Exercise walk-through

7.2

Reactions of alkenes and alcohols – chemistry only (4.7.2.1–4.7.2.3)

AQA · GCSE · Chemistry

Crude oil and the alkanes

- **Crude oil** is a finite resource found in rocks.
- It formed over millions of years from the remains of plankton buried in mud, so it is not being replaced as fast as we use it.
- **Crude oil** is a mixture of a very large number of compounds.
- Most of them are each a **hydrocarbon** : a compound of hydrogen and carbon only.

Cracking and alkenes

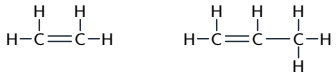
- **Crude oil** contains more large hydrocarbons than we need, and fewer small ones such as petrol. **Cracking** breaks long **hydrocarbon** molecules into shorter, more useful ones.
- In catalytic **cracking**, the vapour is passed over a hot catalyst; in steam cracking, it is mixed with steam at a very high temperature.
- Cracking makes smaller alkanes, which are useful fuels, and alkenes, which are used to make polymers and other chemicals.
- **Worked example 4.** Balance $\mathrm{C_{10}H_{22}} \rightarrow \mathrm{C_8H_{18}} + \mathrm{X}$.

Sources for this lesson

- AQA, *GCSE Chemistry (8462) specification*, section 4.7.
- ICI, laboratory notebook of E. W. Fawcett and R. O. Gibson (27 March 1933), and Royal Society of Chemistry, "The discovery of polythene" (National Historic Chemical Landmark, Northwich).
- J. R. Whinfield and J. T. Dickson, British patent 578,079 (1941), the first **polyester** (PET).
- J. D. Watson and F. H. C. Crick, "Molecular structure of nucleic acids", *Nature* (25 April 1953).

Exercises 2.1·2.3

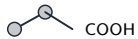
2.1 Give the general formula of the alkenes. [1]



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

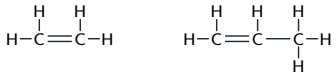


2.3 *(HT)* Why is ethanoic acid a weak acid? [2]



Exercises 2.1·2.3

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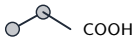
2.1 C_nH_{2n}.

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



2.2 Ethanol.

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

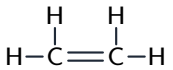


2.3 It is only partially ionised in water; so few H^+ ions form relative to a strong acid of equal concentration.

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Exercise 3.1

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



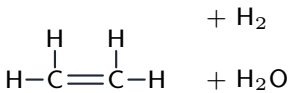
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$+ H_2O$

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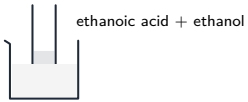
3.1 + hydrogen (nickel catalyst) → ethane; + water/steam (phosphoric acid catalyst) → ethanol; + bromine → dibromoethane, decolourising bromine water.

Setup for exercise 3.2

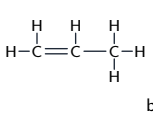
3.2 Describe the conditions for fermentation and the process by which ethanol solution forms. [4]



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]



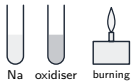
3.4 Draw a fully displayed propene molecule and its bromine-addition product. State the bromine-water colour change. Explain why $CH_2Br–CHBr–CH_3$ is addition rather than replacement of hydrogen. [5]



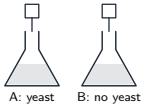
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Exercise 3.2

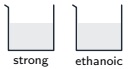
3.5 State what happens when the taught primary ethanol reacts with sodium and with an oxidising agent. Write the balanced equation for ethanol's complete combustion. [5]



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]

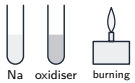


3.7 *(HT)* Equal-concentration solutions of a strong monoprotic acid and ethanoic acid have different pH values. Which has the lower pH? Explain using ionisation, and state why the word "weak" does not mean "dilute". [3]

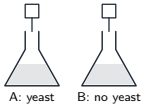


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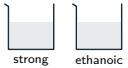
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3.2 Mix sugar solution with yeast; keep warm – around body temperature; exclude oxygen – anaerobic conditions; the yeast's enzymes convert the sugar to ethanol and carbon dioxide, giving a dilute ethanol solution.

3.3 Ester – ethyl ethanoate + water; condensation/esterification reaction; ethanol carries –OH and ethanoic acid carries –COOH.

Full solution on next slide

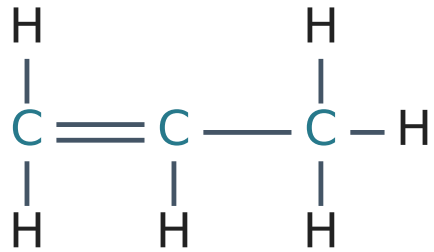
Full solution 3.2 (1/3)

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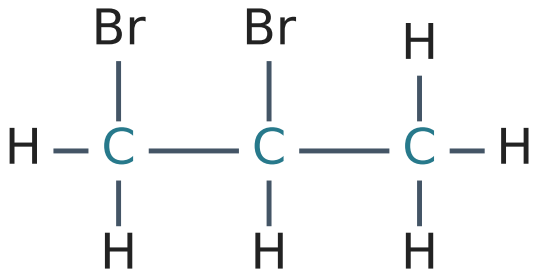
3.4

Propene: starting molecule



Bromine-addition product: all hydrogens retained

Full solution 3.2 (2/3)



Correct displayed starting structure, C=C becomes C–C, one Br on each former C=C carbon with all H retained and valid carbon valencies. Orange → colourless. Two Br atoms have been added without removing hydrogen atoms.

3.5 Sodium gives fizzing/hydrogen; oxidation of the taught primary ethanol gives ethanoic acid.

Full solution 3.2 (3/3)

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

Correct products, C/H balanced, O balanced including ethanol's oxygen. The shown hydration product from propene is not primary ethanol and must not be assigned this oxidation rule blindly.

3.6 B is a yeast-free control to compare gas formation without yeast. Carbon dioxide must escape to prevent pressure build-up in a tightly sealed vessel. Gas measurement does not measure the proportions of ethanol and water or establish ethanol purity. Other conditions must remain matched.

3.7 The strong acid has lower pH at the same stated concentration, because it ionises more completely and gives more H^+; ethanoic acid is partially ionised. Weak describes ionisation, while dilute describes amount per volume.