Organic Reactions by type

- ☐ Substitution
- ☐ Addition
- ☐ Elimination
- ☐ Oxidation
- ☐ Acid-base

As you study the different functional groups, and meet the reactions on the following pages tick the boxes ☑

Substitution

An atom is replaced by another atom/group

- The organic product is (still) saturated
- Two products are made

Alkanes:

☐ **Alkane to Haloalkane**

- React with Br_2 or Cl_2. Needs *uv* light and/or heat to occur.
  (It doesn't matter which H you substitute in the formula but limit it to just one @ L2).

$$CH_3CH_3 + Br_2 \rightarrow CH_3CH_2Br + HBr$$

Haloalkanes:

☐ **Haloalkane to Alcohol**

- React with KOH(aq), heat.

$$CH_3CH_2Br \rightarrow CH_3CH_2OH$$

☐ **Haloalkane to Amine**

- React with Conc. NH_3(alc)

$$CH_3CH_2Br \rightarrow CH_3CH_2NH_2$$

We do not normally worry about the other product made in these reactions, just the organic product.

Addition

One bond of the C=C bond breaks and an atom/group adds onto each of the two adjacent C atoms. (Often written as the C=C bond breaks and 2 atoms/groups add on).

- The organic product is saturated
- One product is made
- If the alkene is asymmetrical and the reagent is asymmetrical then a major and minor product is made. Remember "rich get richer" where the H is added to the C of the C=C which originally had most H atoms.

☐ Alkene to Alkane

- H_2, Ni or Pt catalyst

$$CH_2=CH_2 + H_2 \rightarrow CH_3CH_3$$

☐ Alkene to Haloalkane

- Br_2 or Cl_2

$$CH_2=CH_2 + Br_2 \rightarrow CH_2BrCH_2Br$$

- HBr or HCl

$$CH_2=CH_2 + HCl \rightarrow CH_3CH_2Cl$$

☐ Alkene to Alcohol

- H_2O/H^+, heat (or dilute acid, heat)

$$CH_2=CH_2 + H_2O \rightarrow CH_3CH_2OH$$

☐ Alkene to (addition) Polymer

- Ethene monomers, heat and catalyst, e.g. 3 repeating units

$$3CH_2=CH_2 \rightarrow -(CH_2-CH_2)-_3$$

Elimination

An H atom and an atom/group are removed from two adjacent carbon atoms.

- The organic product is unsaturated / has a C=C
- Two products are made (but we are interested in the organic one)
- If the alcohol or haloalkane is asymmetrical then a major and minor product is made. Remember "poor get poorer" where the H is removed from the C atom which originally had least H atoms.

☐ Alcohol to Alkene

- Conc. H_2SO_4

  $CH_3CH_2OH \rightarrow CH_2=CH_2$ (H_2O is removed / dehydration reaction)

☐ Haloalkane to Alkene

- KOH(alc), heat

  $CH_3CH_2Cl \rightarrow CH_2=CH_2$ (HCl is removed)

  $CH_3CH_2Br \rightarrow CH_2=CH_2$ (HBr is removed)

Oxidation

This group don't look like they have much in common but they all involve an oxidation reaction (reaction with an oxidising agent). There is always an accompanying reduction reaction (so the reactions are REDOX reactions).

☐ **Combustion (burning)**

- Alkanes, alkenes, alkynes, alcohols etc are all flammable. Any "burning" reaction is an "oxidation" reaction.

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

☐ **Alkene to Diol**

- Uses potassium permanganate, $KMnO_4$.
- No heat is needed. The MnO_4^- ion has a purple colour.

$$CH_2{=}CH_2 \rightarrow CH_2OHCH_2OH$$

- If MnO_4^- with no acid, MnO_4^- is reduced to brown $MnO_2(s)$
- If MnO_4^-/H^+, MnO_4^- is reduced to colourless $Mn^{2+}(aq)$

☐ **(Primary) Alcohol to Carboxylic Acid**

- With MnO_4^-/H^+, heat (colour change - purple $MnO_4^-(aq)$ to colourless $Mn^{2+}(aq)$)
  OR
- With $Cr_2O_7^{2-}/H^+$, heat (colour change - orange $Cr_2O_7^{2-}(aq)$ to green $Cr^{3+}(aq)$)

$$C_2H_5OH \rightarrow CH_3COOH$$

Acid-base

At L2 the only organic acids are carboxylic acids e.g. CH_3COOH AND the only organic bases are amines e.g. $CH_3CH_2NH_2$.

☐ Reactions of Carboxylic Acids

- With H_2O (explaining why carboxylic acids are acidic)

$$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$$

- With Mg (a reactive metal)

$$2CH_3COOH + Mg \rightarrow (CH_3COO)_2Mg + H_2$$

- With NaOH

$$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$$

- With $NaHCO_3$

$$CH_3COOH + NaHCO_3 \rightarrow CH_3COONa + H_2O + CO_2$$

- With Na_2CO_3 (OR with $CaCO_3$, marble chips)

$$2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + H_2O + CO_2$$

$$2CH_3COOH + CaCO_3 \rightarrow (CH_3COO)_2Ca + 2H_2O + CO_2$$

Note: CH_3COONa is often written as $CH_3COO^-\ Na^+$

☐ Reactions of Amines

- With H_2O (explaining why amines are basic)

$$CH_3CH_2NH_2 + H_2O \rightleftharpoons CH_3CH_2NH_3^+ + OH^-$$

- With HCl (acid)

$$CH_3CH_2NH_2 + HCl \rightarrow CH_2CH_2NH_3^+Cl^- \text{ (a salt)}$$

☐ Reaction of Carboxylic Acid and Amine (In 2017 exam; not usually asked!)

- $CH_3COOH + CH_3CH_2NH_2 \rightarrow CH_3CONHCH_2CH_3 + H_2O$
  OR $CH_3COOH(aq) + CH_3CH_2NH_2(aq) \rightarrow CH_3COO^-(aq) + CH_3CH_2NH_3^+(aq)$