Paper 3

Questions are applicable for both core and extended candidates

1 Table 2.1 shows the masses of some of the ions in a 1000 cm^3 sample of river water.

Table 2.1

name of ion	formula of ion	mass of ion in 1000 cm^3 of river water / mg
	NH_4^+	0.4
calcium	Ca^{2+}	1.4
chloride	Cl^-	0.1
hydrogencarbonate	HCO_3^-	1.2
magnesium	Mg^{2+}	0.6
nitrate	NO_3^-	0.8
phosphate	PO_4^{3-}	1.3
sodium	Na^+	0.5
	SO_4^{2-}	0.4

(e) River water can contain acids such as ethanoic acid and methylbutanoic acid.

(i) Draw the displayed formula for ethanoic acid.

[1]

(ii) Ethanoic acid reacts with sodium hydroxide.

Complete the word equation for this reaction.

ethanoic acid + sodium hydroxide → ..... + ...

[2]

2 **(a)** Fig. 7.1 shows the displayed formula of compound **S**.

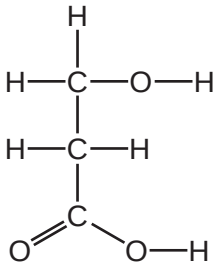


Fig. 7.1

(i) On Fig. 7.1, draw a circle around the carboxylic acid functional group. [1]

(ii) Deduce the molecular formula of compound **S**.

..... [1]

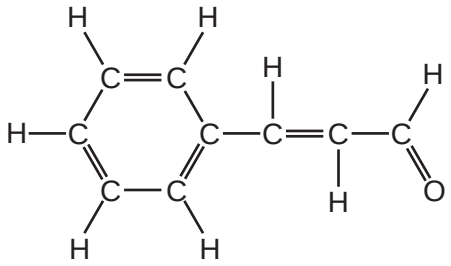
(c) Ethanoic acid is a carboxylic acid.

Complete the word equation for the reaction of ethanoic acid with sodium hydroxide.

ethanoic acid	+	sodium hydroxide	→	....	+	.....

[2]

3 Toothpaste contains cinnamal. The structure of cinnamal is shown.



(d) Cinnamal can be oxidised to a carboxylic acid.

(i) Draw the structure of a carboxylic acid functional group to show all of the atoms and all of the bonds.

[1]

(ii) Ethanoic acid is a carboxylic acid.
Ethanoic acid reacts like a typical acid.

Complete the word equation for the reaction of ethanoic acid with sodium carbonate.

ethanoic acid	+	sodium carbonate	→	sodium ethanoate	+	....	+	.....

[2]

Paper 4

Questions are applicable for both core and extended candidates unless indicated in the question

4 The equation for the reaction between methanoic acid and ethanol in the presence of a catalyst can be represented as shown.

$$HCOOH + CH_3CH_2OH \rightleftharpoons \mathbf{X} + H_2O \qquad \Delta H = -29.5\,kJ/mol$$

X represents the ester formed.

(a) (i) In the equation, methanoic acid is represented by the formula HCOOH.

Name this type of formula.

..... [1]

(ii) Write the empirical formula of methanoic acid.

..... [1]

(b) Name and draw the displayed formula of ester **X**. **(extended only)**

name .....

displayed formula

[3]

5 Propane, propene, propan-1-ol and propanoic acid are members of different homologous series. Molecules of these substances contain three carbon atoms.

(a) Explain why members of a homologous series have similar chemical properties.

..... [1]

(b) Name the homologous series to which propanoic acid belongs.

..... [1]

(c) State the general formula of the homologous series to which propanoic acid belongs.

..... [1]

(g) Propanoic acid reacts with aqueous sodium carbonate to form a salt.

(i) Suggest the name of the salt formed.

..... [1]

(ii) Suggest the formula of the anion in this salt.

..... [1]

(h) Propanoic acid forms an ester when it reacts with ethanol in the presence of a catalyst.

(i) Suggest a suitable catalyst. **(extended only)**

..... [1]

(ii) Name the ester formed. **(extended only)**

..... [1]

(iii) Draw the displayed formula of this ester. **(extended only)**

[2]

6 Some symbol equations and word equations, **A** to **J**, are shown.

A $Fe^{3+} + 3OH^- \rightarrow Fe(OH)_3$

B $H^+ + OH^- \rightarrow H_2O$

C ethane + chlorine → chloroethane + hydrogen chloride

D $C_{12}H_{26} \rightarrow C_8H_{18} + C_4H_8$

E ethene + steam → ethanol

F chlorine + aqueous potassium iodide → iodine + aqueous potassium chloride

G $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$

H ethanoic acid + ethanol → ethyl ethanoate + water

I calcium carbonate → calcium oxide + carbon dioxide

J $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

Use the equations to answer the questions that follow.
Each equation may be used once, more than once, or not at all.

Give the letter, **A** to **J**, for the equation that represents: **(extended only)**

(c) the formation of an ester ..... [1]

7 Ethanol is manufactured by **two** methods:

method 1 fermentation of aqueous glucose

method 2 catalytic addition of steam to an alkene.

(e) Ethanol can be converted to ethanoic acid by reacting it with an acidified oxidising agent.

(i) Name the acidified oxidising agent. **(extended only)**

..... [1]

(ii) State, in terms of redox, what type of reagent ethanol is in this reaction. **(extended only)**

..... [1]

(f) Ethanoic acid reacts with calcium to form a salt and one other product.

(i) Name the salt.

..... [1]

(ii) Write the formula of the salt.

..... [1]

(iii) Identify the other product.

..... [1]

8 Ethanoic acid is manufactured by the reaction of methanol with carbon monoxide.

An equilibrium mixture is produced.

$$CH_3OH(g) + CO(g) \rightleftharpoons CH_3COOH(g)$$

(e) Ethanoic acid is a member of the homologous series of carboxylic acids.

State the general formula of this homologous series.

..... [1]

(f) Draw the structure of the carboxylic acid containing three carbon atoms. Show all of the atoms and all of the bonds.

[2]

(g) When carboxylic acids react with alcohols, esters are produced.

The formula of ester **X** is $CH_3CH_2CH_2COOCH_3$.

(i) Name ester **X**. **(extended only)**

..... [1]

(ii) Give the name of the carboxylic acid and the alcohol that react together to produce ester **X**.

(extended only)

carboxylic acid .....

alcohol .....

[2]