



Jyoti Nivas College Autonomous
Hosur Road, Koramangala, Bangalore – 560095
Department of Chemistry
Programme: B. Sc.
V Semester
Chemistry – V NEP
Advanced Inorganic and Organic Chemistry I

CREDITS:4

NO. OF HOURS: 60
Course Code: 21VCH5T

Course Objectives:

This course aims to impart to the student, knowledge of:

I. Understanding Core Concepts:

1. A comprehensive understanding of coordination chemistry, including the properties, structures, and applications of coordination and organometallic compounds.
2. Fundamentals in nuclear and radiochemistry, focusing on nuclear reactions, radioactive decay, and the applications of radioisotopes.
3. Properties, synthesis, and applications of steel and alloys.
4. Organic chemistry topics, such as amines, heterocyclic compounds, amino acids, proteins, enzymes, lipids, vitamins, and natural products.

II. Analytical Skills:

5. Classification and differentiation between various chemical compounds.
6. Theoretical concepts to solve problems related to chemical properties and reactions.
7. Chemical nomenclature and the interpretation of chemical structures.

III. Practical Applications:

8. The industrial and biological applications of coordination and organometallic compounds.
9. Practical uses of radioisotopes in different fields such as medicine, agriculture, and archaeology.
10. Manufacturing processes and applications of different types of steel and alloys.

IV. Critical Thinking:

11. Analyzing and interpretation of data related to chemical properties and reactions.
12. The advantages and limitations of various chemical theories and models.
13. Classification of the Vitamins and analysis of their biological importance.

Course Specific Outcomes:

After the completion of this course, the student would be able to:

I. Understand Core Concepts:

- CO1. Gain a comprehensive understanding of coordination chemistry, including the properties, structures, and applications of coordination and organometallic compounds.
- CO2. Acquire foundational knowledge in nuclear and radiochemistry, focusing on nuclear reactions, radioactive decay, and the applications of radioisotopes.
- CO3. Learn about the properties, synthesis, and applications of steel and alloys.
- CO4. Develop an understanding of organic chemistry topics, such as amines, heterocyclic compounds, amino acids, proteins, enzymes, lipids, vitamins, and natural products.

II. Showcase Analytical Skills:

- CO5. Develop the ability to classify and differentiate between various chemical compounds.
- CO6. Apply theoretical concepts to solve problems related to chemical properties and reactions.
- CO7. Enhance skills in chemical nomenclature and the interpretation of chemical structures.

III. Possess Practical Applications:

- CO8. Assimilate the industrial and biological applications of coordination and organometallic compounds.
- CO9. Gain insights into the practical uses of radioisotopes in different fields such as medicine, agriculture, and archaeology.
- CO10. Learn about the manufacturing processes and applications of different types of steel and alloys.

IV. Develop Critical Thinking:

- CO11. Analyze and interpret data related to chemical properties and reactions.
- CO12. Evaluate the advantages and limitations of various chemical theories and models.
- CO13. Identify the types of Vitamins and predict their biological importance.

CO No.	Course outcomes statement	Knowledge level
1.	Gain a comprehensive understanding of coordination chemistry, including the properties, structures, and applications of coordination and organometallic compounds.	K1, K2, K3
2.	Acquire foundational knowledge in nuclear and radiochemistry, focusing on nuclear reactions, radioactive decay, and the applications of radioisotopes.	K1, K2, K3
3.	Learn about the properties, synthesis, and applications of steel and alloys.	K1, K2, K3
4.	Develop an understanding of organic chemistry topics, such as amines, heterocyclic compounds, amino acids, proteins, enzymes, lipids, vitamins, and natural products.	K1, K2, K3
5.	Develop the ability to classify and differentiate between various chemical compounds.	K2, K3
6.	Apply theoretical concepts to solve problems related to chemical properties and reactions.	K3, K4 & K5
7.	Enhance skills in chemical nomenclature and the interpretation of chemical structures.	K2, K3
8.	Assimilate the industrial and biological applications of coordination and organometallic compounds.	K3, K4 & K5
9.	Gain insights into the practical uses of radioisotopes in different fields such as medicine, agriculture, and archaeology.	K3, K4 & K5
10.	Learn about the manufacturing processes and applications of different types of steel and alloys.	K3
11.	Analyze and interpret data related to chemical properties and reactions.	K4 & K5
12.	Evaluate the advantages and limitations of various chemical theories and models.	K5
13.	Identify the types of Vitamins and predict their biological importance.	K1, K2 & K3

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	✓	✓		✓						✓
CO 2	✓	✓		✓						✓
CO 3	✓	✓		✓					✓	✓
CO 4	✓	✓		✓						✓
CO 5	✓	✓		✓						✓
CO 6	✓	✓		✓						✓
CO 7	✓	✓		✓	✓					✓
CO 8	✓	✓		✓						✓
CO 9	✓	✓		✓				✓		✓
CO 10	✓	✓	✓	✓					✓	✓
CO 11	✓	✓		✓	✓		✓			✓
CO 12	✓	✓		✓			✓			✓
CO 13	✓	✓		✓						✓

Programme Objectives aligned with Graduate attributes

PO1- Knowledge

PO2- Scientific thinking

PO3- Entrepreneurial skills

PO4- Analytical skills

PO5- Communication skills

PO6- Social commitment

PO7- Research and Inquiry

PO8- Conservation of Environment

PO9- Employability

PO10- Academic orientation

Syllabus

Paper V: Advanced Inorganic and Organic Chemistry I

60 Hours

Unit I

15 Hours

Coordination Compounds

10 Hours

Differences between double salts and complex salts with examples. Ligands - definition and their classification (mono-, bi-, tri-, tetra-, penta- and hexa- dentate ligands; ambidentate ligands), with examples for each class. Coordination number- definition with examples. IUPAC Nomenclature of coordination compounds. Complexes in living systems: Haemoglobin, Vitamin B₁₂, chlorophyll.

Theories of structure and bonding: Werner's Theory – explanation for the formation of complexes. EAN rule – statement with illustrations. Valence bond theory – Postulates, high and low spin complexes with examples, limitations of VBT. Crystal field theory. Crystal field splitting (octahedral, tetrahedral and square-planar complexes) and crystal field stabilization energies-

definition and illustrations with examples, factors affecting crystal field splitting energy. Limitations of CFT.

Properties of coordination compounds: Magnetic properties of $[\text{CoF}_6]^{3-}$, $[\text{Co}(\text{NH}_3)_6]^{3+}$, $[\text{Fe}(\text{CN})_6]^{4-}$, $[\text{Fe}(\text{CN})_6]^{3-}$ based on VBT and CFT. Spectral properties of $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$, $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$, $[\text{CoCl}_4]^{2-}$. Isomerism in complexes: Structural isomerism - ionization, linkage, hydrate and coordination isomerism with examples. Stereoisomerism- geometrical and optical isomerism of coordination compounds with coordination numbers 4 and 6 with examples.

Organometallic Compounds

5 Hours

Classification of ligands based on hapticity. Synthesis and structure of $\text{K}[\text{PtCl}_3(\eta^2\text{-C}_2\text{H}_4)]$ and $[\text{Fe}(\eta^5\text{-C}_5\text{H}_5)_2]$. Metal carbonyls: Structures of $\text{Cr}(\text{CO})_6$, $\text{Co}_2(\text{CO})_8$, $\text{Mn}_2(\text{CO})_{10}$; eighteen electron rule and its deviations with examples.

Applications of coordination/organometallic compounds: cis-platin in cancer therapy, $\text{Na}_2\text{Ca}[\text{EDTA}]$ in the treatment of lead poisoning, Wilkinson's Catalyst in alkene hydrogenation (mechanism for specific reaction), Ziegler-Natta catalyst in olefin polymerisation, Monsanto acetic acid process.

Unit II

15 Hours

Nuclear and Radiochemistry

9 Hours

Review: Properties of radioactivity, types of radiations and their properties, atomic number and mass number, isotopes and isobars. Nucleus – nucleons, nuclear force, nuclear density, stability - explanation using meson theory, n/p ratio, n versus p graph. Mass defect; Binding energy - definition, Binding energy curve, graph, calculation of binding energy to show that 1 amu = 931 MeV. Explanation of the instability of the nuclei. Problems.

Radioactive decay law: derivation of $N = N_0 e^{-\lambda t}$, half-life period of a radioisotope, relationship between half-life and decay constant, numerical problems. Radioactive equilibrium - explanation, introduction of the terms parent and daughter elements. Group displacement law - statement and explanation - with examples; radioactive series - U, Th, Ac and Np series (mention of the first and last stable elements, number of α - and β - particles. Type of series: viz., $4n$, $(4n+1)$, $(4n+2)$ and $(4n+3)$).

Artificial radioactivity: Rutherford's first artificial transmutation, induced radioactivity; nuclear reactions – differences between chemical and nuclear reactions; reason for the large amount of Q value; symbolic representation of a nuclear reaction, (Bethe's notation) introduction of the term projectile, comparison of neutron, proton, α , γ and deuteron as projectiles. Examples of nuclear reaction induced by γ -radiation, α , n, p and deuteron. Nuclear fission - explanation with an example, chain reaction, principle of atomic bomb, calculation of energy liberated, fissionable isotopes.

Nuclear fusion and fission: Explanation with an example, thermonuclear reaction, comparison of fusion and fission.

Applications of Radioisotopes: Use of radioisotopes in tracer technique - agriculture (phosphorous in agriculture research), medicine (phosphorous to check for cracks in bones, sodium/iodine to detect clots in blood vessels), food preservation. Carbon dating - numerical problems on carbon dating.

Self-study: Atomic energy programme in India. The principle of a hydrogen bomb. Nuclear reactors: principle, working of a thermal reactor, diagram, and explanation of the terms like nuclear fuel, control rods, moderators and coolant. Breeder reactors- a brief explanation of their functioning.

Steel and Alloys

6 Hours

Manufacture of steel by Bessemer process. (Removal of silicon, decarbonisation, demagnetisation, desulphurisation, dephosphorisation) heat and surface treatment (argon, nitriding, and carburizing). Composition and properties of different types of steels (role of Ni, Cr, Mo, Si, Mn, V, W, Al) Grades of steel. Classification of alloys - ferrous alloys (iron base alloys - cast iron and steel, tool steel) and nonferrous alloys (copper, lead and tin alloys – composition of brass, bronze, cupro-nickel, manganin, constantan, antifriction bearing, solders, Pb-Sn, Pb-Sb). Specific

properties of elements in alloys (role of Ti in Al and Mg alloys, Ni in copper and iron alloys, Sn and Cu in lead base alloys).

Unit III

15 Hours

Amines

5 Hours

Classification, nomenclature, preparation of alkyl and aryl amines - reductive amination of carbonyl compounds (ethanamine and 2-propanamine), Gabriel phthalimide synthesis (ethanamine), reduction of nitrobenzene, Hoffmann's bromamide reaction. Relative basicity of amines in aqueous solution. Explanation using inductive, resonance, steric and solvation effects [(a) ammonia, methylamine, dimethylamine and trimethylamine; (b) methylamine and aniline]. Reactions - amines as nucleophiles (methylation and acylation), formation of quaternary ammonium salts (reaction of tertiary amine and alkyl halide), distinguishing reactions of primary-, secondary and tertiary amines (reactions with equations for Hinsberg's test). Diazotization: formation of benzene diazonium chloride. Synthetic applications of benzenediazonium chloride in the preparation of (i) chlorobenzene, bromobenzene and benzonitrile by Sandmeyer's reaction, (ii) phenol and phenylhydrazine by reduction reaction and (iii) 1-phenylazo-2-naphthol by coupling reaction.

Heterocyclic Compounds

5 Hours

Introduction: Nomenclature of heterocyclic compounds. Aromaticity of pyrrole, furan, thiophene and pyridine. Comparison of their aromaticity and with benzene Structure, reactivity, synthesis and reactions of: pyrrole, furan, thiophene, pyridine. Structures of indole, pyrimidine and purine.

Amino Acids and Proteins

5 Hours

L- α -Amino acids: Introduction, structure, Classification on the basis of polarity of R - groups; essential and non-essential amino acids. Preparation of glycine by Gabriel method. Zwitter ionic property of amino acids. Reaction of amino acids with Ninhydrin. The peptide bond. Sanger's and Edman's- degradation reactions with their significance.

Proteins: levels of organization of proteins: primary-, secondary-, tertiary- and quaternary structures with examples (α - helix, β - pleated sheet, triple helix and the structure of haemoglobin). Denaturation and renaturation of proteins. Anfinsen's experiment.

Unit IV

15 Hours

Enzymes

3 Hours

Introduction, holoenzyme (apo-enzyme and co-enzyme). Active site, specificity (Group, absolute and stereoselectivity with examples). Classification of enzymes (EC code number not required) with examples. Enzyme substrate interaction- Fischer and Koshland models. Enzyme kinetics - factors affecting the rate of enzymatic reactions - enzyme concentration, substrate concentration (mention M. M. equation), pH and temperature. Allosteric enzymes - definition and example. Enzyme inhibitions - Competitive, noncompetitive and uncompetitive inhibition with one example for each.

Lipids

3 Hours

Introduction, classification - simple, complex and derived with examples. Fatty acids: definition, classification as saturated and unsaturated with examples and structure (lauric, myristic, palmitic, stearic, oleic, linoleic, linolenic and arachidonic acids). Essential fatty acids - definition with examples. Triglycerides: Structure of simple and mixed glycerides. Properties of triglycerides- acid and alkali hydrolysis, saponification number, iodine number and their significance. Rancidity (oxidative and hydrolytic), causes and prevention. Biological importance of triglycerides. Phosphoglycerides: General structure of 3-Sn-phosphatidic acid, lipid bilayer (as in cell membrane), micelles, liposomes and its applications, structure and biological importance of lecithin, cephalin, phosphatidylserine. Cholesterol: structure, biological importance and clinical significance.

Vitamins

2 Hours

Classification. Biological importance and deficiency symptoms of Vitamins A, Vitamin B₁ (thiamine), Vitamin B₆ (pyridoxine), folic acid, pantothenic acid, riboflavin, Vitamin C, Vitamin E (α -tocopherol), Vitamin H (biotin), Vitamins K₁ and K₂.

Natural Products

7 Hours

Carbohydrates: Introduction and classification (based on the number of monosaccharide units, sugars and non-sugars) with examples. Monosaccharides: Definition with examples, classification of monosaccharides (based on functional group). Aldoses: Structures of D-aldohexoses (glucose) - Open and Haworth structures. Epimers (Example: D-galactose and D-glucose). Elucidation of open chain structure of D-glucose. Mechanism of mutarotation and anomeric effect. Ketoses: Structure of fructose- (pyranose and furanose forms). Inter-conversion of glucose and fructose. Disaccharides: Definition with examples. Formation of glycosidic bond with examples.

Terpenes and terpenoids: Occurrence, isoprene rule and classification. Structural elucidation and synthesis of citral (from methyl heptenone). Structures and uses of limonene, menthol, α -terpineol, and camphor.

Alkaloids: Introduction, classification (based on heterocyclic ring present) and general characteristics. Synthesis of nicotine (from succinimide). Structures and uses of ephedrine, caffeine, cocaine, atropine, quinine and morphine.

References and Recommended Books:

1. Basic Inorganic Chemistry- F. A. Cotton, G. Wilkinson and P. L. Gaus; John Wiley and sons. Inc, 6th edition (1999).
2. Advanced Inorganic Chemistry, 6th edition; F. A. Cotton and G. Wilkinson.
3. Inorganic Chemistry IV edition; J. E. Huheey, E. A. Keiter and R. L. Keiter, Addison; Wesley (1993).
4. Inorganic Chemistry, II edition, D. F. Shriver, P. W. Atkins and C. H. Langford, ELBS; Oxford University Press, 1994.
5. Chemistry of elements; N. N. Greenwood and A. E. Earnshaw, Butterworth Heinemann (1997).
6. Concise Inorganic Chemistry, 5th edition; J. D. Lee (1996).
7. Essentials of nuclear chemistry, 4th edition; H. J. Arniker, NAIL publishers (1995); Chapters 1, 3 and 4.
8. Nuclear and Radioactive chemistry; Friedlander, Kennedy and Miller; Chapters 8 and 9.
9. Inorganic Chemistry, 3rd Edition; Gary. L. Miessler and Donald . A. Tarr (2007).
10. Advanced Organic Chemistry - Reactions, Mechanism and Structure, Jerry March, John Wiley (2008).
11. Advanced Organic Chemistry, F A Carey and R J Sundberg Plenum, (1990).
12. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman, (2000).
13. Structure and mechanism of Organic Chemistry, C K Ingold, Cornell University Press (1999).
14. Organic Chemistry, R T Morrison and R N Boyd, Prentice-Hall, (1998).
15. Modern Organic Reactions, H O House, Benjamin, (1972).
16. Principles of Organic Synthesis, R O C Norman and J M Coxon, Blackie Academic and Professional, (1996).
17. Stereochemistry of Organic Compounds, D Nasipuri, New-Age International, (1999).
18. Stereochemistry of Carbon Compounds, E L Eliel, S H Wilen and L N Mander, John Wiley, (1994).
19. Stereochemistry, Potapov, MIR, Moscow, 1984.
20. Organic Chemistry, Volumes I and II, I L Finar, Longman, (1999).

Chemistry V Practical: Advanced Organic and Inorganic Chemistry Practical I

CREDITS: 2

NO. OF HOURS PER WEEK: 4

Course Code: 21VCH5P

Course Objectives:

This course aims to impart to the student mastery over

- Preparation of solutions required for an experiment.
- The various techniques involved in the preparation of organic compounds and coordination compounds.
- The principles of qualitative analysis of a mixture of inorganic salts containing rare elements and the skills required for the analysis.

Specific Course Outcomes:

On completion of the course, students should be able to:

- Prepare reagents required for analysis
- Design a scheme for synthesis of organic compounds and coordination compound and execute it based on the principles learned.
- Solve problems encountered during a synthesis.
- Communicate the results of the experiment in a written and oral form.
- Carry out qualitative tests and identify inorganic radicals in a salt mixture.

Part A: One-step Preparations

1. Preparation of Benzaldehyde by Cannizarro Reaction
2. Preparation of 4-chlorotoluene from 4-toluidine from Sandemeyer Reaction
3. Synthesis of 2,4,6-tribromoaniline
4. Synthesis of 2,4-dichlorophenoxyacetic acid
5. Cis- and trans- potassium dioxalatochromium(III) complex
6. Hexamminecobalt(III)chloride
7. Mercury tetrathiocyanatocobaltate.
8. Preparation of pentamminechlorocobalt(III)chloride.

Part B: Qualitative Analysis

1. Systematic Qualitative Analysis of a binary mixture of bifunctional organic compounds (4 sessions)
2. Semi micro qualitative analysis of mixtures containing two anions, two common cations and one less familiar elements: W, Mo, Ce, Th, Zr, V, U (4 sessions)

References and Recommended Books:

1. Vogel's Text book of Qualitative Chemical Analysis, J. Bassett, G. H. Jeffery and J. Mendham, ELBS (1986).
2. Vogel's text book of Quantitative Chemical Analysis, 5th Edition, J. Bassett, G. H. Jeffery and J. Mendham, and R. C. Denny, Longman Scientific and Technical (1999).
3. Inorganic Semimicro Qualitative Analysis, V. V. Ramanujam; The National Pub. Co. (1974).
4. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Von Nostrand Reinhold Co., London (1972).
5. Laboratory manual of Organic Chemistry- B. B. Dey, M V Sitaraman and T R Govindachari, Allied Publishers, New Delhi, (1996).
6. Practical Organic Chemistry - Mann and Saunders, (1980).
7. Textbook of Practical Organic Chemistry- A. I. Vogel, (1996).
8. Textbook of Quantitative Organic Analysis- A. I. Vogel, (1996).
9. A Handbook of Organic Analysis - Clarke and Hayes, (1964).
10. Comprehensive practical organic chemistry: Preparation and quantitative Analysis,
11. V. K. Ahluwalia, R. Aggarwal, Universities Press (India), 2000.

12. Comprehensive practical organic chemistry: Qualitative analysis, V.K. Ahluwalia, S. Dhingra, Universities Press (India), 2000.
13. An advanced course in practical chemistry, A. Ghoshal, B. Mahapatra and A. Kr. Nad, New central book agency, Calcutta, 2000.
14. Advanced practical organic chemistry, J. Mohan, Vol. I and II, Himalaya Publishing House, 1992.
15. Practical organic chemistry (Quantitative analysis), B. B. Dey, M. V. Sitaraman and T. R. Gov- indachari, Allied Publishers, New Delhi, 1992.



JYOTI NIVAS COLLEGE AUTONOMOUS, BANGALORE- 560095

III B.Sc., V Semester, 21VCH5T

Chemistry V

Advanced Inorganic and Organic Chemistry I

End Semester Question Paper Format for Theory

Maximum Marks: 60

Time: 2 Hrs 30 mins

The question paper shall have **Sections A, B and C**. **Section A** shall consist of **9** questions of **2** marks each of which the student answers **5** questions. **Section B** shall consist of **8** questions of **4** marks each of which the student answers **5** questions. **Section C** shall consist of **4** questions of **10 (can be split as 5+5 and 6+4)** marks of which the student answers **3** questions to give due weightage to all chapters. The question paper shall consist of questions drawn from the respective chapters such that the marks allotted to these chapters are in proportion to the number of teaching hours prescribed. **Paper setters are requested to avoid 2 marks questions in Section B. Questions should not be set from Review portion of the Syllabus.**

Blue print of Question Paper

Unit	Chapter Title	Hours of Teaching	Marks Allotted
I	Coordination Compounds	15	23
	Organometallic Compounds	(10+5)	(15+8)
II	Nuclear and Radiochemistry	15	22
	Steel and Alloys	(9+6)	(14+8)
III	Amines	15	22
	Heterocyclic compounds	(5+5+5)	(7+8+7)
	Amino Acids and Proteins		
IV	Enzymes	15	23
	Lipids	(3+3+2+7)	(4+4+3+12)
	Vitamins		
	Natural Products		
Total		60	Sec A: 9 x 2 = 18 Sec B: 8 x 4 = 32 Sec C: 4 x 10 = 40 Total = 90
Max. Marks for students: 60 (A: 5 x 2=10 + B: 5 x 4 = 20 + C: 3 x 10 = 30)			



JYOTI NIVAS COLLEGE AUTONOMOUS, BANGALORE- 560095

III B.Sc., V Semester, 21VCH5T

Chemistry V

Advanced Inorganic and Organic Chemistry I

Model Question Paper

Time: 2 Hours 30 Minutes

Max. Marks: 60

Section A

Answer any five of the following questions.

(5 x 2 = 10)

1. Calculate CFSE for d^7 system in octahedral strong ligand field.
2. What is hapticity? Explain with a suitable example.
3. What is artificial transmutation? Give one example.
4. What is carburizing of steel? Explain.
5. Explain Sandmeyer's reaction with a suitable example.
6. Give the synthesis of Thiophene and Pyrrole from Furan.
7. Write any two biological importance of Vitamin A.
8. Name the sulphur containing amino acids. Write their structures.
9. What is meant by iodine number of a lipid. Mention its importance.

Section B

Answer any five of the following questions.

(5 x 4 = 20)

10. Distinguish between double salts and complex salts with suitable examples.
11. Give one method of synthesis for $[\text{Fe}(\eta^5\text{-C}_5\text{H}_5)_2]$ or ferrocene and draw its structure.
12. Write the nuclear reactions induced by alpha particles.
13. What are ferrous alloys? Explain each type.
14. Discuss the factors affecting the basicity of amines with suitable examples.
15. What is meant by iso-electric pH of amino acids. Explain the titration curve for glycine.
16. Explain competitive and non-competitive inhibition with suitable examples.
17. Explain the classification of carbohydrates.

Section C

Answer any three of the following questions.

(3 x 10 = 30)

18. (a) Discuss the salient features of Valence Bond Theory (VBT) for Coordination compounds.
(b) Discuss the electronic spectra of $[\text{CoCl}_4]^{2-}$.

(5+5)

19. (a) What are the types of radioactive decay series? Mention each type of decay series.
(b) Explain - Binding energy. Show the relationship between mass number and binding energy. **(5+5)**
20. (a) Explain the aromatic and resonance character of Furan and Pyridine.
(b) Write any two reactions of pyrrole & thiophene. **(5+5)**
21. (a) Write the structures and uses of limonene and caffeine.
(b) Explain the structural elucidation of glucose. **(5+5)**
