Year 12 Chemistry - Lesson Plan 3/3
Designing & Communicating Syntheses: Mastering Flowcharts

Mr Haynes

Module 7: Organic Chemistry (Approx. Week 9/10)

Lesson Overview

- **Lesson Title:** Designing & Communicating Syntheses: Mastering Flowcharts
- **Duration:** 60 minutes
- **Focus Inquiry Question:** How can we represent multi-step organic syntheses? (Culminating task)
- **Placement:** Assumes L1 & L2 completed. Assumes all relevant reactions from EduKG subset (Alkene Add/Sub, Haloalkane Sub, Alcohol Sub/Dehyd/Oxid, Esterification) have been covered in the module.

Syllabus Alignment & Knowledge Nodes Targeted

- **Outcomes:** CH12-14 (Analyses structure, predicts reactions), CH11/12-6 (Solves scientific problems - complex synthesis), CH11/12-7 (Communicates scientific understanding - flowchart conventions).
- **Content:** Constructing multi-step synthesis flowcharts with correct conventions, reagents, and conditions. Applying integrated knowledge of reaction pathways.
- **Knowledge Nodes (Focus):** CHM_M7_SYNTH_N1 (Draft and construct flow charts...). Application of all prerequisite reaction nodes.

Student Learning Objectives (Aligned with Nodes & Cognitive Strategies)

Students will be able to:

- Analyse a multi-step synthesis problem to identify starting material, target product, and required functional group changes. [Analyse - CH11/12-6]
- Utilise the chord-diagram tool and reaction knowledge to devise a logical multi-step synthesis pathway. [Create - CH11/12-6]
- Apply standard flowchart conventions to represent a multi-step synthesis accurately. [Apply - CHM_M7_SYNTH_N1, CH11/12-7]
- Include correct structural formulae (or IUPAC names) for all intermediates and products in a flowchart. [Apply - CH11/12-7]
- Specify correct reagents and conditions for each step in the flowchart. [Apply - CH12-14]
- Justify the chosen reaction pathway and steps. [Evaluate - S6 Metacognition]

Literacy Communicate a complex chemical process clearly and conventionally using a flowchart.

Numeracy Implicitly check atom conservation through balanced steps/structures.

Lesson Structure & Activities

Introduction & Map Review (10 mins)

- **Teacher Activity:** Briefly review the "complete" reaction map using the chord diagram, emphasizing the network of possibilities learned over the module. Pose a quick challenge question: "Can we directly convert an alkane to an ester using the reactions we've learned? Why/why not? What intermediate(s) would be needed?". State lesson objective: To plan complex syntheses and communicate them using formal flowcharts. [S3 Map Review]
- **Student Activity:** Participate in map review and challenge question discussion.
- **Pedagogy Focus:** Consolidation of Schema (S3), Assessing Integrated Understanding.

Instruction & Modelling: Flowchart Construction (15 mins)

- **Teacher Activity:** Explicitly teach standard flowchart conventions for chemical synthesis (referencing CHM_M7_SYNTH_N1 literacy skills): Boxes for compounds (structure or name), Arrows for reactions, Reagents/conditions written above/below arrows. Model solving a more complex (e.g., 3-step) synthesis problem (e.g., Propane → Propan-1-ol → Propanal → Propanoic Acid).
  - First, use the chord diagram tool to plan the route, "thinking aloud" the choices.
  - Then, translate the planned route step-by-step into a correctly formatted flowchart on the board/projector. Emphasise clarity and inclusion of all required details. [S1 Explicit Instruction, S2 Visualisation, S6 Metacognition]
- **Student Activity:** Take notes on flowchart conventions (can be added to Worksheet 3). Follow the modelled example. Ask questions about conventions or the synthesis logic.
- **Pedagogy Focus:** Explicit Teaching of Communication Conventions (CH11/12-7), Modelling the Link between Planning (Tool) and Communicating (Flowchart).

Group Synthesis Challenge (25 mins)

- **Teacher Activity:** Divide students into small groups (3-4). Provide each group with a different, challenging synthesis problem (e.g., starting from a simple alkane/alkene, synthesise a specific ester or ketone) via Activity Sheet 3. Provide access to the chord diagram tool for planning and materials for flowchart construction (large paper, mini-whiteboards, or digital tool). Instruct groups to produce a complete, conventional flowchart as their solution. Circulate to facilitate, guide, and ask probing questions (S6 prompts). [Problem-Based Learning element, S4 Interleaving via varied problems]
- **Student Activity:** Work collaboratively in groups. Analyse the assigned problem. Use the chord diagram tool to brainstorm and plan a viable pathway. Construct the synthesis flowchart, ensuring correct structures/names, reagents, conditions, and conventions. Discuss and justify steps within the group.
- **Pedagogy Focus:** Collaborative Problem Solving (CH11/12-6), Application of Integrated Knowledge (Create Level), Practice with Communication Conventions (CH11/12-7), Active Learning.
- **ICT Integration:** Chord Diagram Tool (Student Use), Optional Digital Whiteboard/Drawing Tool.

Peer Review / Gallery Walk (10 mins)

- **Teacher Activity:** Facilitate a gallery walk or structured peer review. Groups display their flowcharts. Provide a simple peer review checklist (on Activity Sheet 3 or separate) focusing on: Logical sequence, Correct structures/names, Correct reagents/conditions, Clear conventions. Encourage constructive feedback. Briefly summarise common successes/errors observed. Assign Exit Ticket.
- **Student Activity:** Display group flowchart. View and provide feedback on other groups' flowcharts using the checklist. Discuss feedback received. Complete Exit Ticket.
- **Pedagogy Focus:** Peer Assessment, Reinforcing Communication Standards (CH11/12-7), Identifying Common Errors, Formative Assessment.

Resources Required

- Interactive Chord Diagram Visualisation Tool.
- Projector / Whiteboard.
- Student devices (for tool access).
- Materials for flowchart construction (large paper/posters, markers, mini-whiteboards, or digital collaborative whiteboard).
- Activity Sheet 3 (containing synthesis challenge problems and peer review checklist - see below).
- Worksheet 3 (summary of flowchart conventions - see below).
- Exit Ticket question (prepared separately, e.g., "Outline the first two steps (reactants, reagents) needed to convert but-1-ene into ethyl ethanoate.").

Assessment

- **Formative:** Observation of group collaboration, planning strategies, and flowchart construction. Evaluation of final group flowcharts based on logic, accuracy, detail, and conventions. Quality of peer feedback provided. Analysis of Exit Ticket responses.

Differentiation

- **Support:** Assign specific roles within groups (e.g., planner, recorder, reagent checker). Provide partially solved synthesis problems or flowcharts with gaps to fill. Offer a checklist of key reactions.
- **Extension:** Challenge groups to find the most efficient (fewest steps) pathway. Ask them to propose a synthesis for a target molecule not directly derivable using only the learned reactions, requiring slight modification or an additional step. Ask groups to include potential side reactions or yield considerations (conceptual).

Lesson 3: Designing & Communicating Syntheses

Mastering Flowcharts (CHM_M7_SYNTH_N1)

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Gosford High School

Module 7: Organic Chemistry

Outline

The Interconnected Network

Let's look at the full reaction map (Chord Diagram) incorporating all the reactions we've learned in this module.

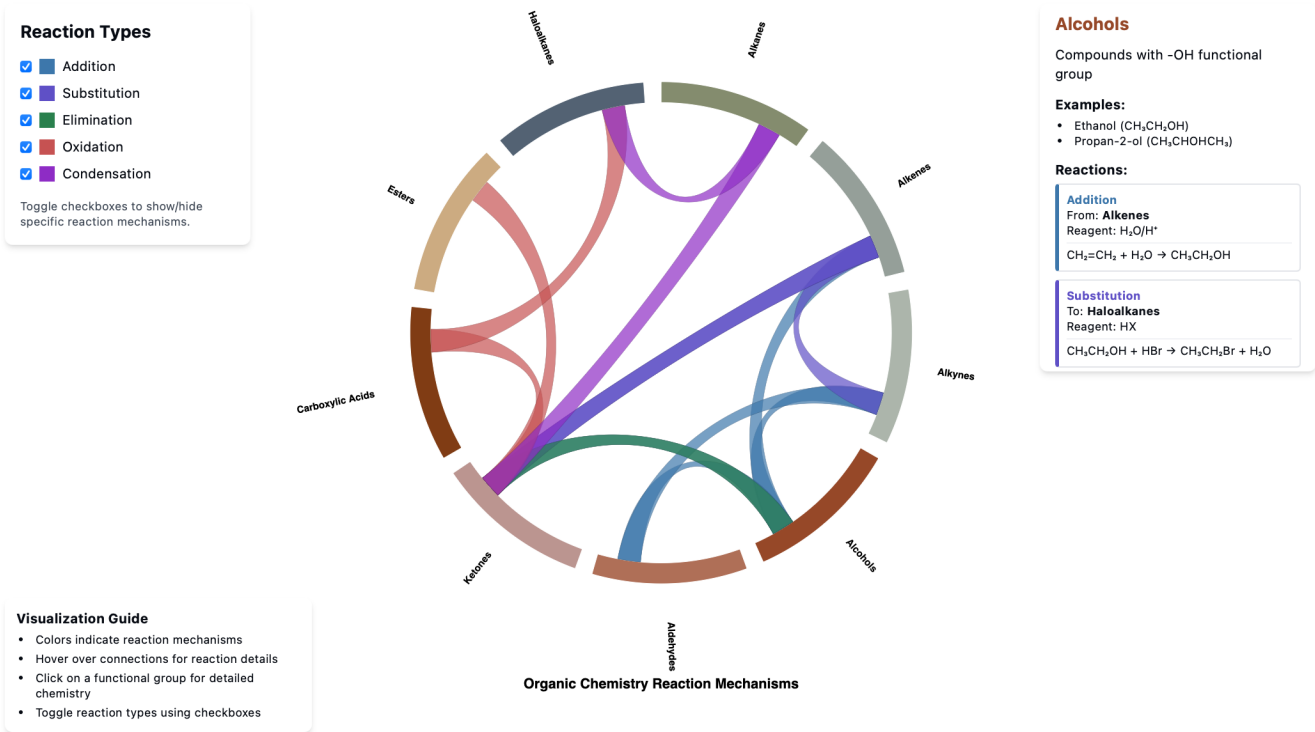


Figure: Overview of Key Functional Group Interconversions

Challenge Question: Can we directly convert an Alkane to an Ester using

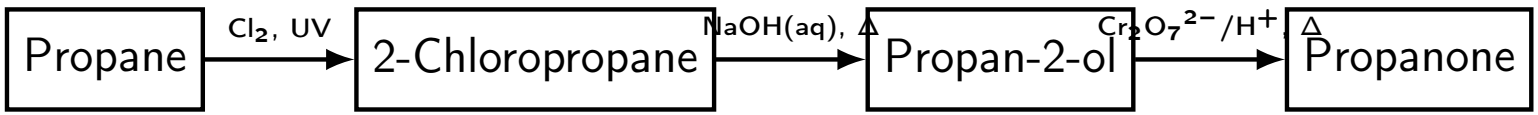
Communicating Synthesis Clearly (CHM_M7_SYNTH_N1)

Flowcharts are the standard way to show multi-step syntheses. **Key**

Conventions (Worksheet 3):

- **Compounds:** In boxes (Use IUPAC Name or Structural Formula).
- **Reactions:** Use arrows $\rightarrow$.
- **Reagents/Conditions:** Write above/below the arrow for THAT step.
- **Layout:** Logical flow (e.g., top-to-bottom).

Example (Propane $\rightarrow$ Propanone):



Plan then Draw: Example

Problem: Synthesise Propanoic Acid from Propane. **Teacher Modelling**

("Think Aloud"):

1. *"Start=Alkane, Target=Carboxylic Acid."*
2. *"Map Check: Alkane → Haloalkane → Alcohol (Primary needed for Acid) → Carboxylic Acid. Path looks viable."* Intermediates: 1-Chloropropane, Propan-1-ol.
3. *"Translate to Flowchart:"* (Draw step-by-step on board/slide)
   - Box 1: Propane ($CH_3CH_2CH_3$)
   - Arrow 1: Reagents Cl_2, UV Light (Free radical sub gives mix, but targets pathway) → Box 2: 1-Chloropropane ($CH_3CH_2CH_2Cl$)
   - Arrow 2: Reagents NaOH(aq), heat (Substitution) → Box 3: Propan-1-ol ($CH_3CH_2CH_2OH$)
   - Arrow 3: Reagents $Cr_2O_7^{2-}/H^+$, heat (Oxidation [O]) → Box 4: Propanoic Acid (CH_3CH_2COOH)
4. *"Ensure all reagents/conditions and structures/names are correct."*

Design Build Your Flowchart

Work in your groups on the challenge problem from Activity Sheet 3. **Your**

Task Recap:

- Analyse the problem (Start/Target).
- Plan your route using the Chord Diagram tool.
- Construct a formal, accurate flowchart on your paper/board.
- Include all compounds (structures/names) and reagents/conditions.

Goal: Create a chemically correct and clearly communicated synthesis plan. *(Teacher circulates, facilitates group work, asks probing questions)*

Evaluating Flowcharts

Time for Peer Review / Gallery Walk.

- Display your group's flowchart.
- Use the checklist on Activity Sheet 3 to review another group's work.
- Focus on: Logical Steps, Correct Chemistry (Structures/Reagents), Clear Conventions.
- Provide constructive feedback.

Final Summary:

- Synthesis requires integrated knowledge and planning (use the map!).
- Flowcharts are the standard way to communicate these plans accurately (CH11/12-7).

Next Steps: Complete Exit Ticket. Revise reaction pathways for upcoming assessments.

Thank you!

Questions?

Year 12 Chemistry - Activity Sheet 3
Group Synthesis Challenge & Flowchart Peer Review

Organic Chemistry

Module 7 - Lesson 3

Aim

To apply your integrated knowledge of organic reactions to design a multi-step synthesis pathway and communicate it using a conventional flowchart. To provide constructive feedback on peers' flowcharts.

Part A: Group Synthesis Challenge

Instructions: Work in your assigned group. Your task is to design a synthesis pathway for the problem below and represent it as a detailed, accurate flowchart.

1. Analyse the starting material and target product.
2. Use the Chord Diagram Visualisation tool and your knowledge to plan a logical sequence of reactions.
3. Construct a flowchart on the provided materials (paper/whiteboard/digital).
4. Ensure your flowchart includes:
    - Correct structures or IUPAC names for all compounds (starting material, intermediates, product) in boxes.
    - Arrows clearly indicating each reaction step.
    - Accurate reagents and conditions listed for every step on the arrows.
    - Adherence to standard flowchart conventions.
5. Be prepared to justify your chosen pathway.

Challenge Problem (Teacher will assign one per group)

Problem 1: Design a synthesis pathway to produce **ethyl propanoate** starting from **ethene** and **propane**. (Assume necessary inorganic reagents are available).

Problem 2: Design a synthesis pathway to produce **butanone** starting from **but-1-ene**.

Problem 3: Design a synthesis pathway to produce **1,2-dichloroethane** starting from **ethanol**.

Problem 4: Design a synthesis pathway to produce **propanoic acid** starting from **propane**.

Part B: Flowchart Peer Review Checklist

Instructions: When reviewing another group's flowchart, consider the following criteria:

Criteria	Description	Check ()
1. Logical Pathway	Does the sequence of reactions make chemical sense to get from start to target?	
2. Correct Structures/Names	Are the structures or names shown for reactants, intermediates, and products accurate?	
3. Correct Reagents/Conditions	Are the specified reagents and conditions appropriate for each reaction step shown?	
4. Flowchart Conventions	Are compounds in boxes? Are arrows used correctly? Are reagents/conditions placed appropriately on arrows?	
5. Clarity & Neatness	Is the flowchart easy to read and understand?	

Constructive Feedback / Comments:

Year 12 Chemistry - Worksheet 3
Designing Syntheses: Flowchart Conventions

Student Name: _____ ID: _____

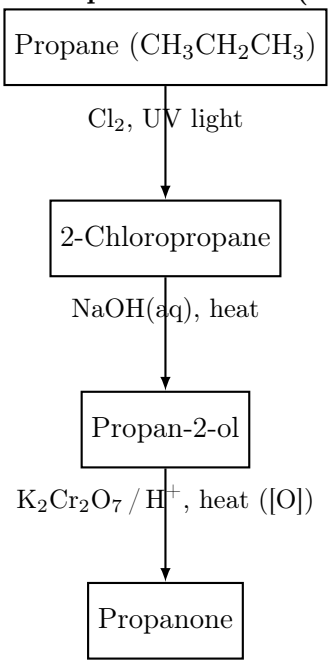
Module 7 - Lesson 3

Part 1: Flowchart Conventions (Node: CHM_M7_SYNTH_N1)

Flowcharts are used to communicate multi-step synthesis pathways clearly and conventionally. Key conventions include:

- **Compounds:** Represented inside boxes. Use either the correct IUPAC name or the structural formula. Be consistent.
- **Reactions:** Represented by arrows pointing from reactant(s) to product(s).
- **Reagents & Conditions:** Written clearly above or below the reaction arrow corresponding to that specific step. Include necessary catalysts, solvents, heat (Δ), UV light, etc.
- **Sequence:** Steps are arranged logically, usually top-to-bottom or left-to-right, showing the progression from starting material to final product via intermediates.

Example Flowchart (Propane → Propanone):



Part 2: Planning Space for Synthesis Challenge

Instructions: Use the space below (or separate paper) to plan and draft the flowchart for the synthesis problem assigned to your group (see Activity Sheet 3). Use the Chord Diagram tool for initial planning. Remember to include all intermediates, reagents, and conditions.

Assigned Problem: _____

Planning Notes (Routes explored, key steps):

Draft Flowchart:

Justification Notes (Why was this route/these steps chosen?):