

Alcohols, acids, esters and polymers explained

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

Name: _____ Date: _____ Class: _____

These 20 problems train you to recognise the -OH, -COOH and ester groups, write and balance equations for fermentation, combustion and neutralisation, name esters, and describe addition and condensation polymers. They also use mole calculations, percentage yield and atom economy.

The set is written for GCSE, IGCSE, O Level, CBSE Class 9-10 and NGSS high school chemistry. Start with the recall problems, then move to the calculations; the last five combine several ideas.

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

Problem 1 Functional group vocabulary (easy)

Zara in Kampala labels some compounds: $\text{C}_2\text{H}_5\text{OH}$, CH_3COOH , $\text{CH}_3\text{COOC}_2\text{H}_5$ and $\text{C}_3\text{H}_7\text{OH}$.

1. Name the functional group in $\text{C}_2\text{H}_5\text{OH}$.
2. Which formula shows a carboxylic acid?
3. Which formula is an ester?
4. Name the other alcohol in the list.

Problem 2 Formulae from names (easy)

Tomasz in Gdansk writes formulae for homologous series members.

1. Write the formula of butanol.
2. Write the formula of propanoic acid.
3. Write the formula of the alcohol with 5 carbon atoms using $\text{C}_n\text{H}_{2n+1}\text{OH}$.

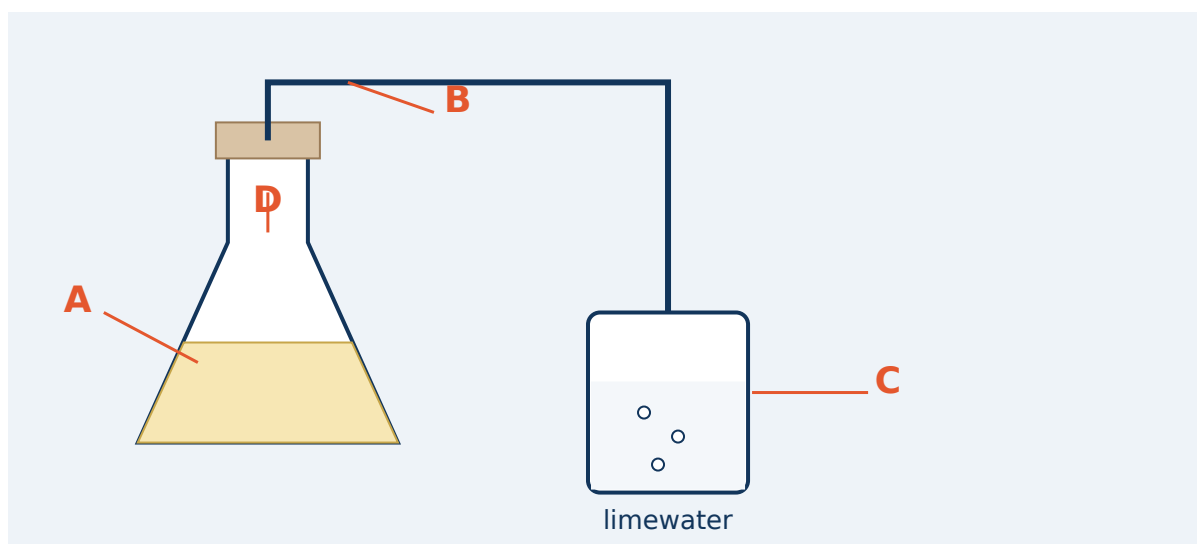
Problem 3 Naming esters (easy)

Name the ester made from each pair.

1. Ethanol and propanoic acid.
2. Methanol and ethanoic acid.
3. Butanol and methanoic acid.

Problem 4 Fermentation apparatus (easy)

Ngozi in Enugu sets up a fermentation flask. The letters mark parts of the apparatus.



Fermentation apparatus with parts A to D.

1. Name the mixture at A.
2. Which letter is the limewater?
3. What happens to the limewater?
4. Give the best temperature range for the flask.

Problem 5 Polymer words (easy)

Decide whether each statement is true or false, and correct the false ones.

1. A monomer is a long chain made of many polymer molecules.
2. In addition polymerisation nothing is lost.
3. In condensation polymerisation water is often lost.
4. Poly(ethene) is made from ethanol.

Problem 6 Fermenting glucose (medium)

A brewery in Nairobi ferments 36 g of glucose, $C_6H_{12}O_6$. (A_r : C = 12, H = 1, O = 16.)

1. Balance $C_6H_{12}O_6 \rightarrow C_2H_5OH + CO_2$.
2. Calculate the moles of glucose.
3. Calculate the mass of ethanol and the mass of carbon dioxide.

Problem 7 Ethanol as a fuel (medium)

A cooking stove in Kisumu burns ethanol. A student burns 23 g of ethanol. (A_r : C = 12, H = 1, O = 16.)

1. Write the balanced equation for complete combustion.
2. Calculate the moles of ethanol.
3. Calculate the mass of carbon dioxide and of water formed.

Problem 8 Ethanoic acid reactions (medium)

Hana in Prague tests ethanoic acid.

1. Balance $\text{CH}_3\text{COOH} + \text{NaHCO}_3 \rightarrow \text{CH}_3\text{COONa} + \text{H}_2\text{O} + \text{CO}_2$.
2. Name the salt and the gas formed.
3. Balance $\text{CH}_3\text{COOH} + \text{Mg} \rightarrow (\text{CH}_3\text{COO})_2\text{Mg} + \text{H}_2$ and say what is seen.

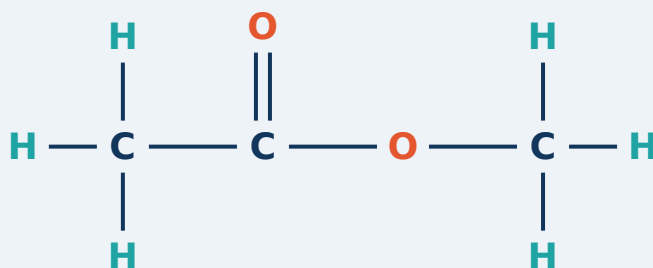
Problem 9 Vinegar and pH (medium)

A bottle of wine left open in a kitchen in Lyon turns into vinegar. A solution of ethanoic acid of concentration 0.1 mol/dm^3 has pH 3, while hydrochloric acid of the same concentration has pH 1.

1. Explain why the wine turns sour.
2. Compare the hydrogen ion concentrations of the two acids.
3. Explain the difference using the words weak and strong.

Problem 10 Reading an ester (medium)

Compound Q is shown.



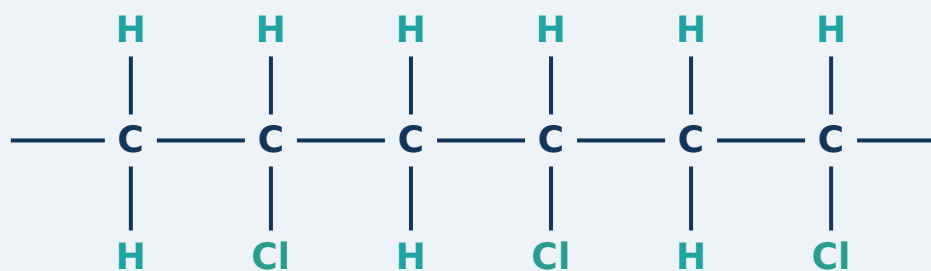
compound Q

Displayed formula of compound Q.

1. Identify the functional group.
2. Write the molecular formula of Q.
3. Name the alcohol and acid that make Q.

Problem 11 Poly(chloroethene) chain (medium)

A water pipe in Johannesburg is made of PVC. A segment of the chain is shown.



segment of a polymer chain

Segment of a PVC chain.

1. Write the repeat unit in the form $-\text{CH}_2-\text{CHX}-$ and give X.
2. Draw or describe the monomer, and give its name.
3. Name the type of polymerisation.

Problem 12 Choosing a plastic (medium)

Data for four plastics: low-density poly(ethene) softens at $90\text{ }^{\circ}\text{C}$, density 0.92 g/cm^3 ; high-density poly(ethene) $125\text{ }^{\circ}\text{C}$, 0.95 g/cm^3 ; poly(propene) $150\text{ }^{\circ}\text{C}$, 0.90 g/cm^3 ; PVC $80\text{ }^{\circ}\text{C}$, 1.4 g/cm^3 .

1. Which plastics survive boiling water at $100\text{ }^{\circ}\text{C}$?
2. Which plastic is best for a container reheated at $120\text{ }^{\circ}\text{C}$?
3. Which plastic sinks in water?
4. Calculate the mass of 500 cm^3 of PVC.

Problem 13 Mass of a polymer chain (medium)

(A_r : C = 12, H = 1, Cl = 35.5)

1. Calculate the relative formula mass of one repeat unit of poly(ethene), C_2H_4 .
2. A chain has 1000 units. Find its relative formula mass.
3. Calculate the relative mass of a PVC chain of 800 repeat units, $\text{C}_2\text{H}_3\text{Cl}$.

Problem 14 Ethanol petrol blend (medium)

A motorist in São Paulo fills a 40 dm^3 tank with a blend that is 10 % ethanol by volume. The density of ethanol is 0.79 kg/dm^3 and $M = 46\text{ g/mol}$.

1. Calculate the volume of ethanol in the tank.
2. Calculate its mass in kilograms.
3. Calculate the moles of ethanol.

Problem 15 Plastic waste (medium)

Ibrahim in Zanzibar sees plastic bags on the beach.

1. Explain why bags made of poly(ethene) remain in the environment for many years.
2. Give two methods to reduce the problem.

Problem 16 Yield of an ester (hard)

Ethanoic acid (6.0 g) reacts with excess ethanol to make ethyl ethanoate: $\text{CH}_3\text{COOH} + \text{C}_2\text{H}_5\text{OH} \rightleftharpoons \text{CH}_3\text{COOC}_2\text{H}_5 + \text{H}_2\text{O}$. The student collects 5.9 g of ester. (A_r : C = 12, H = 1, O = 16.)

1. Calculate the moles of ethanoic acid.
2. Calculate the theoretical mass of ester.
3. Calculate the percentage yield and suggest why it is below 100 %.

Problem 17 A polyester chain (hard)

A polyester chain forms from 50 molecules of a diol ($M = 62$) and 50 molecules of a diacid ($M = 166$). At every link one water molecule ($M = 18$) is lost.

1. How many ester links does the chain contain?
2. How many water molecules are lost?
3. Calculate the relative molecular mass of the chain.

Problem 18 Composition of PVC (hard)

PVC has the repeat unit $\text{C}_2\text{H}_3\text{Cl}$. (A_r : C = 12, H = 1, Cl = 35.5)

1. Calculate the percentage by mass of chlorine.
2. Calculate the percentages of carbon and hydrogen.
3. Show that the three percentages add up to 100 %.

Problem 19 Find the errors (hard)

A student writes: (a) "Fermentation needs plenty of oxygen." (b) "Ethyl methanoate is made from methanol and ethanoic acid." (c) "Poly(propene) still contains C=C bonds so it decolourises bromine water." (d) "Carboxylic acids are strong acids because they contain $-\text{COOH}$."

1. Decide whether each statement is correct.
2. Correct every wrong one.

Problem 20 Two routes to ethanol (hard)

Ethanol can be made by fermenting glucose ($\text{C}_6\text{H}_{12}\text{O}_6 \rightarrow 2\text{C}_2\text{H}_5\text{OH} + 2\text{CO}_2$) or by hydrating ethene ($\text{C}_2\text{H}_4 + \text{H}_2\text{O} \rightarrow \text{C}_2\text{H}_5\text{OH}$). (A_r : C = 12, H = 1, O = 16.)

1. Calculate the atom economy of each route for ethanol.
2. Give one advantage of each route.
3. Recommend a route for a country with plenty of sugar cane and little oil, with a reason.