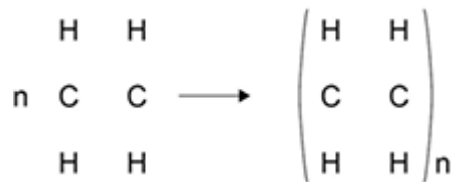


**Q1.**Ethene is used to produce poly(ethene).

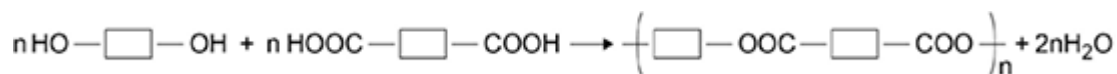
- (a) Draw the bonds to complete the displayed formulae of ethene and poly(ethene) in the equation.



(2)

- (b) Polyesters are made by a different method of polymerisation.

The equation for the reaction to produce a polyester can be represented as:



Compare the polymerisation reaction used to produce poly(ethene) with the polymerisation reaction used to produce a polyester.

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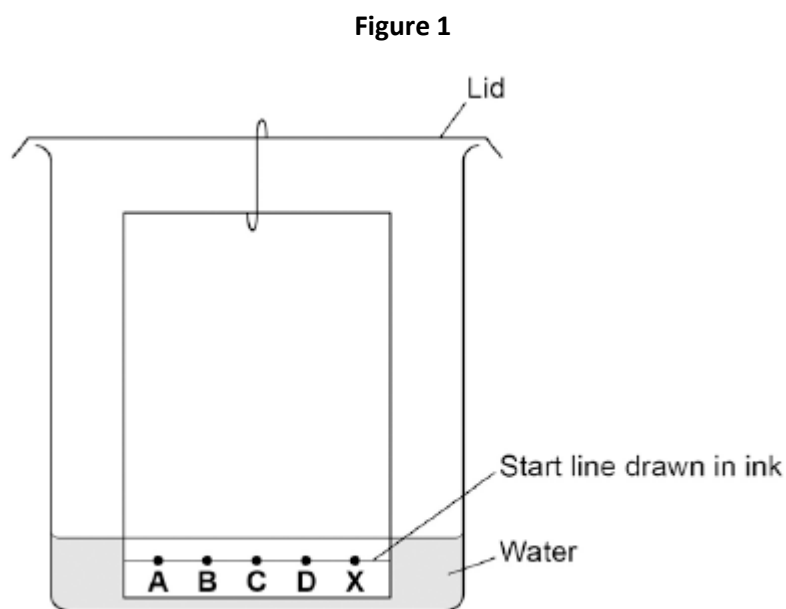
(4)  
(Total 6 marks)

**Q2.** A student investigated food dyes using paper chromatography.

This is the method used.

1. Put a spot of food colouring **X** on the start line.
2. Put spots of four separate dyes, **A**, **B**, **C** and **D**, on the start line.
3. Place the bottom of the paper in water and leave it for several minutes.

**Figure 1** shows the apparatus the student used.



- (a) Write down **two** mistakes the student made in setting up the experiment and explain what problems one of the mistakes would cause.

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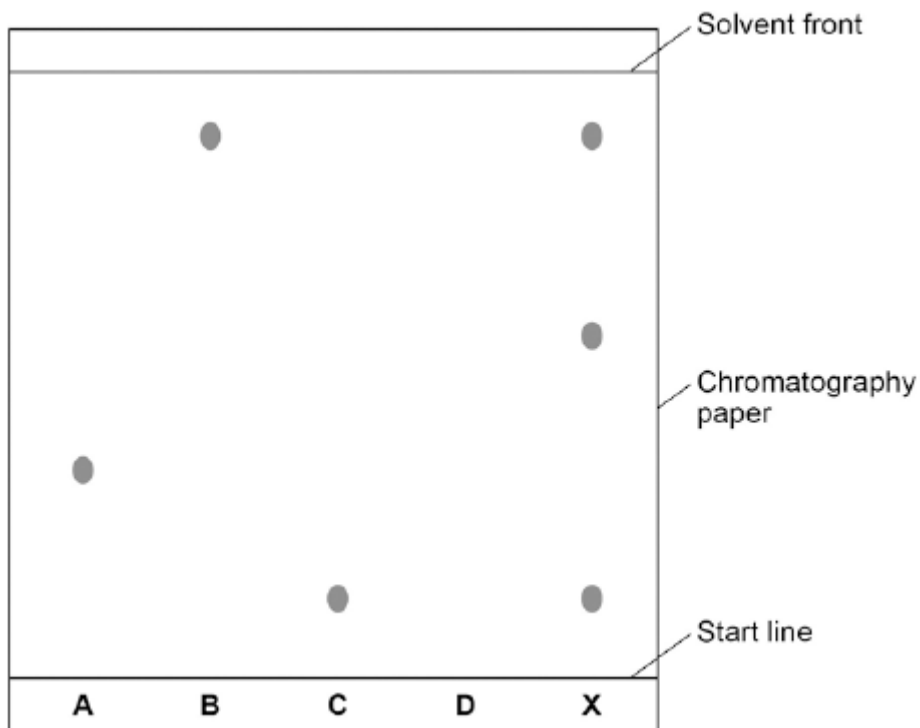
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(2)

- (b) Another student set up the apparatus correctly.

**Figure 2** shows the student's results. The result for dye **D** is not shown.

**Figure 2**



Calculate the  $R_f$  value of dye **A**

Give your answer to two significant figures.

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$R_f$  value = .....

(3)

(c) Dye **D** has an  $R_f$  value of 0.80. Calculate the distance that dye **D** moved on the chromatography paper.

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Distance moved by dye **D** = .....

(1)

(d) Explain how the different dyes in **X** are separated by paper chromatography.

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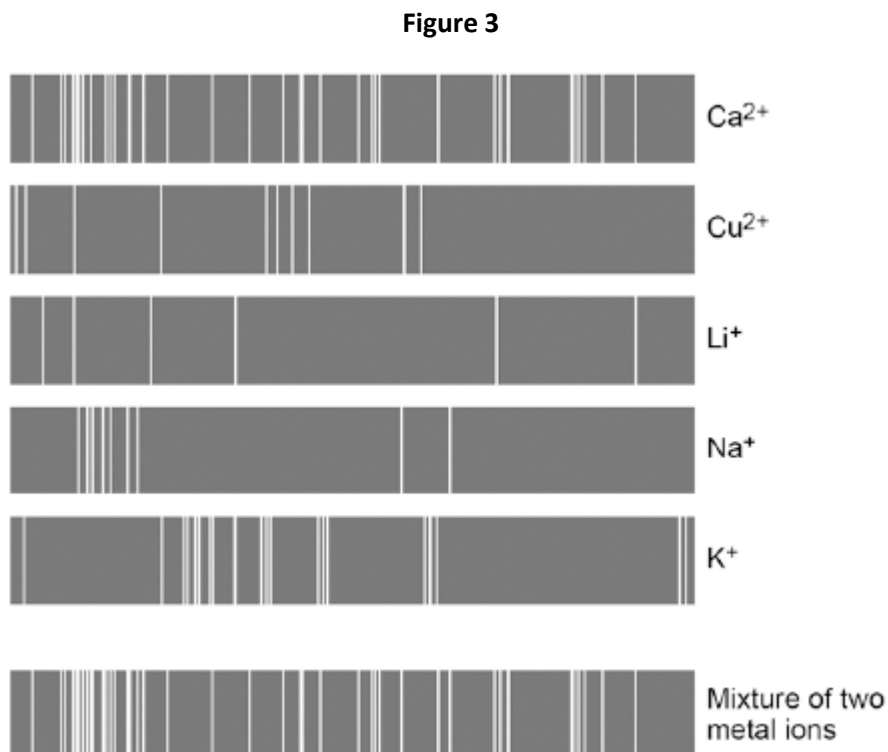
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(4)

(e) Flame emission spectroscopy can be used to analyse metal ions in solution.

**Figure 3** gives the flame emission spectra of five metal ions, and of a mixture of two metal ions.



Use the spectra to identify the **two** metal ions in the mixture.

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.....

(2)

(f) Explain why a flame test could **not** be used to identify the two metal ions in the mixture.

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(2)

(g) Two students tested a green compound **X**.  
The students added water to compound **X**.  
Compound **X** did not dissolve.

The students then added a solution of ethanoic acid to compound **X**.  
A gas was produced which turned limewater milky.

Student **A** concluded that compound **X** was sodium carbonate.  
Student **B** concluded that compound **X** was copper chloride.

Which student, if any, was correct?

Explain your reasoning.

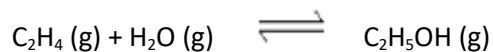
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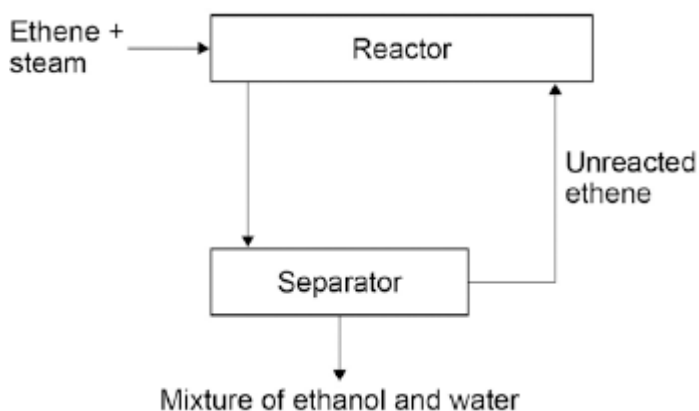
(Total 18 marks)

**Q3.**In industry ethanol is produced by the reaction of ethene and steam at 300°C and 60 atmospheres pressure using a catalyst.

The equation for the reaction is:



The figure below shows a flow diagram of the process.



(a) Why does the mixture from the separator contain ethanol and water?

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(1)

(b) The forward reaction is exothermic.

Use Le Chatelier's Principle to predict the effect of increasing temperature on the amount of ethanol produced at equilibrium.

Give a reason for your prediction.

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(2)

(c) Explain how increasing the pressure of the reactants will affect the amount of ethanol produced at equilibrium.

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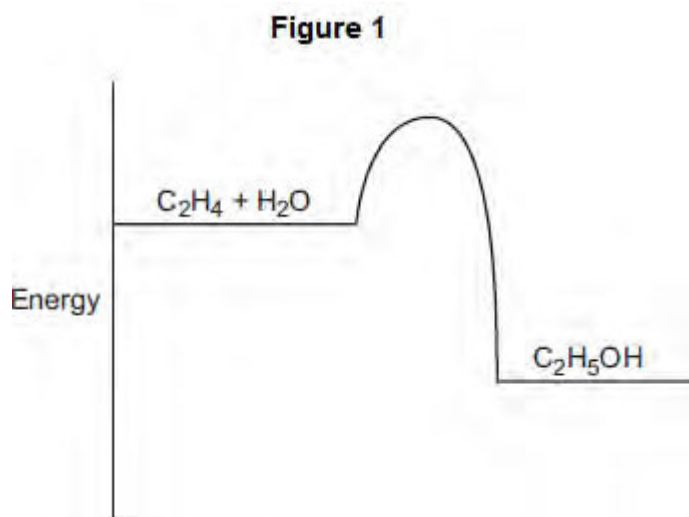
(2)  
(Total 5 marks)

**Q4.** This question is about ethanol.

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



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



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

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(1)

(ii) A catalyst is used for the reaction.

Explain how a catalyst increases the rate of the reaction.

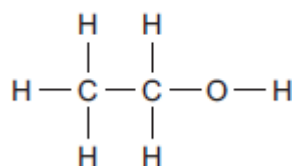
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(2)

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



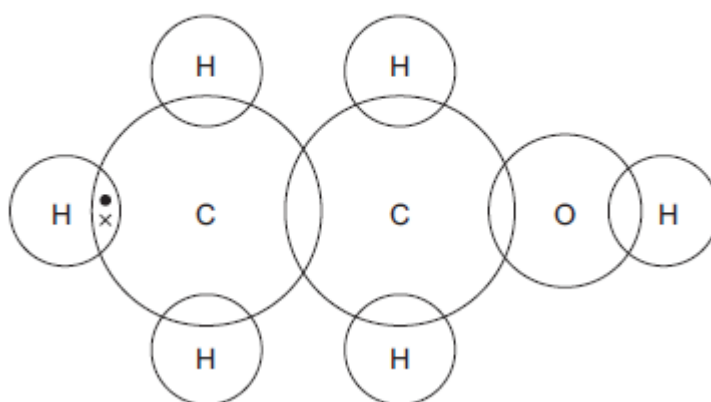
**Figure 2**



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

Show the outer shell electrons only.

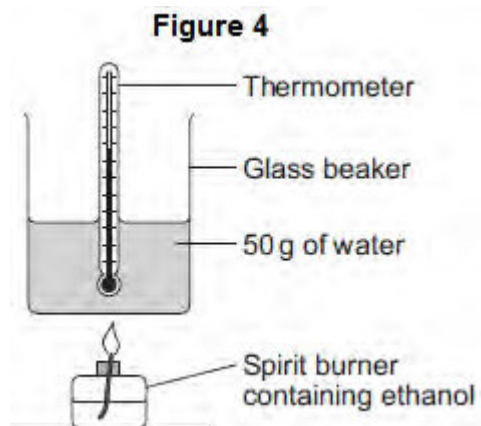
**Figure 3**



(2)

- (c) A student burned some ethanol.

**Figure 4** shows the apparatus the student used.



- (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

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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<sub>2</sub>H<sub>5</sub>OH) that were burned.

Relative atomic masses (A<sub>r</sub>): H = 1; C = 12; O = 16

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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	$\begin{array}{c} \text{H} \\   \\ \text{H}-\text{C}-\text{O}-\text{H} \\   \\ \text{H} \end{array}$	$\begin{array}{c} \text{H} \quad \text{H} \\   \quad   \\ \text{H}-\text{C}-\text{C}-\text{O}-\text{H} \\   \quad   \\ \text{H} \quad \text{H} \end{array}$	$\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \\   \quad   \quad   \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{O}-\text{H} \\   \quad   \quad   \\ \text{H} \quad \text{H} \quad \text{H} \end{array}$
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.

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**(3)**  
**(Total 15 marks)**

**Q5.** 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)**

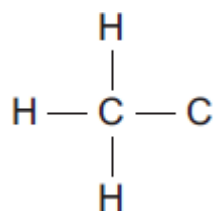
- (c) Ethanoic acid ( $\text{CH}_3\text{COOH}$ ) can be produced from ethanol ( $\text{CH}_3\text{CH}_2\text{OH}$ ).

- (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.

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(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.

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(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?

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(1)

(Total 10 marks)