

Alcohols, acids, esters and polymers explained

Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Worksheet answers

Each answer shows the rule or formula, the substitution and the final result in bold with its unit. Compare your method with the model, not just the final number, because exam marks reward the steps as well as the result.

Level: Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** GCSE C7

Problem 1 Functional group vocabulary

1. **Hydroxyl, -OH** (an alcohol).
2. **CH₃COOH**, which has -COOH.
3. **CH₃COOC₂H₅**, which has the -COO- link.
4. C₃H₇OH is **propanol**.

Problem 2 Formulae from names

1. **C₄H₉OH**.
2. **C₂H₅COOH** (three carbons including the one in -COOH).
3. n = 5 gives **C₅H₁₁OH**.

Problem 3 Naming esters

The alcohol gives the first word and the acid the second.

1. **Ethyl propanoate**.
2. **Methyl ethanoate**.
3. **Butyl methanoate**.

Problem 4 Fermentation apparatus

1. **Sugar solution with yeast**.
2. **C**.
3. It turns **cloudy (milky)** because carbon dioxide is formed.
4. **30 to 40 °C**.

Problem 5 Polymer words

1. **False**: a polymer is the long chain; monomers are the small units.
2. **True**.
3. **True**.
4. **False**: it is made from ethene.

Problem 6 Fermenting glucose

1. $\text{C}_6\text{H}_{12}\text{O}_6 \rightarrow 2\text{C}_2\text{H}_5\text{OH} + 2\text{CO}_2$.
2. $M = 180$; $n = 36 \div 180 = \mathbf{0.20 \text{ mol}}$.
3. Ethanol $0.40 \text{ mol} \times 46 = \mathbf{18.4 \text{ g}}$; CO_2 $0.40 \text{ mol} \times 44 = \mathbf{17.6 \text{ g}}$. Check: $18.4 + 17.6 = 36.0 \text{ g}$.

Problem 7 Ethanol as a fuel

1. $\text{C}_2\text{H}_5\text{OH} + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 3\text{H}_2\text{O}$.
2. $M = 46$; $n = 23 \div 46 = \mathbf{0.50 \text{ mol}}$.
3. $\text{CO}_2 = 1.0 \text{ mol} \times 44 = \mathbf{44 \text{ g}}$. $\text{H}_2\text{O} = 1.5 \text{ mol} \times 18 = \mathbf{27 \text{ g}}$.

Problem 8 Ethanoic acid reactions

1. Already balanced: $\text{C } 3 = 3$, $\text{H } 5 = 5$, $\text{O } 5 = 5$. $\text{CH}_3\text{COOH} + \text{NaHCO}_3 \rightarrow \text{CH}_3\text{COONa} + \text{H}_2\text{O} + \text{CO}_2$.
2. **Sodium ethanoate** and **carbon dioxide**.
3. $2\text{CH}_3\text{COOH} + \text{Mg} \rightarrow (\text{CH}_3\text{COO})_2\text{Mg} + \text{H}_2$. The magnesium dissolves and bubbles of hydrogen appear.

Problem 9 Vinegar and pH

1. Microbes in the air **oxidise ethanol to ethanoic acid**.
2. Each pH unit is a factor of 10. pH 1 means $0.1 \text{ mol/dm}^3 \text{ H}^+$ and pH 3 means 0.001 mol/dm^3 , so ethanoic acid has **100 times fewer** hydrogen ions.
3. Hydrochloric acid is a **strong acid** that ionises completely; ethanoic acid is **weak**: only a small fraction ionises.

Problem 10 Reading an ester

1. The **ester group**, $-\text{COO}-$.
2. Three carbons, six hydrogens and two oxygens: $\text{C}_3\text{H}_6\text{O}_2$.
3. The alkyl part on oxygen has one carbon, so the alcohol is **methanol**; the other part has two carbons, so the acid is **ethanoic acid**. Q is methyl ethanoate.

Problem 11 Poly(chloroethene) chain

1. The repeat unit is $-\text{CH}_2-\text{CHCl}-$, so X is chlorine.
2. The monomer is $\text{CH}_2=\text{CHCl}$, **chloroethene**: a $\text{C}=\text{C}$ bond with one chlorine and three hydrogens.
3. **Addition polymerisation**.

Problem 12 Choosing a plastic

1. Softening above 100 °C: **high-density poly(ethene) and poly(propene)**.
2. **Poly(propene)**, which softens at 150 °C.
3. **PVC**, density above 1.0 g/cm³.
4. $m = 1.4 \times 500 = \mathbf{700\text{ g}}$.

Problem 13 Mass of a polymer chain

1. $2 \times 12 + 4 = \mathbf{28}$.
2. $28 \times 1000 = \mathbf{28\ 000}$.
3. Repeat unit = $24 + 3 + 35.5 = 62.5$; $62.5 \times 800 = \mathbf{50\ 000}$.

Problem 14 Ethanol petrol blend

1. 10 % of 40 dm³ = **4.0 dm³**.
2. Mass = $0.79 \times 4.0 = \mathbf{3.16\text{ kg}}$.
3. $3160\text{ g} \div 46 = \mathbf{68.7\text{ mol}}$.

Problem 15 Plastic waste

1. Poly(ethene) is a long chain with strong C-C and C-H bonds, so it is **unreactive**. Microbes cannot break it down, so it is not biodegradable.
2. **Recycle or reuse** bags, and use biodegradable materials or fewer bags.

Problem 16 Yield of an ester

1. $M(\text{CH}_3\text{COOH}) = 60$; $n = 6.0 \div 60 = \mathbf{0.10\text{ mol}}$.
2. $M(\text{ester}) = 88$; $0.10 \times 88 = \mathbf{8.8\text{ g}}$.
3. $5.9 \div 8.8 \times 100 = \mathbf{67\ \%}$. The reaction is reversible, so it does not go to completion, and some ester is lost in separating it.

Problem 17 A polyester chain

1. 100 monomers in a line have **99 links**.
2. **99 water molecules**.
3. $50 \times 62 + 50 \times 166 = 3100 + 8300 = 11\ 400$; water lost $99 \times 18 = 1782$; $M = 11\ 400 - 1782 = \mathbf{9618}$.

Problem 18 Composition of PVC

1. $M = 62.5$; $\text{Cl} = 35.5 \div 62.5 \times 100 = \mathbf{56.8\ \%}$.
2. $\text{C} = 24 \div 62.5 \times 100 = \mathbf{38.4\ \%}$; $\text{H} = 3 \div 62.5 \times 100 = \mathbf{4.8\ \%}$.
3. $56.8 + 38.4 + 4.8 = \mathbf{100.0\ \%}$.

Problem 19 Find the errors

1. All four are wrong.
2. (a) Fermentation is **anaerobic**: it needs no oxygen. (b) The alcohol gives the first word, so methanol and ethanoic acid make **methyl ethanoate**; ethyl methanoate comes from ethanol and methanoic acid. (c) The C=C bonds open during polymerisation, so poly(propene) has only single bonds and **does not decolourise** bromine water. (d) They are **weak** acids because they ionise only partly.

Problem 20 Two routes to ethanol

1. Fermentation: $2 \times 46 \div 180 \times 100 = 51.1 \%$. Hydration: $46 \div (28 + 18) \times 100 = 100 \%$.
2. Fermentation uses **renewable** sugar at low temperature; hydration is **fast** and gives pure ethanol with no waste product.
3. **Fermentation**, because sugar cane is local and renewable while ethene would have to be imported as oil.