Revision 2 – Organic chemistry – naming organic compounds and pathways.

1) a) Place the molecules below in order of increasing boiling temperature. Explain why.

i. Propan-1-ol, butan-1-ol, pentan-1-ol, octan-1-ol

Propan-1-ol, butan-1-ol, pentan-1-ol, octan-1-ol

Since the functional group is the same for all molecules, the greater the hydrocarbon chain the greater the dispersion forces acting between the molecules Intermolecular forces are greater for larger molecules.

ii. 2-methylbutane, pentane, 2,2-dimethylpropane

You will notice that all molecules have the same molecular mass. The intermolecular forces acting between these hydrocarbons are composed of dispersion forces only. These weak dispersion forces act over small distances and so the closer the molecules can get to each other the greater the interaction and hence the higher the boiling or melting temperature. Surface area is also important as this is where molecules interact with each other, at the surface of each molecule. Branching lowers the surface area exposed and so the more branching a molecule has the lower the surface area of the molecule and hence the lower the interaction between them.

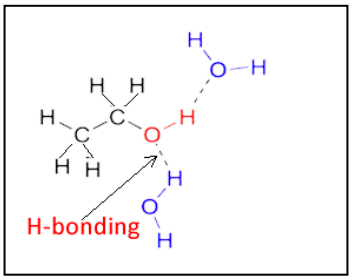
b) Place the following in order of increasing solubility in water. Explain why.

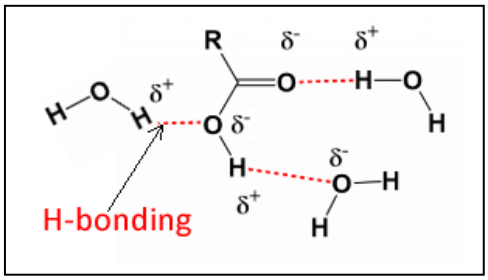
ethane, ethanoic acid, ethanol

ethane -> ethanol -> ethanoic acid

Ethane is a hydrocarbon and hence insoluble in water.

The hydroxyl group, although polar, is not as polar as the carboxyl group COOH and hence interacts less with the water molecules than the carboxyl group.





$Cr_2O_7^{-2}$ H^+ U.V. Cl_2 OH^-

2) Write appropriate reaction pathways for the following. Give all the appropriate reagents

a) Ethane to ethanoic acid

Ethane $\xrightarrow{\text{U.V. } Cl_2}$ chloroethane $\xrightarrow{OH^-}$ ethanol $\xrightarrow{Cr_2O_7^{-2}/H^+}$ ethanal $\xrightarrow{Cr_2O_7^{-2}/H^+}$ ethanoic acid

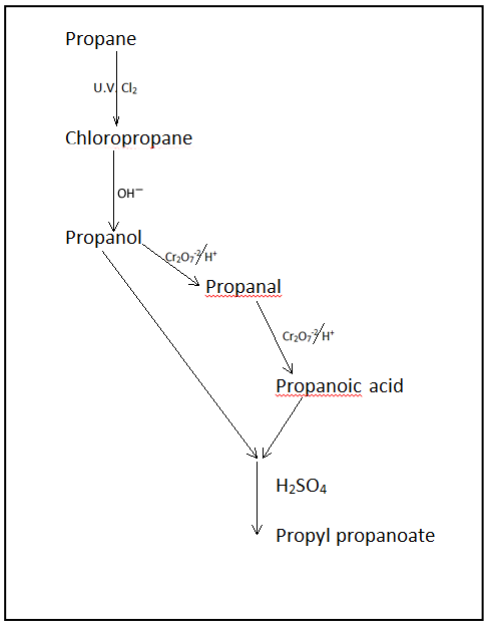
b) Ethane to ethanamine

Ethane $\xrightarrow{\text{U.V. } Cl_2}$ chloroethane $\xrightarrow{NH_3}$ ethanamine

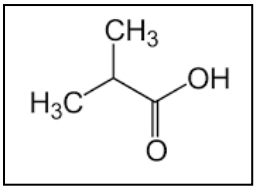
c) Propene to propanoic acid

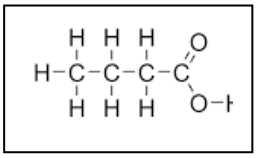
Propene $\xrightarrow[300^oC]{H_3PO_4}$ $\xrightarrow{H_2O}$ propan-1-ol $\xrightarrow{Cr_2O_7^{-2}/H^+}$ propanal $\xrightarrow{Cr_2O_7^{-2}/H^+}$ propanoic acid

3) Write the reaction pathways taken to produce propyl propanoate from propane.



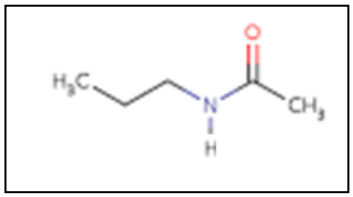
4) Butanoic acid has a formula mass of 88.1g/mol and has a boiling temperature of 163 °C, whereas 2-methylpropanoic acid, which also has a formula mass of 88.1 g/mol has a boiling temperature of 155 °C. Explain why





Branching reduces the surface area of a molecule that is able to interact with other molecules. Dispersion forces act over a wider area in butanoic acid as opposed to 2-methyl propanoic acid. We can also argue the branching does not enable molecules to pack close to each other where dispersion forces are greatest. Hence, branching reduces the intermolecular forces acting between the molecules and lowers the melting temperature of the molecule.

5) Draw the structural formula of the compound formed between propanamine and ethanoic acid



6) Using structural formulae, write a balanced chemical equation for the production of the ester formed when butanoic acid and methanol react in the presence of a suitable catalyst. Name the ester.