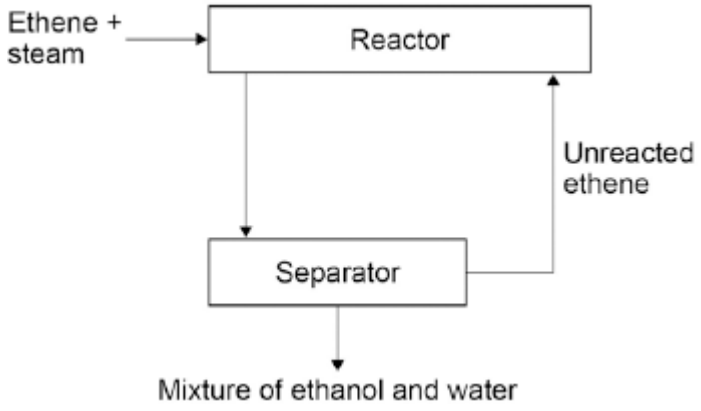
Q1. In industry ethanol is produced by the reaction of ethene and steam at 300°C and 60 atmospheres pressure using a catalyst.

The equation for the reaction is:

$$C_2H_4\ (g) + H_2O\ (g) \rightleftharpoons C_2H_5OH\ (g)$$

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)

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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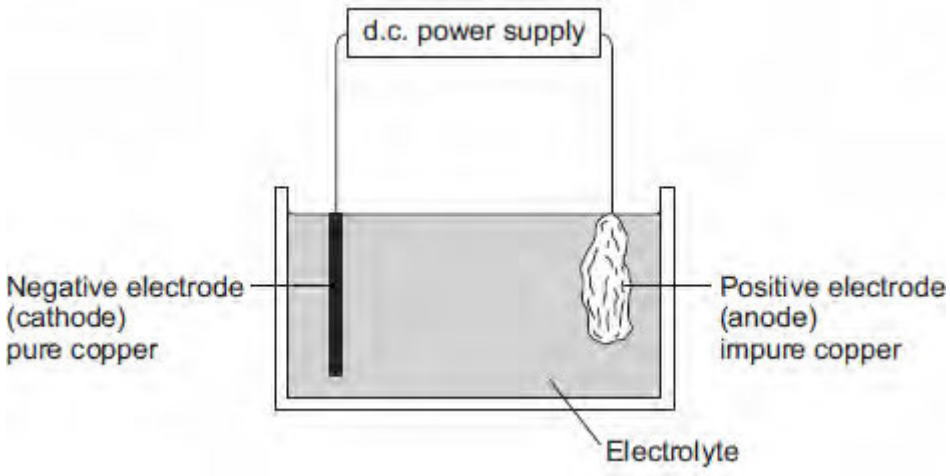
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(2)

(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)

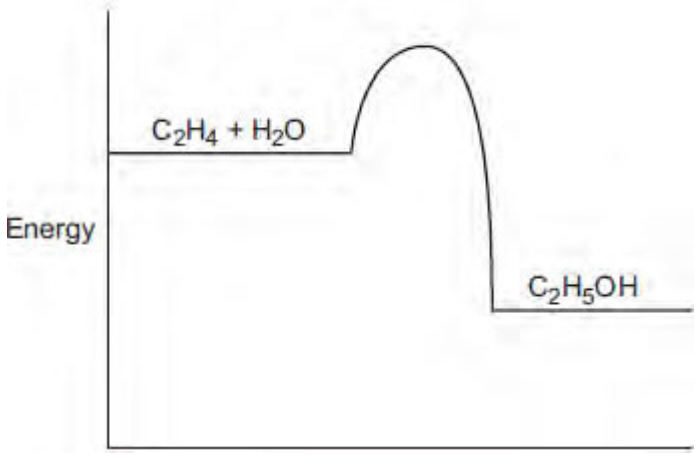
Q3. This question is about ethanol.

(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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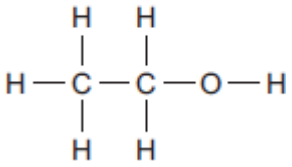
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(2)

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

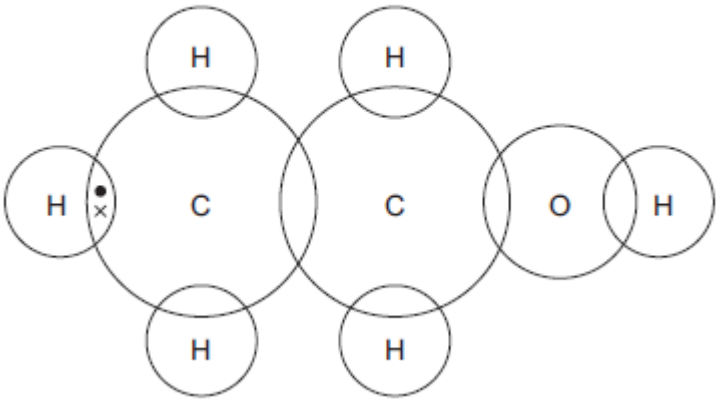
Figure 2



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

Show the outer shell electrons only.

Figure 3

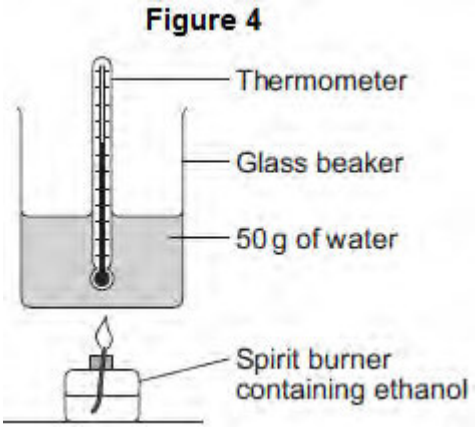


(2)

(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.

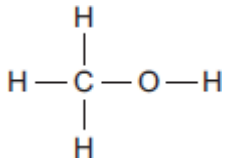
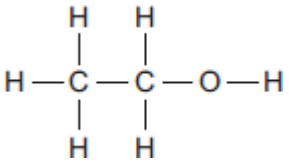
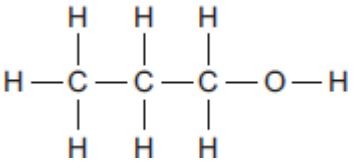
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Energy = ... J / mole

(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)

Q4. This question is about compounds.

(a) The table gives information about the solubility of some compounds.

Soluble compounds
All potassium and sodium salts
All nitrates
Chlorides, bromides and iodides, except those of silver and lead

Use information from the table to answer these questions.

(i) Name a soluble compound that contains silver ions.

.....

(1)

(ii) Name a soluble compound that contains carbonate ions.

.....

(1)

(b) Metal oxides react with acids to make salts.

What type of compound is a metal oxide?

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(1)

(c) Lead nitrate solution is produced by reacting lead oxide with nitric acid.

(i) State how solid lead nitrate can be obtained from lead nitrate solution.

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(1)

(ii) Balance the equation for the reaction.

$$PbO + HNO_3 \longrightarrow Pb(NO_3)_2 + H_2O$$

(1)

(iii) Give the total number of atoms in the formula $Pb(NO_3)_2$

.....

(1)

(d) An oxide of lead that does **not** have the formula PbO contains 6.21 g of lead and 0.72 g of oxygen.

Calculate the empirical formula of this lead oxide.

Relative atomic masses (A_r): O = 16; Pb = 207

You must show your working to gain full marks.

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Empirical formula = ...

(4)

(Total 10 marks)

Q5. This question is about sodium chloride and iodine.

(a) Describe the structure and bonding in sodium chloride.

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(4)

(b) When sodium chloride solution is electrolysed, one product is chlorine.

Name the **two** other products from the electrolysis of sodium chloride solution.

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(2)

(c) Many people do not have enough iodine in their diet.

Sodium chloride is added to many types of food. Some scientists recommend that sodium chloride should have a compound of iodine added.

Give **one** ethical reason why a compound of iodine should **not** be added to sodium chloride used in food.

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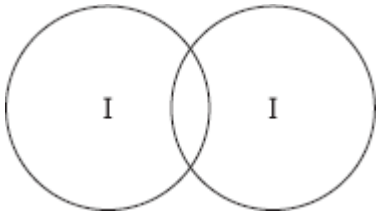
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(1)

(d) The bonding in iodine is similar to the bonding in chlorine.

(i) Complete the diagram below to show the bonding in iodine.

Show the outer electrons only.



(2)

(ii) Explain why iodine has a low melting point.

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(3)

(iii) Explain, in terms of particles, why liquid iodine does not conduct electricity.

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(2)
(Total 14 marks)