7.2 Alkenes, alcohols and carboxylic acids

Name: _____ Class: _____ Date: _____ **Total: 35 marks**

KEY WORDS functional group • fermentation • carboxylic acid

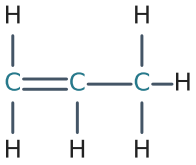
Objective

Describe alkenes, alcohols and carboxylic acids by functional group. Chemistry only. Original questions for spec statements 4.7.2.1–4.7.2.4.

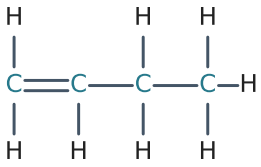
1 Key knowledge and worked examples

Ethene · C_2H_4

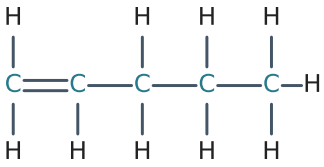
Propene · C_3H_6



Butene · C_4H_8



Pentene · C_5H_{10}



Alkenes C_nH_{2n} – the **C=C** double bond makes them **unsaturated**: ethene, propene, butene, pentene. React by addition: + H_2 (Ni catalyst) → alkane; + H_2O (steam, phosphoric acid) → alcohol; + Br_2 → dibromo compound (bromine water test). Tend to burn in air with **smoky flames** (incomplete combustion); sufficient oxygen gives complete combustion.

Alcohols –OH – methanol, ethanol, propanol, butanol. With **sodium** → hydrogen; **burn** cleanly (fuels); **mix** with water, with limited solubility for longer members; the taught primary forms are **oxidised** → carboxylic acid. **Fermentation**: sugar + **yeast**, warm and **oxygen-free**, gives ethanol solution.

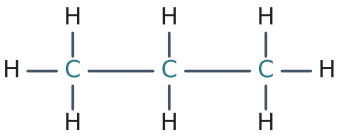
Carboxylic acids –COOH – methanoic, ethanoic, propanoic, butanoic. With **carbonates** → CO_2 fizz; dissolve in water – **weak** acids (HT: partially ionised → higher

pH than strong acids); with **alcohols → esters** (ethyl ethanoate) + water.

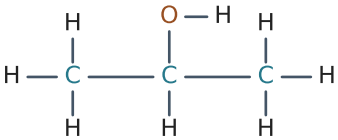
Worked example (3 marks). Describe a test to distinguish ethene from ethane.

Add bromine water to each sample; ethene decolourises the orange bromine water; ethane leaves it orange – no double bond to add across.

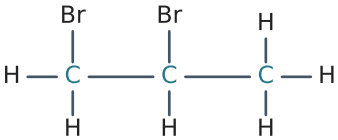
Propene + H_2 → propane · heated nickel



Propene + steam → shown OH-position product · acid catalyst



Propene + Br_2 → dibromo product · no H removed



Worked ethanol combustion. Two C atoms require two CO_2, and six H atoms require three H_2O. The products need seven oxygen atoms; ethanol already supplies one, leaving six from three O_2:

$$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$$

2 Practice

2.1 Give the general formula of the alkenes. [1]

2.2 Name the alcohol made by fermenting sugar solution. [1]

2.3 *(HT)* Why is ethanoic acid a weak acid? [2]

3 Exam-style questions

3.1 For hydrogen addition, hydration and bromine addition to ethene, name the other reactant and the product for each reaction. [6]

3.2 Describe the conditions for fermentation and the process by which ethanol solution forms. [4]

3.3 Ethanoic acid reacts with ethanol. Name the products and the type of reaction, and write the functional groups present in the reactants. [4]

3.4 Draw a fully displayed propene molecule and its bromine-addition product. State the bromine-water colour change. Explain why $CH_2Br–CHBr–CH_3$ is addition rather than replacement of hydrogen. [5]

3.5 State what happens when the taught primary ethanol reacts with sodium and with an oxidising agent. Write the balanced equation for ethanol's complete combustion. [5]

3.6 Two warm sugar solutions have equal volumes and sugar concentrations. A contains yeast; B contains no yeast. Both use approved airlocks. A produces much more gas. Explain the purpose of B, why the vessel needs an escaping-gas path, and why gas volume alone does not establish the purity of the ethanol solution. [4]

3.7 *(HT)* Equal-concentration solutions of a strong monoprotic acid and ethanoic acid have different pH values. Which has the lower pH? Explain using ionisation, and state why the word "weak" does not mean "dilute". [3]