ST.MARY'S COLLEGE (AUTONOMOUS), THOOTHUKUDI

Master of Science (Chemistry)

Course structure (w. e. f. 2021)

Semester - I

Subject	Course code	Title of the paper	Contact Hours /week	Credits	Max. marks		
					CIA	ESE	Total
Core I	21PCHC11	Inorganic Chemistry - I	5	4	40	60	100
Core II	21PCHC12	Organic Chemistry - I	5	4	40	60	100
Core III	21PCHC13	Physical Chemistry - I	4	4	40	60	100
Elective I	21PCHE11/ 21PCHE12	A. Advanced Topics in Chemistry / B. Food and Health Chemistry	4	4	40	60	100
Core Practical I	21PCHCR1	Inorganic Chemistry Practicals - I	4	-	-	-	-
Core Practical II	21PCHCR2	Organic Chemistry Practicals - I	4	-	-	-	-
Core Practical III	21PCHCR3	Physical Chemistry Practicals - I	4	-	-	-	-
			30	**16**	**160**	**240**	**400**

Semester - II

Subject	Course code	Title of the paper	Contact Hours/ week	Credits	Max. marks		
					CIA	ESE	Total
Core IV	21PCHC21	Inorganic Chemistry - II	4	4	40	60	100
Core V	21PCHC22	Organic Chemistry - II	5	4	40	60	100
Core VI	21PCHC23	Physical Chemistry - II	5	4	40	60	100
Elective II	21PCHE21 / 21PCHE22	A. Nanoscience and Technology / B. Energy and Computational Chemistry	4	4	40	60	100
Core Practical I	21PCHCR1	Inorganic Chemistry Practicals - I	4	4	40	60	100
Core Practical II	21PCHCR2	Organic Chemistry Practicals - I	4	4	40	60	100
Core Practical III	21PCHCR3	Physical Chemistry Practicals - I	4	4	40	60	100
			30	**28 + 2**	**280**	**420**	**700**

Semester - III

Subject	Course code	Title of the paper	Contact Hours/ week	Credits	Max. marks		
					CIA	ESE	Total
Core VII	21PCHC31	Inorganic Chemistry - III	5	4	40	60	100
Core VIII	21PCHC32	Organic Chemistry - III	4	4	40	60	100
Core IX	21PCHC33	Physical Chemistry - III	5	4	40	60	100
Elective III	21PCHE31/ 21PCHE32	A. Research Methodology / B. Chemical Instrumentation	4	4	40	60	100
Core XVII Practical IV	21PCHCR4	Inorganic Chemistry Practicals - II	4				
Core Practical V	21PCHCR5	Organic Chemistry Practicals - II	4				
Core Practical VI	21PCHCR6	Physical Chemistry Practicals - II	4				
Self-study Course / MOOC / Internship (Optional)	21PCHSS1/ 21PCHM31 /21PCHI31	Course on Competitive Exams	-	+2		(100)	(100)
			30	**16 + 2**	**160**	**240**	**400**

Semester - IV

Subject	Course code	Title of the paper	Contact Hours/ week	Credits	Max. marks		
					CIA	ESE	Total
Core X	21PCHC41	Inorganic Chemistry - IV	4	4	40	60	100
Core XI	21PCHC42	Organic chemistry - IV	4	4	40	60	100
Core XII	21PCHC43	Physical Chemistry - IV	4	4	40	60	100
Core Practical IV	21PCHCR4	Inorganic Chemistry Practicals - II	4	4	40	60	100
Core Practical V	21PCHCR5	Organic Chemistry Practicals - II	4	4	40	60	100
Core Practical VI	21PCHCR6	Physical Chemistry Practicals - II	4	4	40	60	100
Core Project	21PCHP41	Project	6	6	40	60	100
			30	**30**	**280**	**360**	**700**

Lesson Plan

Objective-Oriented Learning Process (RBT)

Programme	M.Sc. Chemistry
Semester	I
Subject Title	Core: Inorganic Chemistry I
Code	21PCHC11
Hours	5
Total Hours	75
Credits	4
Max. Marks	75
Unit & Title	Unit II: Periodic Properties
Name of the Faculty	K. Saravanadevi
T-L tools	Lecture method, PowerPoint presentations, and videos illustrating periodic trends, group discussions and problem-solving activities.

Prerequisite Knowledge:

Understanding of basic atomic structure, elements, and the periodic table from undergraduate-level studies.

Micro-Planning

Evocation : 2 min
GO : 10 min
SOI : 10 min
FAI : 2 min
SOII : 10 min
FAII : 2 min
Discussion : 10 min
Stimulation : 10 min
Mind Map : 2 min
Summary : 2 min

1. Topic for Learning through Evocation:

The periodic table is an organized chart of elements, arranged based on increasing atomic number. Periodic properties include atomic radius, ionization energy, electron affinity, electronegativity, and trends that arise from the periodic table's structure.

- **Atomic radius** decreases across a period and increases down a group due to increasing nuclear charge and electron shielding, respectively.
- **Ionization energy** increases across a period and decreases down a group, reflecting the ease of removing an electron.
- **Electron affinity and electronegativity** follow similar trends, with notable exceptions based on electronic configurations.

2. Topic Introduction:

Periodic properties help predict the chemical and physical behaviour of elements. Understanding these trends is crucial for designing experiments and explaining reactivity.

2.1 General Objective:

Enable students to understand the origin, trends and exceptions in periodic properties.

2.2 Specific Objectives:

Enable students to:

1. Explain periodic trends in atomic and ionic radii.
2. Analyze the variation in ionization energy and its exceptions.
3. Compare and contrast electron affinity and electronegativity across periods and groups.
4. Apply periodic properties to predict chemical reactivity.
5. Solve problems related to periodic trends using data.

2.3 Taxonomy of Objectives:

Knowledge Dimension	The Cognitive Process Dimension
Factual Knowledge	Remember, Understand
Conceptual Knowledge	Understand, Apply, Analyze
Procedural Knowledge	Apply, Evaluate
Meta-cognitive Knowledge	Create, Evaluate

2.4 Key Words:

Periodic Table, Trends, Atomic Radius, Ionization Energy, Electronegativity, Reactivity.

2.5 Key Diagrams (if any):

- Graphical representation of periodic trends.

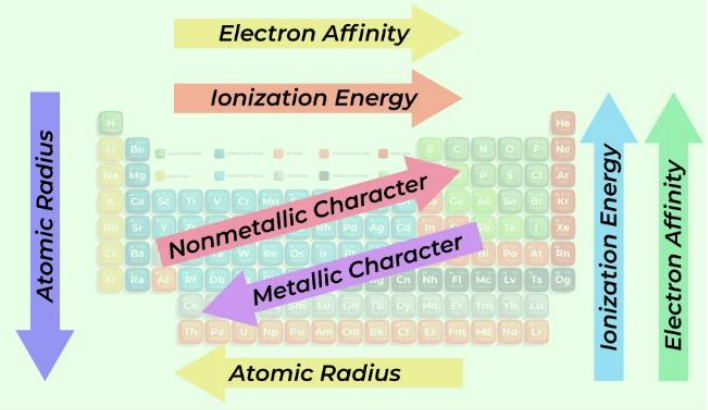
- Comparative charts of ionization energy and electronegativity across groups and periods.

3. Discussion:

Students will work in groups to discuss the observed trends and exceptions in periodic properties using examples from transition metals and non-metals. Each group will present their findings, focusing on:

- How periodic properties affect bonding and reactivity.
- Real-life applications of periodic trends in industries.

4. Mind Map:



5. Summary:

Students summarize the key trends in periodic properties, addressing how periodicity governs element behavior. They explore the relationship between properties such as ionization energy and reactivity.

6. Assessment Through Stimulating Questions/Analogy/New Ideas:

- How does the shielding effect influence periodic trends?
- Explain why noble gases have low electron affinity despite their position in the periodic table.
- Propose a method to teach periodic trends to high school students using everyday analogies.

7. FAQs:

1. What happens to atomic size as we move across a period?
   a) Increases b) Decreases c) No change d) Irregular variation
2. Why does ionization energy decrease down a group?
   a) Increase in shielding effect b) Increase in nuclear charge
   c) Decrease in atomic number d) Increase in electronegativity
3. Which group shows the highest electronegativity?
   a) Alkali metals b) Halogens c) Transition metals d) Noble gases

8. References (Books/Periodicals/Journals):

1. Cotton, F. A., Wilkinson, G., &Gaus, P. L. *Basic Inorganic Chemistry*. Wiley, 3rd Edition, 2012.
2. Huheey, J. E., Keiter, E. A., &Keiter, R. L. *Inorganic Chemistry: Principles of Structure and Reactivity*. Pearson, 4th Edition, 1997.
3. Atkins, P., Overton, T., Rourke, J., Weller, M., & Armstrong, F. *Shriver and Atkins' Inorganic Chemistry*. Oxford University Press, 5th Edition, 2010.
4. Housecroft, C. E., & Sharpe, A. G. *Inorganic Chemistry*. Pearson, 4th Edition, 2012.

9. Verified by Subject Expert

Course In-charge

Approved by HOD

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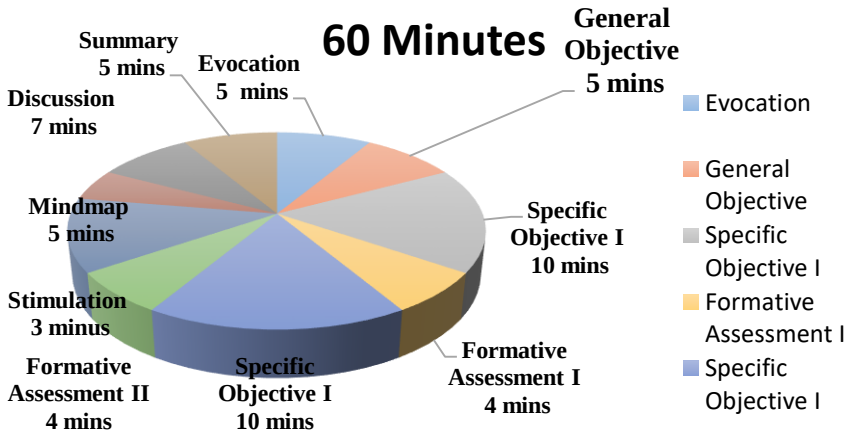
Objective-Oriented Learning Process (RBT)

Programme	M.Sc. Chemistry
Semester	I
Subject Title	Core: Organic Chemistry I
Code	21PCHC12
Hours	5
Total Hours	75
Credits	4
Max. Marks	75
Unit & Title	Unit I: Aromaticity
Name of the Faculty	Dr. C. Zozimus Divya Lobo
T-L tools	Lecture method, molecular models, multimedia videos, problem-solving worksheets, group discussions, and analytical tools like molecular orbital diagrams.

Prerequisite Knowledge:

Familiarity with organic chemistry concepts, including resonance, delocalization of electrons, and the structure of benzene.

Micro-Planning



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GO : 10 min
SOI : 10 min
FAI : 2 min
SOII : 10 min
FAII : 2 min
Discussion : 10 min
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1. Topic for Learning Through Evocation:

Aromaticity is a property of cyclic compounds with delocalized π-electrons that follow specific rules, making them unusually stable. Key concepts include Hückel's rule, antiaromaticity, and non-aromatic compounds.

- **Hückel's rule:** Planar, cyclic compounds with (4n + 2) π-electrons are aromatic.
- **Antiaromatic compounds** have 4n π-electrons, while **non-aromatic compounds** lack planarity or delocalization.

2. Topic Introduction:

Aromaticity explains the unique stability of aromatic compounds and their chemical behavior. Examples include benzene, naphthalene, and heterocyclic compounds like pyridine and furan.

2.1 General Objective:

Enable students to understand aromaticity, its rules, and its applications in explaining the stability of cyclic compounds.

2.2 Specific Objectives:

Enable students to:

1. Define aromaticity and explain Hückel's rule.
2. Differentiate between aromatic, antiaromatic, and non-aromatic compounds.
3. Analyze the role of conjugation and planarity in aromatic systems.
4. Apply aromaticity concepts to predict the stability and reactivity of compounds.
5. Solve problems related to aromaticity in heterocyclic and polycyclic systems.

2.3 Taxonomy of Objectives:

Knowledge Dimension	The Cognitive Process Dimension
Factual Knowledge	Remember, Understand
Conceptual Knowledge	Understand, Apply, Analyze
Procedural Knowledge	Apply, Analyze, Evaluate
Meta-cognitive Knowledge	Create, Evaluate

2.4 Key Words:

Aromaticity, Hückel's Rule, Planarity, Conjugation, Anti-aromaticity, Non-aromaticity, Cyclic Systems.

2.5 Key Diagrams (if any):

- Orbital diagrams of benzene showing delocalized π-electrons.
- Molecular structures of aromatic (benzene), antiaromatic (cyclobutadiene), and non-aromatic (cyclohexane) compounds.

3. Discussion:

Students will be divided into groups to analyze compounds for aromaticity using Hückel's rule. They will discuss:

- How planarity and conjugation affect aromaticity.
- Stability trends in monocyclic and polycyclic systems.
- Real-life applications of aromatic compounds in medicine and materials.

4. Mind Map:

css
CopyEdit
[Aromaticity] --> [Hückel's Rule] --> [(4n + 2) π-electrons] --> [Stability]
--> [Antiaromaticity] --> [4n π-electrons] --> [Unstable]
--> [Non-aromaticity] --> [No Delocalization] --> [Neutral Stability]

5. Summary:

Students summarize the concept of aromaticity by explaining its rules, trends, and applications. Real-world examples like the use of aromatic compounds in drug design and industrial chemistry are emphasized.

6. Assessment Through Stimulating Questions/Analogy/New Ideas:

- Why is benzene more stable than cyclohexatriene?
- What happens to aromaticity if a compound loses planarity?
- Compare the aromaticity of pyrrole, pyridine, and thiophene.
- Suggest potential uses of antiaromatic compounds in advanced materials.

7. FAQs:

1. Which of the following compounds is aromatic?
   a) Benzene b) Cyclobutadiene c) Cyclooctatetraene d) Cyclohexane
2. What is the condition for aromaticity according to Hückel's rule?
   a) 2n + 2 π-electrons b) 4n π-electrons c) 4n + 2 π-electrons d) n π-electrons
3. Why is cyclobutadieneantiaromatic?
   a) It is non-planar.
   b) It has 4n π-electrons.
   c) It lacks conjugation.
   d) It has lone pairs of electrons.

8. References (Books/Periodicals/Journals):

1. Morrison, R. T., & Boyd, R. N. *Organic Chemistry*. Pearson, 6th Edition, 2014.
2. Carey, F. A., &Sundberg, R. J. *Advanced Organic Chemistry*. Springer, 5th Edition, 2007.
3. Clayden, J., Greeves, N., Warren, S., &Wothers, P. *Organic Chemistry*. Oxford University Press, 2nd Edition, 2012.

4. March, J. *Advanced Organic Chemistry: Reactions, Mechanisms, and Structure*. Wiley, 6th Edition, 2007.
5. Anslyn, E. V., & Dougherty, D. A. *Modern Physical Organic Chemistry*. University Science Books, 1st Edition, 2006.

9. Verified by Subject Expert

Course In-charge **Approved by HOD**

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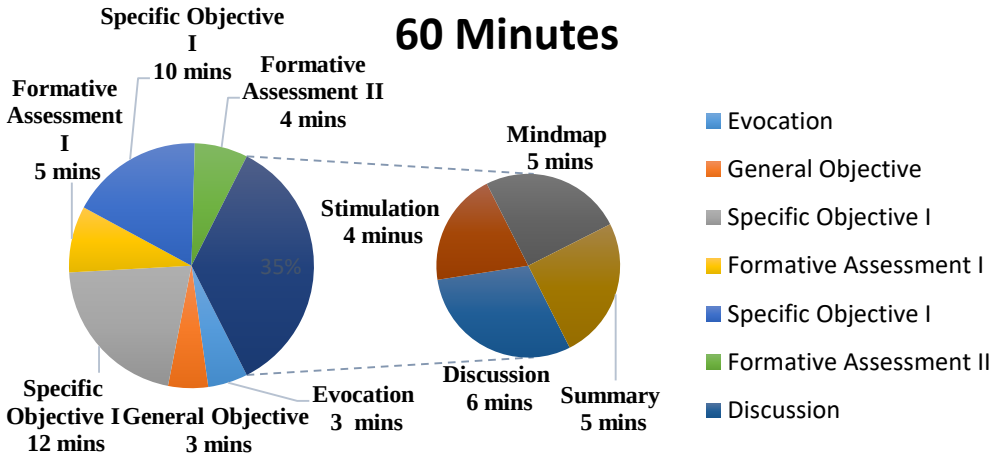
Objective-Oriented Learning Process (RBT)

Programme	M.Sc. Chemistry
Semester	I
Subject Title	Core III: Physical Chemistry-I
Code	21PCHC13
Hours	4
Total Hours	60
Credits	4
Max. Marks	75
Unit & Title	Unit III: Conducting Polymers
Name of the Faculty	Dr. J. Antony Rajam
T-L Tools	Lecture method, PowerPoint presentations, videos of conducting polymer applications, group discussions, and hands-on demonstrations with polymer models

Prerequisite Knowledge:

Basic understanding of polymers, their classification and electrical conductivity mechanisms.

Micro-Planning



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GO : 10 min
SOI : 10 min
FAI : 2 min
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Discussion : 10 min
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Mind Map : 2 min
Summary : 2 min

1. Topic for Learning Through Evocation:

Conducting polymers are organic polymers that conduct electricity due to conjugated π-electron systems. They offer applications in advanced fields like energy storage, sensors, and flexible electronics.

- **Examples of Conducting Polymers:**Polyaniline (PANI), Polypyrrole (PPy), and Polyacetylene.
- **Factors Affecting Conductivity:** Conjugation length, doping level, degree of crystallinity, and molecular weight.
- **Doping in Conducting Polymers:** Introduction of electron donors (n-type) or acceptors (p-type) to enhance conductivity by creating charge carriers.

2. Topic Introduction:

Conducting polymers exhibit electrical conductivity due to their unique structure, making them vital for technological advancements. Their conductivity can be tuned by doping, which introduces or removes electrons in the polymer matrix.

2.1 General Objective:

Enable students to understand the fundamentals of conducting polymers, factors influencing their conductivity, and the role of doping in modifying their properties.

2.2 Specific Objectives:

Enable students to:

1. Explain the structure and properties of conducting polymers.
2. Identify factors influencing the conductivity of polymers.
3. Define doping and its types in conducting polymers.
4. Analyze the effect of doping on the electronic properties of conducting polymers.
5. Explore applications of conducting polymers in real-world technologies.

2.3 Taxonomy of Objectives:

Knowledge Dimension	The Cognitive Process Dimension
Factual Knowledge	Remember, Understand
Conceptual Knowledge	Understand, Apply, Analyze
Procedural Knowledge	Apply, Evaluate
Meta-cognitive Knowledge	Create, Evaluate

2.4 Key Words:

Conducting Polymers, Conductivity, Doping, Conjugation, n-type Doping, p-type Doping, Applications.

2.5 Key Diagrams (if any):

- Diagram of conjugated π-electron systems in conducting polymers.

- Mechanism of doping in conducting polymers (n-type and p-type).
- Conductivity trend graph with respect to doping levels.

3. Discussion:

Students will work in groups to explore:

1. How conjugation length influences the electrical conductivity of polymers.
2. The impact of different dopants on polymer conductivity (e.g., iodine in polyacetylene).
3. Applications of conducting polymers in flexible electronics, batteries, and sensors.

Each group will present examples and trends observed in real-world conducting polymer systems.

4. Mind Map:

rust
CopyEdit
[Conducting Polymers] --> [Structure] --> [Conjugated Systems] --> [Electrical Conductivity]
--> [Factors] --> [Conjugation Length, Doping, Crystallinity, Temperature]
--> [Doping] --> [n-type] --> [Electron Donors]
--> [p-type] --> [Electron Acceptors]

5. Summary:

Students summarize the concept of conducting polymers, key factors affecting their conductivity, and the significance of doping. Applications in energy storage and electronics are highlighted to show their practical importance.

6. Assessment Through Stimulating Questions/Analogy/New Ideas:

- How does the conjugation length affect the conductivity of polyacetylene?
- Compare n-type and p-type doping in conducting polymers.
- Suggest a conducting polymer suitable for use in solar cells and justify your choice.
- Propose a new application of conducting polymers in wearable technology.

7. FAQs:

1. Which of the following is a conducting polymer?
   a) Polyethylene b) Polyaniline c) PVC d) Polystyrene
2. What is the main purpose of doping in conducting polymers?
   a) Increase thermal stability b) Enhance conductivity
   c) Reduce crystallinity d) Improve mechanical properties
3. How does the degree of crystallinity affect conductivity in conducting polymers?
4. Give two examples of p-type dopants used in conducting polymers.

8. References (Books/Periodicals/Journals):

1. Skotheim, T. A., & Reynolds, J. R. *Handbook of Conducting Polymers*. CRC Press, 3rd Edition, 2007.
2. Chandrasekhar, P. *Conducting Polymers: Fundamentals and Applications*. Springer, 1999.
3. Heeger, A. J. *Nobel Lecture: Semiconducting and Metallic Polymers: The Fourth Generation of Polymeric Materials*. Reviews of Modern Physics, 2001.
4. Gowariker, V. R., Viswanathan, N. V., &Sreedhar, J. *Polymer Science*. New Age International Publishers, 2012.
5. Misra, G. *Introductory Polymer Chemistry*. Wiley, 2010.

9. Verified by Subject Expert

Course In-charge

Approved by HOD

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Objective-Oriented Learning Process (RBT)

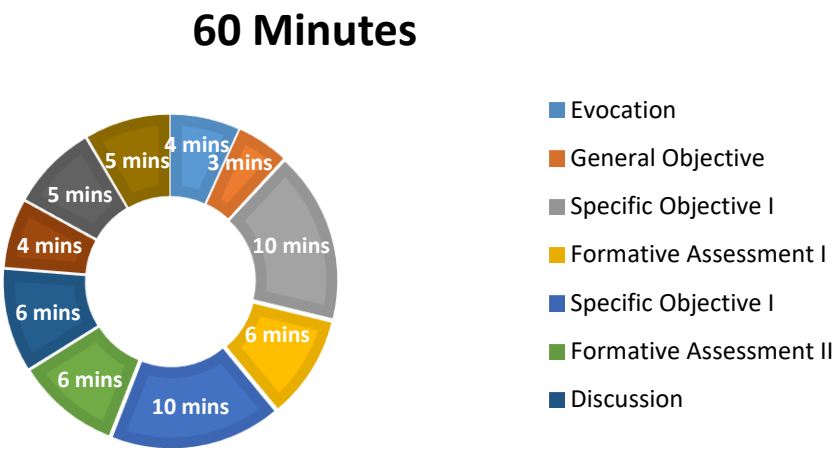
Programme	M.Sc. Chemistry
Semester	I
Subject Title	Elective I: A. Advanced Topics in Chemistry
Code	21PCHE11
Hours	4
Total Hours	60
Credits	4
Max. Marks	75
Unit & Title	Unit I: Molecular modelling and Drug designing
Name of the Faculty	D. Carolin Jeniba Rachel
T-L tools	Lecture method, visual aids such as PowerPoint slides, reaction flowcharts, and animations, demonstrations and case studies on industrial applications, interactive activities like group discussions, problem-solving sessions, and mind mapping, along with assessments through quizzes, analytical questions, and peer teaching.

Prerequisite Knowledge:

Before learning molecular docking, students should be familiar with:

- Basics of molecular interactions and drug-receptor binding.
- Structure and function of biomolecules (proteins, ligands).
- Computational tools and software used in molecular modeling.

2. Micro-Planning:



Evocation : 2 min
GO : 10 min
SOI : 10 min
FAI : 2 min
SOII : 10 min
FAII : 2 min

Discussion : 10 min
Stimulation : 10 min
Mind Map : 2 min
Summary : 2 min

1. Topic for Learning through Evocation

Molecular docking is a **computational technique** used to predict the interaction between a small molecule (ligand) and a target protein (receptor). It plays a crucial role in drug discovery, helping scientists identify potential drug candidates.

2. Topic Introduction

- **Molecular docking** is widely used in rational drug design to predict binding affinity and molecular interactions.
- It involves **ligand preparation, receptor preparation, docking simulation, and result analysis**.
- Docking helps **prioritize drug candidates** before synthesis and biological testing.

2.1. General Objective

To understand the **principles, techniques, and applications** of molecular docking in drug discovery and computational chemistry.

2.2. Specific Outcomes

By the end of this lesson, students will be able to:

1. Define molecular docking and its significance in drug design.
2. Explain different types of molecular docking (Rigid/Flexible Docking).
3. Describe the steps involved in molecular docking.
4. Identify commonly used docking software and tools (AutoDock, Schrodinger, etc.).
5. Interpret docking results using binding scores and interaction analysis.

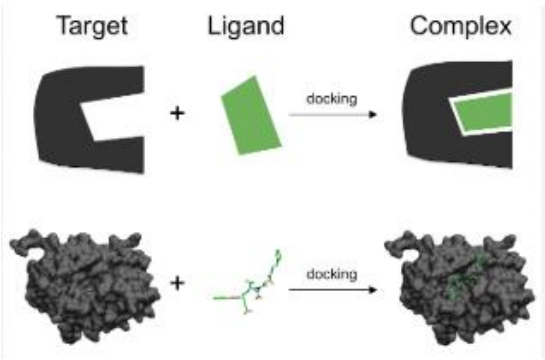
2.3. Taxonomy of Objectives

Knowledge Dimension	**The Cognitive Process Dimension**
Factual Knowledge	1 (Definition), 2 (Types of docking)
Conceptual Knowledge	3 (Understanding docking principles and scoring functions)
Procedural Knowledge	4 (Performing docking using software)
Meta-Cognitive Knowledge	5 (Evaluating docking results for drug discovery)

2.4. Key Words

Molecular docking, ligand, receptor, drug discovery, scoring function, AutoDock, Schrodinger, binding affinity.

2.5. Key Diagrams



- Diagram of ligand-receptor docking.
- Steps in molecular docking workflow.
- Examples of docking interactions (hydrogen bonds, hydrophobic interactions).

3. Discussion

Students will be divided into groups and asked to discuss:

1. The significance of molecular docking in drug discovery.
2. Differences between rigid and flexible docking.
3. Limitations and challenges in molecular docking.

Each group will present their findings, followed by a class discussion.

4. Mind Map

A stepwise diagram of molecular docking:

- **Ligand Preparation → Receptor Preparation → Docking Simulation → Scoring & Interaction Analysis → Result Interpretation**

5. Summary

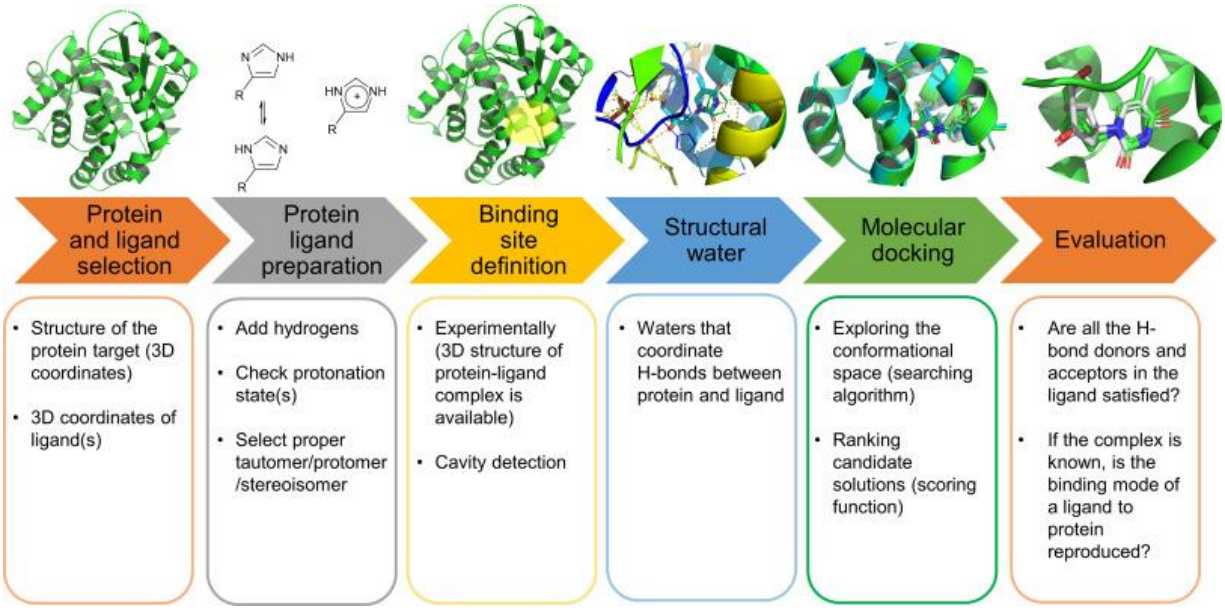
- **Molecular docking** is an in-silico method used to predict ligand-receptor binding.
- **Steps involved**: Ligand preparation, receptor preparation, docking, and result analysis.
- **Common docking tools**: AutoDock, Schrodinger Glide, DockThor, GOLD.
- **Docking applications**: Drug design, protein-ligand interaction studies, biomolecularmodeling.

6. Assessment through Stimulating Questions

1. Why is molecular docking important in drug discovery?
2. What are the key steps in molecular docking?
3. How does scoring function help in evaluating docking results?
4. Compare rigid and flexible docking approaches.
5. Name two commonly used docking software and their applications.

7. FAQ's

1. **Which step is NOT a part of molecular docking?**
   a) Ligand preparation
   b) Receptor preparation
   c) DNA sequencing
   d) Docking simulation
2. **What is the main purpose of molecular docking?**
   a) To design new chemical elements
   b) To predict ligand-receptor interactions
   c) To synthesize drugs directly
   d) To break chemical bonds
3. **Which of the following is a molecular docking software?**
   a) AutoDock
   b) Photoshop
   c) MATLAB
   d) ChemDraw



8. References (Books/Journals)

1. A. R. Leach, *Molecular Modelling: Principles and Applications*, Pearson, 2019.

2. D. C. Young, *Computational Drug Design: A Guide for Computational and Medicinal Chemists*, Wiley, 2016.
3. G. Kitchen et al., *Docking and Scoring in Virtual Screening for Drug Discovery*, Nature Reviews, 2019.
4. R. Huey et al., *AutoDock and AutoDockTools: Automated Docking with Selective Receptor Flexibility*, J. Comp. Chem, 2020.
5. Leach, A. R. (2001). *Molecular Modelling: Principles and Applications.* Pearson.
6. Gohlke, H., &Klebe, G. (2002). "Approaches to the computational docking of ligands to proteins." *Journal of Molecular Biology*, **323**, 793-817.
7. Kitchen, D. B., Decornez, H., Furr, J. R., &Bajorath, J. (2004). "Docking and scoring in virtual screening for drug discovery." *Nature Reviews Drug Discovery*, **3**(11), 935-949.

9. Verified by Subject Expert

Course In-charge

Approved by HOD

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Semester II

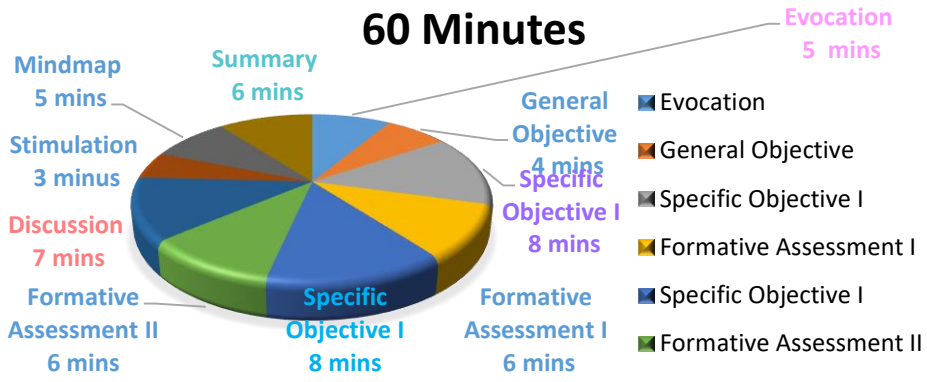
Objective-Oriented Learning Process (RBT)

Programme	M.Sc. Chemistry
Semester	II
Subject Title	Core IV: Inorganic Chemistry-II
Code	21PCHC21
Hours	4
Total Hours	60
Credits	4
Max. Marks	75
Unit & Title	Unit IV: Organometallic Chemistry II
Name of the Faculty	K. Saravanadevi
T-L tools	Lecture method, visual aids such as PowerPoint slides, reaction flowcharts, and animations, demonstrations and case studies on industrial applications, interactive activities like group discussions, problem-solving sessions, and mind mapping, along with assessments through quizzes, analytical questions, and peer teaching.

Prerequisite Knowledge

- Basic understanding of **catalysis** and **reaction mechanisms**.
- Familiarity with **transition metal complexes** and **ligand coordination**.
- Knowledge of **industrial applications of acetic acid production**.

Micro-Planning



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1. Topic for Learning through Evocation

- The **Monsanto Process** is an industrial method for producing **acetic acid** using **homogeneous catalysis**.
- The process involves a **rhodium catalyst** in the presence of **carbon monoxide (CO)** and **methyl iodide (CH_3I)**.
- The key catalytic cycle consists of **oxidative addition, carbonyl insertion, and reductive elimination**.
- Though **efficient and selective**, this process was later replaced by the **Cativa Process** (Iridium-based catalysis).

2. Topic Introduction

- The **Monsanto Process** represents an **efficient industrial application** of **homogeneous catalysis**.
- It uses **transition metal complexes** (rhodium) to **catalyze the conversion of methanol to acetic acid**.
- The process **involves CO as a key reactant** and operates under **mild conditions with high selectivity**.
- Industrial improvements led to the **Cativa Process**, which uses an **iridium-based catalyst**.

2.1 General Objective

To enable students to understand the **Monsanto Process**, its catalytic cycle, and its industrial relevance.

2.2 Specific Outcome

By the end of the lesson, students should be able to:

1. Explain the **Monsanto Process** and its role in **acetic acid production**.
2. Describe the **catalytic cycle** of **rhodium** in the reaction mechanism.
3. Compare the **Monsanto Process** with the **Cativa Process**.
4. Analyze the **environmental and economic impact** of this process.
5. Evaluate the role of **homogeneous catalysts** in industrial applications.

2.3. Taxonomy of Objectives

Knowledge Dimension	Cognitive Process Dimension
Factual Knowledge	Remember, Understand
Conceptual Knowledge	Understand, Apply, Analyze
Procedural Knowledge	Apply, Analyze, Evaluate

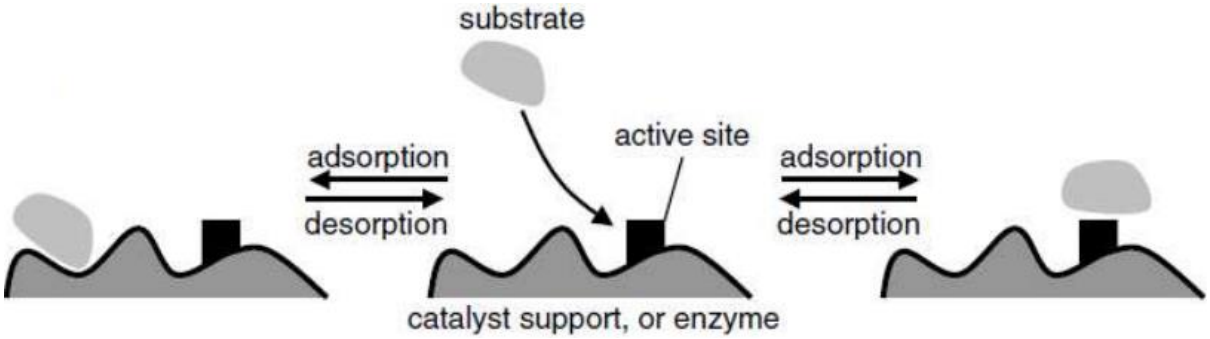
Knowledge Dimension Cognitive Process Dimension

Meta-Cognitive Knowledge Create, Evaluate

2.4. Key Words

- Homogeneous Catalysis
- Monsanto Process
- Rhodium Catalyst
- Oxidative Addition
- Carbonyl Insertion
- Reductive Elimination
- Acetic Acid Production
- Cativa Process
- Industrial Catalysis

2.5. Key Diagram

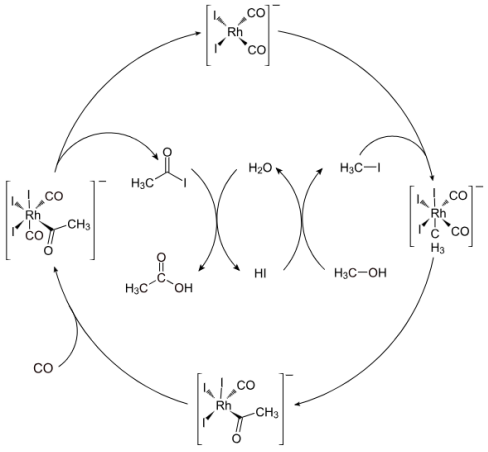


3. Discussion

Group Activities & Class Discussion

- **Students analyze**: The role of **transition metal catalysts** in industrial chemistry.
- **Debate**: Which is more efficient—Monsanto or Cativa?
- **Real-world application**: Discussion on **current industrial methods** for acetic acid production.
- **Mind Mapping Activity**: Visualizing the **catalytic cycle**.

4. Mind Map



5. Summary

- The **Monsanto Process** is a **homogeneous catalytic process** used for **acetic acid production**.
- It relies on a **rhodium catalyst** that follows a **three-step catalytic cycle**.
- The **Cativa Process** is a **more efficient, iridium-based alternative**.
- Industrial factors such as **cost, efficiency, and environmental impact** determine process selection.

6. Assessment through Stimulating Questions/Analogy/New Ideas

1. Why is **rhodium** preferred as a catalyst in the Monsanto Process?
2. Describe the role of **oxidative addition** in the catalytic cycle.
3. What are the advantages of the **Cativa Process** over the **Monsanto Process**?
4. Discuss the **environmental concerns** associated with this process.
5. Compare **homogeneous** vs. **heterogeneous** catalysis in industrial applications.

7. FAQs

1. Which of the following is the main catalyst used in the Monsanto Process?

a) Iridium b) Rhodium c) Palladium d) Nickel

2. The oxidative addition step in the Monsanto Process involves the addition of:

a) CO b) CH_3I c) Acetic Acid d) Methanol

3. Why was the Monsanto Process replaced by the Cativa Process?

a) Lower efficiency b) High catalyst cost

c) Environmental concerns d) More efficient iridium catalyst

4. What happens during the reductive elimination step?

a) Formation of methyl iodide b) Release of acetic acid

c) Catalyst activation d) Oxidation of rhodium

8. References

1. Miessler, G. L., Fischer, P. J., &Tarr, D. A. (2022). *Inorganic Chemistry*. Pearson.
2. Collman, J. P., Hegedus, L. S., Norton, J. R., & Finke, R. G. (2013). *Principles and Applications of Organotransition Metal Chemistry*. University Science Books.
3. Crabtree, R. H. (2014). *The Organometallic Chemistry of the Transition Metals*. Wiley.
4. Atkins, P., & Overton, T. *Inorganic Chemistry*. Oxford University Press, 6th Edition, 2010.
5. Crabtree, R. H. *The Organometallic Chemistry of the Transition Metals*. Wiley, 5th Edition, 2009.
6. Gates, B. C. *Catalytic Chemistry*. Wiley, 1992.
7. Hartley, F. R. *Homogeneous Catalysis*. Springer, 1983.
8. Thomas, J. M., & Thomas, W. J. *Principles and Practice of Heterogeneous Catalysis*. Wiley, 2nd Edition, 2014.

9. Verified by Subject Expert

Course In-charge

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Objective-Oriented Learning Process (RBT)

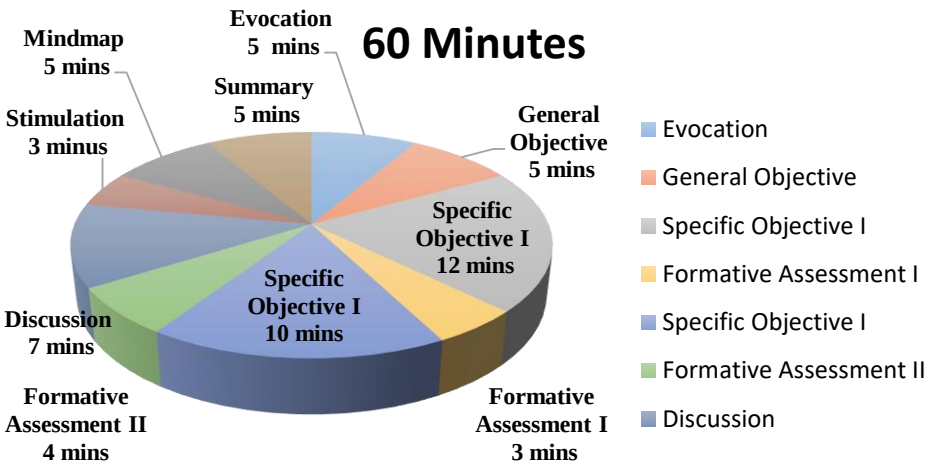
Programme	M.Sc. Chemistry
Semester	II
Subject Title	Core V: Organic Chemistry II
Code	21PCHC22
Hours	5
Total Hours	75
Credits	4
Max. Marks	75
Unit & Title	Unit III Alkaloids and Flavonoids
Name of the Faculty	Dr. C. Zozimus Divya Lobo
T-L tools	Lecture method, multimedia presentations, molecular models, diagrams of alkaloid structures, case studies, and group discussions.

Prerequisite Knowledge

Before learning about alkaloid extraction, students should be familiar with:

- Basic organic chemistry concepts.
- Properties of alkaloids and their significance in medicinal chemistry.
- Solubility principles and acid-base reactions.

Micro-Planning



Evocation : 2 min
GO : 10 min
SOI : 10 min
FAI : 2 min
SOII : 10 min
FAII : 2 min
Discussion : 10 min
Stimulation : 10 min

Mind Map : 2 min
Summary : 2 min

1. Topic for Learning through Evocation

Alkaloids are naturally occurring nitrogenous compounds found in plants, fungi, and marine organisms. They have significant medicinal and physiological effects. Their extraction is an essential process in pharmaceutical and natural product chemistry.

2. Topic Introduction

Alkaloids occur as salts or free bases in plants. Their extraction depends on their solubility properties and acid-base chemistry. General methods involve solvent extraction, acid-base treatment, and purification techniques.

2.1. General Objective

To understand the various extraction techniques used for isolating alkaloids from natural sources.

2.2. Specific Objectives

By the end of this lesson, students will be able to:

1. Define alkaloids and their occurrence in nature.
2. Explain different methods used for alkaloid extraction.
3. Understand the role of solvent polarity in alkaloid extraction.
4. Compare traditional and modern extraction methods.
5. Summarize the purification and isolation methods of alkaloids.

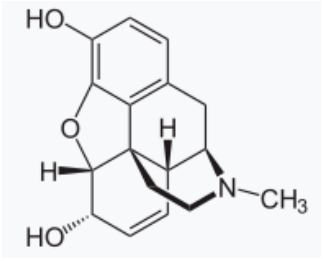
2.3. Taxonomy of Objectives

Knowledge Dimension	**The Cognitive Process Dimension**
Factual Knowledge	1 (Definition), 2 (Classification)
Conceptual Knowledge	2, 3 (Understanding the chemical basis of extraction)
Procedural Knowledge	4 (Performing extraction procedures in the lab)
Meta-Cognitive Knowledge	5 (Evaluating the best extraction technique based on application)

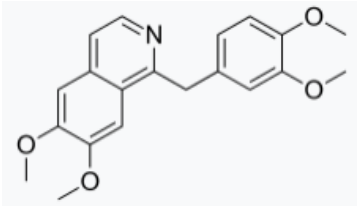
2.4. Key Words

Alkaloids, extraction, acid-base reaction, solvent extraction, precipitation, chromatography.

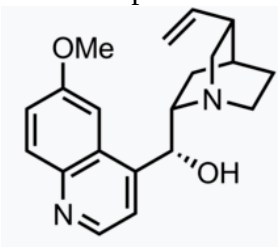
2.5. Key Diagrams



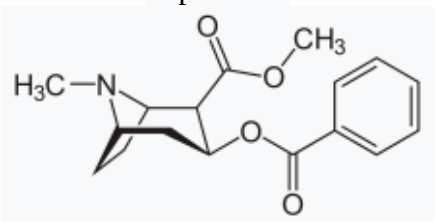
Morphine



Papaverine



Quinine



Cocaine

- Flowchart showing different extraction techniques.
- Chemical structure of common alkaloids.
- Solvent polarity scale diagram.

3. Discussion

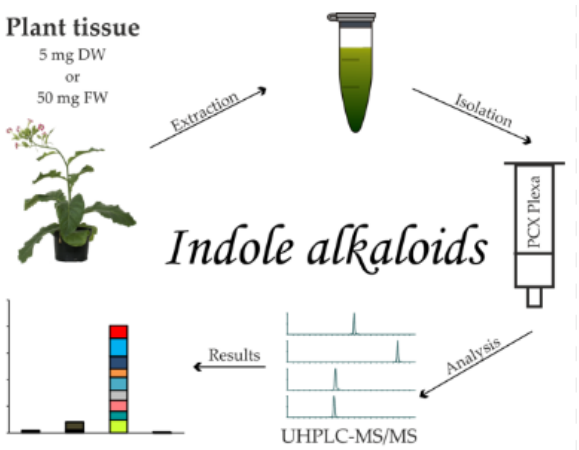
Students will be divided into groups and asked to discuss:

1. The importance of solvent selection in alkaloid extraction.
2. Advantages and disadvantages of different extraction techniques.
3. How pH influences alkaloid solubility and separation.

Each group will present their findings, followed by a class discussion.

4. Mind Map

A stepwise diagram of alkaloid extraction:



5. Summary

- Alkaloids are extracted using solvents such as ethanol, methanol, chloroform, and ether.
- Acid-base treatment helps in isolating alkaloids in free base or salt form.
- Purification techniques include precipitation, chromatography, and crystallization.
- Modern methods like supercritical fluid extraction and ultrasound-assisted extraction improve efficiency.

6. Assessment through Stimulating Questions

1. Why is solvent polarity important in alkaloid extraction?
2. How does acid-base treatment affect the solubility of alkaloids?
3. Compare maceration and percolation methods in alkaloid extraction.
4. What modern extraction techniques have improved efficiency?
5. What are the advantages of chromatography in alkaloid purification?

7. FAQ's

1. **Which solvent is commonly used for alkaloid extraction?**
   a) Water
   b) Chloroform
   c) Acetone
   d) Ethanol
2. **Why are alkaloids often extracted using acidic solutions?**
   a) To increase solubility
   b) To precipitate proteins
   c) To neutralize the plant material
   d) To change the color of the extract
3. **Which modern technique is widely used for alkaloid extraction?**
   a) Soxhlet extraction
   b) Supercritical fluid extraction
   c) Simple distillation
   d) Acid hydrolysis

8. References (Books/Journals)

1. F. S. Stoll, *Alkaloids: Chemical and Biological Perspectives*, Elsevier, 2016.
2. G.A. Cordell, *The Alkaloids: Chemistry and Pharmacology*, Academic Press, 2017.
3. P. M. Dewick, *Medicinal Natural Products: A Biosynthetic Approach*, Wiley, 2013.
4. Pinder, *The Chemistry of Alkaloids*, Springer, 2021.
5. Trease& Evans, *Pharmacognosy*, Elsevier, 2019.
6. Finar, I. L. *Organic Chemistry Volume 2: Stereochemistry and the Chemistry of Natural Products*. Pearson, 5th Edition, 2009.
7. Dewick, P. M. *Medicinal Natural Products: A Biosynthetic Approach*. Wiley, 3rd Edition, 2009.
8. Mann, J., Davidson, R. S., Hobbs, J. B., & Banthorpe, D. V. *Natural Products Chemistry and Biological Significance*. Longman, 1994.
9. Bentley, R. *Alkaloids: Chemical and Biological Perspectives*. Pergamon Press, 1990.
10. Pelletier, S. W. *The Chemistry of the Alkaloids*. Springer, 1970.

9. Verified by Subject Expert

Course In-charge

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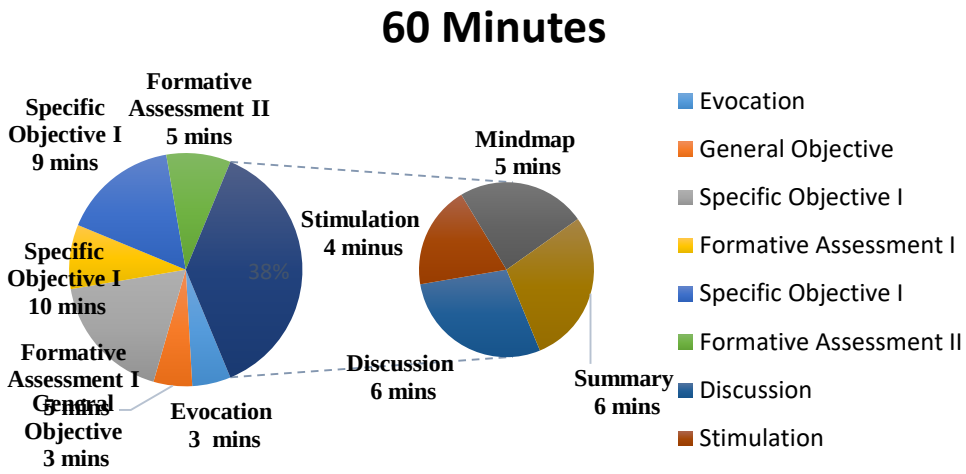
Objective-Oriented Learning Process (RBT)

Programme	M.Sc. Chemistry
Semester	II
Subject Title	Core VI: Physical Chemistry - II
Code	21PCHC23
Hours	5
Total Hours	75
Credits	4
Max. Marks	75
Unit & Title	Unit IV: Surface Chemistry and Catalysis
Name of the Faculty	Dr. J. Antony Rajam
T-L tools	Lecture method, multimedia presentations, molecular models, experimental demonstrations, diagrams of adsorption isotherms, and group discussions

Prerequisite Knowledge:

Basic understanding of surface chemistry, molecular interactions, and colloidal systems.

Micro-Planning



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GO : 10 min
SOI : 10 min
FAI : 2 min
SOII : 10 min
FAII : 2 min
Discussion : 10 min
Stimulation : 10 min
Mind Map : 2 min
Summary : 2 min

1. Topic for Learning Through Evocation:

Surface phenomenon and adsorption processes involve interactions at interfaces, influencing a variety of natural and industrial processes.

Key topics include:

- **Adsorption:** Physical adsorption (physisorption) vs. chemical adsorption (chemisorption).
- **Adsorption Isotherms:**
  - Freundlich isotherm (empirical).
  - Langmuir isotherm (monolayer adsorption).
  - Gibbs adsorption equation (thermodynamic perspective).
  - BET isotherm (multi-layer adsorption).
- **Measurement of Surface Area:** Techniques such as BET analysis and gas adsorption methods.
- **Micelles and Reverse Micelles:** Formation, structure, and applications in detergents and drug delivery.
- **Microemulsion:** Thermodynamically stable systems of oil, water, and surfactants.
- **Solubilisation:** Role of micelles in dissolving nonpolar solutes in polar solvents.

2. Topic Introduction:

Surface chemistry is crucial for understanding adsorption, surface area measurement, and colloidal systems like micelles and microemulsions, which have wide-ranging applications in industries and pharmaceuticals.

2.1 General Objective:

Enable students to understand the principles of adsorption, surface chemistry, and colloidal systems, along with their practical applications.

2.2 Specific Objectives:

Enable students to:

1. Define adsorption and distinguish between physisorption and chemisorption.
2. Explain adsorption isotherms (Freundlich, Langmuir, Gibbs, BET) and their significance.
3. Describe methods for measuring surface area using adsorption data.
4. Analyze the formation and applications of micelles, reverse micelles, and microemulsions.
5. Apply the concept of solubilisation in practical systems like detergents and drug formulations.

2.3 Taxonomy of Objectives:

Knowledge Dimension	The Cognitive Process Dimension
Factual Knowledge	Remember, Understand

Knowledge Dimension	The Cognitive Process Dimension
Conceptual Knowledge	Understand, Apply, Analyze
Procedural Knowledge	Apply, Analyze, Evaluate
Meta-cognitive Knowledge	Create, Evaluate

2.4 Key Words:

Adsorption, Physisorption, Chemisorption, Freundlich Isotherm, Langmuir Isotherm, BET, Micelles, Reverse Micelles, Microemulsion, Solubilisation.

2.5 Key Diagrams (if any):

- Adsorption isotherms (Freundlich, Langmuir, BET).
- Structure of micelles and reverse micelles.
- Schematic representation of microemulsions and solubilisation.

3. Discussion:

Students will work in groups to:

1. Discuss the difference between physisorption and chemisorption using examples.
2. Compare and contrast the different adsorption isotherms (Freundlich, Langmuir, BET).
3. Evaluate the role of micelles in solubilisation and drug delivery systems.
4. Analyze case studies of surface area measurement techniques in industrial applications.

4. Mind Map:

```
css
CopyEdit
[Surface Phenomenon] --> [Adsorption] --> [Physisorption, Chemisorption]
                       --> [Isotherms] --> [Freundlich, Langmuir, Gibbs,
BET]
                       --> [Surface Area Measurement]
                       --> [Micelles and Reverse Micelles] -->
[Applications]
                       --> [Microemulsion] --> [Stability, Uses]
                       --> [Solubilisation] --> [Role of Micelles]
```

5. Summary:

Students summarize the key principles of adsorption, the different types of adsorption isotherms, and the significance of surface chemistry in real-world applications. The importance of micelles, microemulsions, and solubilisation in industrial and pharmaceutical processes is highlighted.

6. Assessment Through Stimulating Questions/Analogy/New Ideas:

- How does the Langmuir isotherm explain monolayer adsorption?

- Compare the BET isotherm to the Langmuir isotherm.
- Suggest industrial applications where micelles and microemulsions are critical.
- How does solubilisation enhance the efficacy of drug delivery?

7. FAQs:

1. What is the key difference between physisorption and chemisorption?
   a) Type of adsorbate b) Strength of interaction
   c) Surface area d) Temperature independence
2. Which adsorption isotherm is used for multilayer adsorption?
   a) Freundlich b) Langmuir c) BET d) Gibbs
3. What is the role of surfactants in the formation of microemulsions?
4. Describe one method used for measuring surface area.

8. References (Books/Periodicals/Journals):

1. Atkins, P., & de Paula, J. *Physical Chemistry*. Oxford University Press, 10th Edition, 2014.
2. Adamson, A. W., &Gast, A. P. *Physical Chemistry of Surfaces*. Wiley, 6th Edition, 1997.
3. Shaw, D. J. *Introduction to Colloid and Surface Chemistry*. Butterworth-Heinemann, 4th Edition, 1992.
4. Israelachvili, J. *Intermolecular and Surface Forces*. Academic Press, 3rd Edition, 2011.
5. Myers, D. *Surfaces, Interfaces, and Colloids: Principles and Applications*. Wiley-VCH, 2nd Edition, 1999.

9.Verified by Subject Expert

Course In-charge

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LESSON PLAN FOR SCIENCE

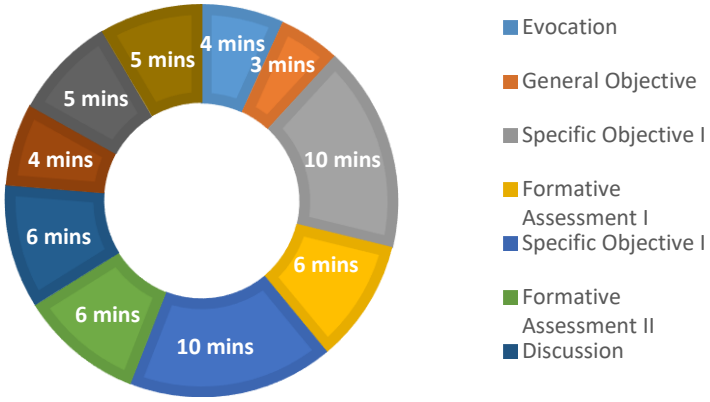
Programme	M.Sc. Chemistry
Semester	II
Subject Title	Elective II A. Nanoscience and Technology
Code	21PCHE21
Hours	4
Total Hours	60
Credits	4
MaxMarks	75
Unit & Title	Unit III: Carbon nanotubes
Name of the Faculty	D. Carolin Jeniba Rachel
T-L tools	Lecture method, visual aids such as PowerPoint slides, reaction flowcharts, and animations, demonstrations and case studies on industrial applications, interactive activities like group discussions, problem-solving sessions, and mind mapping, along with assessments through quizzes, analytical questions, and peer teaching.

Prerequisite Knowledge:

Before learning introduction of carbon nanotube, students should be familiar with:

- Basics structure of carbon nanotubes and allotropes
- Knowledge about lattice structures**.**
- Nanotechnology Basics

Micro-Planning



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GO : 10 min
SOI : 10 min
FAI : 2 min
SOII : 10 min

FAII : 2 min
Discussion : 10 min
Stimulation : 10 min
Mind Map : 2 min
Summary : 2 min

1. Topic for Learning through Evocation

Carbon nanotubes are cylindrical molecules made entirely of carbon atoms, arranged in a hexagonal pattern (similar to graphene, but rolled into a tube). They are incredibly strong, lightweight, and have amazing electrical and thermal properties.

2. Topic Introduction

Carbon Nanotubes (CNTs**)** are cylindrical nanostructures made entirely of carbon atoms. They can be thought of as a sheet of graphene rolled into a tube, with diameters typically in the nanometer range (a billionth of a meter). Despite their tiny size, they have extraordinary mechanical, electrical, and thermal properties**.**

2.1. General Objective

To explore and utilize the exceptional mechanical, electrical, thermal, and chemical properties of carbon nanotubes to develop innovative solutions for applications in materials science, electronics, energy storage, medicine, and environmental technologies..

2.2 Specific Objectives

By the end of this lesson, students will be able to:

1. To understand the structure and types of carbon nanotubes (SWCNT and MWCNT).
2. To investigate the synthesis methods for producing high-quality carbon nanotubes.
3. To analyze the mechanical, electrical, thermal, and chemical properties of CNTs.
4. To explore practical applications of CNTs in electronics, energy storage, biomedicine, and nanocomposites.
5. To evaluate the environmental impact and challenges related to the large-scale use of CNTs.

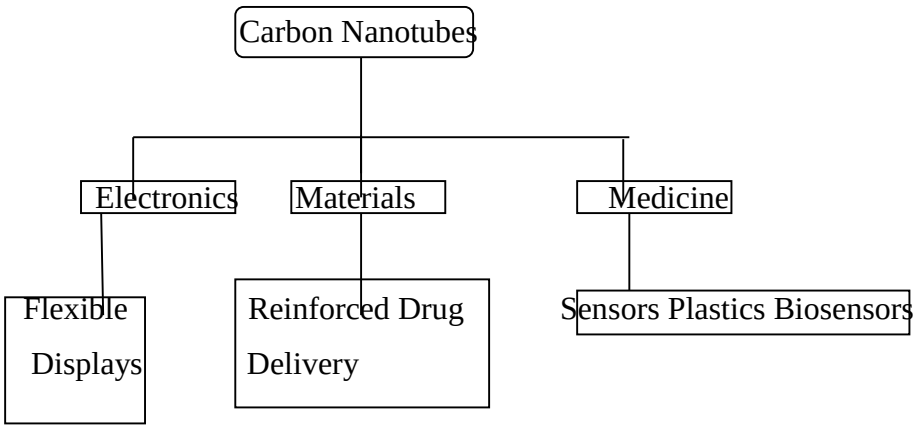
2.3. Taxonomy of Objectives

Knowledge Dimension	**Cognitive Process Dimension**
A. Factual Knowledge	Remember (1), Understand (2,3), Apply (4)
B. Conceptual Knowledge	Understand (2,3,4), Analyze (4,5)
C. Procedural Knowledge	Apply (3,4), Evaluate (5)
D. Meta-Cognitive Knowledge	Create (5)

2.4. Key Words

Nanomaterials,Carbon Allotrope, Single-Walled Carbon Nanotubes (SWCNT),Multi-Walled Carbon Nanotubes (MWCNT),Grapheme Sheet, Cylindrical Nanostructure, High Strength, Electrical Conductivity, Thermal Conductivity, Chemical Vapor Deposition (CVD)

2.5. Key Diagrams



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3. Discussion

Students will be divided into groups and asked to discuss:

1. Structure and Types of CNTs.
2. Multi-Walled Carbon Nanotubes (MWCNT).
3. Properties of Carbon Nanotubes

4. Mind Map

A stepwise diagram of molecular docking:

[Carbon Nanotubes (CNTs)]

|

| | | | |

Definition Structure Properties Synthesis Applications

| | | |

| | | |

- High Strength - CVD - Electronics

- High Conductivity - Arc Discharge - Energy Storage

- Thermal Conductivity - Laser Ablation - Biomedicine

- Lightweight - Composite Materials

- Flexible **- Environmental Uses**

- Chemically Stable

| | |

History **Types** **Challenges**

(Sumio Iijima, 1991) | |

- SWCNT **- High Cost**

- MWCNT **- Toxicity Concerns**

- Aggregation Issues

- Processing Difficulty

5. Summary

Carbon Nanotubes (CNTs) are cylindrical nanostructures made entirely of carbon atoms, first discovered in 1991 by Sumio Iijima**.** They are essentially rolled-up sheets of graphene, forming tubes with diameters measured in nanometers. CNTs exhibit exceptional mechanical strength, electrical conductivity, thermal conductivity, and flexibility, making them highly valuable in **advanced** materials, electronics, energy storage, and biomedical application

6. Assessment through Stimulating Questions

1. What are carbon nanotubes? Explain their discovery and significance.
2. Differentiate between Single-Walled Carbon Nanotubes (SWCNT) and Multi-Walled Carbon Nanotubes (MWCNT).
3. Describe the structure of carbon nanotubes. How is it related to graphene?.
4. What are the key physical and chemical properties of carbon nanotubes?
5. Why are carbon nanotubes considered stronger than steel?
6. How do carbon nanotubes exhibit both metallic and semiconducting behavior?
7. Discuss the thermal conductivity of CNTs. How does it compare to other materials like copper?

7. FAQ's

1.Who discovered Carbon Nanotubes?

a) Hentri Bacqueral

b) Sumio Iijima

c) John Dolton

d) Jane Goodal

2 .Which are the types of Carbon Nanotubes?

a) Single-Walled Carbon Nanotube

b) Multy-Walled Carbon Nanotubes

c) Dublet-Walled Carbon Nanotubes

d) To break chemical bonds

3. How are Carbon Nanotubes made?

a) Chemical Vapour Deposition

b) Distillation method

c) Iron exchange method

d) Fractional method

8. References

1. Dresselhaus, M. S., Dresselhaus, G., & Avouris, P. (Eds.). (2001). Carbon Nanotubes: Synthesis, Structure, Properties, and Applications**.** Springer. D. C. Young, *Computational Drug Design: A Guide for Computational and Medicinal Chemists*, Wiley, 2016.
2. Tans, S. J., Verschueren, A. R., & Dekker**,** C. (1998). Room-temperature transistor based on a single carbon nanotube**.** Nature, 393(6680), 49-52.
3. Iijima, S. (1991). Helical microtubules of graphitic carbon**.** Nature, 354(6348), 56-58.DOI: 10.1038/354056a0
4. Ajayan, P. M. (1999). Nanotubes from Carbon**.** Chemical Reviews, 99(7), 1787-1800.DOI: 10.1021/cr970102g

9. Verified by Subject Expert

Course In-charge

Approved by HOD

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Semester III

Objective-Oriented Learning Process (RBT)

Programme	M.Sc. Chemistry
Semester	III
Subject Title	Core VII: Inorganic Chemistry-III
Code	21PCHC31
Hours	5
Total Hours	75
Credits	4
Max. Marks	100
Unit & Title	Unit I: Solid State I
Name of the Faculty	K.Saravanadevi
T-L tools	Lecture method, PowerPoint presentations, diagrams of defects and dislocations, multimedia videos, and group discussions.

Prerequisite Knowledge:

Basic understanding of crystalline solids, lattice structures, and bonding in solids.

Micro-Planning

Evocation : 2 min
GO : 10 min
SOI : 10 min
FAI : 2 min
SOII : 10 min
FAII : 2 min
Discussion : 10 min
Stimulation : 10 min
Mind Map : 2 min
Summary : 2 min

1. Topic for Learning Through Evocation:

Defects in solids are deviations from the ideal arrangement of atoms or ions in a crystal. These defects significantly influence the physical and chemical properties of materials.

Key topics include:

- **Point Defects:**
  - Schottky Defects: Equal number of cations and anions missing from the lattice.
  - Frenkel Defects: A cation or anion displaced from its normal position to an interstitial site.
- **Line Defects:**
  - Edge dislocations: A missing half-plane of atoms.
  - Screw dislocations: A helical arrangement of atoms around a dislocation line.
- **Surface Defects:** Imperfections at the crystal's surface, including grain boundaries and vacancies.
- **Dislocations:** Linear defects causing distortion in the crystal lattice.

2. Topic Introduction:

Dislocations and defects in solids are critical in determining material properties such as conductivity, strength, and reactivity. This topic explores their types, characteristics, and effects.

2.1 General Objective:

Enable students to understand the nature of dislocations and defects in solids and their role in influencing material properties.

2.2 Specific Objectives:

Enable students to:

1. Define and classify defects in crystalline solids.
2. Differentiate between Schottky and Frenkel defects.
3. Describe the structure and impact of line defects (edge and screw dislocations).
4. Analyze the role of surface defects in material behavior.
5. Discuss the significance of dislocations in solid-state chemistry and material science.

2.3 Taxonomy of Objectives:

Knowledge Dimension	The Cognitive Process Dimension
Factual Knowledge	Remember, Understand
Conceptual Knowledge	Understand, Apply, Analyze
Procedural Knowledge	Apply, Analyze, Evaluate
Meta-cognitive Knowledge	Create, Evaluate

2.4 Key Words:

Point Defects, Schottky Defects, Frenkel Defects, Line Defects, Edge Dislocations, Screw Dislocations, Surface Defects, Crystalline Solids.

2.5 Key Diagrams (if any):

- Schematic representation of Schottky and Frenkel defects.
- Diagrams of edge and screw dislocations.
- Representation of surface defects, such as grain boundaries.
- Visualization of dislocations in crystal lattices.

3. Discussion:

Students will work in groups to:

1. Compare and contrast Schottky and Frenkel defects in ionic solids.
2. Discuss the impact of edge and screw dislocations on material properties.
3. Explore how surface defects affect the reactivity and mechanical behavior of crystals.
4. Relate the presence of dislocations to real-world applications, such as semiconductor design and metallurgy.

4. Mind Map:

css
CopyEdit
[Defects in Solids] --> [Point Defects] --> [Schottky Defects, Frenkel Defects]
--> [Line Defects] --> [Edge, Screw Dislocations]
--> [Surface Defects] --> [Grain Boundaries, Vacancies]
--> [Applications] --> [Material Properties, Reactivity, Strength]

5. Summary:

Students summarize the key types of defects (point, line, surface), their characteristics, and their impact on the properties of crystalline solids. The practical significance of these defects in material science is highlighted.

6. Assessment Through Stimulating Questions/Analogy/New Ideas:

- Why do Schottky and Frenkel defects occur in ionic solids?
- How do dislocations influence the strength of metals?
- Propose ways to minimize the impact of surface defects in crystal growth.
- Compare the roles of edge and screw dislocations in plastic deformation.

7. FAQs:

1. What is a Schottky defect?
   a) A cation displaced to an interstitial site.
   b) Equal number of cations and anions missing.

c) Grain boundary imperfection.
d) Dislocation line in a lattice.

2. Which defect involves a cation or anion in an interstitial position?
   a) Schottky defect b) Frenkel defect
   c) Edge dislocation d) Surface defect
3. What is the difference between edge and screw dislocations?
4. How do surface defects affect the reactivity of solids?

8. References

1. West, A. R. *Solid State Chemistry and Its Applications*. Wiley, 2nd Edition, 2014.
2. Azaroff, L. V. *Introduction to Solids*. McGraw-Hill, 1960.
3. Hull, D., & Bacon, D. J. *Introduction to Dislocations*. Butterworth-Heinemann, 5th Edition, 2011.
4. Callister, W. D., &Rethwisch, D. G. *Materials Science and Engineering: An Introduction*. Wiley, 9th Edition, 2014.
5. Hannay, N. B. *Solid State Chemistry*. Prentice-Hall, 1967.

9. Verified by Subject Expert:

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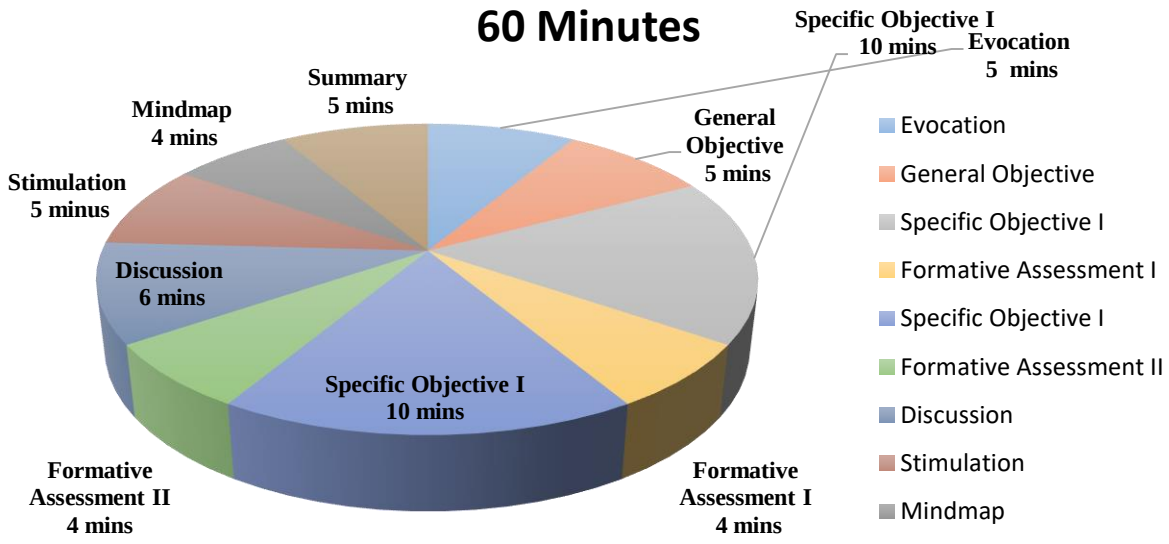
Objective-Oriented Learning Process (RBT)

Programme	M.Sc. Chemistry
Semester	III
Subject Title	Core VIII: Organic Chemistry-III
Code	21PCHC32
Hours	4
Total Hours	60
Credits	4
Max. Marks	100
Unit & Title	Unit II: Conformational Analysis
Name of the Faculty	Dr. C. Zozimus Divya Lobo
T-L tools	Lecture method, molecular models, multimedia presentations, conformational energy diagrams, group discussions, and problem-solving exercises.

Prerequisite Knowledge:

Basic understanding of stereochemistry, conformational isomerism, and cycloalkane structures.

Micro-Planning



Evocation : 2 min
GO : 10 min
SOI : 10 min
FAI : 2 min
SOII : 10 min
FAII : 2 min

Discussion : 10 min
Stimulation : 10 min
Mind Map : 2 min
Summary : 2 min

1. Topic for Learning Through Evocation:

Conformational analysis is the study of the spatial arrangement of atoms in a molecule and the energy changes associated with different conformations.

Key topics include:

- **Fused Bicyclic Systems:**
  - Structure and types of fused systems (cis- and trans-fused).
  - Stability and conformational preferences in fused systems.
- **Decalin:**
  - Cis- and trans-decalin conformations.
  - Relative stabilities and ring strain considerations.
- **Perhydrophenanthrene:**
  - Analysis of three fused cyclohexane rings.
  - Steric interactions and axial-equatorial preferences.
  - Conformational lock and its impact on reactivity.

2. Topic Introduction:

Fused bicyclic systems like decalin and perhydrophenanthrene are common in natural products and synthetic molecules. Understanding their conformations is critical for predicting their chemical behavior and reactivity.

2.1 General Objective:

Enable students to understand the conformational analysis of fused bicyclic systems and their implications in stereochemistry and reactivity.

2.2 Specific Outcome:

Enable students to:

1. Define fused bicyclic systems and describe their structural features.
2. Analyze the conformational differences between cis- and trans-decalin.
3. Explain the conformational behavior of perhydrophenanthrene and its implications.
4. Relate conformational preferences to stability and ring strain.
5. Solve stereochemical problems involving fused bicyclic systems.

2.3 Taxonomy of Objectives:

Knowledge Dimension	The Cognitive Process Dimension
Factual Knowledge	Remember, Understand
Conceptual Knowledge	Understand, Apply, Analyze

Knowledge Dimension	The Cognitive Process Dimension
Procedural Knowledge	Apply, Analyze, Evaluate
Meta-cognitive Knowledge	Create, Evaluate

2.4 Key Words:

Conformational Analysis, Fused Bicyclic Systems, Decalin, Perhydrophenanthrene, Cis-Fused, Trans-Fused, Stability, Ring Strain.

2.5 Key Diagrams (if any):

- Chair conformations of cis- and trans-decalin.
- 3D representation of perhydrophenanthrene.
- Energy diagrams comparing the stabilities of different conformations.
- Axial and equatorial interactions in fused rings.

3. Discussion:

Students will work in groups to:

1. Compare the conformations of cis- and trans-decalin and discuss their stability differences.
2. Analyze steric and ring strain effects in perhydrophenanthrene.
3. Solve stereochemical problems involving the rotational barriers and conformational energy.

4. Mind Map:

css
CopyEdit
[Fused Bicyclic Systems] --> [Decalin] --> [Cis-Fused, Trans-Fused, Stability]
--> [Perhydrophenanthrene] --> [Steric Interactions, Axial/Equatorial Preferences]
--> [Applications] --> [Natural Products, Reactivity Predictions]

5. Summary:

Students summarize the conformational analysis of decalin and perhydrophenanthrene, highlighting the factors influencing their stability and reactivity.

6. Assessment Through Stimulating Questions/Analogy/New Ideas:

- Why is trans-decalin more stable than cis-decalin?
- What role do axial and equatorial interactions play in perhydrophenanthrene?
- Propose how conformational analysis of these systems can aid in drug design.
- Compare the conformations of perhydrophenanthrene with those of cholesterol.

7. FAQs:

1. Which fused bicyclic system is more stable, cis-decalin or trans-decalin? Why?
   a) Cis-decalin b) Trans-decalin
   c) Both are equally stable d) Depends on the solvent
2. How does ring strain affect the conformational preferences of fused systems?
3. What is the significance of the "conformational lock" in perhydrophenanthrene?
4. Why is perhydrophenanthrene more rigid than decalin?

8. References (Books/Periodicals/Journals):

1. Eliel, E. L., Wilen, S. H., & Doyle, M. P. *Basic Organic Stereochemistry*. Wiley, 2001.
2. Nasipuri, D. *Stereochemistry of Organic Compounds: Principles and Applications*. New Age International Publishers, 3rd Edition, 1994.
3. Kalsi, P. S. *Stereochemistry: Conformation and Mechanism*. New Age International Publishers, 8th Edition, 2017.
4. Carey, F. A., &Sundberg, R. J. *Advanced Organic Chemistry, Part B: Reactions and Synthesis*. Springer, 5th Edition, 2007.
5. Clayden, J., Greeves, N., Warren, S., &Wothers, P. *Organic Chemistry*. Oxford University Press, 2nd Edition, 2012.

9. Verified by Subject Expert:

Course In-charge

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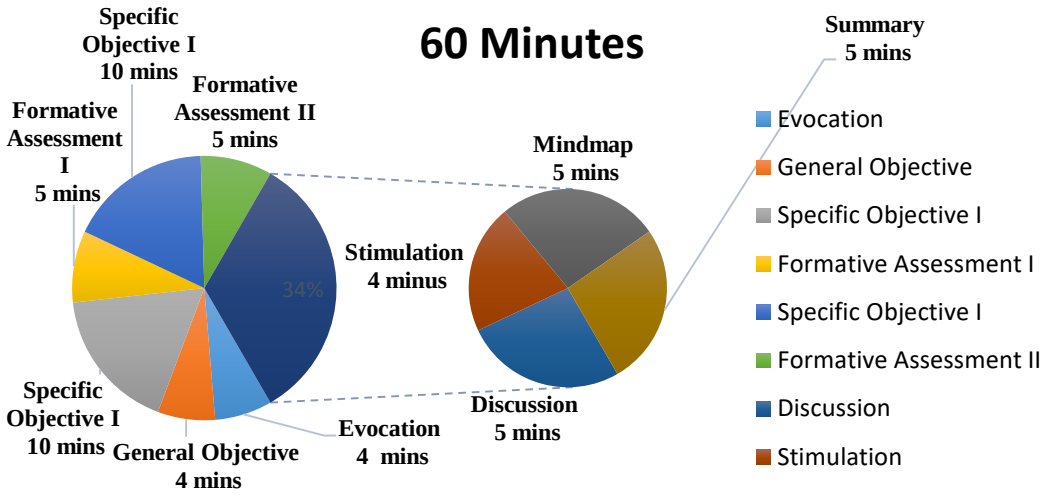
LESSON PLAN FOR SCIENCE

Programme	M.Sc. Chemistry
Semester	III
Subject Title	Core IX: Physical Chemistry-III
Code	21PCHC33
Hours	5
Total Hours	75
Credits	4
Max. Marks	75
Unit & Title	Unit IV: Nuclear Magnetic Resonance Spectroscopy
Name of the Faculty	Dr. J. Antony Rajam
T-L tools	Lecture method, audio-visual aids (molecular models, simulation software for NMR spectra), group discussion, problem-solving exercises

Prerequisite Knowledge:

- Basics of Nuclear Magnetic Resonance (NMR) Spectroscopy
- Spin quantum numbers and magnetic properties of nuclei
- Chemical shift and coupling constants

Micro-Planning:



Evocation : 2 min
GO : 10 min
SOI : 10 min
FAI : 2 min
SOII : 10 min
FAII : 2 min
Discussion : 10 min
Stimulation : 10 min

Mind Map : 2 min
Summary : 2 min

1 Topic for Learning Through Evocation

- **AX and AMX spin systems**: Understanding simple spin-spin coupling patterns in NMR spectra.
- **Chemical shift and coupling constants**: How they influence the NMR spectra of simple molecules.
- **Interpretation of spectra**: Recognizing and predicting NMR splitting patterns in AX and AMX systems.

2. Topic Introduction:

Nuclear Magnetic Resonance (NMR) spectroscopy is a powerful tool for studying molecular structures and interactions. The analysis of spin-spin coupling in simple systems, such as AX and AMX type molecules, provides fundamental insights into the principles of J-coupling and spectral interpretation.

2.1 General Objective

To enable students to understand NMR spectral patterns of simple AX and AMX molecules and their interpretation.

2.2 Specific Outcome

The students will be able to:

1. Describe the basic concepts of spin-spin coupling in NMR spectroscopy.
2. Explain the characteristics of AX and AMX type molecules.
3. Interpret NMR spectra of simple AX and AMX type molecules.
4. Analyze and compare different coupling constants in these systems.
5. Apply theoretical concepts to predict spectral patterns.

2.3. Taxonomy of Objectives

Knowledge Dimension	Cognitive Process Dimension
A. Factual Knowledge	Remember (1), Understand (2,3), Apply (4)
B. Conceptual Knowledge	Understand (2,3,4), Analyze (4)
C. Procedural Knowledge	Apply (3,4), Evaluate (5)
D. Meta-Cognitive Knowledge	Create (5)

2.4. Keywords:

- AX and AMX spin systems
- Coupling constants (J values)
- First-order and second-order splitting
- Chemical shift

- Pascal's triangle for spin systems

2.5. Key Diagrams (if any):

- NMR spectra of AX and AMX molecules
- Coupling patterns (doublet, triplet, quartet, etc.)
- Schematic representation of spin systems

3. Discussion:

- **Group Activity:** Students will work in groups to analyze given spectra and identify AX and AMX patterns.
- **Real-World Application:** Discussing the importance of these spin systems in structural elucidation of organic molecules.
- **Hands-on Practice:** Using NMR simulation software to generate and interpret spectra.

4. Mind Map:

A visual representation of:

- Types of spin systems → AX vs. AMX
- Coupling Constants → First-order vs. Second-order
- Spectral Interpretation → Examples & Applications

5. Summary

Nuclear Magnetic Resonance (NMR) spectroscopy is a powerful technique used to determine the structure of organic molecules. For simple systems, such as AX and AMX types, NMR provides clear insights into coupling patterns, chemical shifts, and spin-spin interactions.

6.Assessment Through Stimulating Questions/Analogy/New Ideas:

1. How does coupling constant (J) vary in AX and AMX systems?
2. Why does an AMX system show second-order effects compared to an AX system?
3. How do symmetry and magnetic equivalence affect the NMR spectra?
4. Can we determine molecular conformation using AX and AMX NMR patterns?

7. FAQs:

1. What type of spin system is present in $CHCl_3$?
   a) AX b) AMX c) ABC d) None
2. Which parameter determines the first-order or second-order nature of a spin system?
   a) Chemical shift b) Coupling constant (J)
   c) External magnetic field strength d) Both a and b
3. In an AMX system, the order of J-values generally follows:
   a) J_AM > J_AX > J_MX

b) J_AX > J_AM > J_MX

c) J_AM = J_AX = J_MX

d) None of the above

8. References:

1. Silverstein, Bassler, Morrill - Spectrometric Identification of Organic Compounds
2. Pavia, Lampman, Kriz - Introduction to Spectroscopy
3. Claridge - High-Resolution NMR Techniques in Organic Chemistry

9. Verified by Subject Expert:

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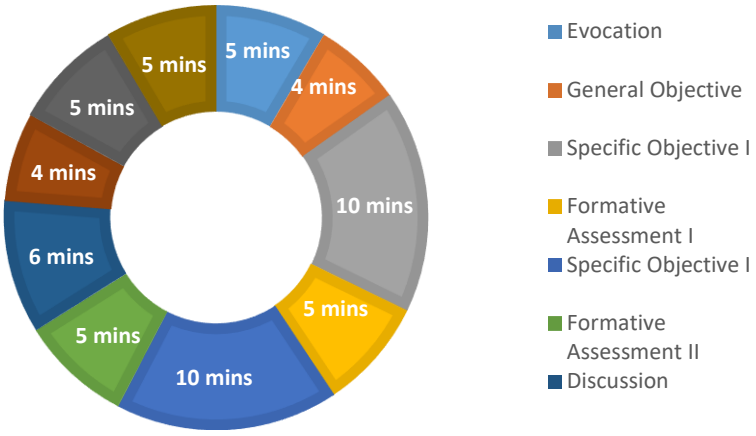
Objective-Oriented Learning Process (RBT)

Programme	M.Sc. Chemistry
Semester	III
Subject Title	Elective III: A. Research Methodology
Code	21PCHE31
Hours	4
Total Hours	60
Credits	4
Max. Marks	75
Unit & Title	Unit II Thermo and electro analytical methods
Name of the Faculty	D. Carolin Jeniba Rachel
T-L tools	Lecture method, audio-visual aids (diagrams, working models, and animations of TGA), problem-solving exercises, case studies, and hands-on software demonstrations...

Prerequisite Knowledge:

- Basic understanding of thermal analysis techniques.
- Knowledge of mass changes in materials upon heating.
- Fundamentals of phase transitions and decomposition reactions.

Micro-Planning:



Evocation : 2 min
GO : 10 min
SOI : 10 min
FAI : 2 min
SOII : 10 min
FAII : 2 min
Discussion : 10 min
Stimulation : 10 min
Mind Map : 2 min

Summary : 2 min

1 Topic for Learning Through Evocation

- **Thermogravimetric Analysis (TGA):** Understanding the concept of mass loss with temperature changes.
- **Instrumentation:** Components and working of a TGA system.
- **Applications:** Use of TGA in polymers, pharmaceuticals, and material science.

2. Topic Introduction

Thermo gravimetric Analysis (TGA) is an analytical technique used to measure the change in the mass of a substance as a function of temperature or time under a controlled atmosphere. It is widely used in material science, chemistry, and pharmaceuticals to study thermal stability, composition, and decomposition patterns of materials.

2.1 General Objective

To enable students to understand the working principle, instrumentation, and applications of Thermo gravimetric (TGA) in material characterization.

2.2 Specific Outcome

The students will be able to:

1. Define Thermogravimetric Analysis (TGA) and its significance.
2. Explain the working principle of TGA and the role of heat-induced weight changes.
3. Describe the major components of a TGA instrument.
4. Interpret TGA curves for different materials.
5. Apply TGA for thermal stability studies in polymers, pharmaceuticals, and other materials.

2.3. Taxonomy of Objectives

Knowledge Dimension	Cognitive Process Dimension
A. Factual Knowledge	Remember (1), Understand (2,3), Apply (4)
B. Conceptual Knowledge	Understand (2,3,4), Analyze (4,5)
C. Procedural Knowledge	Apply (3,4), Evaluate (5)
D. Meta-Cognitive Knowledge	Create (5)

2.4. Keywords:

- Thermogravimetric Analysis (TGA)
- Mass loss, decomposition temperature
- Thermal stability

- Instrumentation (Furnace, Balance, Sample holder)
- Applications in polymer degradation, pharmaceuticals, and inorganic materials

2.5. Key Diagrams (if any):

- Schematic diagram of a TGA instrument
- Representative TGA curves of different materials
- Graphical representation of weight loss vs. temperature

3. Discussion:

- **Group Activity:** Students will analyze different TGA thermograms and interpret the weight loss patterns.
- **Real-World Application:** Discussing TGA use in detecting material composition and stability.
- **Hands-on Practice:** Using software simulations to generate and interpret TGA curves.

4. Mind Map:

A visual representation of:

- **Principle of TGA** → Relationship between weight loss and temperature.
- **Instrumentation** → Components: Furnace, microbalance, gas flow system, and data analysis software.
- **Applications** → Polymers, Pharmaceuticals, Catalysts, Inorganic materials.

5.Summary

Thermogravimetric Analysis (TGA) is an analytical technique used to measure the change in the mass of a material as a function of temperature or time under a controlled atmosphere. It is essential for studying thermal stability, composition, and decomposition behavior of various materials.

6.Assessment Through Stimulating Questions/Analogy/New Ideas:

1. What factors influence mass loss in TGA?
2. How does the heating rate affect TGA results?
3. What are the major differences between TGA and Differential Thermal Analysis (DTA)?
4. How can TGA be used to determine the composition of a polymer blend?

7. MCQs & Conceptual Questions:

1. What is the primary purpose of TGA?
   a) To measure electrical conductivity
   b) To determine weight loss with temperature
   c) To analyze molecular vibrations
   d) To measure pH changes
2. Which component of TGA is responsible for detecting weight changes?
   a) Furnace
   b) Sample holder
   c) Microbalance
   d) Data processing unit
3. A sharp weight loss in a TGA curve indicates:
   a) Physical adsorption
   b) Chemical reaction or decomposition
   c) Phase transition
   d) Crystal formation

8. References:

1. Willard, Merritt, Dean, Settle - **Instrumental Methods of Analysis**
2. Skoog, Holler, Crouch - **Principles of Instrumental Analysis**
3. Brown, F. - **Introduction to Thermal Analysis: Techniques and Applications**

9. Verified by Subject Expert:

Course In-charge

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Semester IV

Objective-Oriented Learning Process (RBT)

Programme	M.Sc. Chemistry
Semester	IV
Subject Title	Core: Inorganic Chemistry-IV
Code	21PCHC41
Hours	4
Total Hours	60
Credits	4
Max. Marks	75
Unit & Title	Unit III Nuclear Chemistry
Name of the Faculty	D. Carolin Jeniba Rachel
T-L tools	Lecture method, audio-visual aids (animations of nuclear reactions, videos of nuclear experiments), problem-solving exercises, case studies, and hands-on numerical calculations..

Prerequisite Knowledge:

- Basics of atomic structure and radioactivity.
- Understanding of isotopes, nuclear binding energy, and stability.
- Laws of conservation (mass-energy, charge, momentum) in nuclear reactions.

Micro-Planning:

Evocation : 2 min
GO : 10 min
SOI : 10 min
FAI : 2 min
SOII : 10 min
FAII : 2 min
Discussion : 10 min

Stimulation : 10 min
Mind Map : 2 min
Summary : 2 min

1 .Topic for Learning Through Evocation

- **Nuclear Reactions:** Understanding different types and their significance.
- **Types of Nuclear Reactions:** Fission, Fusion, Transmutation, Capture, and Spallation.
- **Energy Changes in Nuclear Reactions:** Mass defect and binding energy calculations.

2. Topic Introduction

Nuclear reactions involve changes in the nucleus of an atom, resulting in the transformation of elements and the release or absorption of large amounts of energy. Unlike chemical reactions, which involve electrons, nuclear reactions alter the composition, energy state, or structure of the atomic nucleus. These reactions are fundamental to various applications, including nuclear power generation, medical imaging and treatment, and understanding astrophysical processes like stellar fusion.

2.1.General Objective

To enable students to understand the different types of nuclear reactions, their mechanisms, and applications.

2.2 Specific Objectives

The students will be able to:

1. Define and classify **nuclear reactions** based on reactants and products.
2. Explain the concepts of **nuclear fission and fusion** with real-world examples.
3. Differentiate between **elastic and inelastic scattering** in nuclear processes.
4. Describe the **principle of artificial transmutation** and its significance.
5. Apply mass-energy equivalence to calculate **Q-values** for nuclear reactions.

2.3. Taxonomy of Objectives

Knowledge Dimension	Cognitive Process Dimension
A. Factual Knowledge	Remember (1), Understand (2,3), Apply (4)
B. Conceptual Knowledge	Understand (2,3,4), Analyze (4,5)
C. Procedural Knowledge	Apply (3,4), Evaluate (5)
D. Meta-Cognitive Knowledge	Create (5)

2.4. Keywords:

- Nuclear Fission & Fusion
- Transmutation & Spallation
- Q-Value and Mass Defect
- Neutron Capture
- Elastic & Inelastic Scattering

2.5. Key Diagrams (if any):

- Representation of nuclear fission and fusion.
- Energy-level diagrams for nuclear reactions.
- Nuclear reaction equations (e.g., neutron capture, transmutation).
- Graphical representation of mass defect and binding energy.

3. Discussion:

- **Group Activity:** Students will classify given nuclear reactions and predict products.
- **Real-World Application:** Discussion on nuclear power plants, hydrogen bomb, and medical isotope production.
- **Hands-on Practice:** Calculation of Q-values and reaction energetics.

4. Mind Map:

A visual representation of:

- **Types of Nuclear Reactions** → Fission, Fusion, Transmutation, Spallation.
- **Energy Aspects** → Binding Energy, Mass Defect, Q-Values.
- **Applications** → Nuclear Power, Medical Imaging, Space Exploration.

5.Summary

Nuclear reactions involve changes in an atom's nucleus, leading to the transformation of elements and the release or absorption of large amounts of energy. Unlike chemical reactions, nuclear reactions alter the nucleus, making them fundamental to applications like nuclear power, medical treatments, and astrophysics.

6. Assessment through Stimulating Questions

1. What is the main difference between nuclear fission and fusion?
2. How do Q-values determine whether a nuclear reaction is exothermic or endothermic?
3. Why is neutron capture significant in nuclear reactors?
4. How does artificial transmutation contribute to isotope production?

7. FAQ's

1. In nuclear fission, the nucleus splits into:
   a) Two or more smaller nuclei b) A single larger nucleus
   c) Electron and proton pairs d) Only gamma rays
2. The Q-value of a nuclear reaction represents:
   a) The charge of the nucleus b) The energy released or absorbed
   c) The number of protons lost d) The decay rate of an isotope
3. In a fusion reaction, energy is released because:
   a) The total binding energy of the products is higher than the reactants
   b) Mass defect is zero c) Neutrons are absorbed
   d) The reaction occurs at room temperature

8. References:

1. Friedlander, Kennedy, Miller - **Nuclear and Radiochemistry**
2. Arnikar, H.J. - **Essentials of Nuclear Chemistry**
3. S. Glasstone - **Sourcebook on Atomic Energy**

9. Verified by Subject Expert

Course In-charge **Approved by HOD**

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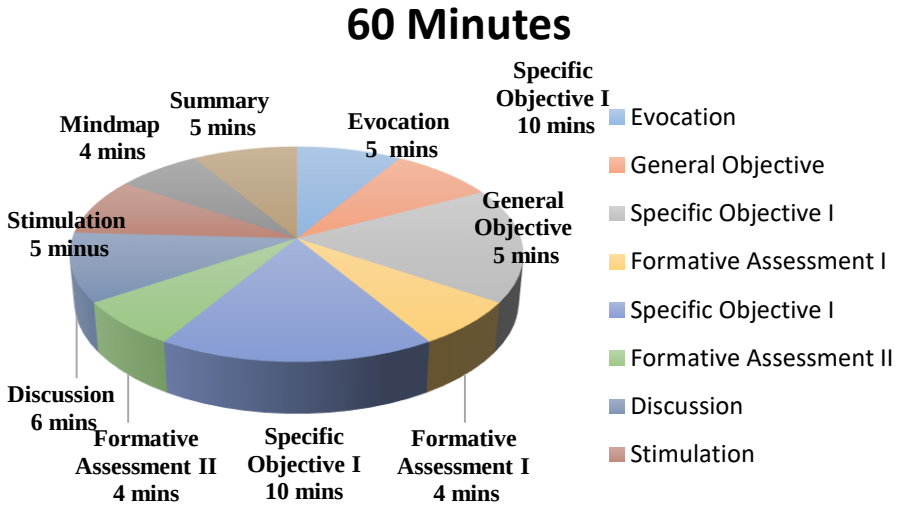
Objective-Oriented Learning Process (RBT)

Programme	M.Sc. Chemistry
Semester	IV
Subject Title	Core XI: Organic Chemistry IV
Code	21PCHC42
Hours	4
Total Hours	60
Credits	4
Max. Marks	75
Unit & Title	Unit III Heterocycles and Nucleic acids
Name of the Faculty	Dr. C. Zozimus Divya Lobo
T-L tools	Lecture method, audio-visual aids (animations and 3D models of DNA), molecular modelling software, problem-solving exercises, and case studies

Prerequisite Knowledge:

- Basics of **nucleotides, nucleosides, and their chemical structures**.
- Understanding of **hydrogen bonding and base pairing**.
- Knowledge of **biopolymers and their biological significance**.

Micro-Planning:



Evocation : 2 min
GO : 10 min
SOI : 10 min
FAI : 2 min
SOII : 10 min
FAII : 2 min

Discussion : 10 min
Stimulation : 10 min
Mind Map : 2 min

Summary : 2 min

1. Topic for Learning Through Evocation

- **Structure of DNA:** Understanding the double-helical model proposed by Watson and Crick.
- **Base Pairing Rules:** Complementary hydrogen bonding between purines and pyrimidines.
- **Chemical Stability & Function:** Role of sugar-phosphate backbone and base stacking.

2. Topic Introduction

The Watson-Crick model of DNA, proposed by James Watson **and** Francis Crick in 1953, describes the molecular structure of deoxyribonucleic acid (DNA), the genetic material in living organisms. This groundbreaking model revealed how genetic information is stored, replicated, and transmitted from one generation to the next, laying the foundation for modern molecular biology and genetics.

2.1 General Objective

To enable students to understand the chemical structure, stability, and biological significance of the **Watson-Crick model of DNA**.

2.2. Specific Objectives

The students will be able to:

1. Describe the **chemical structure** of DNA.
2. Explain the **Watson-Crick base-pairing** rules.
3. Understand the **role of hydrogen bonding and base stacking** in DNA stability.
4. Differentiate between **A-DNA, B-DNA, and Z-DNA**.
5. Analyze the **importance of the DNA double helix in replication and genetic information storage**.

2.3. Taxonomy of Objectives

Knowledge Dimension	Cognitive Process Dimension
A. Factual Knowledge	Remember (1), Understand (2,3), Apply (4)
B. Conceptual Knowledge	Understand (2,3,4), Analyze (4,5)

Knowledge Dimension	Cognitive Process Dimension
C. Procedural Knowledge	Apply (3,4), Evaluate (5)
D. Meta-Cognitive Knowledge	Create (5)

2.4. Keywords:

- **Double Helix**
- **Base Pairing (A-T, G-C)**
- **Hydrogen Bonding**
- **Sugar-Phosphate Backbone**
- **Helical Structure and Stability**

2.5. Key Diagrams (if any):

- **Watson-Crick DNA Double Helix Model**
- **Base Pairing (A-T, G-C) with Hydrogen Bonds**
- **Comparison of A-DNA, B-DNA, and Z-DNA**
- **DNA Supercoiling and Major/Minor Grooves**

3. Discussion:

- **Group Activity:** Students will analyze and construct a physical or virtual DNA model.
- **Real-World Application:** Understanding how **DNA mutations affect genetic diseases**.
- **Hands-on Practice:** Using molecular visualization software to explore DNA 3D structures.

4. Mind Map:

A visual representation of:

- **Watson-Crick Model** → Helical Structure, Base Pairing, Hydrogen Bonding.
- **Types of DNA** → A, B, Z-Forms.
- **Functions** → Replication, Genetic Information Storage.

5.Summary

The Watson-Crick model of DNA**,** proposed by James Watson and Francis Crick in 1953, describes DNA as a double helix composed of two anti-parallel polynucleotide strands**.** The backbone of each strand consists of deoxyribose sugars and phosphate groups**,** connected by phosphodiester bonds**.**

6. Assessment through Stimulating Questions

1. How do hydrogen bonds contribute to the stability of the DNA double helix?
2. What are the differences between A-DNA, B-DNA, and Z-DNA?
3. Why is the sugar-phosphate backbone negatively charged?
4. How does the structure of DNA influence its function in replication?

7. FAQ's

1. Which of the following base pairs are found in DNA?
   a) A-G and C-T
   b) A-T and G-C
   c) A-C and G-T
   d) A-U and G-C
2. The DNA double helix is stabilized mainly by:
   a) Covalent bonds
   b) Ionic bonds
   c) Hydrogen bonding and base stacking
   d) Van der Waals forces
3. The **major and minor grooves** of DNA result from:
   a) The unequal spacing of the sugar-phosphate backbone
   b) The presence of ribose sugar
   c) The breaking of hydrogen bonds
   d) The supercoiling of DNA

8. References:

1. Nelson, Cox - **Lehninger Principles of Biochemistry**
2. Voet&Voet - **Biochemistry**
3. Watson, Crick - **Original Research Paper on DNA Structure (Nature, 1953)**

9. Verified by Subject Expert

Course In-charge

Approved by HOD

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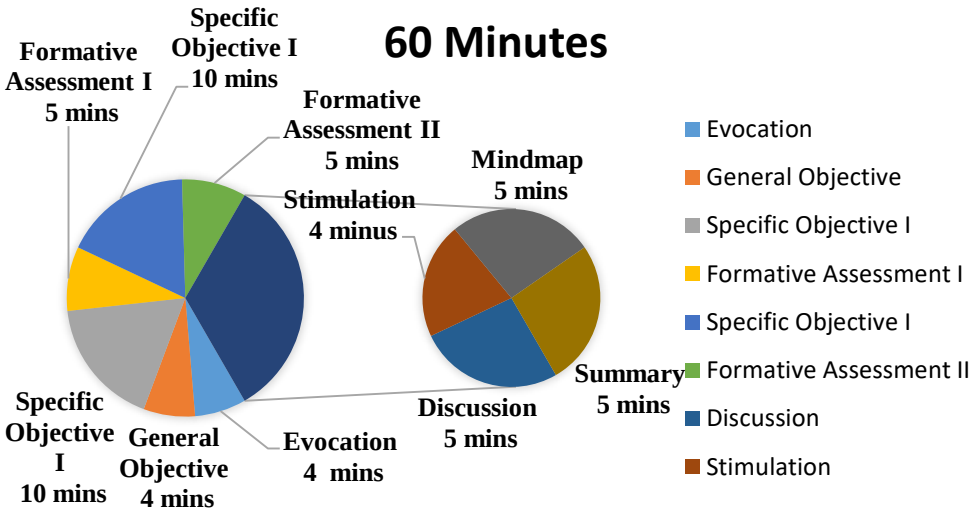
Objective-Oriented Learning Process (RBT)

Programme	M.Sc. Chemistry
Semester	IV
SubjectTitle	Core XII: Physical Chemistry IV
Code	21PCHC43
Hours	4
Total Hours	60
Credits	4
MaxMarks	75
Unit & Title	Unit V EPR and Mossbauer Spectroscopy
Nameof the Faculty	Dr. Antony Rajam
T-Ltools	Lecture method, audio-visual aids (animations of electron paramagnetic resonance (EPR) spectra, molecular models), problem-solving exercises, case studies, and hands-on spectral interpretation using simulation software.

Prerequisite Knowledge:

- Basics of **Electron Paramagnetic Resonance (EPR)** spectroscopy.
- Understanding of **nuclear spin and magnetic interactions**.
- Concept of **hyperfine coupling** and **Zeeman splitting** in magnetic fields.

Micro-Planning:



Evocation : 2 min
GO : 10 min
SOI : 10 min
FAI : 2 min
SOII : 10 min
FAII : 2 min

Discussion : 10 min
Stimulation : 10 min
Mind Map : 2 min
Summary : 2 min

1 .Topic for Learning Through Evocation

- **Hyperfine Splitting in EPR:** Role of nuclear spin in spectral patterns.
- **Deuterium (^2H) Hyperfine Interaction:** Differences from proton (^1H) coupling due to nuclear spin (I = 1).
- **Methyl Radical ($CH_3•$) in EPR:** Hyperfine interaction of the unpaired electron with hydrogen nuclei.

2. Topic Introduction

Electron Paramagnetic Resonance (EPR)**,** also known as Electron Spin Resonance (ESR)**,** is a powerful spectroscopic technique used to study chemical species with unpaired electrons, such as free radicals and transition metal complexes. A key feature of EPR spectra is hyperfine splitting, which arises from the interaction between the magnetic moment of an unpaired electron and nearby nuclear spins. This splitting provides detailed information about the electronic structure and local environment of the paramagnetic species.

2.1.General Objective

To enable students to understand the principles and applications of **hyperfine splitting in EPR spectra**, focusing on **deuterium and the methyl radical**.

2.2 Specific Outcome

The students will be able to:

1. Define **hyperfine splitting** and explain its role in EPR spectroscopy.
2. Differentiate between **proton (^1H) and deuterium (^2H) hyperfine interactions**.
3. Describe the **EPR spectrum of the methyl radical** and its splitting pattern.
4. Apply **theoretical calculations** to determine the hyperfine coupling constants.
5. Analyze**experimental EPR spectra** of radicals containing deuterium and methyl groups.

2.3. Taxonomy of Objectives

Knowledge Dimension	Cognitive Process Dimension
A. Factual Knowledge	Remember (1), Understand (2,3), Apply (4)
B. Conceptual Knowledge	Understand (2,3,4), Analyze (4,5)
C. Procedural Knowledge	Apply (3,4), Evaluate (5)
D. Meta-Cognitive Knowledge	Create (5)

2.4. Keywords:

- Electron Paramagnetic Resonance (EPR)
- Hyperfine Coupling
- Deuterium vs. Proton Interaction
- Methyl Radical (CH_3•)
- Nuclear Spin and Magnetic Moment

2.5. Key Diagrams (if any):

- **EPR spectra of deuterium and proton-coupled radicals.**
- **Spin multiplicity rule (2I + 1) and its effect on splitting patterns.**
- **Schematic representation of methyl radical splitting in EPR.**

3. Discussion:

- **Group Activity:** Students will interpret given EPR spectra for different radical systems.
- **Real-World Application:** Use of EPR in **free radical detection** and **isotopic substitution studies**.
- **Hands-on Practice:** Using spectral simulation software to generate EPR spectra for deuterium and methyl radicals.

4. Mind Map:

A visual representation of:

- **Hyperfine Splitting** → Concept, Origin, Spin Multiplicity.
- **Deuterium vs. Proton Interaction** → Differences in Spectral Patterns.
- **Methyl Radical (CH_3•) EPR** → Interpretation & Applications.

6.Summary

Hyperfine splitting in Electron Paramagnetic Resonance (EPR**)** arises from interactions between the magnetic moment of an unpaired electron and nearby nuclear spins. This splitting provides valuable information about the electronic environment and molecular structure of paramagnetic species.

6. Assessment through Stimulating Questions

1. Why does deuterium (^2H) exhibit different hyperfine splitting compared to proton (^1H)?
2. How does the spin multiplicity rule apply to hyperfine interactions in EPR?
3. Why is the EPR spectrum of the methyl radical a triplet?
4. How does isotopic substitution affect the EPR spectral pattern?

7. FAQ's

1. The nuclear spin of deuterium (^2H) is:
   a) ½ b) 1 c) 3/2 d) 0
2. In the EPR spectrum of the methyl radical (CH_3•), the number of hyperfine lines is:
   a) 1 b) 2 c) 3 d) 4

3. Hyperfine coupling in EPR arises due to:
   a) Electron-electron interaction b) Spin-orbit coupling
   c) Magnetic interaction between an unpaired electron and nuclear spin
   d) Change in molecular symmetry

8. References:

1. Wertz & Bolton - Electron Spin Resonance: Elementary Theory and Practical Applications
2. Poole &Farach - Theory of Magnetic Resonance
3. Weil, Bolton & Wertz - Electron Paramagnetic Resonance: Elementary Theory and Applications

9. Verified by Subject Expert

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