

Name:

Date:

C5 - Test 6
ENERGY CHANGES
Advanced

GCSE

CHEMISTRY

AQA - Combined Science

Mark

Grade

Materials

For this paper you must have:

- Ruler
- Pencil and Rubber
- Scientific calculator, which you are expected to use when appropriate

Instructions

- Answer all questions
- Answer questions in the space provided
- All working must be shown

Information

- The marks for the questions are shown in brackets

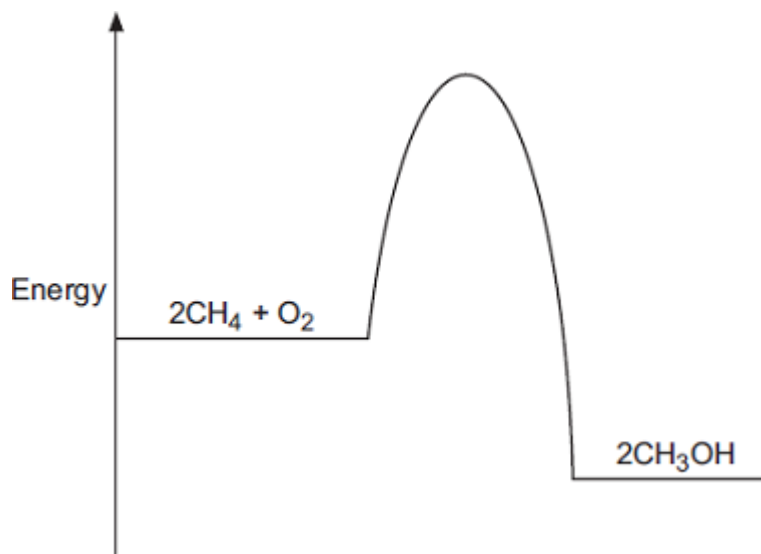
1.

Methanol (CH_3OH) can be made by reacting methane (CH_4) and oxygen (O_2). The reaction is exothermic.

The equation for the reaction is:



(a) The energy level diagram for this reaction is given below.



(i) How does the diagram show that this reaction is exothermic?

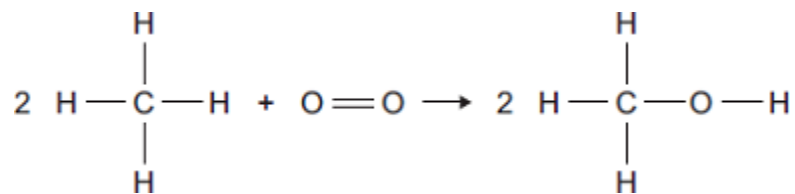
(1)

(ii) A platinum catalyst can be used to increase the rate of this reaction.

What effect does adding a catalyst have on the energy level diagram?

(1)

- (b) The equation can also be written showing the structural formulae of the reactants and the product.



- (i) Use the bond energies given in the table to help you to calculate the energy change for this reaction.

Bond	Bond energy in kJ
C—H	435
O=O	497
C—O	336
O—H	464

Energy change = _____ kJ

(3)

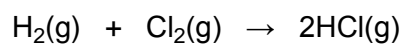
- (iii) In terms of the bond energies, why is this an exothermic reaction?

(1)

(Total 6 marks)

2.

Some of the hydrogen and chlorine are reacted together to form hydrogen chloride.



Bond	Bond energy in kJ/mol
Cl-Cl	242
H-Cl	431
H-H	436

- (i) Use the bond energies to calculate the energy change for the formation of hydrogen chloride.

Energy change = _____ kJ/mol

(3)

- (ii) Is this reaction exothermic or endothermic? Explain your answer.

(2)

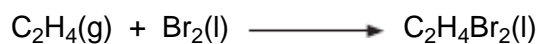
- (iii) Explain why hydrogen chloride only acts as an acid when dissolved in water.

(3)

(Total 8 marks)

3.

The equation for the reaction of ethene and bromine is:

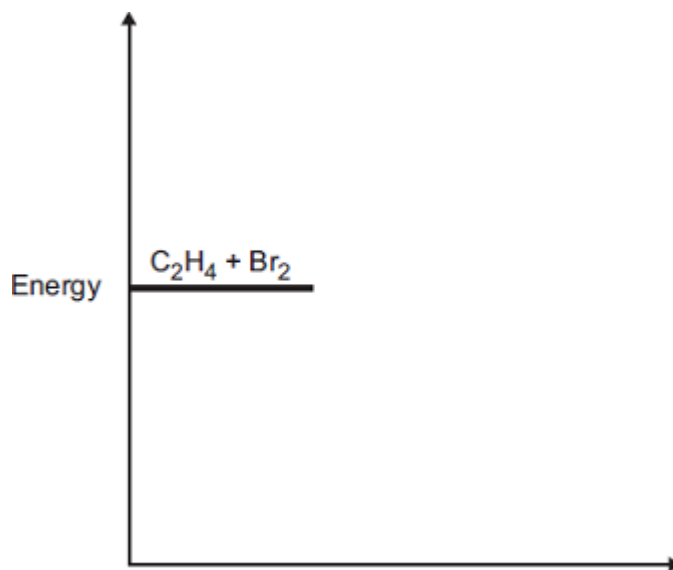


The reaction is exothermic.

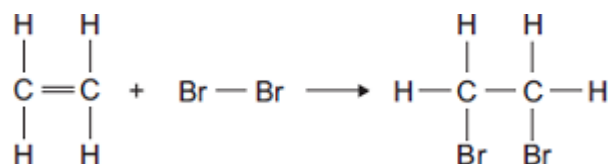
(a) Complete the energy level diagram.

You should label:

- the activation energy
- the enthalpy change (ΔH).

**(3)**

(b) (i) The equation for the reaction can be represented as:



Bond	Bond dissociation energy in kJ per mole
C—H	413
C=C	614
Br—Br	193
C—C	348
C—Br	276

Use the bond dissociation energies in the table to calculate the enthalpy change (ΔH) for this reaction.

Enthalpy change (ΔH) = _____ kJ per mole

(3)

(ii) The reaction is exothermic.

Explain why, in terms of bonds broken and bonds formed.

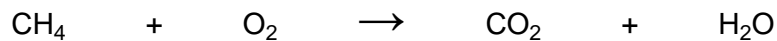
(2)

(Total 8 marks)

4.

This question is about energy changes in chemical reactions.

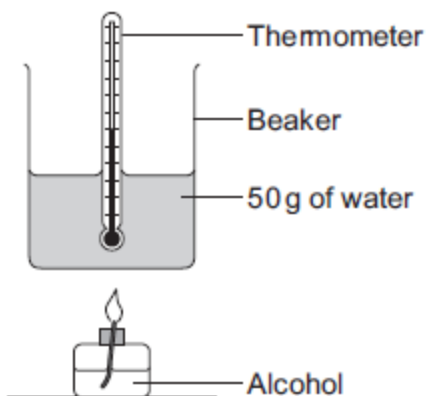
(a) Balance the chemical equation for the combustion of methane.



(1)

(b) Alcohols are used as fuels.

A group of students investigated the amount of energy released when an alcohol was burned. The students used the apparatus shown in the diagram below.



In one experiment the temperature of 50 g of water increased from 22.0 °C to 38.4 °C. The mass of alcohol burned was 0.8 g.

Calculate the heat energy (Q) in joules, released by burning 0.8 g of the alcohol. Use the equation:

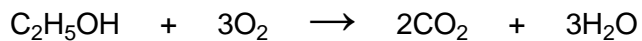
$$Q = m \times c \times \Delta T$$

Specific heat capacity (c) = 4.2 J / g / °C

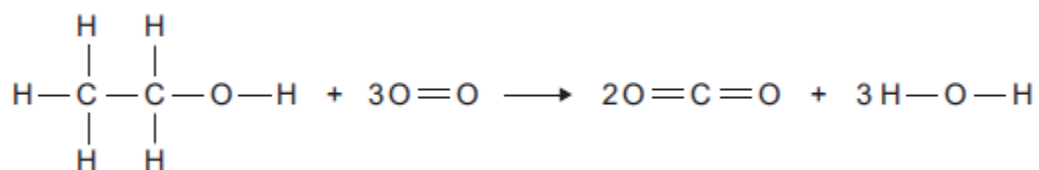
Heat energy (Q) = _____ J

(3)

(c) The chemical equation for the combustion of ethanol is:



(i) The equation for the reaction can be shown as:



Bond	Bond energy in kJ per mole
C — H	413
C — C	347
C — O	358
C = O	799
O — H	467
O = O	495

Use the bond energies to calculate the overall energy change for this reaction.

Overall energy change = _____ kJ per mole

(3)

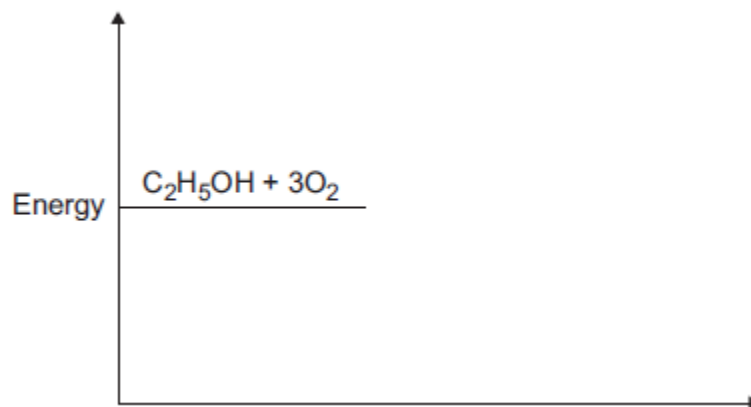
(ii) The reaction is exothermic.
Explain why, in terms of bonds broken and bonds formed.

(2)

(iii) Complete the energy level diagram for the combustion of ethanol.

On the completed diagram, label:

- activation energy
- overall energy change.

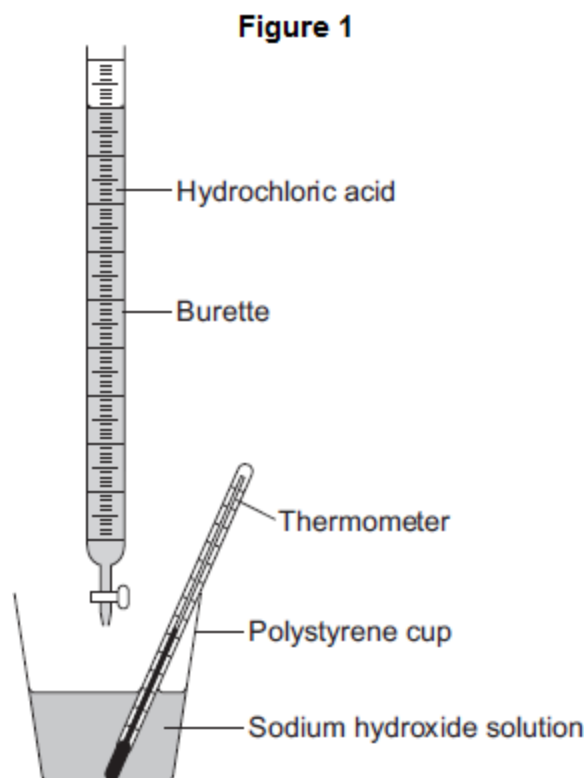


(3)
(Total 12 marks)

5.

A student investigates the energy released when hydrochloric acid completely neutralises sodium hydroxide solution.

The student uses the apparatus shown in **Figure 1**.



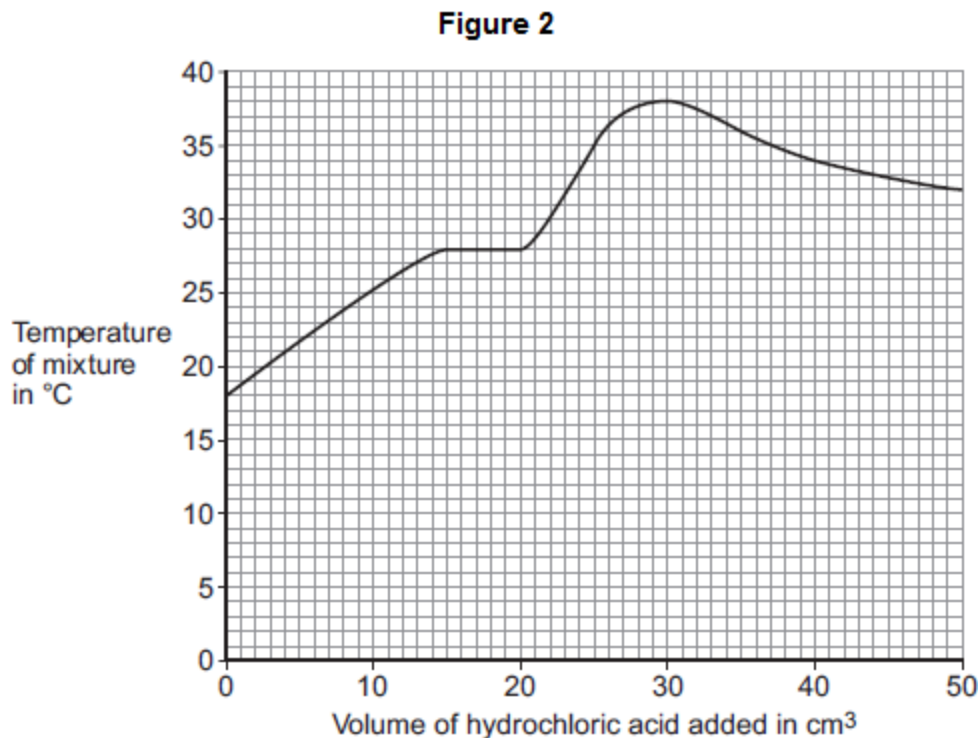
The student:

- measures 25 cm³ sodium hydroxide solution into a polystyrene cup
- fills a burette with hydrochloric acid
- measures the temperature of the sodium hydroxide solution
- adds 5 cm³ hydrochloric acid to the sodium hydroxide solution in the polystyrene cup
- stirs the mixture and measures the highest temperature of the mixture
- continues to add 5 cm³ portions of hydrochloric acid, stirring and measuring the highest temperature of the mixture after each addition.

(a) The student has plotted a graph of the results.

The graph line has been incorrectly drawn by including an anomalous result.

The graph is shown in **Figure 2**.



(i) Suggest a cause for the anomalous result when 20 cm³ of hydrochloric acid is added.

(1)

(ii) Suggest the true value of the temperature of the anomalous point.

Temperature = _____ °C

(1)

(iii) What was the **total** volume of the mixture when the maximum temperature was reached?

Total volume of the mixture = _____ cm³

(1)

(iv) Calculate the overall temperature increase in this experiment.

Overall temperature increase = _____ °C

(1)

- (v) Use your answers to (iii) and (iv) and the equation to calculate the energy released in the reaction. Give the unit.

Assume the volume in cm^3 is equivalent to the mass of solution in grams.

Equation: $Q = mc\Delta T$

where:

Q = energy released

m = mass of solution (g)

c = 4.2 (J per g per $^{\circ}\text{C}$)

ΔT = change in temperature ($^{\circ}\text{C}$)

Energy released = _____ Unit = _____

(2)

- (b) The student did the experiment again, starting with 50 cm^3 of sodium hydroxide solution instead of 25 cm^3 .

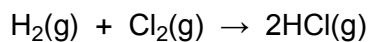
Explain why this would make no difference to the overall temperature increase.

(2)

(Total 8 marks)

6.

Hydrogen chloride is made by reacting hydrogen with chlorine.



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

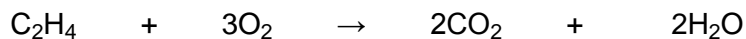
Is the reaction between hydrogen and chlorine exothermic or endothermic?
Use the bond energies to explain your answer.

(Total 3 marks)

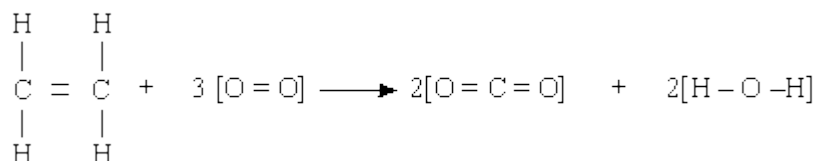
7.

You will find the information on the Data Sheet helpful when answering this question.

This equation shows the reaction between ethene and oxygen.



The structural formulae in the equation below show the bonds in each molecule involved.



Use the three stages shown at (a), (b) and (c) below to calculate the nett energy transfer when the formula mass (1 mole) of ethene reacts with oxygen.

- (a) Write down the bonds broken and the bonds formed during the reaction. (Some have already been done for you.)

Bonds broken	
Number	Type
4	[C - H]
1	[C = C]

Bonds formed	
Number	Type
4	[C = O]

(2)

- (b) Calculate the total energy changes involved in breaking and in forming all of these bonds. (Some have already been done for you.)

Total energy change in breaking bonds
$[4 \times 413] = 1652$
$[1 \times 612] = 612$
Total = kJ

Total energy change in forming bonds
$4 \times [805] = 3220$
Total = kJ

(4)

- (c) Describe, as fully as you can, what the figures in (b) tell you about the overall reaction.

(2)

(Total 8 marks)

8.

When ammonium chloride is dissolved in water, there is a temperature change.

A student investigated how the temperature of water changed when different masses of ammonium chloride were added to the same volume of water.

The water used was at room temperature.

The student's results are shown in the table.

Mass of ammonium chloride in g	Final temperature of solution in °C
10	14.5
20	8.5
25	5.5
30	2.5
35	1.0
40	1.0
45	1.0

(a) (i) Use the correct word from the box to complete the sentence.

endothermic **exothermic** **reduction**

When ammonium chloride dissolves in water, the change can be described as _____ .

(1)

(ii) Give a reason for your answer to part (a) (i). Refer to the table of results in your answer.

(1)

(b) The student added the ammonium chloride to water and stirred the mixture.

The water was in a glass beaker.

His teacher said that using a glass beaker could cause inaccurate results.

What could the student have used instead of a glass beaker to improve the accuracy?

Give a reason why this would improve the accuracy of his results.

(2)

(c) The student made sure his investigation was a fair test.

State **two** control variables the student should keep the same.

Give a reason why changing each of these two control variables would affect the temperature change.

Control variable 1 _____

Reason _____

Control variable 2 _____

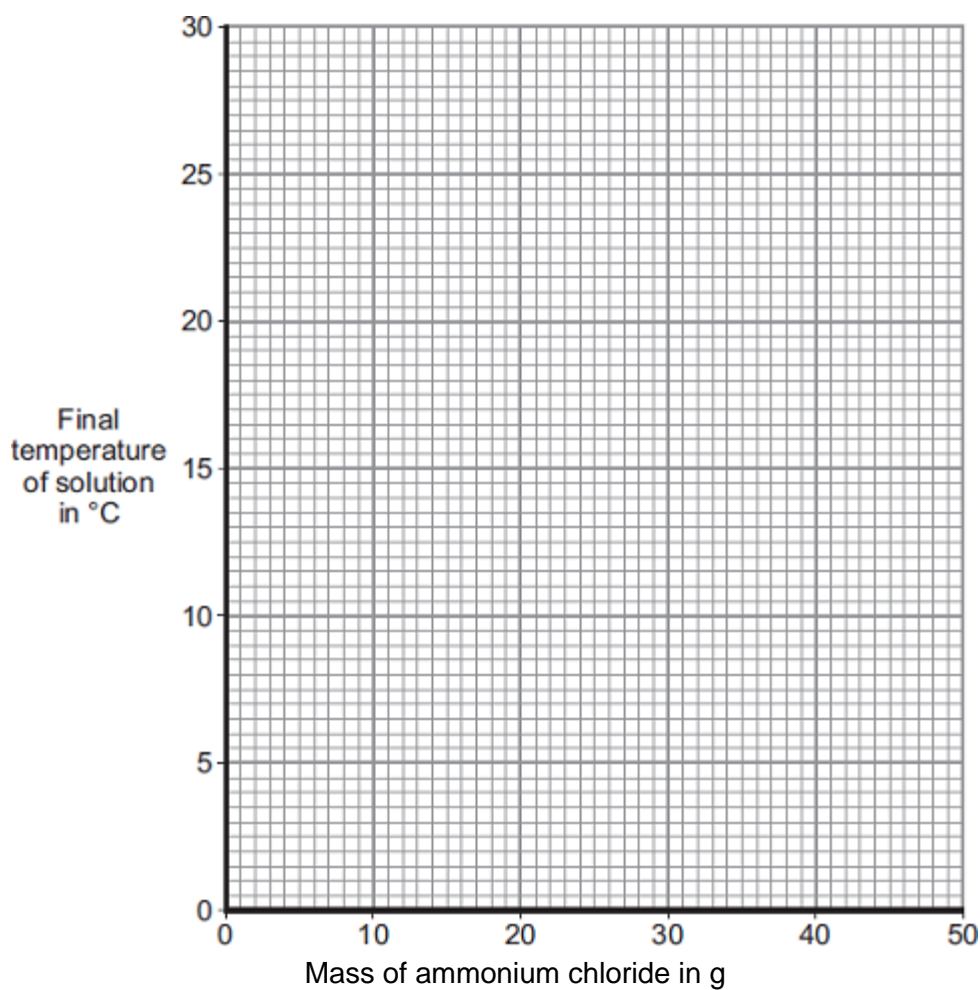
Reason _____

(4)

(d) (i) The student's results table has been repeated below.

Mass of ammonium chloride in g	Final temperature of solution in °C
10	14.5
20	8.5
25	5.5
30	2.5
35	1.0
40	1.0
45	1.0

Plot the results on the grid.



(2)

(ii) Complete the graph by drawing two straight lines of best fit through the points.

(2)

(iii) Use the graph to estimate the temperature of the room.

Show your working on the graph.

Temperature of room = _____ °C

(2)

(e) Explain why the final temperature was the same for all masses of 35 g and greater.

(2)

(f) A second student also did one of the experiments.

This student recorded a final temperature of 14.5 °C.

Both students dissolved 20 g of ammonium chloride in water.

Use the graph to explain the difference in the two final temperatures.

(2)

(Total 18 marks)