Year 12 Chemistry - Lesson Plan 2/3
Navigating Pathways: Connecting Reactions for Short Syntheses

Mr Haynes

Module 7: Organic Chemistry (Approx. Week 6/7)

Lesson Overview

- **Lesson Title:** Navigating Pathways: Connecting Reactions for Short Syntheses
- **Duration:** 60 minutes
- **Focus Inquiry Question:** How are different classes of organic compounds interconverted through reaction pathways? (Focus on 2-3 step sequences)
- **Placement:** Assumes L1 completed. Assumes students have now learned Alcohol Oxidation (CHM_M7_ALC_N6) and Esterification (CHM_M7_ESTER_N1, CHM_M7_NOM_N11).

Syllabus Alignment & Knowledge Nodes Targeted

- **Outcomes:** CH12-14 (Predicts reactions involving carbon compounds), CH11/12-6 (Solves scientific problems - synthesis planning), CH11/12-7 (Communicates understanding).
- **Content:** Applying knowledge of multiple reaction steps in sequence. Introduction to synthesis planning logic.
- **Knowledge Nodes (Focus):** CHM_M7_ALC_N6 (Oxidation), CHM_M7_ESTER_N1 (Esterification), CHM_M7_NOM_N11 (Ester Naming). Review/Application of nodes from L1.

Student Learning Objectives (Aligned with Nodes & Cognitive Strategies)

Students will be able to:

- Identify multi-step pathways (2-3 steps) between functional groups using the chord-diagram tool. [Apply - S2 Visualisation]
- Propose a logical sequence of known reactions to achieve a simple synthetic transformation. [Analyse - CH11/12-6]
- Identify necessary reagents and conditions for each step in a proposed short synthesis. [Apply - CH12-14]
- Name reactants, intermediates, and products (including simple esters) in a short synthesis pathway. [Apply - CHM_M7_NOM_N11]
- Articulate the planning process for solving a simple synthesis problem. [Apply - S6 Metacognition]
- Update and utilise their reaction map (mental or visual) incorporating oxidation and esterification. [Apply - S3 Concept Mapping]

Literacy Describe a short synthesis pathway using correct terminology and reaction representation.

Lesson Structure & Activities

Introduction & Retrieval Practice (10 mins)

- **Teacher Activity:** Brief retrieval quiz: "Show the reagents needed to convert 1-chloropropane to propan-1-ol." "What functional group results from dehydrating an alcohol?". Briefly review the chord diagram from L1, highlighting the previously learned connections. Add new nodes/reactions (Oxidation, Esterification) to the discussion/visualisation. [S3 Update Map, supports S4]
- **Student Activity:** Answer retrieval questions. Observe map update.
- **Pedagogy Focus:** Retrieval Practice, Activation of Prior Knowledge, Integrating New Knowledge into Schema (S3).

Modelling Short Synthesis Planning (15 mins)

- **Teacher Activity:** Explicitly model solving a 2-step synthesis problem (e.g., Ethene → Ethanoic Acid).
  - Step 1: Identify Start/End functional groups.
  - Step 2: Use the chord diagram tool to find path(s) - "Ethene to Alcohol (Addition), then Alcohol to Carboxylic Acid (Oxidation)". Identify intermediate (Ethanol).
  - Step 3: Write out the sequence, adding specific reagents/conditions for each step learned previously (hover on tool or recall).
  - Step 4: "Think aloud" the metacognitive process: "I need to get from alkene to acid. The map shows I can go via alcohol. First step is hydration... second step is oxidation of a primary alcohol..." [S1 Explicit Instruction, S2 Visualisation, S6 Metacognition]
- **Student Activity:** Follow the modelled example. Ask clarifying questions.
- **Pedagogy Focus:** Modelling Problem-Solving Process, Explicit use of Visualisation Tool for Planning, Metacognitive Scaffolding (S6).

Paired Problem Solving (25 mins)

- **Teacher Activity:** Provide pairs of students with simple 2 or 3-step synthesis problems (via Activity Sheet 2 or whiteboard). Encourage them to use the chord diagram tool *first* to plan their route, then write down the detailed steps (structures/names, reagents/conditions) on mini-whiteboards or paper. Circulate, prompt with planning questions ("What intermediate is needed?", "What reaction achieves that?", "Check the tool for reagents."). [S4 Interleaving if problems mix reaction types]
- **Student Activity:** Work in pairs. Use the visualisation tool to plan pathways for given synthesis problems. Draft the reaction sequence with structures, names, reagents, conditions. Discuss strategy with partner.
- **Pedagogy Focus:** Collaborative Learning, Applying Knowledge, Problem Solving (CH11/12-6), Active use of Visualisation Tool, Metacognitive Practice (S6 prompts).
- **ICT Integration:** Chord Diagram Tool (Student Use), Devices.

Sharing Consolidation (10 mins)

- **Teacher Activity:** Select 1-2 pairs to present their pathway for one problem on the board. Facilitate discussion – "Did anyone find a different route using the tool?". Briefly summarise the process of using the map for planning.

- **Student Activity:** Share proposed pathway if selected. Observe and comment on others' pathways. Ask questions.
- **Pedagogy Focus:** Communicating Solutions (CH11/12-7), Peer Learning, Consolidating the Planning Strategy.

Resources Required

- Interactive Chord Diagram Visualisation Tool.
- Projector / Whiteboard.
- Student devices with internet access.
- Mini-whiteboards or paper for drafting pathways.
- Activity Sheet 2 (containing 2/3-step synthesis problems - see below).

Assessment

- **Formative:** Observation of paired problem-solving process (use of tool, discussion, logic). Review of drafted pathways on mini-whiteboards/paper (checking for correct intermediates, reagents, conditions). Quality of participation in sharing session.

Differentiation

- **Support:** Provide partially completed pathways (e.g., give the intermediate). Offer a list of possible reagents to choose from. Pair students strategically.
- **Extension:** Challenge students to find the *shortest* possible route if multiple exist. Ask them to propose a synthesis for a slightly more complex target requiring 3 steps.

Lesson 2: Navigating Pathways

Connecting Reactions for Short Syntheses

Mr Haynes

Gosford High School

Module 7: Organic Chemistry

Outline

Recap & Expanding the Map

Retrieval Practice: (Teacher asks questions, e.g., "Reagent for Haloalkane $\rightarrow$ Alcohol?", "Product of alcohol dehydration?") **Review:**

Briefly show Chord Diagram from L1. Remind students of the connections learned. **New Reactions (Adding to our map):**

- **Alcohol Oxidation [CHM_M7_ALC_N6]:**
  - Primary Alcohol $\xrightarrow{[O]}$ Aldehyde $\xrightarrow{[O]}$ Carboxylic Acid
  - Secondary Alcohol $\xrightarrow{[O]}$ Ketone
  - Tertiary Alcohol $\xrightarrow{[O]}$ No reaction (usually)
  - *(Show these connections on the projected visualiser)*
- **Esterification [CHM_M7_ESTER_N1]:**
  - Carboxylic Acid + Alcohol $\xrightarrow{H^+/\Delta}$ Ester + H_2O
  - *(Show this connection on the visualiser)*
- **Ester Naming [CHM_M7_NOM_N11]:** (Brief mention - e.g., *Alkyl Alkanoate*)

From A to C via B: Planning Pathways

Often, we can't get from starting material (A) to target product (C) in one step. We need intermediate compounds (B). **The Strategy:**

1. Identify Starting and Target Functional Groups.
2. **Use the Chord Diagram Tool:** Find pathway(s) connecting Start to Target. Identify the intermediate functional group(s).
3. Write out the sequence of reactions.
4. Add specific reagents and conditions for each step.

Modelling: Ethene to Ethanoic Acid

Problem: Convert Ethene (C_2H_4) to Ethanoic Acid (CH_3COOH).
Teacher Modelling ("Think Aloud" - S6):

1. *"Start is Alkene, Target is Carboxylic Acid."*
2. *"Look at the map (Chord Diagram)... Alkene connects to Alcohol. Alcohol connects to Aldehyde, which connects to Carboxylic Acid (for primary). So, the path is Alkene $\rightarrow$ Alcohol $\rightarrow$ Carboxylic Acid. Intermediate = Alcohol (Ethanol)."*
3. *"Write the sequence:"*
   - Step 1 (Alkene $\rightarrow$ Alcohol): $CH_2{=}CH_2 \longrightarrow CH_3CH_2OH$. *"What reagent? Map hover/recall... Hydration."* Reagent: H_2O / H^+.
   - Step 2 (Alcohol $\rightarrow$ Acid): $CH_3CH_2OH \longrightarrow CH_3COOH$. *"What reagent? Map hover/recall... Oxidation of primary alcohol."* Reagent: Strong Oxidising Agent (e.g., $Cr_2O_7^{2-}/H^+$), shown as [O].
4. *"Check: Path makes sense, reagents identified."*

(Show final written sequence clearly)

$$CH_2{=}CH_2 \xrightarrow{H_2O\,/\,H^+} CH_3CH_2OH \xrightarrow{[O]} CH_3COOH$$

Paired Problem Solving Activity

Now, work with your partner on the problems from Activity Sheet 2.
Instructions Recap:

- Use the Chord Diagram tool to **PLAN** your route first.
- Write down the detailed steps on mini-whiteboard/paper/Worksheet 2:
  - Structures (or names).
  - Reagents & Conditions for each arrow.
- Discuss your strategy with your partner. Use the metacognitive prompts!

(Teacher circulates, assists, and prompts using S6 questions)

Navigating Pathways: Key Takeaways

- We expanded our reaction map with Alcohol Oxidation and Esterification.
- We practiced using the map (visualiser) to plan short (2-3 step) synthesis pathways.
- The planning process: Identify Start/Target $\rightarrow$ Find Route via Intermediates (using map) $\rightarrow$ Add Reagents/Conditions.
- This moves us from knowing single reactions to connecting them.

Next Steps:

- Review drafted pathways.
- **Preview Lesson 3:** Tackling more complex synthesis problems and learning to communicate them using formal flowcharts (Syllabus requirement!).

Thank you!

Questions?

Year 12 Chemistry - Activity Sheet 2
Paired Problem Solving: Short Syntheses

Organic Chemistry

Module 7 - Lesson 2

Aim

To practice planning and representing short (2-3 step) organic synthesis pathways using your knowledge of reactions and the visualisation tool.

Instructions

Work with your partner. For each problem below:

1. Identify the starting material and the target product.
2. Use the Chord Diagram Visualisation tool to help you brainstorm possible reaction sequences. Identify necessary intermediates.
3. On your mini-whiteboard or paper (or Worksheet 2), write out the step-by-step reaction pathway.
4. For each step, clearly show the structure (or IUPAC name) of the reactant and product.
5. Above/below the reaction arrow for each step, write the necessary reagent(s) and conditions.
6. Be prepared to explain your chosen pathway.

Synthesis Problems

Problem Set A: Propose a 2-step synthesis pathway for the conversion of **ethene** to **ethanoic acid**.

Problem Set B: Propose a synthesis pathway for the conversion of **propane** to **propanone**. (Hint: This might take more than 2 steps).

Problem Set C: Propose a synthesis pathway for the conversion of **1-bromobutane** to **butanoic acid**.

Problem Set D (Ester Challenge): Propose a synthesis pathway for the conversion of **propene** to **propyl ethanoate**. (Hint: You'll need to synthesise both the alcohol and the acid parts, potentially from the propene starting material if possible, or assume ethanoic acid is available).

Metacognitive Prompts (Consider while working):

- What functional group change is needed?
- What reaction(s) can achieve this change? (Check the visualizer!)
- What reagents/conditions are specific to that reaction?
- Is there another way to make this connection?

Year 12 Chemistry - Worksheet 2
Navigating Pathways: Short Syntheses

Student Name: _____ ID: _____

Module 7 - Lesson 2

Part 1: New Reactions - Oxidation & Esterification

1. Oxidation of Alcohols (Node: CHM_M7_ALC_N6):

a) What type of alcohol (primary, secondary, tertiary) is oxidised to form an aldehyde (which can be further oxidised to a carboxylic acid)?

b) What type of alcohol is oxidised to form a ketone?

c) What type of alcohol is generally resistant to oxidation under these conditions?

d) Name a common oxidising agent used for these reactions (often represented as [O]).

2. Esterification (Node: CHM_M7_ESTER_N1):

a) What two types of functional groups react to form an ester?

b) What catalyst and condition are typically required for esterification?

c) What small molecule is also produced during esterification?

3. Ester Naming (Node: CHM_M7_NOM_N11): Name the following esters:

a) The ester formed from methanol and ethanoic acid: _____

b) The ester formed from propan-1-ol and propanoic acid: _____

c) Draw the structure of ethyl propanoate:

Part 2: Planning Short Syntheses

Instructions: For the synthesis problems assigned in class (see Activity Sheet 2), use the space below to plan your pathway. Use the Chord Diagram tool to help identify intermediates and reaction types. For each step, show: Reactant Structure/Name $\xrightarrow{\text{Reagent(s)/Conditions}}$ Product Structure/Name.

Problem 1: [e.g., Ethene to Ethanoic Acid]

Planning Notes (Intermediates? Reaction Types?):

Pathway: Step 1: Step 2:

Problem 2: [e.g., Propane to Propanone]

Planning Notes:

Pathway: Step 1: Step 2: (Add more steps if needed)

Problem 3: [e.g., 1-Bromobutane to Butanoic Acid]

Planning Notes:

Pathway: Step 1: Step 2: (Add more steps if needed)