Master

Kirkcaldy High School

N4/5 Chemistry

Unit 2 - part 2

Natures Chemistry

Name: ______________________

Class: ______________________

Teacher: ______________________

Assessment Page

End of topic questions

Topic title	Date	Mark/Total Mark
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Homework

Homework title	Date	Mark/Total Mark
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Teacher comments

Date: ________________

Everyday Consumer Products – Alcohols – N4/5

Learning Intentions

- To learn about alcohols.

Success Criteria

☐ I can state the functional group found in alcohols.

☐ I can name and draw alcohols.

☐ I can draw isomers of a given alcohol.

☐ I can explain how alcohols can be prepared from alkenes.

Introduction

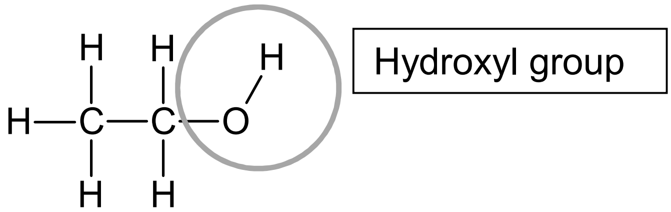
The alcohols are an example of a homologous series of compounds which are not hydrocarbons.

The alcohols are named in the same way as hydrocarbons, they have a prefix which indicates the number of carbon atoms and they each end with the suffix **–anol**.

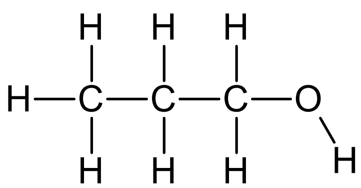
Alcohols contain a **functional group**, this is the part of the molecule responsible for their chemistry.

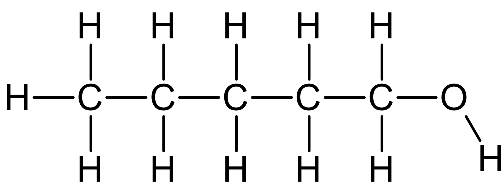
The functional group in the alcohols is called the **hydroxyl group** and consists of an oxygen and a hydrogen atom bonded together.

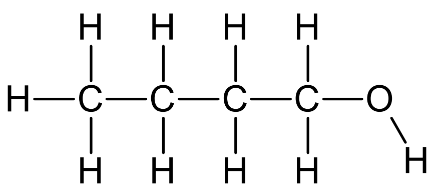
e.g.



Name the following using the rules above







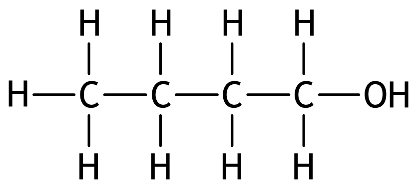
We actually need to more specific with the naming, we need to specify which carbon the hydroxyl group is bonded to.

Systematic naming

As with hydrocarbons, the alcohols can form isomers which each have their own systematic name. Isomers of alcohols differ in the position of the hydroxyl group, some isomers can also have branches.

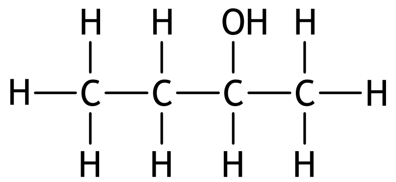
The rules for systematically naming alcohols are very similar to those for naming alkanes and alkenes. First identify the longest chain of carbons, count so that the functional group is on the smallest number and then name the alcohol.

Examples



Longest chain – butanol
OH on C_1

butan-1-ol



Longest chain – butanol
OH on C_2

butan-2-ol

Naming questions

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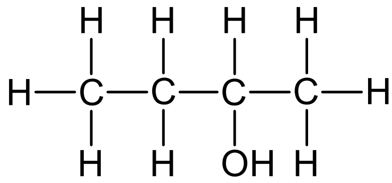

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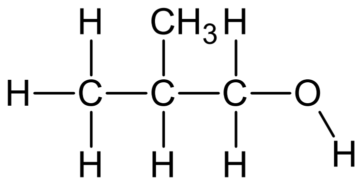

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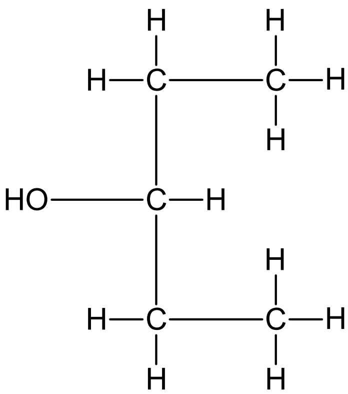

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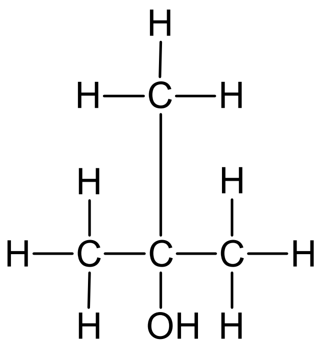

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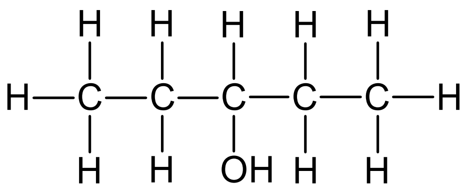

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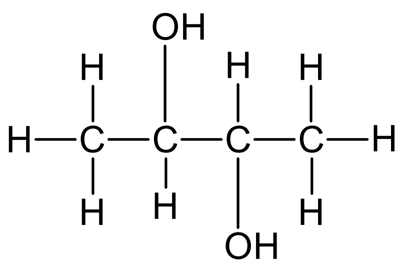

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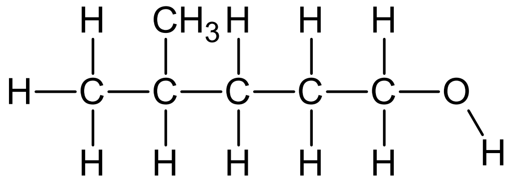

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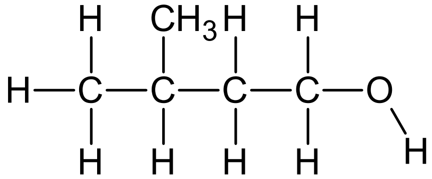

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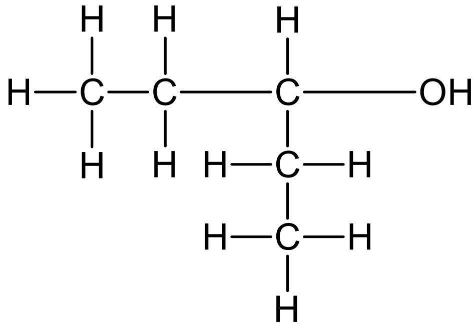

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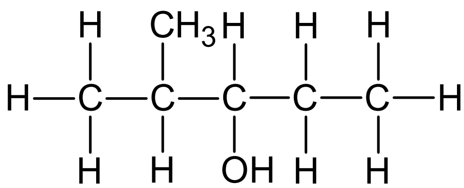

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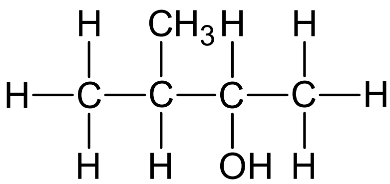

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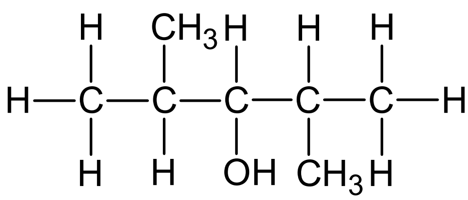


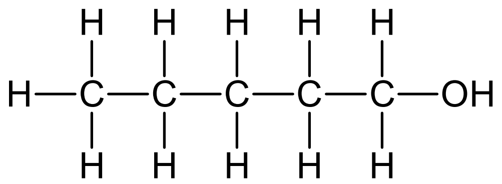
Drawing Questions
Draw the full structural formula for the following

Propan-2-ol	**3-methylpental-2-ol**
Pental-3-ol	***2,3-dimethylpental-2-ol***
2-methylbutan-2-ol	***2-methylbutan-2,3-diol***

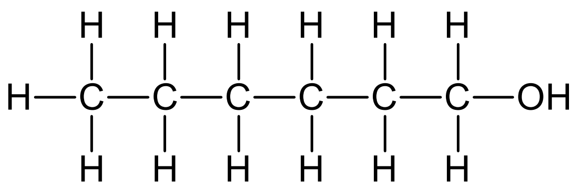
Isomers questions

With alcohols you may move the hydroxyl group and/or add branches to make isomers.

Draw and name 3 isomers of pentan-1-ol.

 **Pentan-1-ol**	

Draw and name 3 isomers of hexan-1-ol.

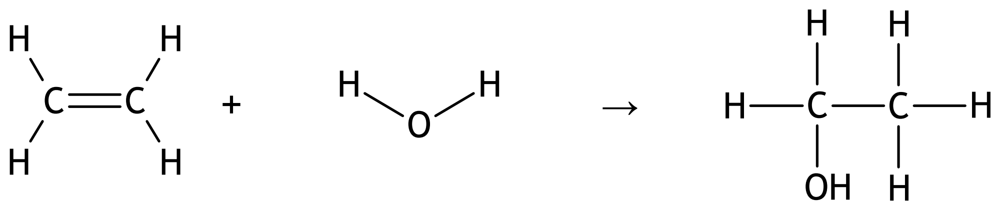
 **Hexan-1-ol**	

Industrial Preparation of Alcohols

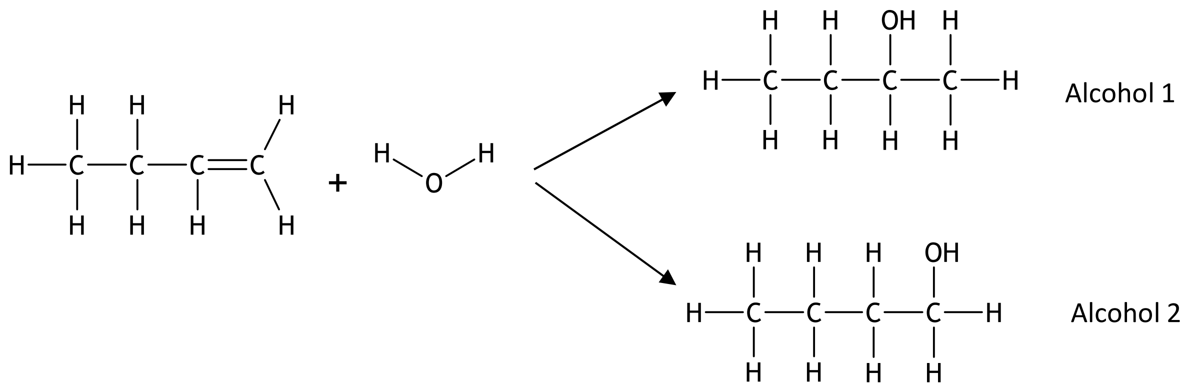
When large quantities of alcohol are needed or a specific alcohol is needed alkenes can be used to form alcohols.

Water molecules can be reacted with alkenes in a process known as **hydration**.

Hydration is another example of an **addition** reaction.

e.g. 

Some alkenes can produce more than one alcohol

e.g. 

In the above reaction 2 alcohols are formed.

Name the two alcohols and state the term used to describe the two.

Draw and name all the possible products of the hydration of

1. pent-2-ene

2. but-2-ene

3. pent-1-ene

4. Write a general statement linking the number of products to the position of the double bond

Extension questions:

Chemcord purple books (N5): page 90 – 93

SCHOLAR

Alcohol uses

Solvents: Alcohols like ethanol are used as solvents in laboratories and industries. Solvents are used to **dissolved** substances.

Antiseptics: Alcohols such as 2-methylpropane (isopropyl alcohol) are used for disinfecting wounds.

Fuel: Ethanol can be used as a biofuel.

Beverages: Ethanol is the active ingredient in alcoholic drinks.

Cosmetics: Alcohols are often used in cosmetic and skincare products like toners.

Alcohol reactions

Combustion: Alcohols combust in the presence of **oxygen** to produce water and carbon dioxide.

Alcohol general formula

The general formula for the alcohols is: $C_nH_{2n+1}OH$

where n = the number of carbons

1. $C_4H\ OH$
2. $C_6H\ OH$
3. $C_8H\ OH$
4. $C\ \ H_{11}OH$
5. $C\ \ H_{15}OH$
6. $C\ \ H_{19}OH$

Solubility/miscibility/m.p. & b.p. of Alcohols

Alcohols are generally **soluble** in water, they become **less** soluble as the length of the chain **increases**.

Alcohols are generally **miscible** in water. This means that they mix **without** forming a **layer**.

The melting/boiling point of alcohols **increase** as the chain length **increases**. This is due to **increased** strength of **intermolecular** forces.

Date: ________________

Everyday Consumer Products – Carboxylic Acids – N4/5

Learning Intentions

- To learn about carboxylic acids.

Success Criteria

☐ I can state the functional group in a carboxylic acid molecule.

☐ I can name/draw carboxylic acids.

☐ I can draw isomers of carboxylic acids.

Introduction

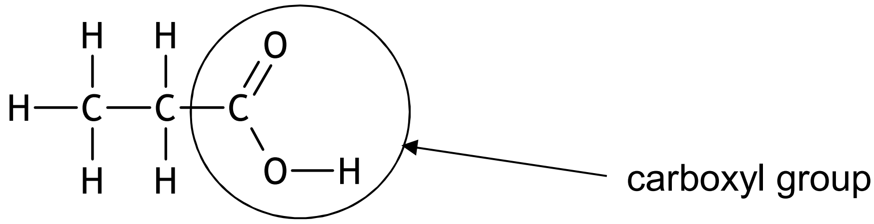
The carboxylic acids are another example of a homologous series of compounds which are not hydrocarbons.

The carboxylic acids are names just like other homologous series and can be identified by the suffix **–anoic acid**

Carboxylic acids contain a **functional group** called the **carboxyl group**.

Carboxylic acids are **non-toxic** acids and have a pH of less than **7**, usually around pH **4**.

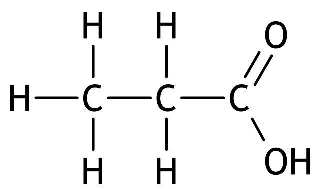
e.g.



Again the molecular formula is often written to show the functional group e.g. C_2H_5COOH

The structure is also often drawn without showing the bond between the oxygen and the hydrogen.

e.g.



The carboxyl group can only be located on the carbon atoms at the end of a chain and so there is no need to number the carboxyl group in the systematic name. The carbon on the carboxyl group will always be carbon number ‘1’.

Naming Questions

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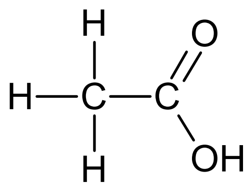

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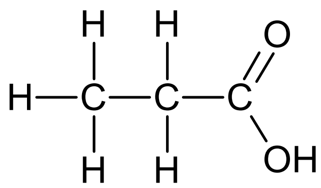

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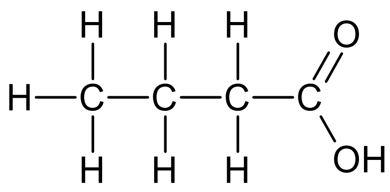

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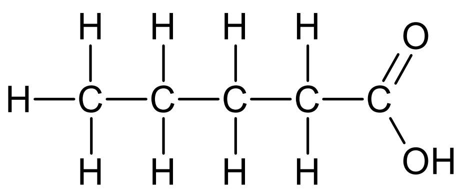

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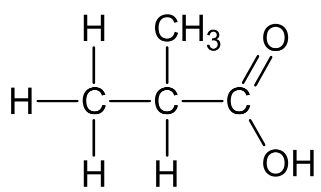

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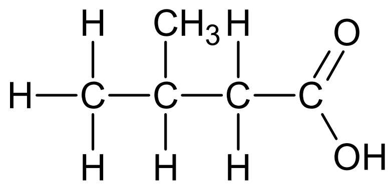

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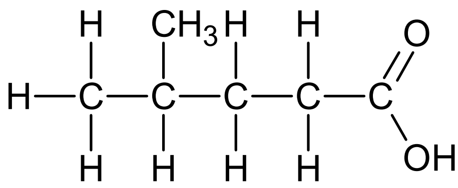

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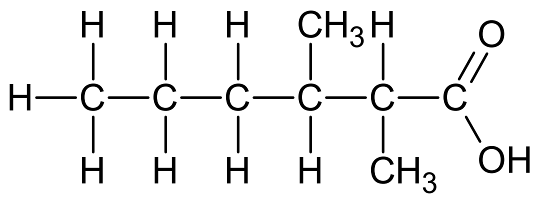

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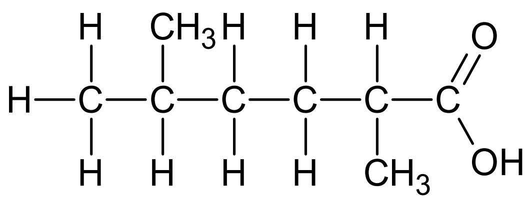

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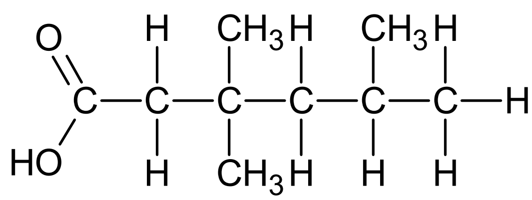


Drawing Questions

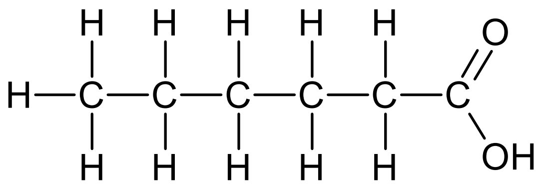
Draw the full structural formula for the following

Propanoic acid	**2,3-dimethylbutanoic acid**
2-methylbutanoic acid	***2,4-dimethylpentanoic acid***
3-methylpentanoic acid	***2,5-dimethylhexanoic acid***

Isomers

With carboxylic acids, you cannot move the carboxyl functional group but you can add branches

Draw and name 5 isomers of hexanoic acid.

 **Hexanoic acid**	

Carboxylic Acids uses

Food Industry: Ethanoic acid* is used as a preservative and flavouring agent.

Vinegar is a diluted solution of **ethanoic acid***

Cosmetics: Fatty acids are used in soaps and lotions.

Plastics: Acrylic acid is used in the production of plastics.

Pharmaceuticals: Some carboxylic acids are used as starting materials for drugs.

Carboxylic acids reactions

Neutralization: Carboxylic acids react with **metals/bases** to form **salts** and water.

$$CH_3COOH + NaOH \dashrightarrow \mathbf{CH_3COONa} + H_2O$$

Sodium ethanoate
(salt)

Naming salts of carboxylic acids

1. **Identify the Carboxylic Acid**: First, determine which carboxylic acid has reacted to form the salt. For example, if ethanoic acid (CH_3COOH) is the parent acid, you'll start with "ethan-."
2. **Change the Suffix**: Replace the "-oic" in the acid name with "-oate." For ethanoic acid, this would make it "ethanoate."
3. **Name the metal**: Identify the metal or other positively charged ion in the base that has replaced the hydrogen ion (H^+) in the carboxylic acid. For example, if sodium hydroxide (NaOH) is the base, you'd identify the metal as "sodium."
4. **Combine**: Combine the names of the metal and the modified carboxylic acid. In our example, the salt formed would be "**sodium ethanoate**."

Examples:

- The salt of propanoic acid (C_3H_7COOH) and sodium (Na) would be named "sodium propanoate."

Questions

Carboxylic Acid	Base	Name of the salt
Ethanoic acid	Potassium Hydroxide	
Butanoic acid	Sodium Hydroxide	
Propanoic acid	Calcium Hydroxide	

Carboxylic acids general formula

The general formula for the carboxylic acids is: $C_nH_{2n+1}COOH$

where n = the number of carbons

1. C_3H COOH

2. C_5H COOH

3. C_7H COOH

4. C_9H COOH

5. C H_7COOH

6. C $H_{13}COOH$

7. C $H_{17}COOH$

8. C $H_{21}COOH$

Solubility/miscibility/m.p. & b.p. of carboxylic acids

Carboxylic acids are generally **soluble** in water, they become **less** soluble as the length of the carbon chain **increases**.

Methanoic, **ethanoic**, **propanoic** and **butanoic** acid are **miscible** in water. This means they can mix without forming a **layer**.

The melting/boiling point of carboxylic acids increase as the chain length increases. This is due to **increased** strength of **intermolecular** forces.

Extension questions:
Chemcord purple books (N5): page 94
SCHOLAR

Date: _______________

Carbohydrates – N4

Learning Intentions

- To learn about carbohydrates and products made from plants.

Success Criteria

- ☐ I can state the elements found in carbohydrates
- ☐ I can state a use for carbohydrates.
- ☐ I can state the different types of carbohydrates and the chemical test for each.
- ☐ I can describe the products made from plants.

Carbohydrates

Carbohydrates are organic compounds made up of **carbon**, **hydrogen**, and **oxygen** atoms. They are an essential source of energy for living organisms, including humans. Carbohydrates can be simple, like glucose, or complex, like starch.

Glucose and Starch

Glucose

Glucose is a **simple** sugar (monosaccharide) that serves as a primary source of **energy** for cells. It is soluble in water and can be found naturally in **fruits** and **honey**.

Testing for Glucose: The **Benedict's** test is commonly used to identify the presence of glucose. When Benedict's reagent is added to a glucose solution and heated, a colour change from **blue to orange-red** occurs, indicating the presence of glucose.

Starch

Starch is a **complex** carbohydrate (polysaccharide) found in plants. It serves as an **energy storage** molecule and is found in foods like **potatoes** and **rice**.

Testing for Starch: The **iodine** test is commonly used to test for starch. A few drops of **iodine** solution are added to the sample. If starch is present, the colour changes from **yellow-brown** to **blue-black**.

Plants to Products

Various products like **paper**, **clothing**, and **biofuels** are made from plants. Some food items like bread and pasta also originate from plant-based carbohydrates.

Fermentation

Fermentation is a biological process that **converts sugar** into other compounds like **alcohol** or **acids**. It is often employed in food and beverage production. For example, the fermentation of glucose by **yeast** produces **ethanol** and **carbon dioxide**, which is crucial for bread making and alcohol production.

Questions

1. **State** the elements found in carbohydrates.
2. **State** is the primary role of glucose in living organisms?
3. **Describe** the Benedict's test. What colour change indicates the presence of glucose?
4. **Describe** the function of starch in plants?
5. **Describe** the chemical test for the presence of starch in a sample?
6. **List** at least two products that are made from plant-based carbohydrates **and** the plant they come from.
7. **Describe** the process of fermentation, and what are its key by-products?

Date: _______________

Energy from Fuels – N4/5

Learning Intentions

- To learn how to calculate the energy release from burning fuels.

Success Criteria

☐ I can state the name given to reactions that release heat.

☐ I can calculate the energy release from a fuel.

Introduction

The main reaction hydrocarbons and alcohols are involved in is **combustion** reactions, this makes them **fuels**. Combustion of fuel releases **energy**, therefore it is an **exothermic** reaction.

The unit for measuring energy is **Joules** (**J**) or **kilojoules** (**kJ**).

Ethanol can be used as an ‘alternative fuel’ to replace fossil fuels (hydrocarbons).

The energy released in the burning of a fuel can be calculated using the heat energy to raise the temperature of a known mass of water.

Calculating energy from fuels

The energy released from burning fuels can be determined experimentally and calculated using the equation:

$$E_H = cm\Delta T$$

Energy = specific heat capacity of water x mass of water x temperature change

E_h = energy released (kJ)

c = specific heat capacity of water (4.18 kJ kg^{-1} $°C^{-1}$) - *Data booklet*

m = mass of water (kg) [we assume that 1 litre = 1 kg]

ΔT = temperature change (°C)

Combustion Experiment

Reaction Title: ____

Aim: ____

____

Method:

Results:

Conclusion: ____

____

____

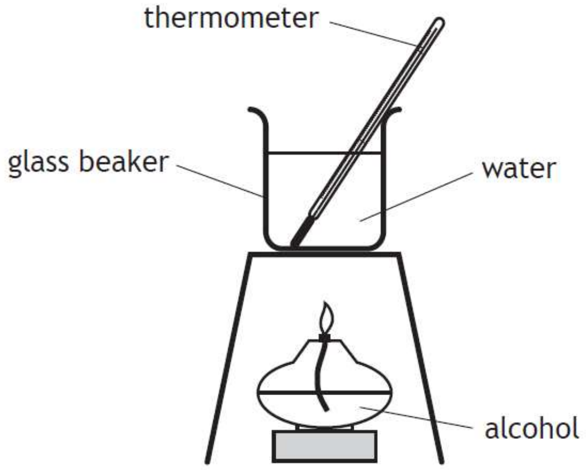
Evaluation: ____

____

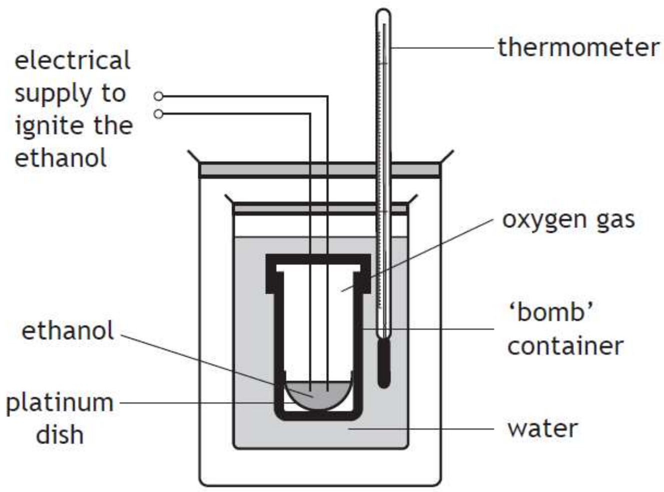
____

Improving the combustion experiment

Given the set-up for the combustion experiment below, list all the ways that heat is lost for the experiment. <u>All of these factors mean that the energy calculated will be much lower than expected.</u>



To ensure all the energy from the combustion of a fuel is measured a **bomb calorimeter** is used instead (shown below). Detail the changes made to improve the experiment from the previous set-up.



Calculations

1. Methanol (CH_3OH) - One gram of methanol is completely combusted to heat 100 cm³ of water and raises its temperature by 15°C. How much energy was released?

2. Ethanol (C_2H_5OH) - One gram of ethanol is completely combusted to heat 100 cm³ of water and raises its temperature by 25°C. How much energy was released?

3. Propanol (C_3H_7OH) - One gram of propanol is completely combusted to heat 100 cm³ of water and raises its temperature by 35°C. How much energy was released?

Linking statement

Write a general statement linking the length of the carbon chain in the alcohol to the energy released when they are burned:

____

____

____

Questions

1. Ethene (C_2H_4) - One gram of ethene is completely combusted to heat 200 cm^3 (200g) of water, raising its temperature by 10°C. How much energy was released?

2. Propane (C_3H_8) - One gram of propane is completely combusted to heat 50 cm^3 (50g) of water, raising its temperature by 20°C. How much energy was released?

3. Butane (C_4H_{10}) - One gram of butane is completely combusted to heat 150 cm^3 (150g) of water, raising its temperature by 15°C. How much energy was released?

4. Pentene (C_5H_{10}) - One gram of pentene is completely combusted to heat 300 cm^3 (300g) of water, raising its temperature by 25°C. How much energy was released?

5. For an unknown hydrocarbon, we know that its complete combustion releases 12 kJ of energy, raising the temperature of water by 30°C. Calculate the mass of water (in kg) that was heated. *You will need to rearrange the equation.*

Extension questions:

Chemcord purple books (N5): page 97 – 98

SCHOLAR

Date: ________________

Calculations from balanced equations – N5

Learning Intentions

- To practice calculation from balanced equations.

Success Criteria

☐ I can perform a calculation from balanced equations.

Introduction

When the number of moles of a reactant or product is known, a balanced equation can be used to calculate the quantity of any other chemical in the equation.

e.g. 66 g of propane is burned in a plentiful supply of oxygen. Calculate the mass of carbon dioxide produced in the reaction.

The steps to answer this question are

1. **Write a balanced equation**

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

2. **Calculate the number of moles of the 'known' substance from the equation.**

Moles of methane = mass / GFM
= 66 g / 44 g
= 1.5 moles

3. **Use the balanced equation to identify the molar ratio of 'known' substance to 'required' substance and then calculate the number of moles of the 'required' substance**

propane	:	carbon dioxide
1 mole	:	3 moles
1.5 moles	:	4.5 moles

4. **Answer the question by calculating the required value of the 'required' substance.**

Mass of carbon dioxide = moles x GFM
= 4.5 x 44 g
= 198 g

Calculations

1. If 16 g of methane (CH_4) is completely burned in oxygen, calculate the mass of carbon dioxide (CO_2) produced. Use the following balanced chemical equation:

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

2. 22.4 g of ethene (C_2H_4) is burned in excess oxygen. How much carbon dioxide (CO_2) is produced? The balanced equation is:

$$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$$

3. Propane (C_3H_8) burns in oxygen to produce carbon dioxide and water. If 44 g of propane is burned, what mass of carbon dioxide (CO_2) will be produced? Use the balanced equation:

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

4. Butane (C_4H_{10}) is used in lighters. If 58 g of butane is burned, how much CO_2 is produced? The reaction is:

$$2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$$

5. How much carbon dioxide is produced when 28 g of ethyne (C_2H_2) is burned in oxygen? Use the reaction:

$$2C_2H_2 + 5O_2 \rightarrow 4CO_2 + 2H_2O$$

6. Hexane (C6H14) is used as a solvent. If 86 g of hexane is burned, what mass of CO2 will be produced? The reaction is:

$$2C_6H_{14} + 19O_2 \rightarrow 12CO_2 + 14H_2O$$

7. If 72 g of benzene (C_6H_6) is burned in oxygen, calculate the mass of CO_2 produced. The balanced equation is:

$$2C_6H_6 + 15O_2 \rightarrow 12CO_2 + 6H_2O$$

8. If 30 g of propene (C_3H_6) is completely combusted in oxygen, calculate the mass of carbon dioxide produced. The reaction is:

$$C_3H_6 + 4.5O_2 \rightarrow 3CO_2 + 3H_2O$$

9. Octane (C_8H_{18}), found in gasoline, is burned in a car engine. If 114 g of octane is burned, how much CO_2 is produced? The reaction is:

$$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$$

Extension questions:

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Topic	2015	2016	2017	2018	2019
E.D.C.P/ Energy	MC – S2 – 6c,8,13a	MC – 9 S2 – 9,12a	MC – 12-14 S2 – 7, 12a,14	MC – 12-14 S2 – 9,13	MC – 17 S2 – 2,9

MC = multiple choice section, S2 = section 2, the written section.