# 3.14 Organic synthesis

**What is organic synthesis:**

- This is a part of chemistry dedicated to producing organic compounds.
- Usually starting from crude oil, a cheap raw starting material to make complex molecules / pharmaceuticals which are sold at a profit
- It may be a simple one step reaction or a multi step synthesis requiring many steps.
- Synthesis is useful to copy nature's compounds that may be expensive to extract or in low abundance.
- Synthesis is seen as a puzzle. In order to be good at these puzzles you must know your organic chemical reactions

**Synthesis: Reducing hazards and waste**

- These are always designed with the following aims:
  - Non-hazardous starting materials: Limits the impact of accidents causing damage / environmental damage.
  - High % yield and atom economy: Avoids waste.
  - Fewest steps: 80% of 80% of 80% is just over a total of 50% yield.
  - Avoid solvent use (as much as possible): Hazardous waste / flammable / toxic / separation from product creates waste.

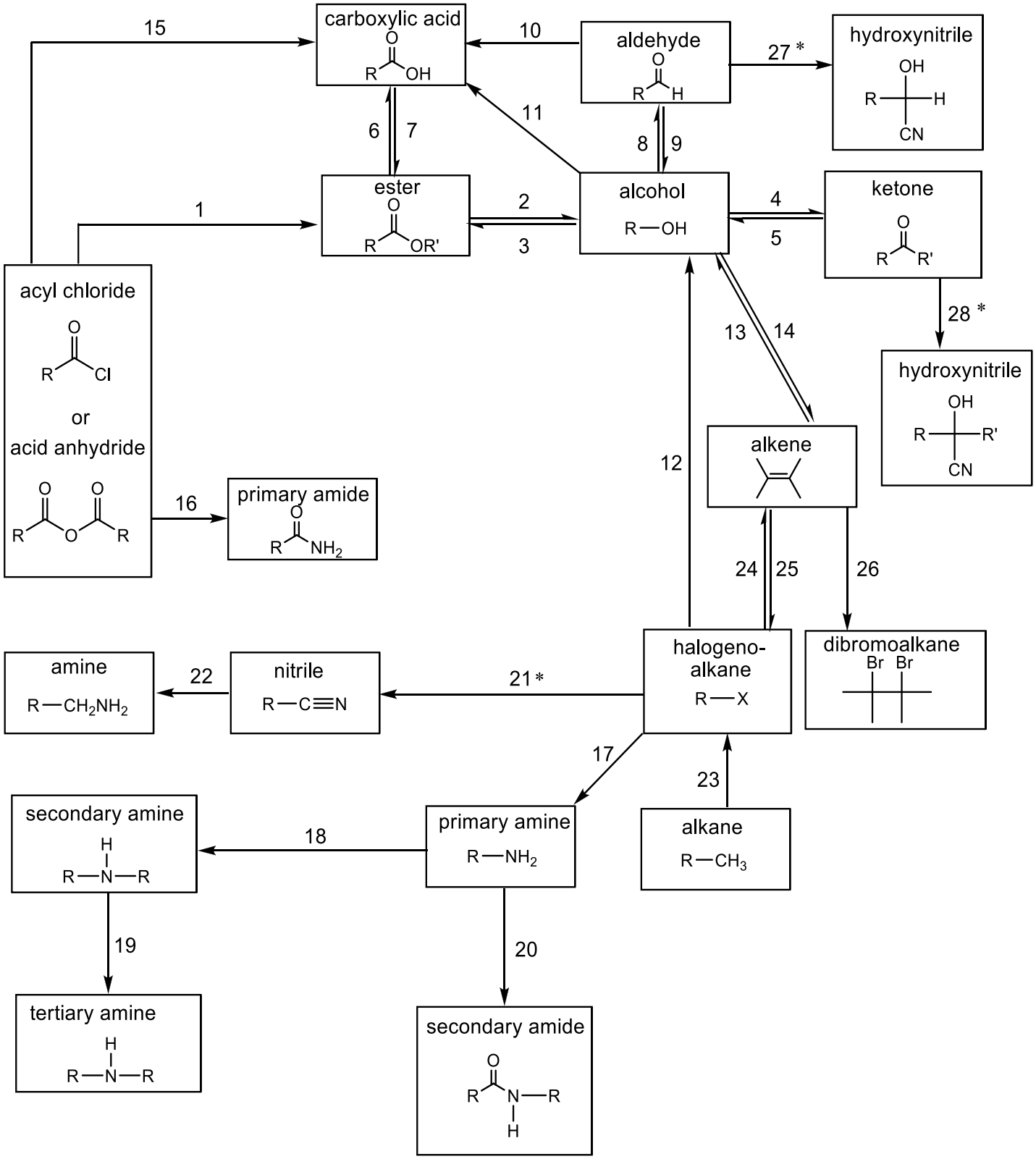
**The general approach:**

1. Examine the **starting molecule's functional group**.
2. Examine the **target molecules functional group**.
3. Note which functional group has been changed on the starting molecule.
4. Note what that functional group has been changed to in the target molecule.
5. Using your knowledge, find the intermediate(s) functional group that the starting molecule can be changed to and the target molecule can be made from.
6. Apply the reagents and conditions and you have a synthesis.

**Synthetic routes:**

- You will need **2 Charts: Aliphatic and Aromatic**.
- You will need to learn all the **reactions: with <u>reagents</u> and <u>conditions</u>**.

**Aliphatic routes:**




* The carbon chain is 1 carbon longer than the reactant

| Reaction | Reagent(s) | Conditions | Reaction Type |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |
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| 13 | | | |
| 14 | | | |
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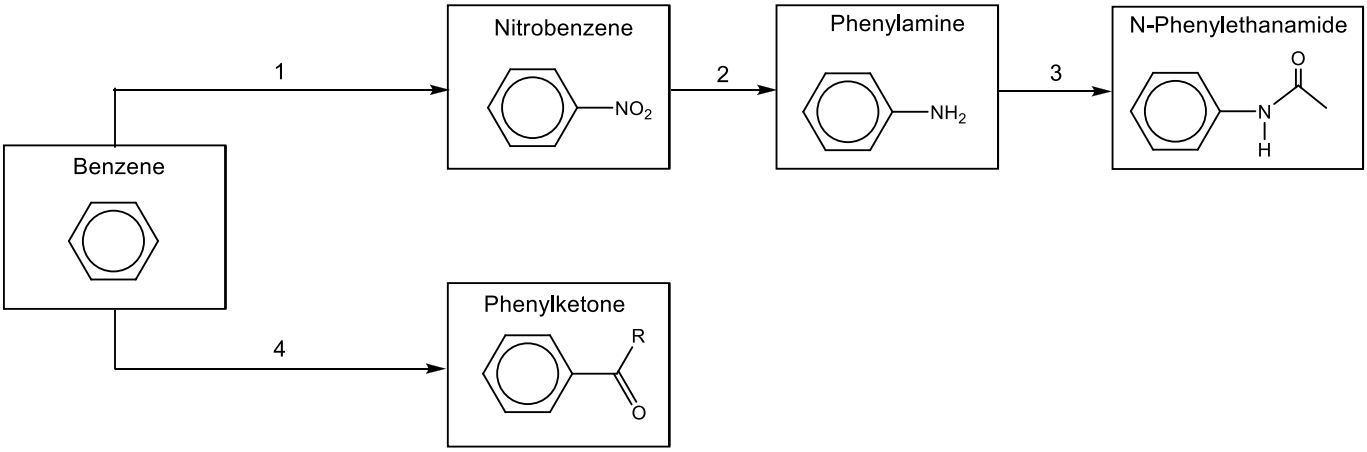
| 18 | | | |
| 19 | | | |
| 20 | | | |
| 21 | | | |
| 22 | | | |
| 23 | | | |
| 24 | | | |
| 25 | | | |

| Reaction | Reagent(s) | Conditions | Reaction Type |
|---|---|---|---|
| 26 | | | |
| 27 | | | |
| 28 | | | |

**Aromatic routes:**




| Reaction | Reagent(s) | Conditions | Reaction Type |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |

**Examples:**

**Starting molecule**: Propene **Target molecule**: Propanoic acid

**2 – step synthesis:-**

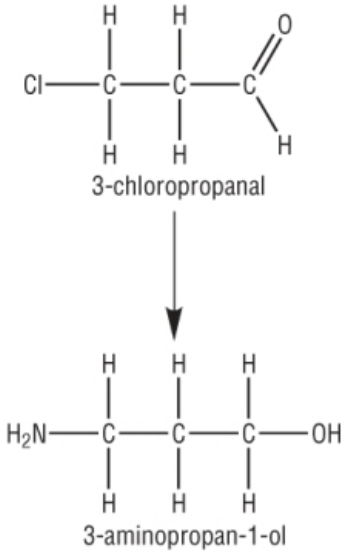
$CH_3CH = CH_2$ → Unknown → $CH_3 – CH_2– COOH$

$CH_3CH = CH_2$ → $CH_3 – CH_2 – CH_2OH$ → $CH_3 – CH_2– COOH$

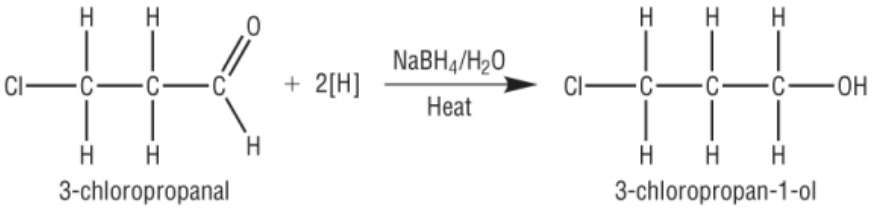
**Step 1:-** Steam and phosphoric acid

**Step 2:-** Reflux with sulphuric acid and potassium dichromate

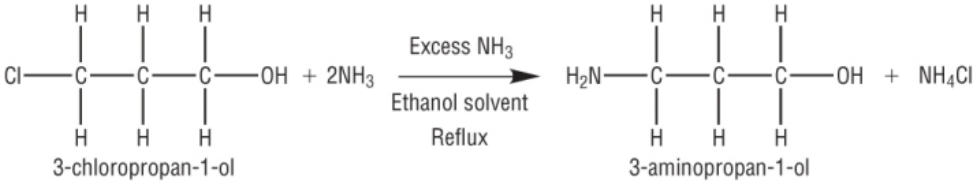
**Example 2:**




**Step 1:**



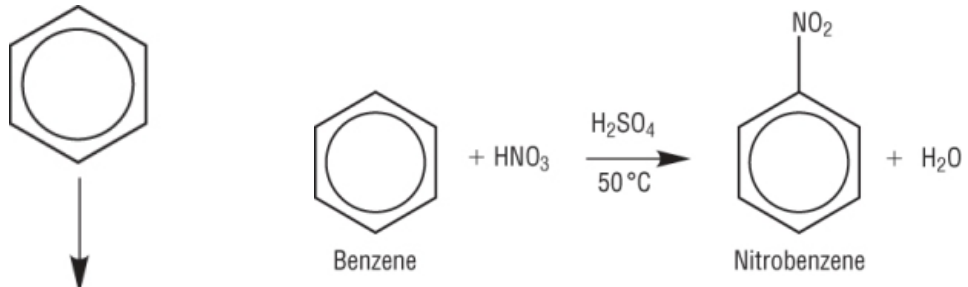

**Step 2:**



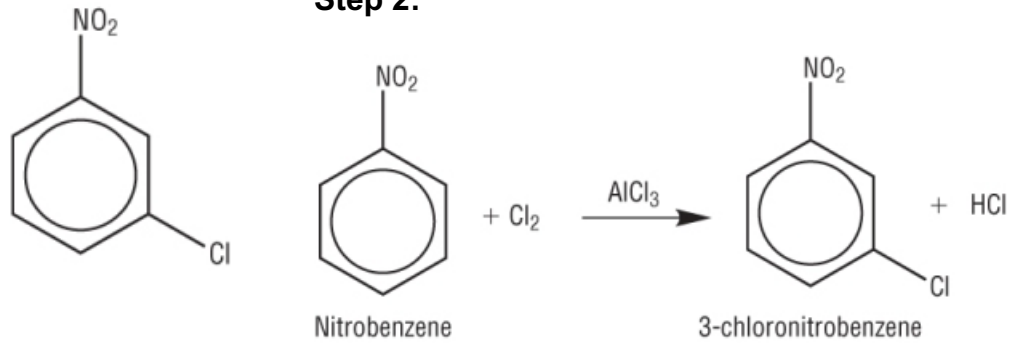

- Either way round is OK

**Example 3:**

**Step 1:**




**Step 2:**



**Have a go at these 2 step synthesis:**

- Include any reagents and conditions for each step

1) Butan-1-ol → 1,2-Dibromobutane

2) 1-Bromobutane → Butanoic acid

3) Propane → Propan – 1 – ol

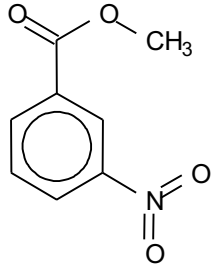
4) Ethanol → 2 Hydroxy propanenitrile

5) Propene → Propanone

6) Benzene → Phenylamine

7) Benzoic acid → Methyl 3-nitrobenzoate:

Benzoic acid → → Methyl 3-nitrobenzoate



**Have a go at these 3 step synthesis:**

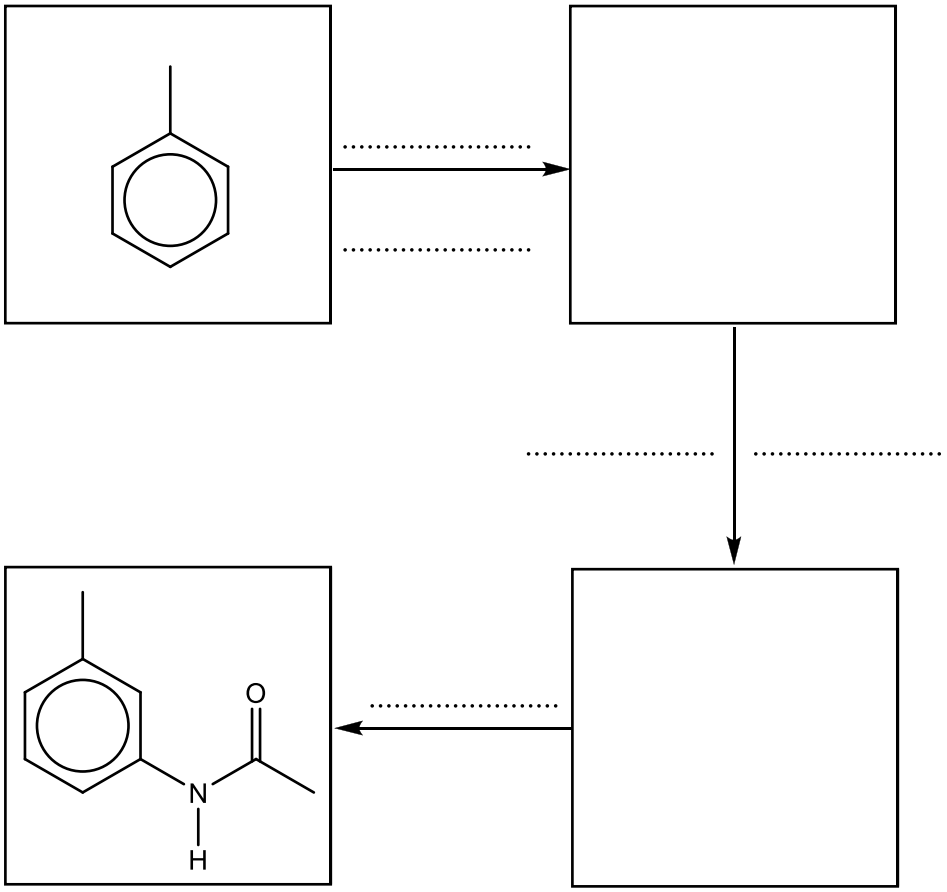
8) Ethanol → Ethylamine

9) Ethene → Propylamine

10) Chloroethane → Methyl ethanoate

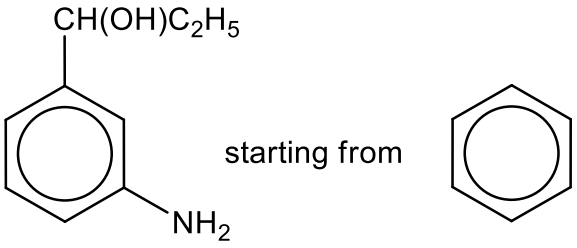
11) Ethene (only) → Ethyl ethanoate

12) Complete the flowchart below:



13)Benzene → N – methyl ethanamide

14)Suggest a four-step synthesis of:




starting from 

For each step, name the type of reaction taking place and the reagents required.