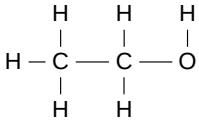
AS90309 Describe the structural formulae and reactions of compounds containing selected organic functional groups

Naming of organic molecules is done according to IUPAC convention

Page 131-132 Green book!

1	meth
2	eth
3	prop
4	but
5	pent
6	hex
7	hept
8	oct

At its simplest, the IUPAC name for an organic compound contains these two parts: a *root* indicating how many carbon atoms are in the longest continuous chain of carbon atoms AND a prefix and/or suffix to indicate the family to which the compound belongs. E.g. the name ethanol indicates a carbon chain of length two (eth-) and an OH functional group (-anol).



Equations should be written using either names or structural formulae.
In writing structural formulae, students may use either the condensed or expanded forms.

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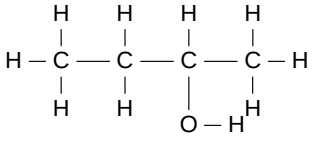
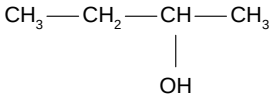


(expanded)

or $CH_3CH_2CH(OH)CH_3$ (condensed)



or

Hint! Make sure bond goes into the O of the OH group.

Recognising selected functional groups (haloalkanes, alcohol, alkene, alkyne, ester, carboxylic acid)

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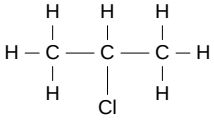
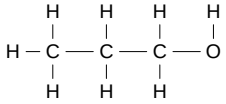
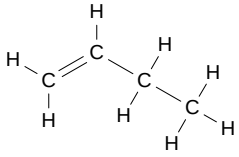
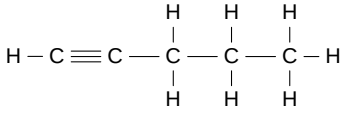
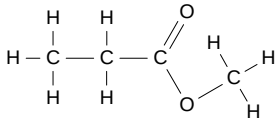
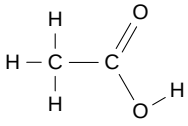








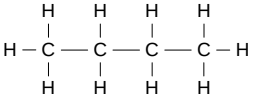




Drawing structures and naming straight or branched chain hydrocarbons (containing up to 8 carbon atoms), haloalkanes, alcohols, and carboxylic acids (containing up to 8 carbon atoms); esters formed from straight chain alcohols and carboxylic acids (up to 8 carbon atoms)

Identifying and drawing structural isomers – chain, position, functional group

Check also in your workbook!



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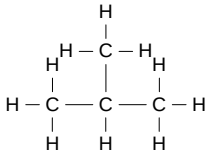
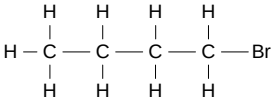


(different skeleton)



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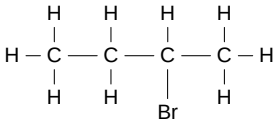
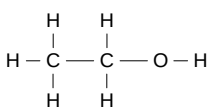
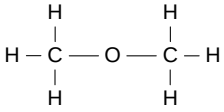
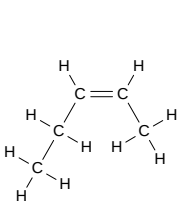
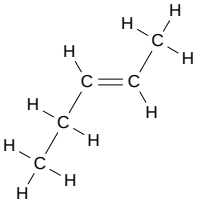
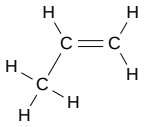
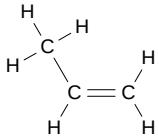
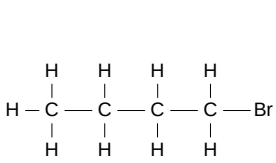
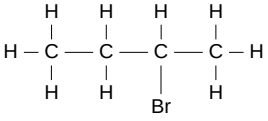
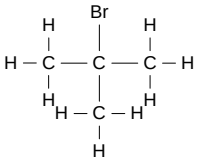
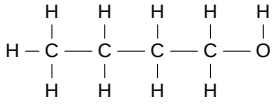
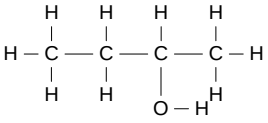
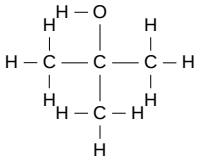
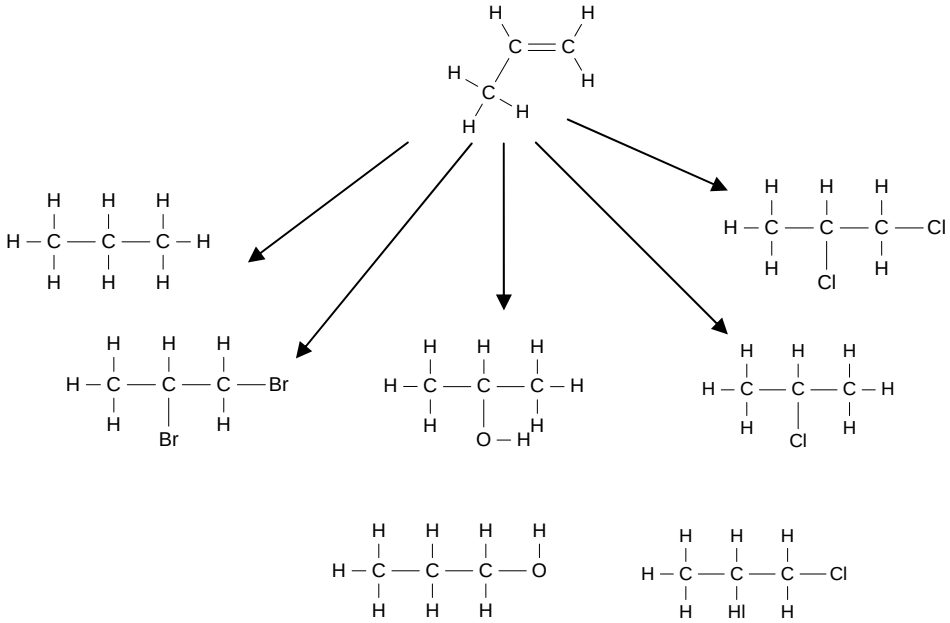
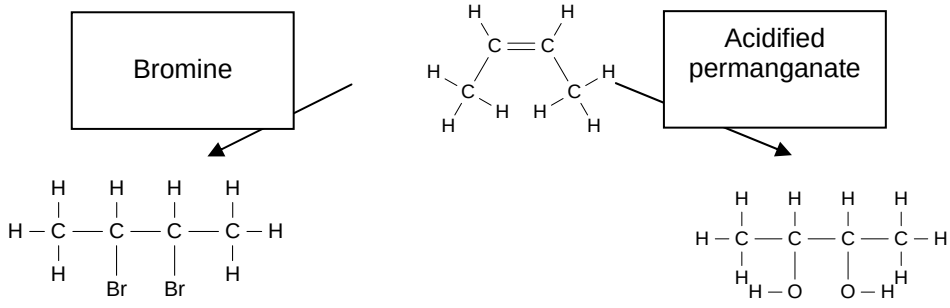
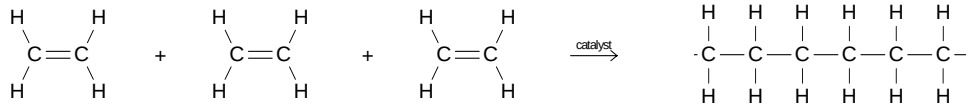
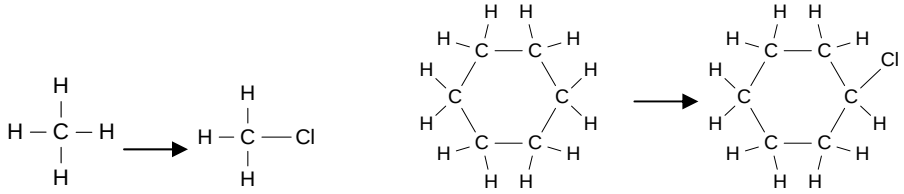
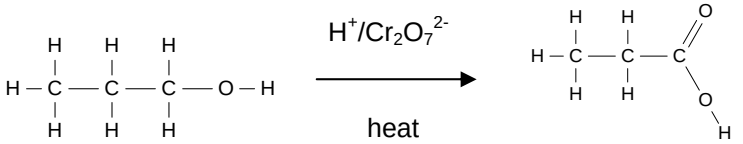
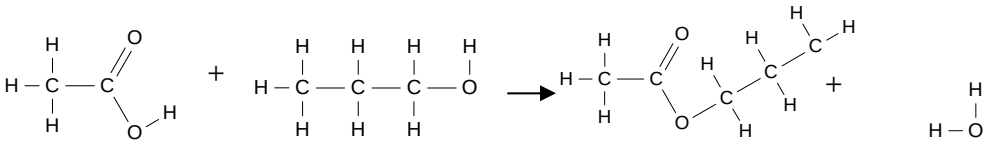
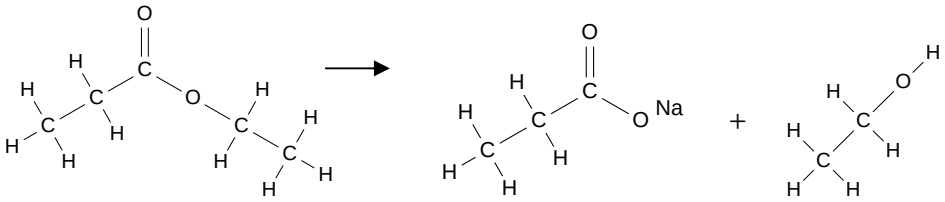


(different position)

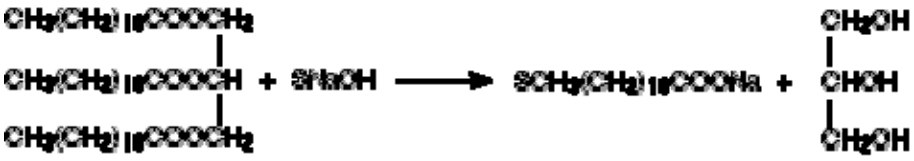
	 and  (different functional group)
Identifying cis-trans isomers and drawing their structural formulae – *occur when there is C=C as there is no "free rotation" around C=C ie it can't twist.*	  But not  
Classifying an alcohol or haloalkane as primary, secondary or tertiary	     
Drawing the products of addition reactions of alkenes of up to 8 carbon atoms with H2/Pt (hydrogenation), Cl_2 (chlorination) Br_2 (bromination), H_2O/H^+ (hydration) and HCl (hydrochlorination) (identification of major and minor products on addition to asymmetric alkenes is included) Page 153 Green book!	
Identifying alkenes using observations of reaction with Br_2 and MnO_4^-. These are addition reactions.	

Addition polymerisation of alkenes	
Drawing a product of halogenation of alkanes (limited to mono-substitution)	
Identifying carboxylic acids using their acidic properties	Turn blue litmus paper RED. Turn UI paper ORANGE. + Mg $\rightarrow$ H_2 gas, + carbonate or hydrogen carbonate $\rightarrow$ CO_2 gas. May have a sharp (vinegary) smell, larger C. acids FOUL smelling!!
Oxidation of primary alcohols to form carboxylic acids	
Formation of esters (may include triglycerides) from carboxylic acids and alcohols	
Hydrolysis of esters (may include triglycerides)	

If the large esters present in animal or vegetable fats and oils are heated with concentrated sodium hydroxide solution exactly the same reaction happens as with the simple esters.

A salt of a carboxylic acid is formed - in this case, the sodium salt of a big acid such as octadecanoic acid (stearic acid). These salts are the important ingredients of soap - the ones that do the cleaning.

An alcohol is also produced - in this case, the more complicated alcohol, propane-1,2,3-triol (glycerol).



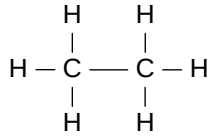
Fat/oil

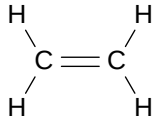
Sodium salt – found in soap

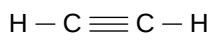
glycerol

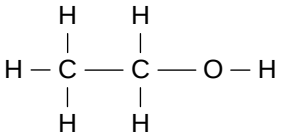
Because of its relationship with soap making, the alkaline hydrolysis of esters is sometimes known as ***saponification***.

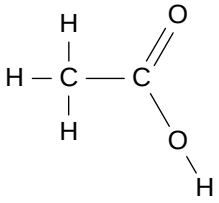
Distinguishing between different functional groups using experimental observations.

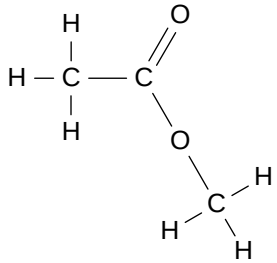


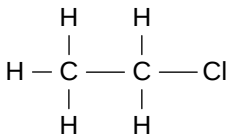












Alkanes

- C1-4 are gases, C5-15 liquids, C16 upwards solids @ room temperature
- Insoluble in water
- **Slowly decolourise Br_2 or Br_2 water in presence of UV light** (or 200-450^{o}C)

Alkenes

- Insoluble in water
- **Rapidly decolourise Br_2 or Br_2 water**
- Burn with smokier / sootier flame that the alkane

Alkynes

- Insoluble in water
- **Rapidly decolourise Br_2 or Br_2 water**
- Burn with smokier / sootier flame that the alkene

Alcohols

- have higher boiling points than the corresponding alkanes (due to attraction between polar OH group on neighboring alcohols).
- C1-3 soluble in water, C4+ insoluble.
- **Primary alcohols are oxidised to carboxylic acids by warming with $H^+/Cr_2O_7^{2-}$. The orange $Cr_2O_7^{2-}$ is reduced to green Cr^{3+}**
- **React with carboxylic acids in presence of conc. sulfuric acid catalyst and heat → ester (pleasant fruity smelling liquid)**

Carboxylic acids

- have higher boiling points than the corresponding alcohols (due to attraction between polar COOH group on neighboring alcohols).
- C1-3 soluble in water, C4+ insoluble.
- **React with reactive metals like Mg or Zn → H_2 gas, with carbonates and hydrogen carbonates → CO_2 gas, turn blue litmus → RED and turns Universal Indicator → ORANGE**
- **React with alcohols in presence of conc. sulfuric acid catalyst and heat → ester (pleasant fruity smelling liquid)**

Esters

- Liquids with low melting points and boiling points (volatile)
- **Insoluble in water**
- **Many have pleasant, often fruity odours**
- Can be hydrolysed (reaction with water) by heating with dilute acid (acid hydrolysis) to give the alcohol and carboxylic acid or NaOH (alkaline hydrolysis) to give the alcohol and the sodium salt of the carboxylic acid.

Haloalkanes

- CH_3Cl, CH_3Br, C_2H_5Cl are all gases at room temperature and pressure. The other haloalkanes are liquids with boiling points related to molar mass.
- They are all immiscible with water.