverse osmosis.
22. Calculate the mole fraction of alcohol, $C_2H_5OH$ and water in a solution made by dissolving 9.2g of alcohol in 18g of water

**(8×2=16 marks)**

## Section-C

***(Answer any 6 questions from the following. Each question carries four marks.)***

23. Write a note on organotin compounds.
24. Write a brief note on the applications of organometallic compounds in agriculture and horticulture.
25. Explain the different energy levels in molecules.
26. Write a note on Werners coordination theory.
27. What are the postulates of Valence bond theory?
28. Suggest the structure of $[NiCl_4]$ on the basis of Valence Bond Theory.
29. Explain the magnetic properties of octahedral complexes with suitable examples.

30. What is osmotic pressure? How will you determine the molecular mass of a substance with this method?

31. Explain high spin and low spin complexes. **(6×4=24 marks)**

## Section-D

***(Answer any 2 questions from the following. Each question carries fifteen marks.)***

32 (a) Explain the synthesis and applications or Grignard reagent. (5 marks)
(b)What are Frankland reagents? Give its significance. (5 marks)
(c) Explain about organosilicon compounds in medicine. (5 marks)

33. (a) Derive an expression for the energy of a rotating molecule.(8 marks)
(b) How can we calculate bondlength from rotational spectra? (7 marks)

34. (a) Write a note on Crystal Field Theory. (5 marks)
(b) Explain the applications of complexes in qualitative analysis. (5marks)
(c) Write a brief note on isomerism in coordination complexes. (5marks)

35. (a) How can we determine Osmotic pressure experimentally? (8 marks)
(b) Write a note on colligative properties. (7 marks) **(15×2=30 marks)**

**(For Botany Majors)**
**SEMESTER I1I Complementary Course III Credit-3**
**(From 2017 admission onwards)**

| **Course code-AUCH 331.2a – Physical and Bioinorganic Chemistry** | |
|---|---|
| **Total Teaching Hours for Semester: 54** | **No of Lecture Hours/Week: 3** |
| **Max Marks: 80** | **Credits: 3** |
| **L-T-P: 3-0-2** | **Complementary Course: III** |
| **Course Outcomes** | |

- To enable the students to understand the concept of acids and bases, buffer solutions.
- To relate the rates of solutions and CST.
- To emphasis on the various aspects of metabolism & interrelationship of metabolic events.
- To apply the concepts of biophysical and catalysis to different chemical processes.
- To help the student to develop the habit of accurate manipulation and an attitude of
- critical thinking.
- To learn the basic analytical methods and appreciate what is involved in an analysis.
- To know the importance of nuclear reactions in the modern world.

**Module I -Ionic Equilibrium** **(9 hrs)**

Arrhenius, Lowry- Bronsted and Lewis concept of acids and bases, Kw and pH, pH of strong and weak acids, Ka and Kb, mechanism of buffer action, pH of buffer, Henderson equation, Hydrolysis of salt, Degree of hydrolysis and hydrolysis constant.

**Module II - Solutions** **(9 hrs)**

Completely miscible liquid pairs, vapour pressure - composition curve, boiling point-composition curve- ideal and non-ideal solutions, fractional distillation, azeotropes. Partially miscible liquids - CST, phenol-water system, nicotine-water system, Effect of impurities on miscibility and CST, immiscible liquid pairs, steam distillation- Distribution law and its limitations, applications of solvent extractions.

**Module III - Spectroscopy- II** **(9 hrs)**

UV-Visible spectroscopy: Absorption, types of electronic transitions, effect of conjugation, concept of chromophore, auxochrome, bathochromic, hypochromic, hyperchromic and hypochromic shifts. UV-Visible spectra of enes - $\lambda_{max}$. Applications

of UV spectroscopy - conjugation, functional group and geometrical isomerism. Principle of NMR, nuclear spin, chemical shift, spin-spin coupling, τ and δ, PMR of simple organic molecules $CHBr_2CH_2Br$, $CH_3CH_2Br$ and $CH_3CH_2OH$ .Principle of MRI.

**Module IV - Bioinorganic Compounds (9 hrs)**

Metalloporphyrins – cytochromes – chlorophyll photosynthesis and respiration – haemoglobin and myoglobin, mechanism of $O_2$ – $CO_2$ transportation, nitrogen fixation, carbon fixation and carbon cycle. Biochemistry of iron toxicity and nutrition, essential and trace elements in biological systems.

**Module V- Biophysical Analysis& Catalysis (9 hrs)**

Osmosis – osmotic pressure, isotonic solutions, determination of molar mass by osmotic pressure measurement – reverse osmosis. Adsorption – Types of adsorption – applications. Factors influencing adsorption.

Catalysis - different types of catalysis, intermediate compound formation theory and adsorption theory.

**Module VI - Nuclear Chemistry (9 hrs)**

Natural radioactivity, modes of decay, Geiger–Nuttal rule, artificial transmutation and artificial radioactivity- nuclear stability, n/p ratio, mass defect and binding energy, nuclear fission and nuclear fusion -applications of radioactivity- $^{14}C$ dating, rock dating, neutron activation analysis and isotope as tracers

**Textbooks**


1. Y. R Sharma, *Elementary Organic Spectroscopy*, S. Chand & Company, 2007.
2. B. R. Puri, L. R. Sharma, *Principles of Physical Chemistry*, Vishal Publishing,
3. R. Gopalan, V. *Ramalingam***,** *Concise Coordination Chemistry*, Vikas Publications, 2008.


**Reference books**


1. P.S. Kalsi, *Chemistry of Natural Products*, New Age International Private Ltd,
2. B.S. Bahl., G.D. Tuli, Arun Bahl, *Essentials of Physical Chemistry*, S. Chand & Co., New Delhi, 2014.

*Model Question Paper*

# Mar Ivanios College (Autonomous), Thiruvananthapuram

## Third Semester B.Sc Botany Degree Programme (CBCSS)

**(2017 Admission onwards)**

## Complementary Course for Botany Majors

**Course Code AUCH 331.2a**

## Physical and Bioinorganic Chemistry

**Time: 3 hours** **Max marks-80**

**SECTION – A**

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

1. What is the Lowry-Bronsted concept of acids and bases?
2. Give an example of a completely miscible liquid solution.
3. Define pH.
4. What is homogeneous catalysis?
5. Give one example of a heterogeneous catalysis
6. Define chemical shift.
7. Explain chromophore with an example.
8. What is meant by a buffer solution? Give one example each for acid buffer solution.
9. What is meant by the term ideal solution?
10. Define Van't Hoff factor.

**(10 × 1 = 10 Marks)**

**SECTION - B**

***(Answer any 8 questions from the following. Each question carries two marks.)***

11. Sketch the vapour pressure –composition curve of ideal solution?
12. What is chemical shift?
13. Explain briefly Lewis concept of acids and bases with two examples.
14. Differentiate respiration and photosynthesis.
15. What are trace elements?
16. Tetramethysilane is chosen as a reference compound in NMR studies. Give reasons.
17. What are the different types of electronic transitions?
18. What is the role of chlorophyll in photosynthesis?
19. A solution containing 7 g of a non-volatile solute in 250 g of water boils at 373.26 K. Find the molecular mass of the solute. (Kb for water is 0.52 K/m).
20. Explain the terms, degree of hydrolysis and hydrolysis constant.

21. Explain Geiger -Nuttal Rule.
22. What are mass defect and average life period?

**(8 X 2 = 16 Marks)**

## SECTION - C

**(*Answer any 6 questions from the following. Each question carries four marks.)***

23. What is energy of activation? What happens to the energy of activation in presence of a catalyst?
24. Explain half-life period of a reaction. A first order reaction has a specific reaction rate of $2.31 \times 10^{-3}\ s^{-1}$. Calculate the half-life period of the reaction.
25. Calculate the pH of a buffer solution containing 0.2 mole of $NH_4Cl$ and 0.1 mole of $NH_4OH$ per litre. Kb for $NH_4OH = 1.85 \times 10^{-5}$.
26. Derive the relation between $K_h$, $K_w$ and $K_a$.
27. Explain the principle of steam distillation?
28. What are the applications of solvent extraction?
29. Which of the following will show spin- spin coupling in their NMR spectra? If coupling is observed, give the spin multiplicity: (a) $ClCH_2CH_2Cl$, (b) $CH_3COCH_3$, (c) $CH_3CHO$, and (d) $ClCH_2CH_2I$.
30. Describe the adsorption theory of catalysis.
31. Explain the principle of Fractional Distillation.

**(6 X 4 = 24 marks)**

## SECTION – D

**(*Answer any 2 question. Each question carries 15 marks*)**

32. (a) Explain the mechanism of $O_2$-$CO_2$ transportation. (8 marks)
    (b) Write a note on nitrogen and carbon fixations. (7 marks)
33. (a) Explain phenol –water system and nicotine-water system (8 marks)
    (b) Explain the vapour pressure-composition curves of non-ideal solutions (7 marks)
34. (a) Define critical solution temperature. Explain systems having upper and lower CST using examples (8 marks)
    (b) Explain the applications of UV spectroscopy. (7 marks)
35. (a) Discuss the advantages of Bronsted-Lowery concept over Arrhenius concept and also the limitations of the Bronsted-Lowery concept. (5 marks)
    (b) The salt of strong acid and strong base does not undergo hydrolysis. Explain? (5 marks)
    (c) Explain the underlying principle in an NMR spectrum and interpret the low resolution NMR spectrum of ethanol molecule. (5 marks)

**(15 X 2 = 30 marks)**

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**(For Botany Majors)**
**SEMESTER IV Complementary Course IV Credit-3**
**(From 2017 admission onwards)**

| **Course code-AUCH 431.2a – Organic Chemistry** | |
|---|---|
| **Total Teaching Hours for Semester: 54** | **No of Lecture Hours/Week: 3** |
| **Max Marks: 80** | **Credits: 3** |
| **L-T-P: 3-0-2** | **Complementary Course: IV** |
| **Course Outcomes** | |

- To help the student to develop the habit of accurate manipulation and an attitude of critical thinking.
- To learn the basic analytical methods and appreciate what is involved in an analysis.
- To enumerate the molecular motif of a living cell, structural and functional hierarchy of biomolecules.
- Students the basic knowledge in Food Chemistry and modern trends in the industry.
- To provide the practical training to the students in the food analysis.
- After going through the course the student is expected to learn about the important drugs and the mode of actions.

**L-T-P 3-0-2** **Total: 54 Hours**

**Module I - Chromatography** **(9 hrs)**

Outline study of adsorption and partition chromatography, paper, thin layer, ion-exchange, gas chromatography- principle-instrumentation and applications and HPLC - Rf and Rt values – Separation of amino acids and dyes.

**Module II -Amino acids and Proteins** **(9 hrs)**

Amino acids: Classification, structure and stereochemistry of amino acids, essential and non-essential amino acids, zwitter ion, isoelectric point, General methods of preparation and reactions of α- amino acids.

Peptides: Structure and synthesis (Carbobenzoxy method, Sheehan method only).

Proteins: Structure of proteins, denaturation and colour reactions.

Nucleic acids: Classification and structure of DNA and RNA. Replication of DNA, Genetic codes - Translation- Transcription.

**Module III - Stereochemistry** **(9 hrs)**

Optical Isomerism : Chirality and elements of symmetry – DL notation – Enantiomers – optical isomerism in glyceraldehydes, lactic acid and tartaric acid – Diastereoisomers –

meso compounds – Cahn-Ingold-Prelog rules – R-S notations for optical isomers with one and two asymmetric carbon atoms- erythro and threo representations. Racemic mixture – resolution – methods of resolution.

**Module - IV Oils, Fats, Soaps, Alkaloids, Terpenes and Vitamins (9 hrs)**

Oils and Fats: Occurrence and extraction. Common fatty acids, soap, saponification value, iodine value, acid value. Alkaloids: Extraction and structural elucidation of conine, nicotine and importance of quinine, morphine and codeine. Terpenes: Essential oils, isolation of citral and geraniol (No structural elucidation) Isoprene and special isoprene rule.

Vitamins: Classification, structure functions and deficiency diseases (structures of vitamin A, B1 and C - but no structural elucidation).

**Module - V Carbohydrates (9 hrs )**

Carbohydrates: Classification, configuration, glyceraldehyde, erythrose, threose, ribose, 2-deoxyribose, arabinose, glucose, fructose and mannose. Preparation and properties of glucose and fructose - Pyranoside structures of glucose and fructose, furanoside structure of fructose (structure elucidation not expected). Mutarotation and epimerization. Conversion of glucose into fructose and vice versa.

**Module- VI Drugs (9 hrs)**

Drugs: Classification of drugs- analgesic, antipyretic, antibiotic, hypnotics, supha drugs, antacids, antimalarials, Synthesis of aspirin, sulphaguanidine, chloramphenicol, Drugs of plant origin. Anticancer compounds from plants. Introduction of herbal plants & medicinal compounds.

**Textbooks**


1. B. K.Sharma, *Chromatography*, GOEL Publishing House, Meerut
2. P. S. Kalsi, *Chemistry of Natural Products*, New Age International Private Ltd.


**Reference books**


1. Chatwal, Gurdeep. R, *Organic Chemistry of Natural Products*, Himalaya Publications
2. Elementary organic spectroscopy, Y.R Sharma, S Chand & Company, 2007.
3. B.R. Puri, R.L. Sharma, Pathania, *Principles of Physical Chemistry*, Vishal Publishing
4. B.S. Bahl., Arun Bahl, *Organic Chemistry*, S. Chand & Co., New Delhi.
5. R.L. Madan, G.D. Tuli, *Simplified Course in Physical Chemistry*, S. Chand & Co.

# *Model Question Paper*

## Mar Ivanios College (Autonomous), Thiruvananthapuram

### Fourth Semester B.Sc Botany Degree Programme

***2017 Admission onwards***

## Complementary Course for Botany Majors

### AUCH 431.2a- ORGANIC CHEMISTRY

**Time: 3 hours** **Max. Marks : 80**

SECTION – A

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

1. What is meant by $R_f$ value?
2. Define racemic mixture.
3. Represent the configurations of D and L glyceraldehyde.
4. Give two examples of essential amino acids.
5. Describe a colour test for proteins.
6. Define Iodine value.
7. What are antipyretics?
8. State Special isoprene rule?
9. What is mordant dye? Give one example.
10. Give the deficiency disease of Vitamin C. **(10 X 1 =10 Marks)**

**SECTION - B**

**(*Answer any 8 questions from the following.***
***Each question carries two marks.)***

11. Give the principle of adsorption chromatography.
12. What is meant by denaturation of proteins?
13. Discuss the importance of Morphine.
14. Which of the following are optically active? Why?
    (i) 2-chloropropane (ii) 2-chlorobutane (iii) 3-chloropentane
15. Give four differences between enantiomers and diastereoisomers.
16. Write a note on the different types of RNA and its functions.
17. How are alkaloids extracted from natural sources?
18. Give the classification of Vitamins.
19. What are antacids? Explain.
20. Give the structure of Vitamin A.
21. Name three anticancer compounds from plant.
22. Explain saponification. **(2 X 8 = 16 Marks)**

## SECTION - C

**(*Answer any 6 questions from the following. Each question carries four marks.)***

23. Discuss the optical isomerism of tartaric acid.
24. Write a note on DNA replication.
25. Give the synthesis of Tryptophan.
26. What is meant by isoelectric point of amino acids?
27. Determine the R & S notations of meso tartaric acid and L-glyceraldehyde.
28. Give a brief account on TLC.
29. Write a note on the methods of isolation of terpenoids.
30. Give the synthesis of Methyl Orange.
31. Explain the cleansing action of soap.

**(4 x 6 = 24 marks)**

## SECTION – D

**(*Answer any 2 question. Each question carries 15 marks*)**

32. (a) Explain Ion exchange Chromatography. (5 marks)
    (b) Give the structure elucidation of Conine. (5 marks)
    (c) Describe the structure of DNA. (5 marks)
33. (a) Discuss briefly the structure of Protein. (5 marks)
    (b) Explain Sheehan's method. (5 marks)
    (c) Discuss the classification of dyes on the basis of application (5 marks)
34. (a) What is resolution? Explain different methods of resolution. (5 marks)
    (b) What are meso compounds? Are they optical activity? Explain with a suitable example. (5 marks)
    (c) Discuss the isolation, structure and uses of geraniol. (5 marks)

35. (a) Give the synthesis of the following drugs
    (i) Aspirin and (ii) sulphaguanidine (5 marks)
    (b) Define Oils and fats and discuss the different methods of extraction. (5 marks)
    (c) Write a short note on the applications of HPLC. (5 marks)

**(15 X 2 = 30 marks)**

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## SYLLABUS FOR LABORATORY COURSES FOR COMPLEMENTARY

## SEMESTER I, II, III & IV

| Course Code AUCH 43.PI 2a LABORATORY COURSES FOR COMPLEMENTARY CHEMISTRY | |
|---|---|
| **Total Teaching Hours for Semester: 54** | **No of Lecture Hours/Week: 2** |
| **Max Marks: 80** | **Credits: 4** |
| | **Complementary Course: V** |
| **Course Outcomes** | |
| • To enable the students to understand better the concepts of organic analysis and appreciate better the applications of analytical methods in industry.<br>• To enable the students to understand the concepts of organic analysis.<br>• To appreciate the chemistry of various functionalised organic compounds through analysis. | |

**Qualitative Analysis**

Systematic analysis with a view to identify the organic compound (aromatic – aliphatic, saturated – unsaturated, detection of elements and detection of functional groups) – glucose, alcohols, phenols, halogen compounds, nitro compounds, amino compounds, aldehydes, ketones, carboxylic acids, amides, urea, thiourea and esters. Only monofunctional compounds are to be given.

A student has to analyse at least twelve organic compounds.

**Organic preparations**

1. Acetanilide from aniline

2. Meta dinitrobenzene from nitro benzene

3. Benzoic acid from benzyl chloride

**Volumetric Analysis**

A. Acidimetry and alkalimetry

a. Preparation and standardization of decinormal 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. Determination of NaOH, and sodium carbonate in a mixture (indicator method).

e. Preparation and standardization of decinormal NaOH using oxalic acid as primary standard.

f. Estimation of a strong acid using standardized NaOH.

**B. Permanganometry**

a. Standardization 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**

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

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

**D. Iodimetry and Iodometry**

a. Standardisation of sodium thiosulphate using Std $K_2Cr_2O_7$

b. Estimation of copper

c. Estimation of iodine

**E. Complexometric titrations**

1. Standardisation of EDTA using Std $Mg^{2+}$ or $Zn^{2+}$ ion solution.

2. 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.

**Chromatography**

a. Paper chromatographic separation of mixture of nitroanilines, amino acids and

sugars

b. Separation of a mixture of dyes by column chromatography.

**Gravimetric Analysis**

1. Estimation of water of hydration in barium chloride crystals

2. Estimation of barium in barium chloride solution.

This laboratory based course reinforces the qualitative and quantitative chemical analysis that the student has learned in the 1st , 2nd , 3rd and 4th semesters

**Books for Study**

1. N. S. Gnanapragasam and G. Ramamurthy, Organic Chemistry – Lab Manual, S. Viswanathan Co. Pvt. Ltd., 1998.

2. J. N. Gurtu and R. Kapoor, Advanced Experimental Chemistry (Organic), S. Chand & Co., 1987.

# Complementary Chemistry offered to Zoology Majors

Each Complementary Course has 4 theory courses and 4 practical courses. The Hour allotments and Credits for all are given in the table.

**Chemistry Complementary Courses -4; Total Credits – 14**

**One Semester – 18 Weeks**

| Instructional Hours | Title of Course | Course | Number Of Credits | Hours\ Week Theory | Lab | Sem |
|---|---|---|---|---|---|---|
| 2×18 = 36<br>2×18 = 36 | | AUCH131. 2e | 2 | 2 | 2 | 1 |
| 2×18 = 36<br>2×18 = 36 | | AUCH231 .2e | 2 | 2 | 2 | 2 |
| 3×18 = 54<br>2×18 = 36 | | AUCH331. 2e | 3 | 2 | 3 | 3 |
| 3×18 =54<br>2×18 = 36 | | AUCH431.2e<br>AUCH43. 2e<br>PI | 3<br>4 | | 3 | 4 |

**GENERAL ASPECTS OF EVALUATION**

**MODE OF EVALUATION-COMMON TO CORE, ELECTIVE,COMPLEMENTARY AND FOUNDATION COURSES**

Evaluation of each course shall involve Continuous Evaluation (CE) with 20 marks and End Semester evaluation (ESE) with 80 marks .

**CONTINUOUS EVALUATION FOR LECTURE COURSE**

The Continuous evaluation will have 20 marks and will be done continuously during the semester. CE components are

Attendance for lecture and laboratory sessions (to be noted separately where both lecture and laboratory hours have been specified within a course);

(v) Assignment /seminar and Test

The weightage is shown in Table I.1. There will be two class tests for which, the better of the two grades obtained will form part of CE. Seminar for each course to be organized by the course teacher and assessed along with a group of teachers in the Department. The topic selection by the student for assignments/seminar will be with the approval of the course teacher.

| **No** | **Marks** | **Component** |
|---|---|---|
| **1** | 5 | Attendance |
| **2** | 5 | Assignment / Seminar |
| **3** | 10 | Tests |
| | 20 | Total |

**QUESTION PAPER PATTERN FOR CONTINOUS EVALUATION TEST**

11. The theory examination has a duration of 3 hours

12. Each question paper has three parts: A, B , C

13. Part A contains ten questions. Each question carries1mark. The questions may be in the forms – one word/one sentence.

14. Part B contains twelve questions. Out of these twelve questions, the students have to answer 8 questions. Each question carries 2 marks. Each answer should contain four points. (Short Answer type).

15. Part C contains nine questions of which the candidate has to answer 6 questions. Each question carries 4 marks. The answer must contain 8 points (Short Essay type). Part D

contains four questions of which the candidate has to answer 2 questions. Each question carries 15 marks.(Long essay type)

Question paper should contain 20% hard, 60% medium and 20% easy questions.

| **Question Paper Pattern for Test** | | |
|---|---|---|
| *Marks* | *Type of Question* | *Question No* |
| 1X10=10 | All / one word/one sentence | Part A: 1-10 |
| 8 X2=16 | 8 out of 12; Short Answer | Part B: 11-22 |
| 4 X6= 24 | 6 out of 9; Short Essay | Part C: 23-31 |
| 2×15=30 | 2 out of 4; Long Essay | Part D:32-35 |
| 80 marks | | TOTAL |

**CONTINUOUS EVALUATION FOR LABORATORY COURSES**

The Continuous evaluation will have 20 marks. The ESE of laboratory courses will be done only in the IV semester. But the corresponding CE are calculated from all the semesters in which there is attendance for laboratory sessions.

| **No** | **Marks** | **Component** |
|---|---|---|
| **1** | 5 | Attendance |
| **2** | 5 | Lab test |
| **3** | 5 | Record |
| **4** | 5 | Punctuality |
| | 20 | |

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## I. 2. 1. EVALUATION OF THE RECORD

On completion of each experiment, a report should be presented to the course teacher as soon as the experiment is over. It should be recorded in a bound note -book and not on sheets of paper. The experimental description should include aim, principle, materials/apparatus required/used, method/procedures, and tables of data collected, equations, calculations, graphs, and other diagrams etc. as necessary and final results. Careless experimentation and tendency to cause accidents due to ignoring safety precautions will be considered as demerits.

| **CE for Laboratory Record** | | |
|---|---|---|
| **Marks** | **Sub Component** | **No** |
| All four sub-components present & satisfactory 5<br>Only three : 4<br>Only two : 3<br>Only one : 2 | Punctual submission and Neat presentation | **1** |
| | Record of more than 90% experiments in the syllabus | **2** |
| | Calculations and absence of errors/mistakes | **3** |
| | Accuracy of the result | **4** |

**During ESE external examiner has to verify the Lab report of experiments certified by the tutor and HOD. The scheme of examination for lab exams may be framed by the Board of examiners.**

**END SEMESTER QUESTION PAPER PATTERN & GUIDELINE FOR QUESTION PAPER SETTERS**

19. The theory examination has a duration of 3 hours

20. Each question paper has four parts: A, B, C and D

21. Part A contains ten questions. Each question carries1mark. The questions may be in the forms – one word/one sentence.

22. Part B contains twelve questions. Out of these twelve questions, the students have to answer eight questions. Each question carries 2 marks. Each answer should contain four points. (Short Answer type).

23. Part C contains nine questions of which the candidate has to answer six questions. Each question carries 4 marks. The answer must contain 8 points (Short Essay type).

24. Part D contains four questions of which the candidate has to answer two. Each question carries 15marks.Essay type question. Each question carries two or three subdivisions (10+5) or (5+5+5) pattern.

25. The total weightage for the entire questions to be answered is 80 marks.

26. Question paper should contain 20% hard,60% medium and 20% easy questions.

27. Question paper setter shall submit a detailed scheme of evaluation along with question paper.

| **Question Paper Pattern for Test** | | |
|---|---|---|
| *Marks* | *Type of Question* | *Question No* |
| 1x10=10 | 10 one word/one sentence | Part A: 1-10 |
| 2x8=16 | 8 out of 12; Short Answer | Part B: 11-22 |
| 4x6=24 | 6 out of 9; Short Essay | Part C: 23-31 |
| 2x15=30 | 2 out of 4; Essay | Part D: 32-35 |
| Total = 80 marks | | |

**SYLLABUS OF COMPLEMENTARY COURSE**
**Theoretical Chemistry**
**(For Students of Zoology Majors)**
**SEMESTER 1; Complementary Course No. – 1;**
**Course Code-AUCH131.2e Credit-2**

| **AUCH 131.2e –Theoretical Chemistry** | |
|---|---|
| **Total Teaching Hours for Semester : 36** | **No of Lecture Hours/Week: 2** |
| **Max Marks: 80** | **Credit-2** |
| **Course Outcomes** | |
| **CO1: To understand the discrete nature of atoms**<br>**CO2: To familiarise the chemical bonding in compounds**<br>**CO3: To familiarise with analytical principles of chemistry**<br>**CO4: To acquire the importance of environmental chemistry, to develop awareness towards air, water and soil pollution.** | |

**L-T-P 2-0-2** **Total: 36 Hours**

**Module I – Atomic Structure** **(9 hrs)**

Atomic spectrum of hydrogen - different series, Rydberg equation, Bohr theory – postulates – statement of Bohr energy equation – derivation of spectral frequency from Bohr equation. Schrodinger wave equation (mention only, no derivation), concept of orbitals, the four quantum numbers and their significances. Orbital wise electron configuration, energy sequence rule – Pauli's principle, Hund's rule, Stability of filled and half filled orbitals.

**Module II – Chemical Bonding** **(9 hrs)**

Energetics of bond formation – Born-Haber cycle. Hybridisation and structure of molecules – sp, $sp^2$, $sp^3$, $dsp^2$, $dsp^3$, $sp^3d^2$ and $sp^3d^3$ hybridisation with examples. Explanation of bond angle in water and ammonia. VSEPR theory with regular and irregular geometry –. Hydrogen bond – inter and intra molecular – its consequences on boiling point – volatility and solubility. Partial covalent character of the ionic bond – Fajan's Rules. A brief review of molecular orbital approach – LCAO method – bond order, bond distance and stability of O2, $O2^{2+}$, $O2^{2-}$, NO, $NO^{+}$,

**Module III – Analytical Principles (9 hrs)**

Principles of volumetric analysis – primary standard – standard solutions normality and molarity, theory of acid-base titrations, permagnometric and dichrometric titrations, iodometry and complexometric titrations. Theory of acid-base indicator – redox indicators. Beer- Lambert law- Principles of colorimetry - estimation of Iron and phosphate

**Module IV – Environmental Chemistry – Air, Water and Soil Pollution (9 hrs)**

Layers of atmosphere.

Air pollution - ozone layer depletion, ozone hole, protection of ozone umbrella – the different types of pollutants - Air pollution caused by fire works, harmful effects of fireworks, acid rain, green house effect, smog –Classic and photochemical Smog-management of air pollution.

Water pollution: Causes- Heat, industrial waste, sewage water, detergents, agricultural pollutants - treatment of industrial waste water-Activated charcoal, Synthetic resin, reverse osmosis and electro dialysis - Water analysis -Quality of drinking water - Indian standard and W H O standard - Dissolved oxygen - BOD, COD.

Soil pollution - Pesticides, Fertilizers, Industrial waste, e-waste and its treatment, plastics - Control of pollution

**Text books**

1. B. R. Puri, L. R. Sharma, *Principles of Inorganic Chemistry*, 6th Edition, 1976.
2. V. K. Ahluwalia, *Environmental Chemistry*, 2nd Edition, New Delhi, 2016.

**Reference books**

1. Manas Chanda, *Atomic Structure and Chemical Bond: Including Molecular Spectroscopy*, Vol. 1, 1981.
2. A. I. Vogel, *A Text Book of Quantitative Inorganic Analysis*, 3rd Edition, London, Longmans, 1961.
3. A. I. Vogel, *A Text book of Qualitative Analysis*,3rd Edition, London, Longman; 1966.
4. A. K. De, *Environmental Chemistry*, 6thEdition, New Age International, New Delhi 2003.
5. S. K. Banerji, Environmental Chemistry. 1st Edition, Prentice-Hall of India, 1993.
6. H.H. Fawcett, W.S. Wood, *Safety and Accident Prevention in Chemical Operations*, 2nd Edition, Wiley-Interscience, New York, 1982.
7. Young, Jay A., ed., *Improving Safety in the Chemical Laboratory*, John Wiley & Sons,

Inc., New York, 1987.
8. SatyaPrakash, R.D. Madan,Modern Inorganic Chemistry, S Chand & Co Ltd, New Delhi, 1987.

**Mar Ivanios College (Autonomous), Thiruvananthapuram**
**Model Question Paper of BSc Chemistry Programme**
**2017 Admission onwards**
**Complementary Course Zoology majors.**
**SEMESTER I Course Code AUCH 131. 2e THEORETICAL CHEMISTRY**

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

**Section A**

***(Answer all questions. Each question carries one 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. Give the structure of XeO3.
6. What is Lattice Energy?
7. What is meant by primary standards?
8. Define Molality.
9. What is the optimum value of DO for good water quality?
10. What is meant by BOD? **(10×1=10 marks)**

**Section-B**

***(Answer any 8 questions from the following. Each question carries two marks)***

11. What is Bohr Bury's rule?
12. Write down the Schrodinger Equation and explain the terms involved.
13. Explain the failures of Bohr's theory?
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. What are dichrometric titrations?
18. How would you prepare 100ml of 0.05M Mohr's salt solution?
19. Methyl orange is not a suitable indicator for the titration of weak acid with strong base. Why?
20. Which are green house gases? Mention their sources.
21. What is reverse osmosis? How it is useful in the purification of waste water?
22. What are chief factors responsible for water pollution? **(2×8=16 marks)**

## Section-C

***(Answer any 6 questions. Each question carries four marks)***

23. If the energy difference between two electronic states of hydrogen atom is 214.68 KJmol1. What will be the frequency of light emitted when the electrons jump from the higher to the lower level?
24. Explain the stability of half filled and completely filled orbitals.
25. Give an account of permanganometric titrations.
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, $BF_3$.
29. Explain Born-Haber Cycle considering the formation of NaCl as an example.
30. Write a note on agricultural pollution.
31. Explain briefly the different methods for the treatment of industrial waste water.

**(8×4=24marks)**

## Section-D

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

32. (a) Discuss Bohr Theory, highlighting its merits and demerits.
    (b)What are quantum numbers? Give its significance.
    (c) Explain various rules regarding electronic configuration.
33. (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) Explain Beer's Law, Lambert's Law and Beer – Lambert Law.

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.

35. (a) Discuss the formation and importance of ozone layer.

(b) What is meant by pollution and pollutants? Explain the classification of air pollutants.

(c) What are the sources of important air pollutants. **(15×2=30 marks)**

**Complementary Chemistry for Zoology Majors**
**INORGANIC AND BIOINORGANIC CHEMISTRY - I**
**(Common for Botany/Zoology/Microbiology Majors)**
**SEMESTER II Course code-AUCH 231 .2e Credit-2**
**(For Students of Zoology Majors)**

| **AUCH 231.2e –Inorganic and Bioinorganic Chemistry** | |
|---|---|
| **Total Teaching Hours for Semester: 36** | **No of Lecture Hours/Week: 2** |
| **Max Marks: 80** | **Credit-2** |
| **Course Outcomes** | |
| **CO1: To introduce preparation and properties of organometallic compounds**<br>**CO2: To familiarise the basic facts and concepts in nuclear chemistry**<br>**CO3: To have an idea about the classification and nomenclature of coordination compounds**<br>**CO4: To understand the basic concepts and $O_2$-$CO_2$ transport mechanism in bioinorganic chemistry** | |

**L-T- P: 2-0-2** **Total time: 36 hours**

**Module I Organometallics (9 hrs)**

Definition and classification, Organo metallic compounds of Mg, Sn, Li, Hg, Fe and their synthesis, applications. Biological and environmental aspects of organic compounds – Organometallic compounds in medicines – organomercury, organoboron, organosilicon and organo arsenic compounds – outline of preparation and uses. Antitumour drugs, silylated derivatives of bioactive organic compounds in agriculture and horticulture. Environmental aspects of Organometallic compounds.

**Module II : Nuclear Chemistry (9 hrs)**

Natural radioactivity, modes of decay, Geiger –Nuttal rule, artificial transmutation and artificial radioactivity- nuclear stability, n/p ratio, mass defect and binding energy, nuclear fission and nuclear fusion, -applications of radioactivity- $^{14}C$ dating, rock dating , neutron activation analysis and isotope as tracers

**Module III - Coordination Chemistry (9 hrs)**

Nomenclature, Coordination number and geometry - chelates – isomerism – structural and stereo isomerism valence bond theory of bonding in octahedral and tetrahedral complexes – drawbacks of valence bond theory – high and low spin complexes – colour and magnetic properties complexes. Application of metal complexes in qualitative and quantitative analysis.

**Module IV – Bio inorganic compounds (9 hrs)**

Metalloporphyrins – cytochromes – chlorophyll photosynthesis and respiration – haemoglobin and myoglobin, mechanism of O2 – CO2 transportation, nitrogen fixation, carbon fixation and carbon cycle. Biochemistry of iron toxicity and nutrition, essential and trace elements in biological systems.

**Text books**


1. B. R. Puri, L. R. Sharma, *Principles of Inorganic Chemistry*, 6th Edition, 1976.
2. Bosolo and Johnson, "Coordination Chemistry" 1986
3. J. D. Lee "Concise Inorganic Chemistry" :, Wiley, 5th Edition,1999
4. *M.N. Hughes*, The lnorganic Chemistry of Biological Process (2nd edn.), Wiley, London, 1981


**Reference books**


1. Cotton F A and Wilkinson G, Advanced Inorganic Chemistry, 3rd Edition, London, John Wiley & Sons, 1988.
2. R.J.P. Williams and J.R.R.F. de Silva, New Trends in *Bio-inorganic Chemistry*, Academic Press, London, 1978.
3. SatyaPrakash, R.D. Madan,Modern Inorganic Chemistry, S Chand & Co Ltd, New Delhi, 1987.

**Mar Ivanios College (Autonomous), Thiruvananthapuram**
**Model Question Paper of BSc Chemistry Programme**
**2017 Admission onwards**
**Complementary Course Zoology majors.**
**SEMESTER II Course Code AUCH 231.2e**
**INORGANIC AND BIOINORGANIC CHEMISTRY – I**

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

**Section A**

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

1. Give the structure of Zeise's salt.
2. Write any one of the preparation methods of organolithium compounds.
3. What is ferrocene? How is it synthesized?
4. What are alpha particles?
5. Define the term radioactivity.
6. Write the IUPAC name of $K_3[Co(NO2)_4Cl_2]$
7. What are low spin complexes?
8. What do you mean by chelate?
9. What are metalloporphyrins?
10. Give an example of anaerobic respiration.

**Section-B**

***(Answer any 8 questions. Each question carries two marks)***

11. What is reformatsky reaction?
12. What is cisplatin? Give its significance.
13. How are organomercurials prepared?
14. Explain Geiger Nuttal Rule.
15. What are half life period and average life period?
16. Define mass defect and binding energy.
17. Write the postulates of Werner's Coordination Theory.
18. What are poly dentate ligands? Give an example.
19. Explain the colours of transition metal complexes.
20. Differentiate respiration and photosynthesis.
21. What are trace elements?
22. What is the role of chlorophil in photosynthesis?

## Section-C

***(Answer any 6 questions. Each question carries four marks.)***

23. Write a note on organotin compounds.
24. Write a brief note on the applications of organometallic compounds in agriculture and horticulture.
25. One microgram of phosphorus- 32 was injected into a living system for biological tracer studies. The half life period of P-32 is 14.3 days. How long will it take for the radioactivity to fall to 10 % of the initial value?
26. Explain the relation between nuclear stability and n/p ratio.
27. Write the biological effects of radiation.
28. Suggest the structure of $[NiCl_4]$ on the basis of Valence Bond Theory.
29. Explain the magnetic properties of octahedral complexes with suitable examples.
30. Discuss briefly the biochemistry of iron toxicity and nutrition.
31. Metal ions play a variety of roles in biological systems. Explain.

## Section-D

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

32.(a) Explain the synthesis and applications or Grignard reagent.
(b) What are Frankland reagents? Give its significance.
(c) Explain about organosilicon compounds in medicine.

33. (a) Explain carbon dating and rock dating.
(b) Give the principle of neutron activation analysis.
(c) Explain the terms nuclear fission and fusion with suitable examples.

34. (a) Write a note on Crystal Field Theory.
(b) Explain the applications of complexes in qualitative analysis.
(c) Write a brief note on isomerism in coordination complexes.

35. (a) Give brief outline of carbon cycle.
(b) Explain nitrogen Fixation.
(c) Write a short note on hemoglobin.

**ORGANIC CHEMISTRY**
**Complementary Chemistry for ZOOLOGY MAJORS**
**SEMESTER III Course-3 Credit-3 Course Code – AUCH 331.2e**

**L-T-P 3-0-2** **Total - 54 hours**

| **AUCH 331.2e - ORGANIC CHEMISTRY** | |
|---|---|
| **Total Teaching Hours for Semester : 54** | **No of Lecture Hours/Week : 5** |
| **Max Marks : 80** | |
| **Course Outcomes.** | |
| **· CO1: Students get awareness on organic reaction mechanisms, various reactive intermediates/transition states and stereochemical outcome of reactions. .**<br>**. CO2: Knowledge on stereochemistry of organic molecules .**<br>**CO3: Knowledge on the basic concepts of carbohydrates, aminoacids, proteins, polymers, nucleic acids and lipids.** | |

**Module I – Mechanisms in organic substitution reactions (9 hrs)**

Electron displacement in organic compounds – Inductive, electromeric and mesomeric effects, influence of inductive effect on acidic and basic properties of organic compounds, hyperconjugation and steric effect. Reaction mechanism - Bond fission, rate determining step, nucleophilic substitution of alkyl halides SN1 & SN2 reactions. Effect of structure on reactivity as illustrated by methyl, ethyl, isopropyl and tertiary butyl groups. Electrophilic addition to ethene and propene –Markownikoff's rule, free radical addition, peroxide effect.

**Module II – Stereochemistry (9 hrs)**

Optical isomerism, chirality, recemisation and resolution, relative and absolute configuration, asymmetric synthesis, optical isomerism due to restricted rotation. Geometrical isomerism, E and Z nomenclature. Aldoximes and ketoximes.

Rotational isomerism. Rotation about carbon – carbon single bond, conformation of ethane, propane, butane, cyclohexane, axial and equatorial bonds.

**Module III – Carbohydrates (9 hrs)**

Classification, configuration, glyceraldehyde, erythrose, threose, ribose, 2-deoxy ribose, arabinose, glucose, fructose and mannose. Preparation and properties of glucose and fructose - Pyranoside structures of glucose and fructose, furanoside structure of fructose (structure elucidation not expected). Mutarotation and epimerization. Conversion of glucose into fructose and vice versa.

**Module IV – Amino acid and Proteins (9 hrs)**

Classification and properties – synthesis of glycine, alanine and tryptophan – polypeptides and proteins, peptide linkage, peptide synthesis, polypeptides, primary,secondary, tertiary and quarternary structure of proteins, test for proteins, Enzymes – Characteristics, catalytic action, theory of enzyme catalysis – Michaelis – Menton theory – Co-enzymes.

**Module V– Nucleic acids and Lipids (9 hrs)**

RNA, DNA – their biological role, hydrolysis of nucleoproteins, elementary idea regarding the structure of nucleic acids.

Lipids – Classification oils, fats and waxes, iodine value and saponification value, properties of oils and fats – phospholipids

**Module VI – Polymers (9 hrs)**

Classification with example – natural and synthetic polymers – condensation and addition polymerization. Elastic fibres, thermoplastics and thermosetting plastics. Terpenes – classification, isoprene rule, essential oils, elementary study of citral and geraniol (structure elucidation not required) Rubber - structure – Vulcanisation of rubber – synthetic rubber – neoprene, butyl rubber, Buna S, Buna N

**Text books:**


1. K.S.Tewari, N.K.Vishnoi and S.N.Mehrotra, A textbook of Organic Chemisty, 2nd Edition, Vikas Publishing House (Pvt) Ltd., New Delhi, 2012.
2. D.Nasipuri, Stereochemistry of Organic Compounds: Principles and Applications, 3rd Edition New Age International Publizhers, New Delhi, 2014.
3. Morrison, R.T., Boyd, R.N. & Bhattacharjee, S.K. Organic Chemistry, 7th ed., Pearson Education, 2011.
4. Jagadamba Singh and Jaya Singh, Photochemistry and Pericyclic rections, 3rd Edition, New Age International, New Delhi, 2012.
5. Bllmeyer, “Textbook of polymer science”, John Wiley and Sons


**References:**

1. A.Bahl and B.S.Bahl, Advanced Organic Chemistry, 5th Edition, S.Chand & Company, New Delhi, 2010.
2. P.S.Kalsi, Organic Reactions, Stereochemistry, and Mechanism, 4th Edition, New Age International Publishers, New Delhi, 2015.
3. March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, Michael B. Smith, 7th Edition, Wiley, 2013
4. Reaction Mechanism in Organic Chemistry, S. M. Mukherjii and S. P. Singh, 3rd Edition Macmillan India Press, New Delhi, 1976.
5. I L Finar, "Organic Chemistry" Vol – 1&11, 5th Edition, Pearson Education, New Delhi, 2010.
6. D.D. Deshpande, "Physical chemistry of macromolecules", Vishal publications, New Delhi, 1985.

**Mar Ivanios College (Autonomous),**
**Thiruvananthapuram**
**Model Question Paper of BSc Zoology Major**
**2017 Admission onwards**
**SEMESTER IV Complementary Chemistry Course Code: AUCH 431 .2e**
**ORGANIC CHEMISTRY**

Time: 3 hours Max marks:80

SECTION – A

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

1. Which is more acidic acetic acid or trichloro acetic acid? Why?
2. Explain Markonikoff's rule with example
3. Represent the configurations of D and L glyceraldehyde
4. Draw the ring structures of glucose and fructose
5. Define mutarotation
6. Give two example of essential aminoacids .

7. Describe a colour test for proteins
8. Define saponification value
9. Give the name and structure of the base present in RNA but not in DNA.
10. What is vulcanization of rubber? **(1 X 10 =10 Marks)**

## SECTION - B

***(Answer any 8 questions. Each question carries two marks.)***

11. Describe hyperconjugative effect with suitable examples.
12. Discuss the optical isomerism of tartaric acid.
13. Which of the following are optically active? Why?
    (i) 2-chloropropane (ii)2-chlorobutane (iii)3-chloropentane
14. Give four differences between enantiomers and diastereoisomers.
15. What is meant by denaturation of proteins?
16. Distinguish between mutarotation and epimerization.
17. Classify the carbohydrates on the basis of behavior towards hydrolysis.
18. What are lipids? How will you classify them?
19. Give a test to distinguish RNA and DNA.
20. How is terpenes classified?
21. What is polymerization? Give an example of linear polymers?
22. Draw the structure of geraniol.

**(2 X 8 = 16 Marks)**

## SECTION - C

***(Answer any 6 questions. Each question carries four marks.)***

23. Explain $S_N1$ and $S_N2$ reactions? Give examples
24. Give an account of inductive effect and show how it is applied to predict the strength of organic acids?
25. Give an account of asymmetric synthesis.
26. Determine the R & S notations of meso tartaric acid and L- glyceraldehyde.
27. What are essential oils? Explain its function with examples.
28. How is glucose is converted into fructose and vice- versa?
29. What is meant by Isoelectric point of aminoacids. 30.Classify polymers based on molecular forces
31. Explain the cleansing action of soap.

**(4 x 6 = 24 marks)**

## SECTION – D

**(*Answer any 2 question. Each question carries 15 marks*)**

32. (a) Explain the effect of structure on reactivity.
    (b) Explain electrophilic addition reactions with examples
    (c) What are meso compounds? Are they optical activite? Explain with a suitable example.

33. (a) Write notes on different conformations of ethane and cyclohexane
    (b) Give an account of the configurations of monoaccharides
    (c) Discuss briefly the structure of Protein.

34. (a) Discuss general physical and chemical properties of oils and fats
    (b) Describe the functions of RNA and DNA
    (c) Explain the structure of DNA

35. (a) Give an account of synthetic rubbers
    (b) Discuss the classification of polymers on the basis of structure (c) Write a note on detergents. **(15x2= 30 marks)**

## PHYSICAL CHEMISTRY

**Complementary Chemistry for ZOOLOGY MAJORS**

**SEMESTER IV Course-4 Credit-3**

**Course Code AUCH 431 .2e**

**L-T-P 3-0-2** **Total : 54 hours**

| AUCH 431.2e - PHYSICAL CHEMISTRY | |
|---|---|
| **Total Teaching Hours for Semester : 54** | **No of Lecture Hours/Week : 5** |
| **Max Marks : 80** | |
| **Course Outcomes** | |
| **· CO1: Students get an awareness on basic concepts of spectroscopy- microwave spectroscopy, Infra red spectra spectroscopy and NMR spectroscopy.**<br>**. CO2: Different concepts of acids and bases, ionic equilibrium, colloids and chromatography.**<br>**CO3: Knowledge on the basic concepts of heterocyclics and alkaloids.** | |

**Module I. Ionic equilibrium** **9 hrs**

Arrhenius, Lowry- Bronstead and Lewis concept of acids and bases, Kw and pH, pH of strong and weak acids, Ka and Kb, mechanism of buffer action, Henderson equation - pH of buffer, Hydrolysis of salt, Degree of hydrolysis and hydrolysis constant .

**Module II: Spectroscopy – I** **9 hrs**

Regions of electromagnetic spectrum - interaction of radiation with matter – Different types of energy levels in molecules – rotation, vibration and electronic levels. Various types of molecular spectra – Microwave spectroscopy – spectra of diatomic molecules – Expression for rotational energy - selection rule – frequency separation. Infra red spectra – equation for frequency of vibration – expression for vibrational energy. Selection rule, calculation of force constant.

**Module III**: **Spectroscopy II** **9 hrs**

Raman spectroscopy:- Stokes and antistokes lines. Quantum theory of Raman spectrum. Advantages and disadvantages of Raman spectrum. Rotational Raman Spectrum. Selection rule and frequency separation. Mutual exclusion principle. NMR spectroscopy. Principle of NMR spectroscopy nuclear spin – interaction with external magnetic field. Chemical shift. Spin – spin coupling. Applications.

**Module IV Colloids** **9 hrs**

Colloidal state: Types of colloids, preparation of colloids-Purification of colloids – ultra filtration and electrodialysis, Kinetic, optical and electrical properties of colloids. Ultra microscope, Electrical double layer and zeta potential. Coagulation of colloids,

Hardy-Schulz rule. Micelles and critical micelle concentration, sedimentation Application of colloids – Cottrell precipitator, purification of water and delta formation.

**Module V: Chromatography** **9 hrs**

Introduction to Chromatography, Classification, Adsorption, Column chromatography, Introduction, Principle, Experimental details, Theory of development, factors affecting column efficiency, Applications, Paper chromatography, Types of paper chromatography, Experimental details, Applications. TLC – Introduction, Features, Advantages and limitations, Detecting agents.

**Module VI: Heterocyclics and alkaloids** **9 hrs**

An outline study of the preparation and properties of furan, pyrrole, thiophene, pyridine. Hoffmann's exhaustive methylation.

Alkaloids – General methods of isolation, general properties, physiological action of alkaloids, conine, morphine and nicotine (no structural elucidation expected).

**Textbooks**


1. Puri, Sharma and Pathania, "Principles of Physical Chemistry",47th Edn, Vishal Publishing Co.
2. Gurdeep Raj, "Advanced Physical Chemistry", Goel Publishing House.
3. C . Banwell, "Fundamentals of Molecular Spectroscopy", McGraw Hill Education
4. Manas Chanda, " Atomic structure and Chemical bonding in Molecular Spectroscopy", McGraw Hill Education India Pvt Ltd


**References**


1. Organic Chemistry of Natural Products, Chatwal,Gurdeep.R, Himalaya Publications
2. Chemistry of natural products, P.S. Kalsi, New Age International Private Ltd
3. Elementary organic spectroscopy, Y.R Sharma, S chand & Company
4. I L Finar, "Organic Chemistry" Vol – 1 & 11, 5th Edition, Pearson Education, New Delhi, 2010.

**Model Question Paper for Zoology Major**
**2017 Admission onwards**
**SEMESTER IV; Complementary Course.IV; Course Code AUCH 431**
**.2e**
**PHYSICAL AND ORGANIC CHEMISTRY**

**Time: 3hours** **Max.Marks : 80**

**SECTION – A**

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

1. What are the units of rate constants for first and second order reactions?
2. Give one example of a reaction in which order and molecularity have different values.
3. Define $P^H$.
4. State Hardy-Schulze rule.
5. Distinguish between lypophilic colloids and lypophobic colloids.
6. Define chemical shift
7. Explain chromophore with an example.
8. What is meant by a buffer solution? Give one example each for acid buffer and basic buffer solution.
9. What is meant by the term ideal solution?
10. Write a short note on zone electrophoresis **(1 X 10 =10 Marks)**

**SECTION - B**

**(*Answer any 8 questions. Each question carries two marks.)***

11. What are the factors which affect the rate of a chemical reaction?
12. Write down the expression that gives the dependence of the rate constant of a chemical reaction on the absolute temperature and explain the terms involved. 13.Explain briefly Lewis concept of acids and bases with two examples
14. What is zeta potential? How does it arise?
15. What is critical micelle concentration? Discuss the structure of micelles in polar and nonpolar media
16. Tetra Methy Silane (TMS) is chosen as a reference compound in NMR studies. Give reasons
17. What are the different types of electronic transitions?
18. Explain the working of Hollow Cathod Lamp

19. What is the difference between GC and HPLC?
20. Explain the terms Degree of hydrolysis and hydrolysis constant.
21. What are the conditions at which the solutions deviate from ideal behaviour?
22. Calculate the mole fraction of alcohol, $C_2H_5OH$ and water in a solution made by dissolving 9.2 g of alcohol in 18g of water.

**(8 X 2 = 16 Marks)**

## SECTION - C

(*Answer **any 6** questions from the following. **Each** question carries **four** marks.)*

23. What is energy of activation? What happens to the energy of activation in presence of a catalyst.
24. Explain Half life period of a reaction. A first order reaction has a specific reaction rate of $2.31 \times 10^{-3}\ s^{-1}$. Calculate the half life period of the reaction.
25. Calculate the pH of a buffer solution containing 0.2 mole of $NH_4Cl$ and 0.1mole of $NH_4OH$ per litre. Kb for NH4OH = $1.85 \times 10^{-5}$.
26. Derive the relation between $K_h$, $K_w$ and $K_a$.
27. Give an account of applications of colloids
28. Explain ultra filtration and electrodialysis techniques used for the purification of colloids.
29. Which of the following will show spin- spin coupling in their NMR spectra? If coupling is observed, give the spin multiplicity : (a) $ClCH_2CH_2Cl$ (b) $CH_3COCH_3$ (c) $CH_3CHO$ (d) $ClCH_2CH_2I$
30. Briefly explain TGA taking suitable example
31. Explain the principle of Fractional Distillation

**(6 X 4 = 24 marks)**

## SECTION – D

**(*Answer any 2 question. Each question carries 15 marks*)**

32. (a) Differentiate between Molecularity and order of a reaction with examples
    (b) Discuss the Kinetic, optical and electrical properties of colloids
    (c) Explain the protective action of colloids
33. (a) Discuss the principle and applications of AAS

(b) Distinguish between AAS and FES

(c) Explain the applications of TGA and DTA

34. (a) Discuss the factors responsible for deviation from Raoult's law by taking suitable examples.

(b) Define critical solution temperature. Explain systems having upper and lower CST using examples.

(c) Explain the applications of UV spectroscopy.

35. (a) Discuss the advantages of Bronsted-Lowery concept over Arrhenius concept and so the limitations of the Bronsted-Lowery concept.

(b) The salt ofstrong acid and strong base does not undergo hydrolysis. Explain.

(c) Explain the underlying principle in an NMR spectrum and interpret the low resolution NMR spectrum of ethanol molecule. **(15X2= 30 marks)**

## SYLLABUS FOR LABORATORY COURSES FOR COMPLEMENTARY CHEMISTRY Course V Course Code AUCH 43.PI 2e Credit4 Semesters 1,2,3 & 4 For students of Botany, Zoology, Home Science Biochemistry and Microbiology majors

### Qualitative Analysis

Systematic analysis with a view to identify the organic compound (aromatic – aliphatic, saturated – unsaturated, detection of elements and detection of functional groups) – glucose, alcohols, phenols, halogen compounds, nitro compounds, amino compounds, aldehydes, ketones, carboxylic acids, amides, urea, thiourea and esters. Only monofunctional compounds are to be given

### Organic preparations

1.Acetanilide from aniline

2.Metadinitrobenzene from nitro benzene

3.Benzoic acid from benzyl chloride

A student has to analyse at least twelve organic compounds.

**Volumetric Analysis**

**A. Acidimetry and alkalimetry**

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

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

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

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

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

e. Estimation of a strong acid using standardized NaOH

**B. Permanganometry**

d. Standardization of KMnO4 by oxalic acid/sodium oxalate and Mohr's salt

e. Estimation of oxalic acid/sodium oxalate

f. Estimation of Mohr's salt

g. Estimation of calcium

**C. Dichrometry**

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

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

**D.Iodimetry and Iodometry**

j. Standardisation of sodium thiosulphate using std potassium dichromate

k. Estimation of copper in a solution

l. Estimation of iodine.

**E.Complexometric titrations**

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

n. 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.

**Chromatography**

a. Paper chromatographic separation of mixture of nitroanilines, amino acids and sugars

b. Separation of a mixture of dyes by column chromatography.

**Gravimetric Analysis**

1. Estimation of water of hydration in barium chloride crystals

2. Estimation of barium in barium chloride solution.

This laboratory based course reinforces the qualitative and quantitative chemical analysis that the student has learned in the $1^{st}$, $2^{nd}$, $3^{rd}$ and $4^{th}$ semesters.