Instructions:

- ✓ **If a substance is 2 words – ensure to only leave one space between the words**
- ✓ **The a number is a subscript- just leave it as a normal number – eg C2H4**
- ✓ **Leave no spaces between words in organic UIPAC names**

Combustion and esterification

Alkanes

Alkanes are fossil fuels

name	Phase
methane	Gas
ethane	Gas
propane	Gas
butane	Gas
pentane	Liquid
hexane	liquid
heptane	Liquid
octane	liquid
nonane	Liquid
decane	Liquid
More than 17 carbons	Waxy solids

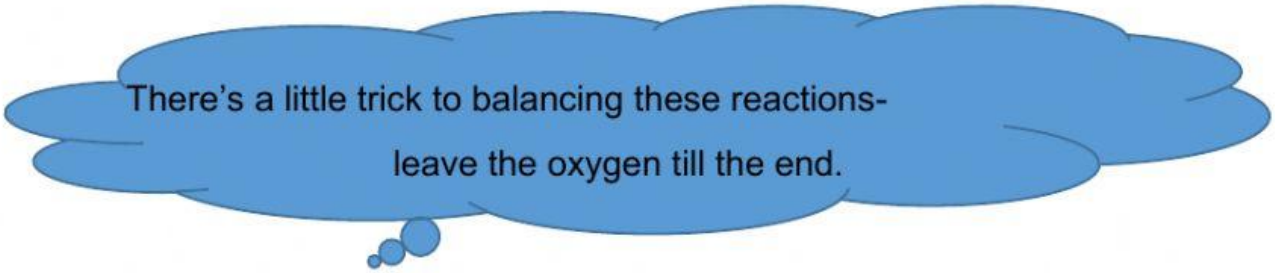
Combustion of alkanes (Badenhorst's line 7 hasn't done yet)

When alkanes combust (burn in oxygen) they always forms water and carbon dioxide

Eg

$CH_4 + 4O_2 \rightarrow CO_2 + 2H_2O$ + energy

The reason alkanes (and alcohols) are used as fuels is because they have very exothermic reactions when burned in oxygen.



$C_2H_6 + O_2 \rightarrow 2CO_2 + 3H_2O + energy$

Notice there are 7 oxygen on the right hand side (4 + 3).

Now I'm going to balance the left hand side oxygen by writing a 3,5 in front the oxygen.

$C_2H_6 + 3{,}5O_2 \rightarrow 2CO_2 + 3H_2O + energy$

But obviously we cannot leave the reaction as it is- so we double everything, to get rid of the half.

2 7 4 6

~~1~~C_2H_6 + ~~3,5~~$O_2 \rightarrow$ ~~2~~CO_2 + ~~3~~H_2O + energy

$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O + energy$

Exercise:

Now balance the following combustion reactions

1.1 $C_3H_8 + O_2 \rightarrow CO_2 + H_2O + energy$

1.2 $C_4H_{10} + O_2 \rightarrow CO_2 + H_2O + energy$

1.3 $C_5H_{12} + O_2 \rightarrow CO_2 + H_2O + energy$

1.4 $C_6H_{14} + O_2 \rightarrow CO_2 + H_2O + energy$

Esterification (in preparation for the prac)

Esters are made by reacting alcohols and carboxylic acids together.

Concentrated _____ is used as the catalyst during the reaction.

It is also knows as a _____ agent.

Eg

Methanol + **prop**anoic acid → **methyl**__**propanoate**__ + water

(*don't leave a space between the words for esters)

The alcohol always becomes the 'side chain' in the ester and the carboxylic acid always becomes the 'main chain' (ending in oate).

Exercise: write the name of the products that form below

2.1 methanol + ethanoic acid → +

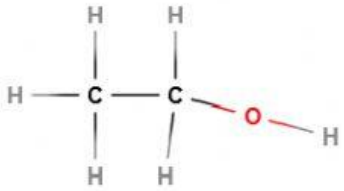
2.2 ethanol + propanoic acid → +

2.3 propan-1-ol + butanoic acid → +

2.4 butan-1-ol + metanoic acid → +

2.5 pentan-1-ol + petanoic acid → +

3.1 Write the IUPAC names of the alcohols, carboxylic acids and esters that form in the reactions below.



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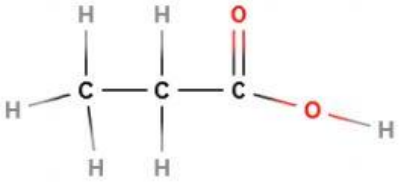
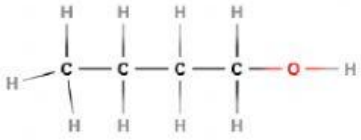


→ + water

3.2



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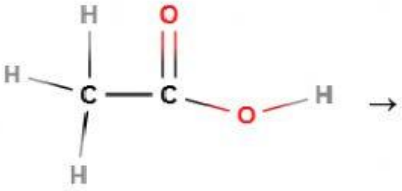
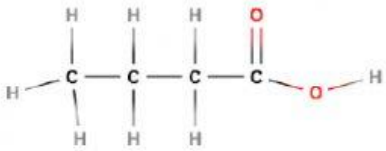


→ + water

3.3



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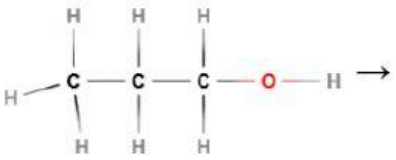


→ + water

Exercise 4: Write the IUPAC name of the products that form

4.1 pentanoic acid + butan-1-ol → + water

4.2 hexanoic acid + propan-1-ol → + water

4.3 hexan-1-ol + butanoic acid → + water

Cracking

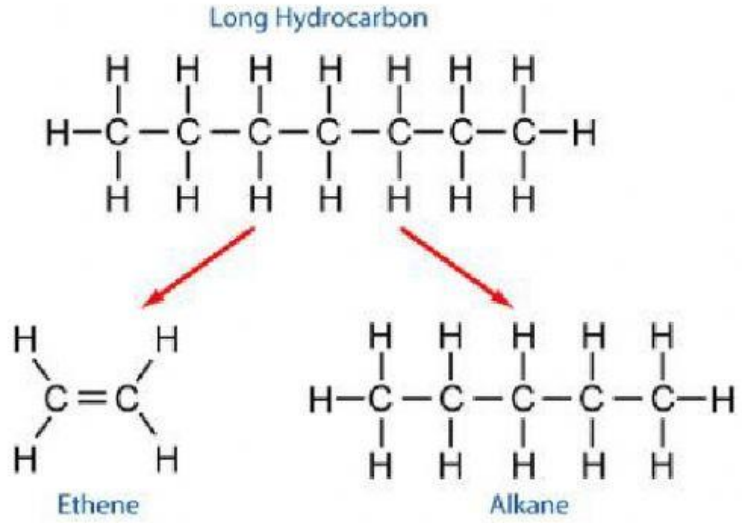
Cracking: the chemical process in which longer chain hydrocarbon molecules are broken down into shorter more useful molecules.

Eg

How many carbons and hydrogens are left over?

$C_7H_{16} \rightarrow C_5H_{12} + \underline{C_2H_4}$

Heptane pentane + ethene



Eg 2

$CH_3{-}CH_2{-}CH_2{-}CH_2{-}CH_2{-}CH_2{-}CH_2{-}CH_2{-}CH_2{-}CH_3$

decane

$CH_3{-}CH{=}CH_2 + CH_3{-}CH_2{-}CH_2{-}CH_2{-}CH_2{-}CH_2{-}CH_3$

propene *heptane*

Eg 3

The reaction represented by the equation below takes place in the presence of a catalyst.

$$C_{13}H_{28}(\ell) \rightarrow C_2H_4(g) + C_3H_6(g) + C_8H_{18}(\ell)$$

Exercise

Complete the following

5.1 The following equation represents the cracking of a hydrocarbon at high temperature and pressure:

$$C_{11}H_{24} \rightarrow 2C_2H_4 + \mathbf{Y} + C_4H_{10}$$

Which ONE of the following is the IUPAC name of product **Y**?

A Prop-1-ene

B Propane

C Ethene

D Ethane

Remember to take into consideration the 2 in front of the C_2H_4 when counting how many Carbons and hydrogens you'll have left over

5.2 $C_4H_{10} \rightarrow C_2H_6$ +

5.3 $C_4H_{10} \rightarrow CH_4$ +

5.4 $C_4H_{10} \rightarrow C_4H_8$ +

5.5 $C_6H_{14} \rightarrow C_3H_6 + C_2H_4$ +

5.6 $C_6H_{14} \rightarrow C_4H_8$ +

5.7 $C_6H_{14} \rightarrow C_6H_{12}$ +

(Structural) Isomers

Organic compounds which have the same molecular formula but different structural formula

There are different types of isomers:

Positional isomers: Same molecular formula, but different positions of the side chain, substituents or functional groups on the parent chain

Functional isomers: Same molecular formula, but different functional groups

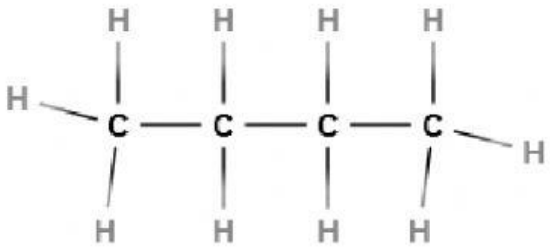
Chain isomers: Same molecular formula, but different types of chains

If you need a bit more help understanding this concept, watch this little video

Exercise:

- First write the molecular formula underneath each compound and then
- Identify what types of isomers the following are

6.1



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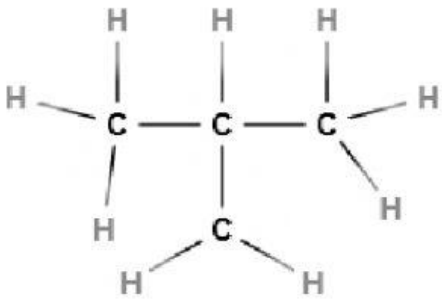


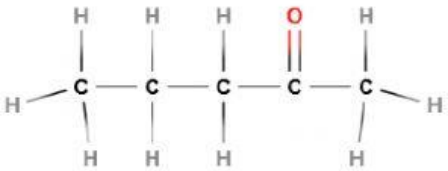
Positional isomers

Functional isomers

Chain isomers

Not isomers – they are the same molecule but with a bend in the chain

6.2



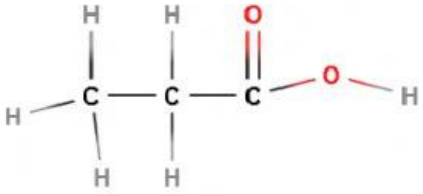
Positional isomers

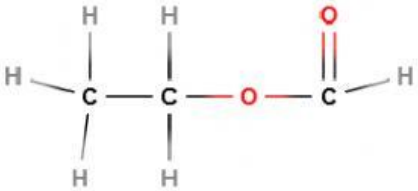
Functional isomers

Chain isomers

Not isomers – they are the same molecule but with a bend in the chain

6.3





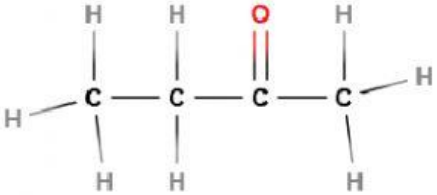
Positional isomers

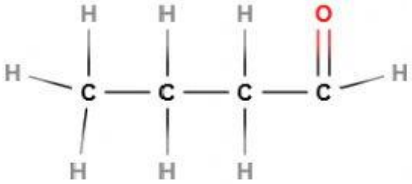
Functional isomers

Chain isomers

Not isomers – they are the same molecule but with a bend in the chain

6.4





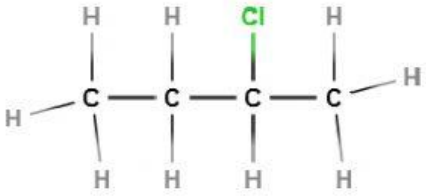
Positional isomers

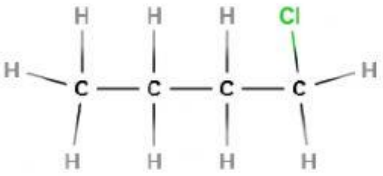
Functional isomers

Chain isomers

Not isomers – they are the same molecule but with a bend in the chain

6.5





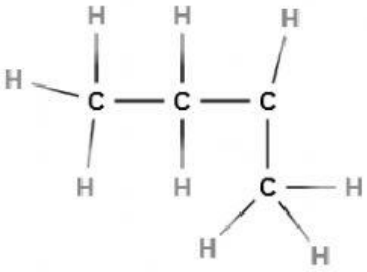
Positional isomers

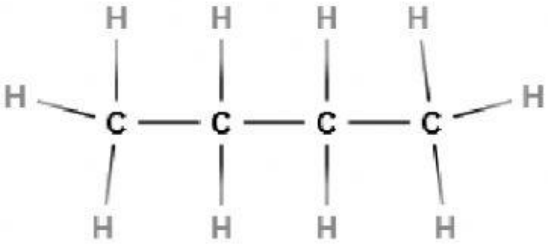
Functional isomers

Chain isomers

Not isomers – they are the same molecule but with a bend in the chain

6.6





Positional isomers

Functional isomers

Chain isomers

Not isomers – they are the same molecule but with a bend in the chain

Exercise

7.1 $C_2H_4O_2$

Give the names of the 2 isomers of the above molecule

7.2 Which of these molecules will have the highest melting point? (give IUPAC name)

7.3 Which of these molecules will have the highest volatility? (give IUPAC name)