GCSE Chemistry

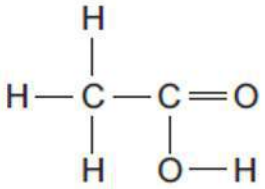
Alcohols, Carboxylic Acids and Esters

Question Paper

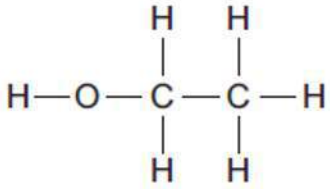
Time available: 64 minutes
Marks available: 62 marks

1. The diagrams represent two compounds, **A** and **B**.

Compound A



Compound B



(a) (i) Compound **B** is an alcohol.

Name compound **B**.

_____

(1)

(ii) Use the correct answer from the box to complete the sentence.

burned	**decomposed**	**oxidised**

To form compound **A**,

compound **B** is _____

(1)

(iii) Compounds **A** and **B** are both colourless liquids.

A test tube contains a colourless liquid, which could be either compound **A** or compound **B**.

Describe a simple **chemical** test to show which compound, **A** or **B**, is in the test tube.

_____

_____

_____

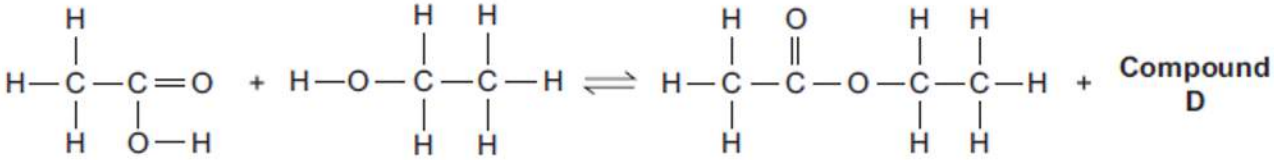
_____

_____

(2)

(b) Compounds **A** and **B** react to produce compound **C** and compound **D**.

Compound A **Compound B** **Compound C**



(i) What is the formula of compound **D**?

_____

(1)

(ii) Compound **C** is an ester.

Name compound **C**.

_____

(1)

(iii) State **one** use of esters.

_____

(1)

(Total 7 marks)

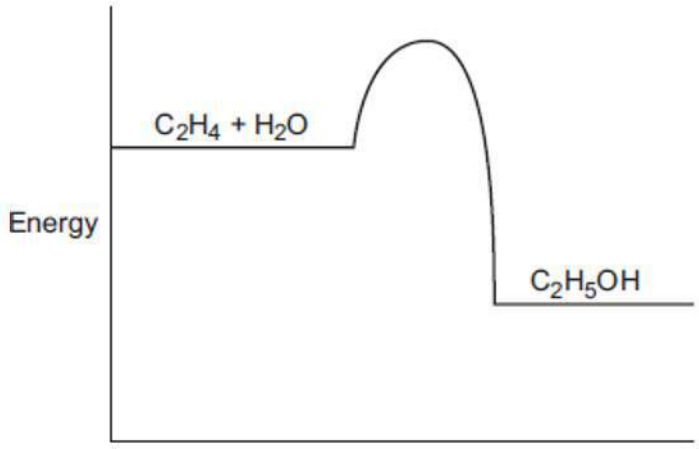
2. This question is about ethanol.

(a) Ethanol is produced by the reaction of ethene and steam:

$$C_2H_4 + H_2O \longrightarrow C_2H_5OH$$

(i) **Figure 1** shows the energy level diagram for the reaction.

Figure 1



How does the energy level diagram show that the reaction is exothermic?

_____

_____

(1)

(ii) A catalyst is used for the reaction.

Explain how a catalyst increases the rate of the reaction.

_____

_____

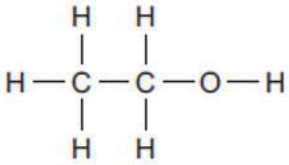
_____

_____

(2)

(b) **Figure 2** shows the displayed structure of ethanol.

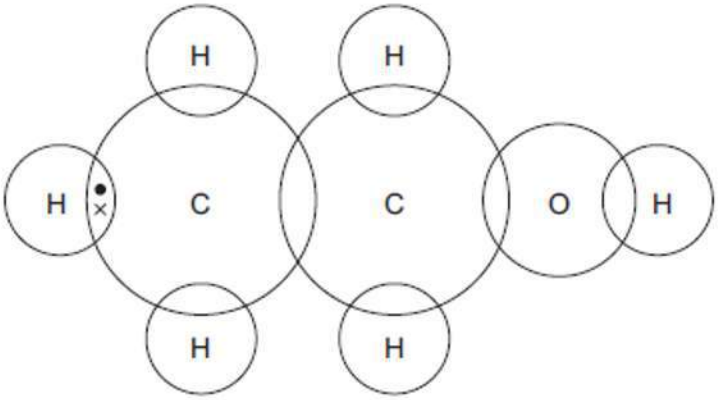
Figure 2



Complete the dot and cross diagram in **Figure 3** to show the bonding in ethanol.

Show the outer shell electrons only.

Figure 3

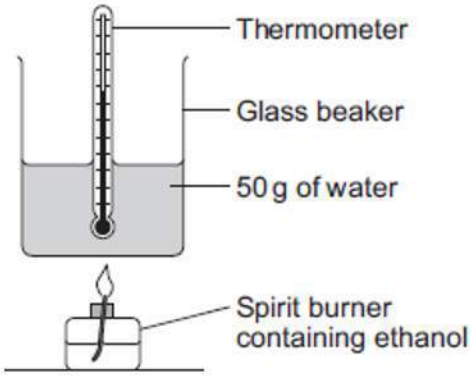


(2)

(c) A student burned some ethanol.

Figure 4 shows the apparatus the student used.

Figure 4



(i) The student recorded the temperature of the water before and after heating.

His results are shown in **Table 1**.

Table 1

Temperature before heating	20.7 °C
Temperature after heating	35.1 °C

Calculate the energy used to heat the water.

Use the equation $Q = m \times c \times \Delta T$

The specific heat capacity of water = 4.2 J / g / °C

_____

_____

_____

_____

_____

Energy used = _____ J

(3)

(ii) **Table 2** shows the mass of the spirit burner before the ethanol was burned and after the ethanol was burned.

Table 2

Mass of spirit burner before ethanol was burned	72.80 g
Mass of spirit burner after ethanol was burned	72.10 g

Calculate the number of moles of ethanol (C_2H_5OH) that were burned.

Relative atomic masses (A_r): H = 1; C = 12; O = 16

_____

_____

_____

_____

_____

Number of moles burned = _____

(3)

(iii) Calculate the energy released in joules per mole.

You should assume that all the energy from the ethanol burning was used to heat the water.

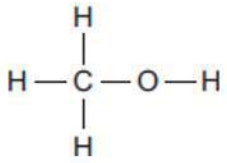
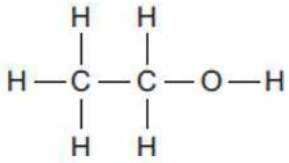
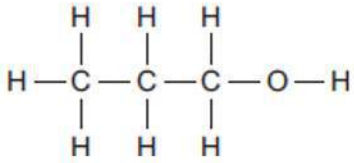
_____

Energy = _____ J / mole

(1)

(d) The names, structures and boiling points of ethanol and two other alcohols are shown in **Table 3**.

Table 3

Name	Methanol	Ethanol	Propanol
Structure			
Boiling point in °C	65	78	97

Use your knowledge of structure and bonding to suggest why the boiling points increase as the number of carbon atoms increases.

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 15 marks)

3. This question is about carboxylic acids.

Carboxylic acids belong to a homologous series.

The table below shows information about the first three carboxylic acids in this homologous series.

Name	Formula	pH of a 0.01 mol/dm^3 solution
Methanoic acid		2.91
Ethanoic acid	CH_3COOH	3.39
	CH_3CH_2COOH	3.44

(a) Complete the table above.

(2)

(b) Ethanoic acid ionises in water.

The equation for the reaction is:

$$CH_3COOH(aq) \rightleftharpoons CH_3COO^-(aq) + H^+(aq)$$

Explain how the equation shows that ethanoic acid is a weak acid.

_____

_____

_____

_____

(2)

(c) A student adds a solution of ethanoic acid to zinc carbonate in an open flask on a balance.

Explain what happens to the mass of the flask and its contents during the reaction.

_____

_____

_____

_____

_____

_____

(3)

(d) The student compares the rates of the reaction of zinc carbonate with:

- 0.01 mol/dm^3 methanoic acid
- 0.01 mol/dm^3 ethanoic acid.

The rate of the reaction with methanoic acid is greater than the rate of the reaction with ethanoic acid.

Explain why.

You should refer to ions in your answer.

Use the table above.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

Ethanoic acid reacts with ethanol to produce an ester.

(e) Give the name of the ester produced when ethanoic acid reacts with ethanol.

_____

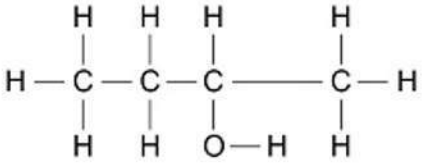
(1)

(f) Hexanedioic acid and ethanediol join together to produce a polyester.

Ethanoic acid and ethanol join together in the same way to produce an ester.

Which is the displayed structural formula of the ester produced when ethanoic acid reacts with ethanol?

Tick (✓) **one** box.



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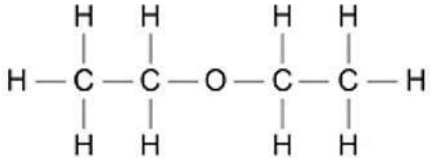

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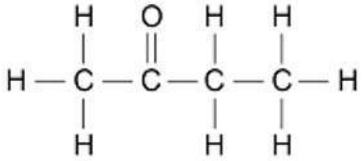

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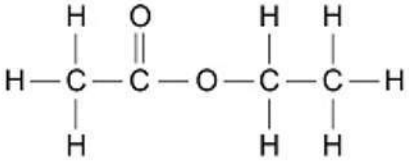


☐

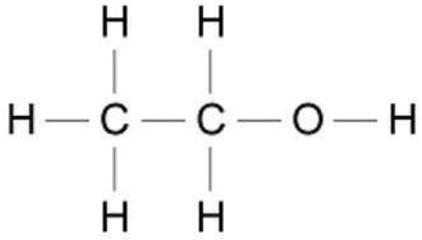
(1)

(Total 12 marks)

4. This question is about ethanol and ethanoic acid.

Ethanol is an alcohol.

(a) The diagram below shows the displayed structural formula of ethanol.



Draw a circle on the diagram above around the alcohol functional group.

(1)

(b) An ethanol molecule contains atoms of three different elements.

Complete the table below to show:

- the name of each element
- the symbol for each element
- the number of atoms of each element in one molecule of ethanol.

Use the diagram above.

Name of element	Symbol for element	Number of atoms in one molecule of ethanol
Carbon	C	
Hydrogen		6
	O	1

(3)

(c) Ethanol removes grass stains from clothes.

What type of substance is ethanol when used to remove grass stains?

Tick (✓) **one** box.

A solute ☐

A solution ☐

A solvent ☐

Wine contains ethanol.

Wine is produced from grape juice by fermentation.

(1)

(d) Complete the sentence.

Grape juice can be fermented to produce wine because

grape juice contains _____.

(1)

(e) What is added to grape juice to cause fermentation?

_____

(1)

(f) Ethanol reacts with ethanoic acid to produce an ester.

What is the name of the ester produced when ethanol reacts with ethanoic acid?

Tick (✓) **one** box.

Ethane ☐

Ethene ☐

Ethyl ethanoate ☐

(1)

(g) Ethanoic acid reacts with sodium carbonate.

The equation for the reaction is:

$$2\ CH_3COOH(aq) + Na_2CO_3(s) \rightarrow 2\ CH_3COONa(aq) + H_2O(l) + CO_2(g)$$

What is the name of the liquid produced by this reaction?

_____

(1)

(h) Vinegar is a solution that contains ethanoic acid.

400 cm^3 of vinegar contains 20 g of ethanoic acid.

Calculate the mass of ethanoic acid in 1.0 dm^3 of vinegar.

_____

_____

_____

_____

_____

_____

Mass = _____g

(3)

(Total 12 marks)

5. This question is about organic compounds.

(a) Ethanol burns in air.

Use the correct answer from the box to complete the word equation for the reaction.

carbon	hydrogen	oxygen

ethanol + _____ → carbon dioxide + water

(1)

(b) Use the correct answer from the box to complete the sentence.

milk	hard water	vinegar

Ethanoic acid is in _____ .

(1)

(c) Ethanoic acid is a carboxylic acid.

Which diagram, **A, B** or **C**, has a ring around the functional group of a carboxylic acid?

Write your answer in the box.

Diagram A

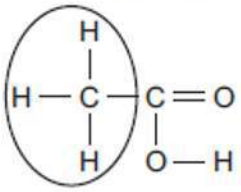


Diagram B

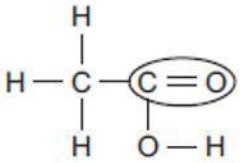


Diagram C

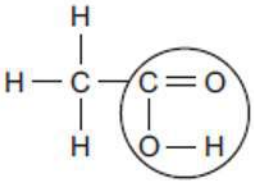


Diagram ☐

(1)

(d) Ethyl propanoate is produced by reacting ethanol with propanoic acid.

What type of organic compound is ethyl propanoate?

Tick (✓) **one** box.

Alcohol ☐

Carboxylic acid ☐

Ester ☐

(1)

(e) Organic compounds such as ethyl propanoate are used in perfumes.

Give **two** properties of these compounds that make them suitable for use in perfumes.

_____

_____

(2)

(Total 6 marks)

6. This question is about organic compounds.

(a) Ethanol is an alcohol.
One use of ethanol is in alcoholic drinks.

Give **two** other uses of ethanol.

_____

_____

(2)

(b) Which gas is produced when sodium reacts with ethanol?

Tick (✓) **one** box.

Carbon dioxide ☐

Carbon monoxide ☐

Hydrogen ☐

Oxygen ☐

(1)

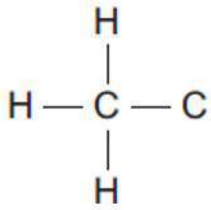
(c) Ethanoic acid (CH_3COOH) can be produced from ethanol (CH_3CH_2OH).

(i) What type of reaction produces ethanoic acid from ethanol?

_____

(1)

(ii) Complete the displayed structure of ethanoic acid.



(1)

(iii) Solutions of ethanoic acid and hydrochloric acid with the same concentration have different pH values.

Explain why the solution of ethanoic acid has a higher pH than the solution of hydrochloric acid.

_____

_____

_____

_____

(2)

(d) Ethanol and ethanoic acid react in the presence of a catalyst to form an ester.

(i) Name the ester made from ethanol and ethanoic acid.

_____

(1)

(ii) What type of chemical is used as a catalyst in this reaction?

_____

(1)

(iii) Esters are used in perfumes because they smell pleasant and are volatile.

What does volatile mean?

_____

(1)

(Total 10 marks)