Q1. This question is about the reaction of ethene and bromine.

The equation for the reaction is:

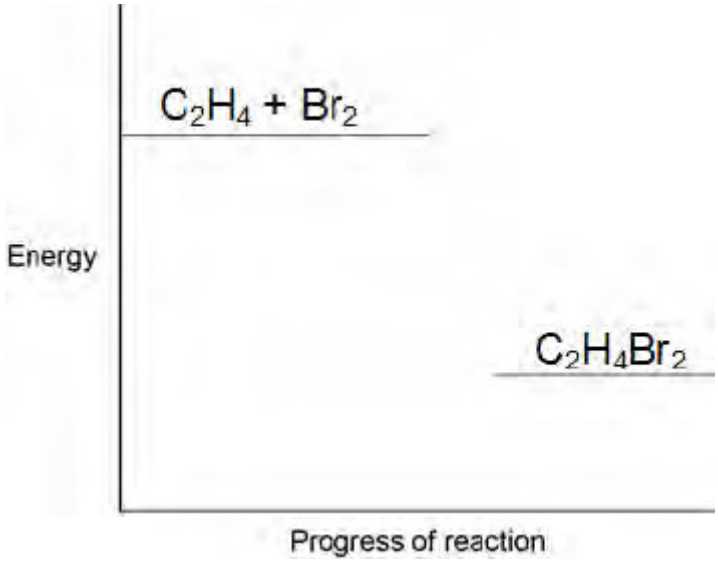
$$C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$$

(a) Complete the reaction profile in **Figure 1**.

Draw labelled arrows to show:

- The energy given out (ΔH)
- The activation energy.

Figure 1



(3)

(b) When ethene reacts with bromine, energy is required to break covalent bonds in the molecules.

Explain how a covalent bond holds two atoms together.

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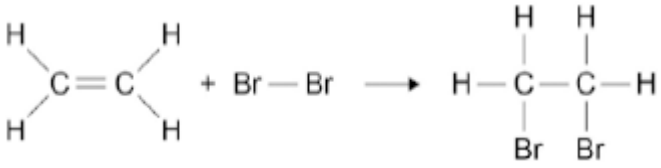
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(2)

(c) **Figure 2** shows the displayed formulae for the reaction of ethene with bromine.

Figure 2



The bond enthalpies and the overall energy change are shown in the table below.

	C=C	C–H	C–C	C–Br	Overall energy change
Energy in kJ / mole	612	412	348	276	–95

Use the information in the table above and **Figure 2** to calculate the bond energy for the Br–Br bond.

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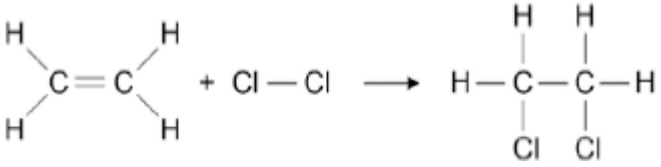
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Bond energy ..... kJ / mole

(3)

(d) **Figure 3** shows the reaction between ethene and chlorine and is similar to the reaction between ethene and bromine.

Figure 3



"The more energy levels (shells) of electrons an atom has, the weaker the covalent bonds that it forms."

Use the above statement to predict and explain how the overall energy change for the reaction of ethene with chlorine will differ from the overall energy change for the reaction of ethene with bromine.

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(6)
(Total 14 marks)

Q2. This question is about copper.

(a) Copper can be extracted by smelting copper-rich ores in a furnace.

The equation for one of the reactions in the smelting process is:

$$Cu_2S(s) + O_2(g) \longrightarrow 2\,Cu(s) + SO_2(g)$$

Explain why there would be an environmental problem if sulfur dioxide gas escaped into the atmosphere.

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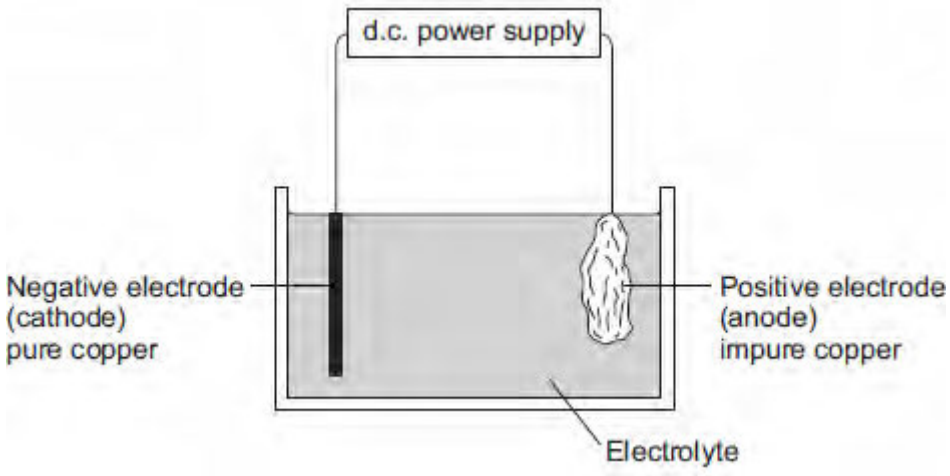
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(2)

(b) The impure copper produced by smelting is purified by electrolysis, as shown below.



Copper atoms are oxidised at the positive electrode to Cu^{2+} ions, as shown in the half equation.

$$Cu(s) \longrightarrow Cu^{2+}(aq) + 2e^-$$

(i) How does the half equation show that copper atoms are oxidised?

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(1)

(ii) The Cu^{2+} ions are attracted to the negative electrode, where they are reduced to produce copper atoms.

Write a balanced half equation for the reaction at the negative electrode.

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(1)

(iii) Suggest a suitable electrolyte for the electrolysis.

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(1)

(c) Copper metal is used in electrical appliances.

Describe the bonding in a metal, and explain why metals conduct electricity.

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(4)

(d) Soil near copper mines is often contaminated with low percentages of copper compounds.

Phytomining is a new way to extract copper compounds from soil.

Describe how copper compounds are extracted by phytomining.

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(3)

(e) A compound in a copper ore has the following percentage composition by mass:

55.6% copper, 16.4% iron, 28.0% sulfur.

Calculate the empirical formula of the compound.

Relative atomic masses (A_r): S = 32; Fe = 56; Cu = 63.5

You must show all of your working.

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Empirical formula = ...

(4)

(Total 16 marks)

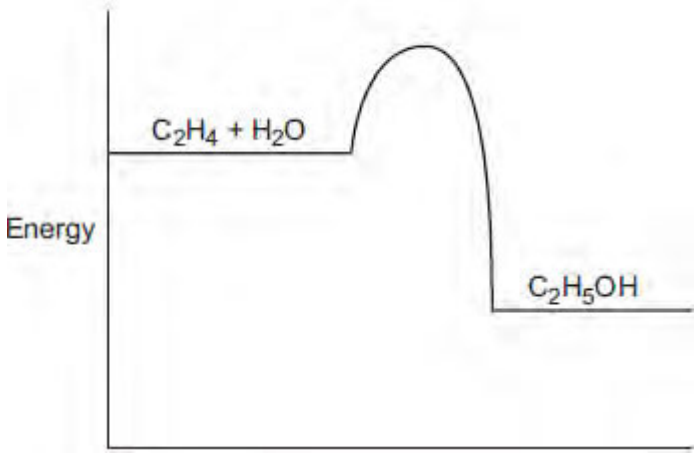
Q3. This question is about ethanol.

(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?

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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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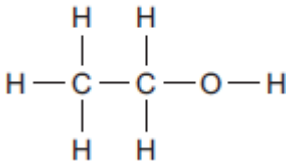
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(2)

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

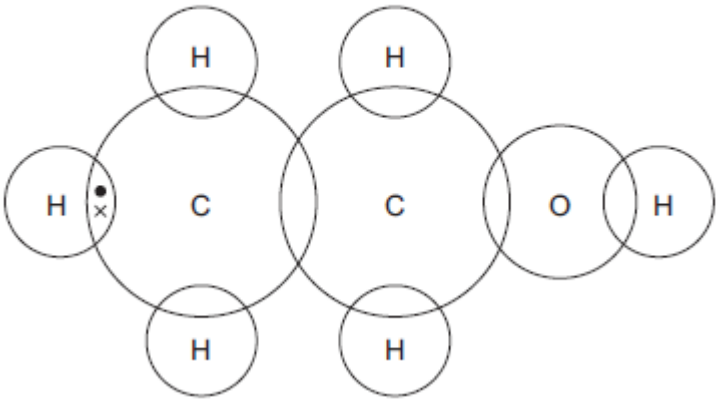
Figure 2



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

Show the outer shell electrons only.

Figure 3

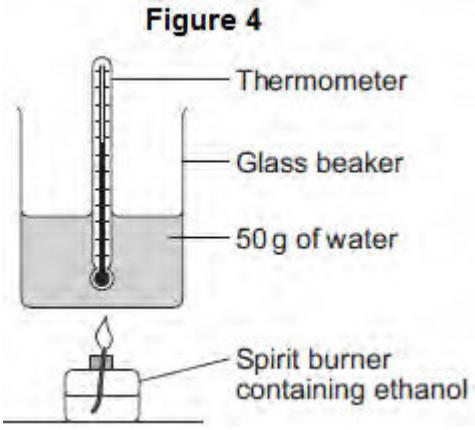


(2)

(c) A student burned some ethanol.

Figure 4 shows the apparatus the student used.

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

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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_2H_5OH) that were burned.

Relative atomic masses (A_r): 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.

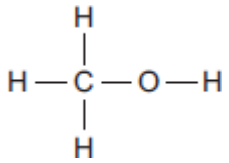
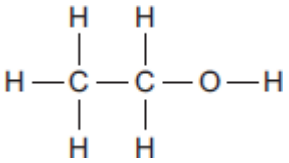
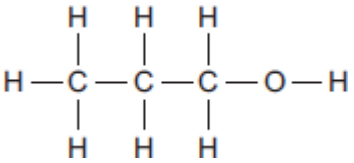
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Energy = ... J / mole

(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.

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(3)
(Total 15 marks)