Calculating and explaining energy changes

1. Energy can be measured in kilojoules (kJ) or in kilocalories (kcal).

The table shows some information about different varieties of crisps.

Variety of crisps	Energy in kJ per 25 g packet
Cheese	548
Salted	550
Chicken	545
Steak	540

(a) Arrange the different varieties of crisps in order of increasing energy. The first one has been done for you.

1 Steak 2 ..... 3 ..... 4 .....

(1)

(b) One variety not given in the table is broccoli.
On the label it states that the energy per 25 g packet is 130 kcal.

1 kcal = 4.2 kJ

Calculate the energy of 25 g of broccoli crisps in kJ.

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Energy = ... kJ

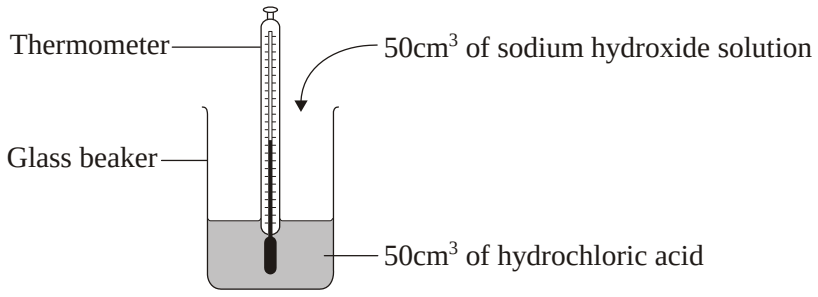
(1)
(Total 2 marks)

2. Read the information about energy changes and then answer the questions.

A student did an experiment to find the energy change when hydrochloric acid reacts with sodium hydroxide. The equation which represents the reaction is:

$$HCl + NaOH \rightarrow NaCl + H_2O$$

The student used the apparatus shown in the diagram.



The student placed 50 cm^3 of hydrochloric acid in a glass beaker and measured the temperature.

The student then quickly added 50 cm3 of sodium hydroxide solution and stirred the mixture with the thermometer. The highest temperature was recorded.

The student repeated the experiment, and calculated the temperature change each time.

	Experiment 1	Experiment 2	Experiment 3	Experiment 4
Initial temperature in °C	19.0	22.0	19.2	19.0
Highest temperature in °C	26.2	29.0	26.0	23.5
Temperature change in °C	7.2	7.0	6.8	4.5

(a) The biggest error in this experiment is heat loss.
Suggest how the apparatus could be modified to reduce heat loss.

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(1)

(b) Suggest why it is important to stir the chemicals thoroughly.

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(1)

(c) Which **one** of these experiments was probably carried out on a different day to the others?
Explain your answer.

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(1)

(d) Suggest why experiment 4 should **not** be used to calculate the average temperature change.

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(1)

(e) Calculate the average temperature change from the first three experiments.

.....

Answer = ... °C

(1)

(f) Use the following equation to calculate the energy change for this reaction.

energy change in joules = 100 × 4.2 × average temperature change

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Answer = ... J

(1)

(g) Which **one** of these energy level diagrams, **A** or **B**, represents the energy change for this reaction?

Explain why.

Diagram A

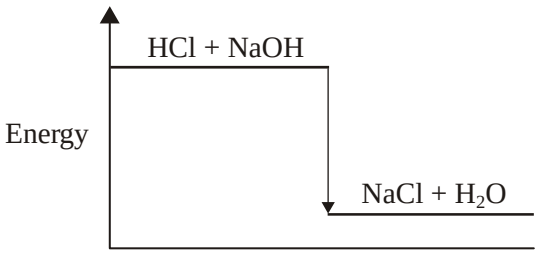
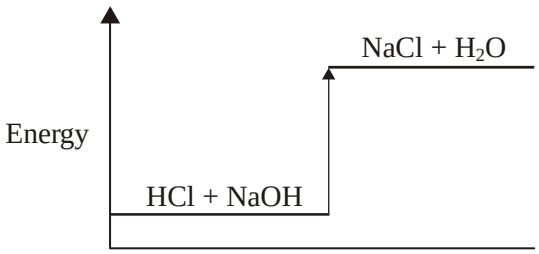


Diagram B



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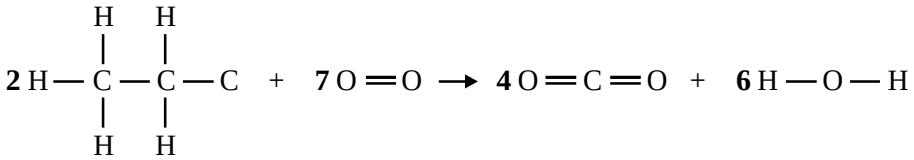
(1)

(Total 7 marks)

3. The balanced equation for the combustion of ethane is shown using structural formulae.



(a) Complete the table to show the number of bonds broken and made when two molecules of ethane react with seven molecules of oxygen.

Type of bond	Number of bonds broken	Number of bonds made
C — C		
C — H		
O = O		
C = O		
H — O		

(2)

(b) The combustion of ethane is a strongly exothermic process. Draw a labelled energy level diagram showing the endothermic and exothermic parts of the overall reaction. Indicate the activation energy on the diagram.

(4)

(c) Explain, in terms of particles and the activation energy of a reaction, how a catalyst is able to increase the rate of reaction.

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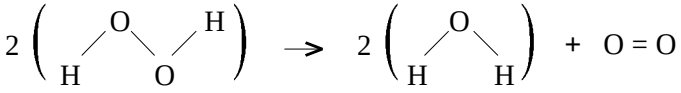
(2)

(Total 8 marks)

4. At room temperature, hydrogen peroxide decomposes very slowly to form water and oxygen. The decomposition is speeded up when a catalyst is added.

(a) The following equation represents the decomposition of hydrogen peroxide. The structural formulae of the chemicals involved are shown.



Use the following information about bond energies to answer this part of the question.

BOND	BOND ENERGY (kJ)
O = O	498
O – O	146
H – O	464

(i) Calculate the energy needed to break all the bonds in the reactants.

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..... kJ

(2)

(ii) Calculate the energy released when new bonds are formed in the products.

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..... kJ

(2)

(iii) Calculate the energy change for this reaction.

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..... kJ

(1)

(iv) Is the reaction exothermic or endothermic?

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Explain why.

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(1)

(b) (i) What is meant by 'activation energy'?

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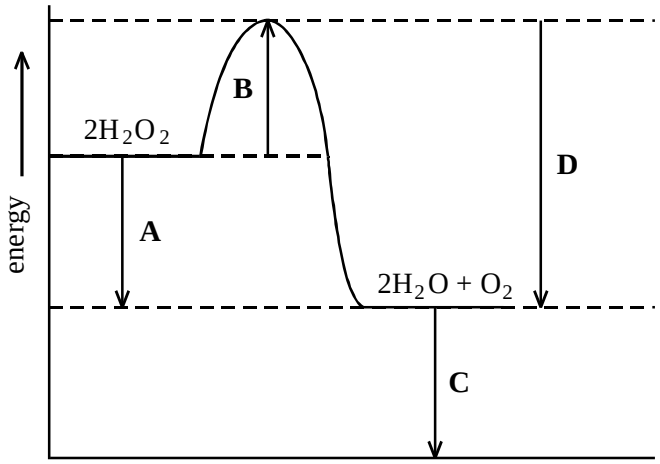
(1)

(ii) The energy level diagram for the decomposition of hydrogen peroxide into water and oxygen is shown below.



Which energy change, **A**, **B**, **C** or **D**, is the activation energy? .....

(1)

(iii) Explain, in terms of energy, how a catalyst makes hydrogen peroxide decompose more quickly.

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(1)

(Total 9 marks)

5. Hydrogen chloride is made by reacting hydrogen with chlorine.

$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$

Bond	Bond energy in kJ
H – H	436
Cl – Cl	242
H – Cl	431

Is the reaction between hydrogen and chlorine exothermic or endothermic?
Use the bond energies to explain your answer.

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(Total 3 marks)