

The Morley Academy

5. Energy Changes Mastery Booklet

(Chemistry Paper 1)

Name : _____

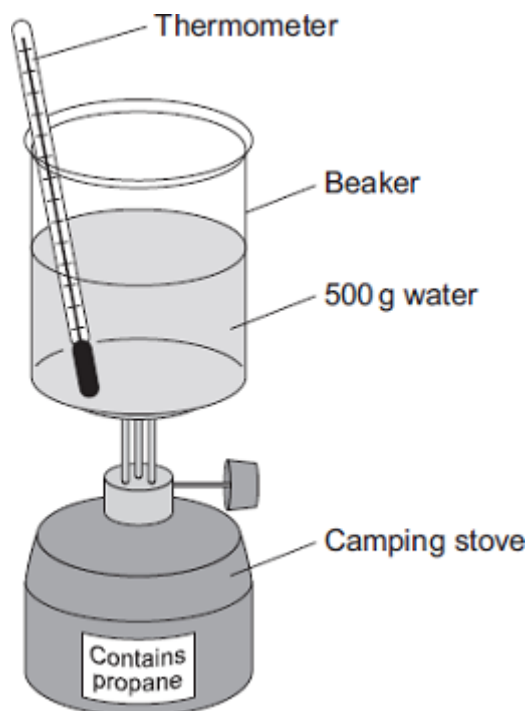
Teacher : _____

Date Given : _____

These booklets are a consolidation of your learning. They should be used in the following way - You should attempt the questions WITHOUT looking at the answers. Then mark your questions with green pen and add any missing marks you missed.

THESE BOOKLETS WILL IMPROVE YOUR GRADES...!!

Q1. A camping stove uses propane gas.



(a) A student did an experiment to find the energy released when propane is burned.

The student:

- put 500 g water into a beaker
- measured the temperature of the water
- heated the water by burning propane for 1 minute
- measured the temperature of the water again.

The student found the temperature change was 20 °C.

The student can calculate the energy released, in joules (J), using the equation:

energy released (J) = mass of water (g) \times 4.2 \times temperature change (°C)

(i) Use the student's result to calculate the energy released in joules (J).

Energy released = _____ J

(2)

(ii) State **two** safety precautions that the student should take during the experiment.

1. _____
2. _____

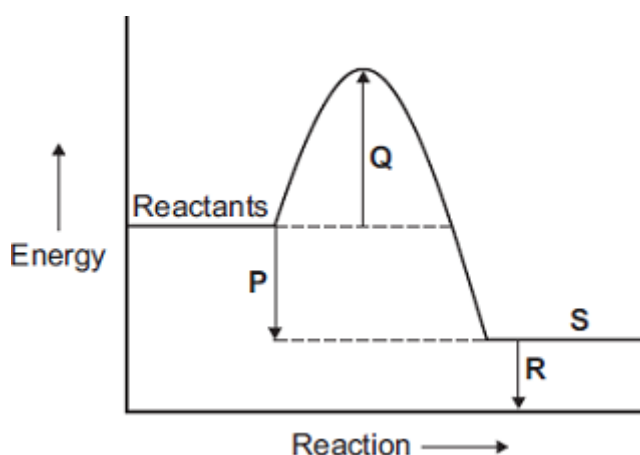
(2)

- (iii) Tick (✓) **two** boxes which describe how the student could make his result more accurate.

	Tick (✓)
Stir the water before measuring the temperature.	
Heat the water until it boils.	
Place a lid on the beaker.	
Use a larger beaker for the water.	

(2)

- (b) The change in energy when propane is burned can be shown in an energy level diagram.



Draw **one** line from each description to the correct letter.

Description

products

activation energy

energy released by the reaction

Letter

P

Q

R

S

(3)

- (c) Propane and hydrogen are both used as fuels.

Some information about propane and hydrogen is given in the table.

Fuel	Resource	Products formed when fuel burned
propane	crude oil	carbon dioxide and water
hydrogen	water	water

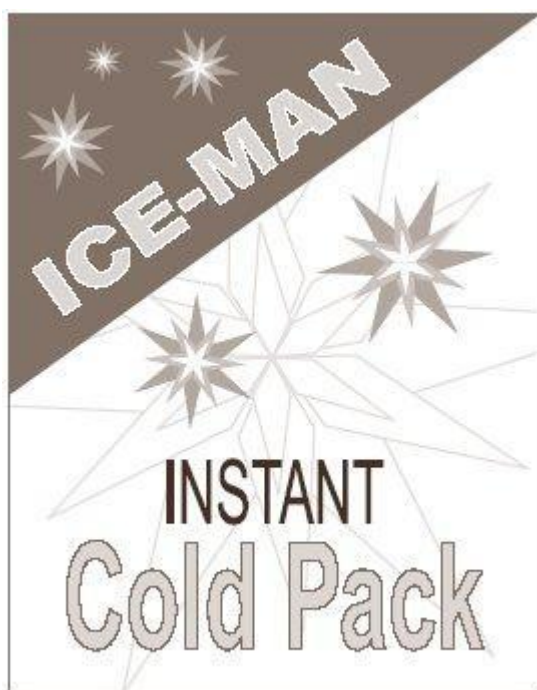
Use the information in the table to suggest **two** disadvantages that propane has as a fuel compared to hydrogen.

1. _____
2. _____

(2)

(Total 11 marks)

Q2. Instant cold packs are used to treat sports injuries.



One type of cold pack has a plastic bag containing water. Inside this bag is a smaller bag containing ammonium nitrate.

The outer bag is squeezed so that the inner bag bursts. The pack is shaken and quickly gets very cold as the ammonium nitrate dissolves in the water.

- (a) **One** of the statements in the table is correct.

Put a tick (✓) next to the correct statement.

Statement	(✓)
The bag gets cold because heat energy is given out to the surroundings.	
The bag gets cold because heat energy is taken in from the surroundings.	
The bag gets cold because plastic is a good insulator.	

(1)

- (b) Draw a ring around the word that best describes the change when ammonium nitrate dissolves in water.

electrolysis endothermic exothermic

(1)

- (c) Suggest and explain why the pack is shaken after the inner bag has burst.

(2)

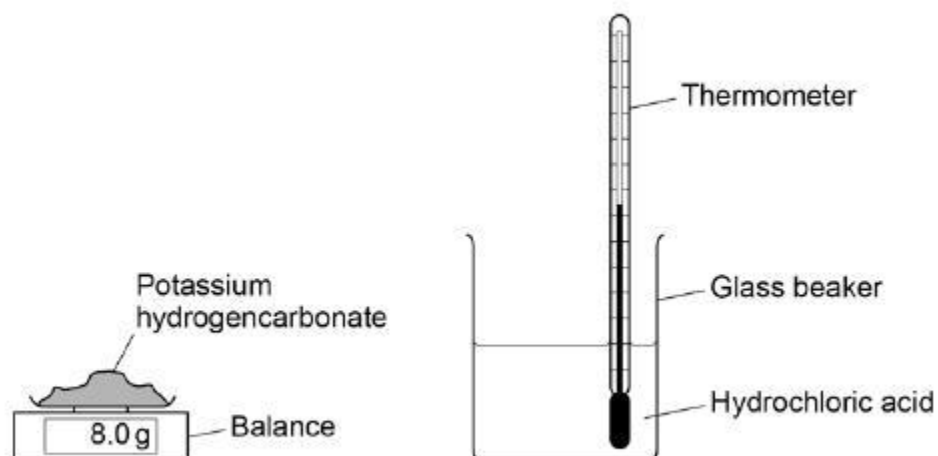
(Total 4 marks)

Q3.

A student investigated the energy change occurring in the endothermic reaction between potassium hydrogencarbonate and hydrochloric acid.

Figure 1 shows the apparatus used.

Figure 1



This is the method used.

1. Measure 50 cm³ hydrochloric acid into a glass beaker.
2. Measure 1.0 g of potassium hydrogencarbonate.
3. Add the potassium hydrogencarbonate to the hydrochloric acid.
4. Stir until all the potassium hydrogencarbonate has reacted.
5. Record the lowest temperature reached.
6. Repeat steps 1–5 two more times.
7. Repeat steps 1–6 with different masses of potassium hydrogencarbonate.

(a) Which is the most suitable apparatus to use to measure 50 cm³ of hydrochloric acid?

Tick (✓) **one** box.

Balance

☐

Conical flask

☐

Gas syringe

☐

Measuring cylinder

☐

(1)

(b) The student used a glass beaker for the reaction.

Suggest **one** change to the apparatus that would improve the accuracy of the results.

Give a reason for your answer.

(2)

(c) Which **two** variables should the student keep the same to make this a fair test?

Tick **two** boxes.

Mass of potassium hydrogencarbonate

☐

Same balance

☐

Same thermometer

☐

Starting temperature of hydrochloric acid

☐

Volume of hydrochloric acid

☐

(2)

(d) **Figure 2** shows part of the thermometer used to measure the temperature.



What is the temperature reading on the thermometer?

Temperature = _____ °C

(1)

The table shows a set of results.

	Test 1	Test 2	Test 3
Lowest temperature in °C	16.1	15.8	15.9

(e) What is the range of the lowest temperature?

From _____ °C to _____ °C

(1)

(f) Calculate the mean lowest temperature.

Use the table above.

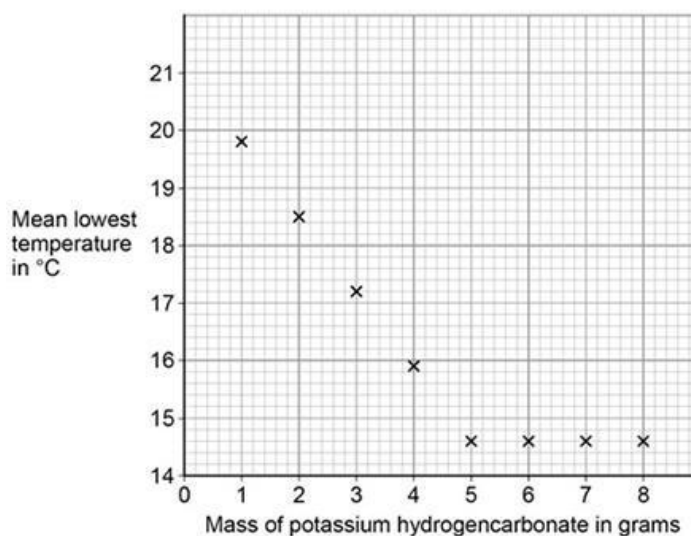
Mean lowest temperature = _____ °C

(2)

(g) How do the results show that the reaction is endothermic?

(1)

The graph shows the student's results.



- (h) Draw **two** straight lines of best fit on the graph above.

(2)

- (i) Describe how the lowest temperature changes as the mass of potassium hydrogencarbonate added increases.

(3)

(Total 15 marks)

Q4. This question is about energy changes in chemical reactions.

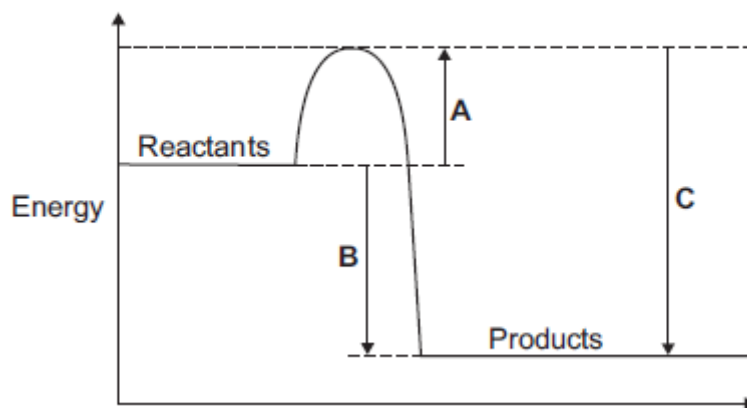
- (a) Complete the word equation for the combustion of hydrogen.

hydrogen + oxygen → _____

(1)

- (b) **Figure 1** shows a simple energy level diagram.

Figure 1



- (i) Which arrow, **A**, **B** or **C**, shows the activation energy?

Tick (✓) **one** box.

A

☐

B

☐

C

☐

(1)

- (ii) What type of reaction is shown by the energy level diagram in **Figure 1**?
Give a reason for your answer.

Type of reaction _____

Reason _____

(2)

- (iii) For a reaction, the value of **A** is 1370 kJ and **C** is 3230 kJ.
Calculate the value of **B**.

B = _____ kJ

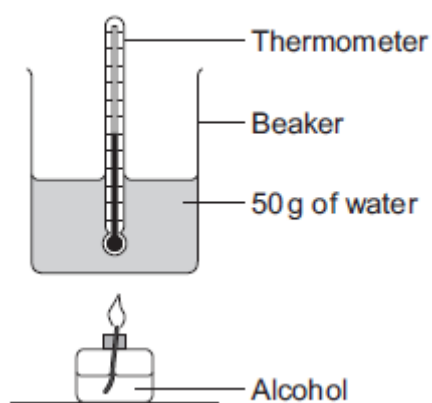
(1)

- (c) Alcohols are used as fuels.

A group of students investigated the amount of energy released when different alcohols are burned.

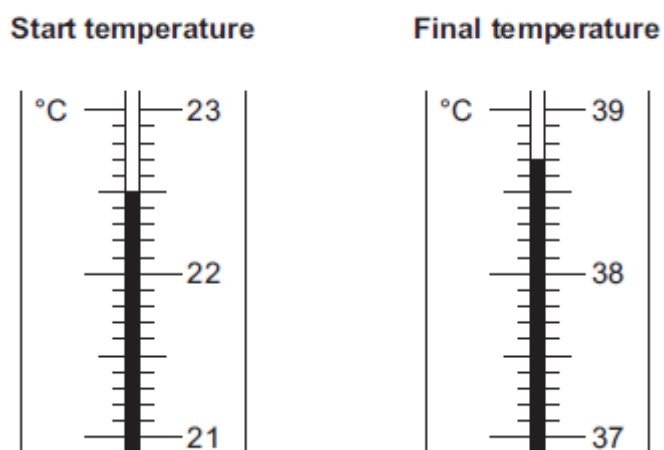
The students used the apparatus shown in **Figure 2**.

Figure 2



- (i) **Figure 3** shows the start temperature and the final temperature of the water.

Figure 3



Write the start temperature and the final temperature of the water in **Table 1**.
Work out the increase in temperature to complete **Table 1**.

Table 1

Start temperature of the water in °C	
Final temperature of the water in °C	
Increase in temperature in °C	

(3)

- (ii) The students worked out the heat energy released by burning 1 g of each alcohol.
The students used the equation:

$$\text{Heat energy released} = m \times 4.2 \times \text{increase in temperature}$$

Look at **Figure 2**. What is the value of m?

m = _____ g
(1)

(iii) **Table 2** shows the students' results.

Table 2

Name of alcohol	Number of carbon atoms in one molecule of alcohol	Heat energy released when 1 g of alcohol is burned in kJ
Methanol	1	11.4
Ethanol	2	13.5
Propanol	3	20.1
Butanol	4	16.8
Pentanol	5	17.2

Which value of heat energy released is anomalous?

(1)

(iv) Look at **Table 2**.

What is the relationship between the number of carbon atoms in one molecule of alcohol and the heat energy released when 1 g of the alcohol is burned?

(1)

(v) The value in a data book for the amount of heat energy released when 1 g of butanol is burned completely is 36.2 kJ.

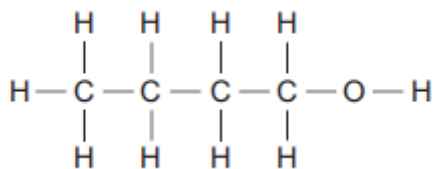
Suggest two reasons why the students' result for butanol is lower than the data book value.

1. _____

2. _____

(2)

(vi) The displayed structure of butanol is:



What is the functional group of the alcohol?

Tick (✓) **one** box.

— C — C

☐

— C — H

☐

— O — H

☐

(1)

(Total 14 marks)

Q5.

Cells contain chemicals which react to produce electricity.

(a) Why can a rechargeable cell be recharged?

(1)

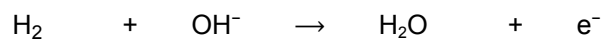
(b) Give **two** factors that affect the voltage produced by a cell.

1.

2.

(2)

(c) Balance the half-equation for the reaction occurring at an electrode in one type of hydrogen fuel cell.



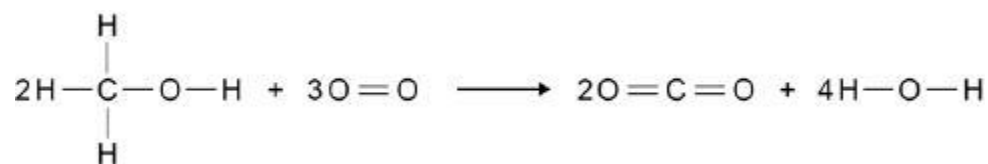
(1)

(d) Why is the fuel cell in Question (c) described as an alkaline fuel cell?

(1)

- (e) Another type of fuel cell uses methanol instead of hydrogen.

The diagram represents the reaction in this fuel cell.



The table shows the bond energies for the reaction.

	C-H	C-O	O-H	O=O	C=O
Bond energy in kJ / mol	412	360	464	498	805

Calculate the overall energy change for the reaction.

Use the diagram and the table above.

Overall energy change = _____ kJ / mol

(3)

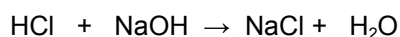
(Total 8 marks)

Q6.

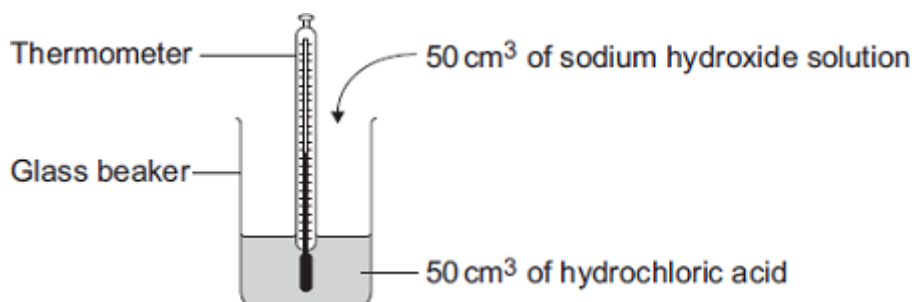
Read the information about energy changes and then answer the questions.

A student did an experiment to find the energy change when hydrochloric acid reacts with sodium hydroxide.

The equation which represents the reaction is:



The student used the apparatus shown in the diagram.



The student placed 50 cm³ of hydrochloric acid in a glass beaker and measured the initial 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.

(1)

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

(1)

- (c) Which **one** of these experiments was probably done on a different day to the others?

Give a reason for your answer.

(1)

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

(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.

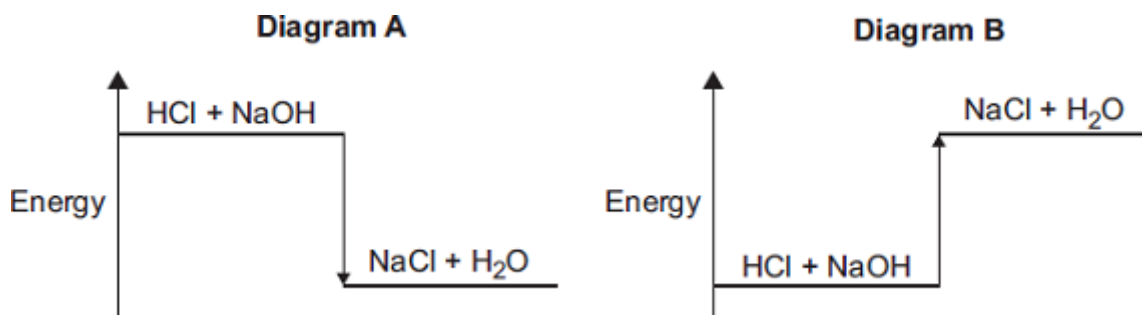
$$\text{Energy change in joules} = 100 \times 4.2 \times \text{average temperature change}$$

Answer = _____ J

(1)

- (g) Which **one** of these energy level diagrams represents the energy change for this reaction?

Give a reason for your answer.



(1)

(Total 7 marks)

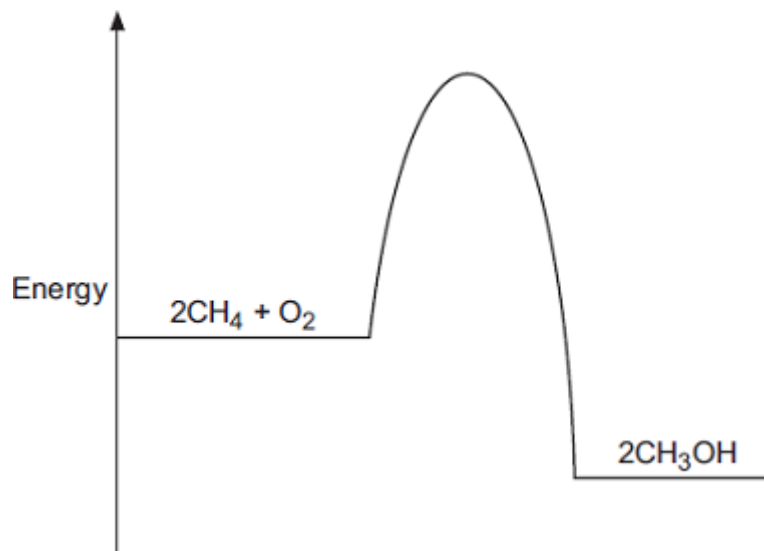
Q7.

Methanol (CH₃OH) can be made by reacting methane (CH₄) and oxygen (O₂).
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?

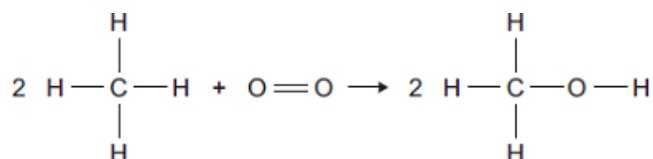
(1)

- (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)

Q8.

Some cars are powered by hydrogen fuel cells.

Figure 1



© Robert Couse-Baker (CC BY-SA 2.0) via Flickr

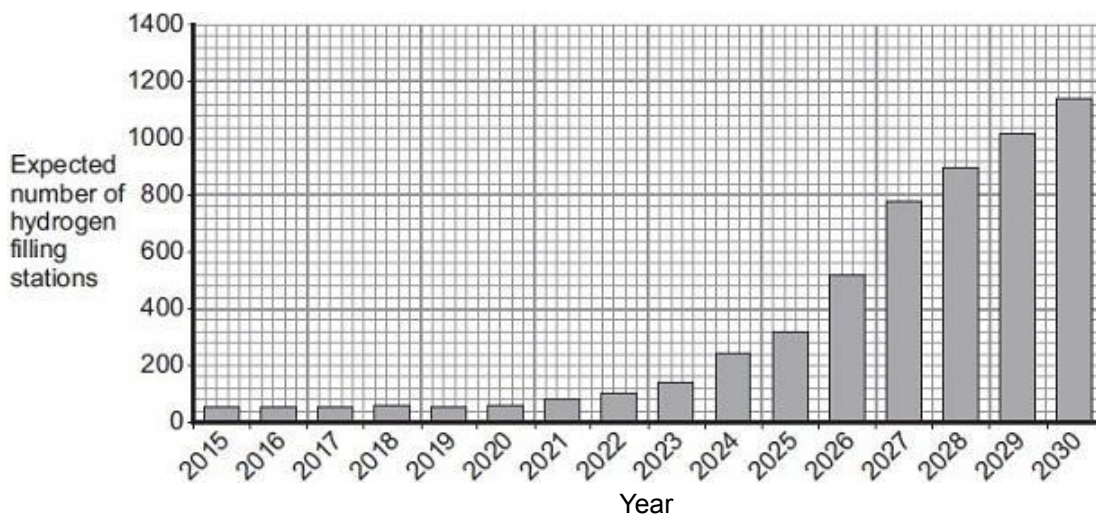
(a) What type of energy is released by hydrogen fuel cells?

(1)

(b) Owners of cars powered by fuel cells buy hydrogen from hydrogen filling stations.

Figure 2 shows how the number of hydrogen filling stations in the UK is expected to increase up to the year 2030.

Figure 2

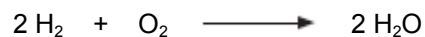


Use the information in **Figure 2** and your own knowledge to answer this question.

Suggest **two** reasons why the UK government might encourage the building of more hydrogen filling stations.

(2)

- (c) The equation for the reaction of hydrogen with oxygen is:



During the reaction, energy is used to break the bonds of the reactants.

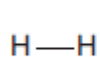
Energy is released when new bonds are made to form the product.

Bond energies for the reaction are given in the table below.

Bond	Bond energy in kJ
H—H	436
O=O	498
O—H	464

The structures of the reactants and product are shown in **Figure 3**.

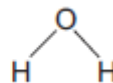
Figure 3



hydrogen



oxygen



water

- (i) Calculate the energy change for the reaction:



Energy change = _____ kJ

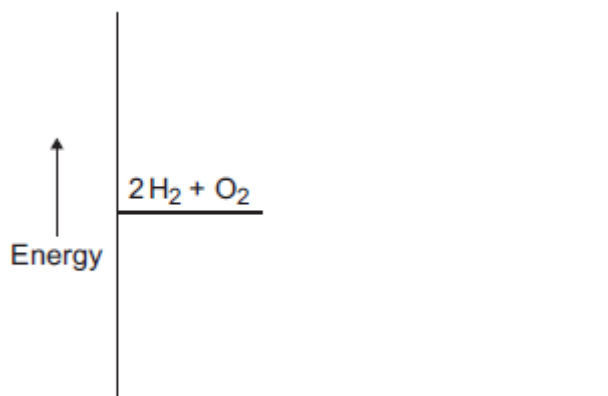
(3)

- (ii) The reaction of hydrogen with oxygen is exothermic.

Complete the energy level diagram for this reaction on **Figure 4**.

Clearly label the activation energy.

Figure 4

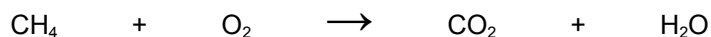


(3)

Q9.

This question is about energy changes in chemical reactions.

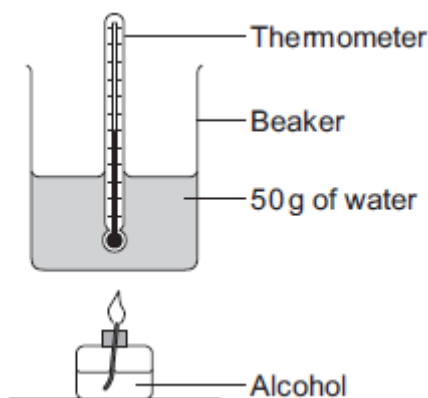
- (a) Balance the chemical equation for the combustion of methane.



(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:

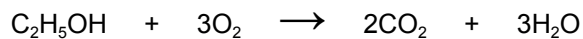
$$Q = m \times c \times \Delta T$$

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

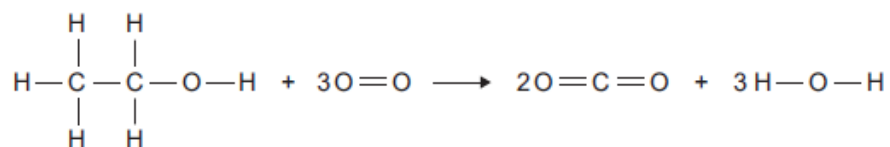
Heat energy (Q) = _____ J

(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.

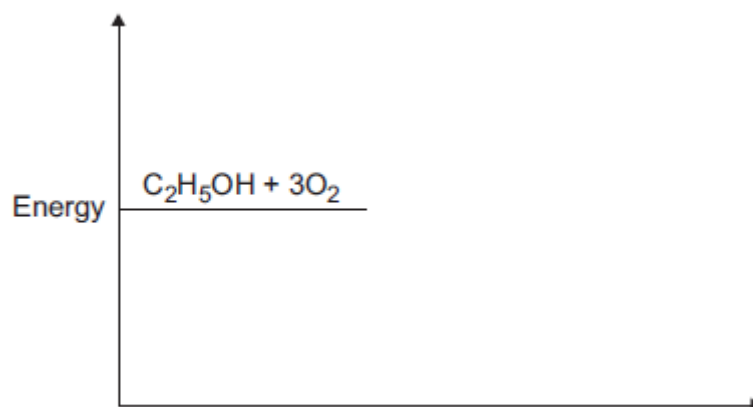
(2)

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

On the completed diagram, label:

- activation energy

- overall energy change.



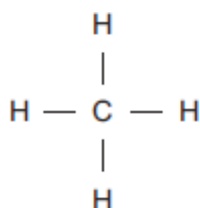
(3)

(Total 12 marks)

Q10.

Methane (CH_4) is used as a fuel.

- (a) The displayed structure of methane is:



Draw a ring around a part of the displayed structure that represents a covalent bond.

(1)

- (b) Why is methane a compound?

Tick (✓) **one** box.

Methane contains atoms of two elements, combined chemically.

☐

Methane is not in the periodic table.

☐

Methane is a mixture of two different elements.



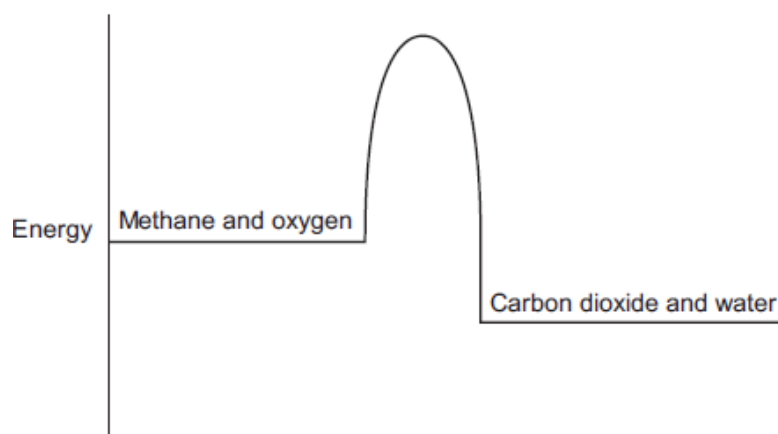
(1)

(c) Methane burns in oxygen.

(i) The diagram below shows the energy level diagram for the complete combustion of methane.

Draw and label arrows on the diagram to show:

- the activation energy
- the enthalpy change, ΔH .



(2)

(ii) Complete and balance the symbol equation for the complete combustion of methane.



(2)

(iii) Explain why the **incomplete** combustion of methane is dangerous.

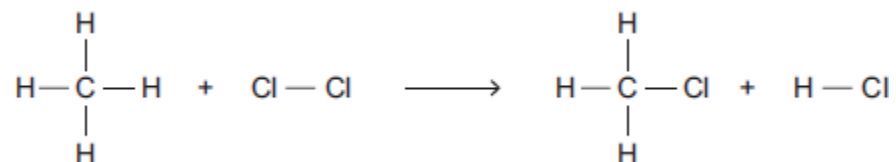
(2)

(iv) Explain why, in terms of the energy involved in bond breaking and bond making, the combustion of methane is exothermic.

(3)

- (d) Methane reacts with chlorine in the presence of sunlight.

The equation for this reaction is:



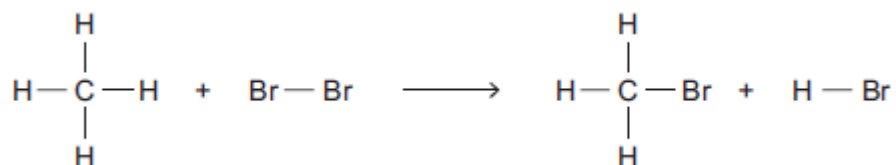
Some bond dissociation energies are given in the table.

Bond	Bond dissociation energy in kJ per mole
C-H	413
C-Cl	327
Cl-Cl	243
H-Cl	432

- (i) Show that the enthalpy change, ΔH , for this reaction is -103 kJ per mole.

(3)

- (ii) Methane also reacts with bromine in the presence of sunlight.



This reaction is less exothermic than the reaction between methane and chlorine.

The enthalpy change, ΔH , is -45 kJ per mole.

What is a possible reason for this?

Tick (✓) **one** box.

CH_3Br has a lower boiling point than CH_3Cl

☐

The C-Br bond is weaker than the C-Cl bond.

☐

The H-Cl bond is weaker than the H-Br bond.

☐

Chlorine is more reactive than bromine.

☐

(1)

(Total 15 marks)

Q11.

The equation for the reaction of ethene and bromine is:

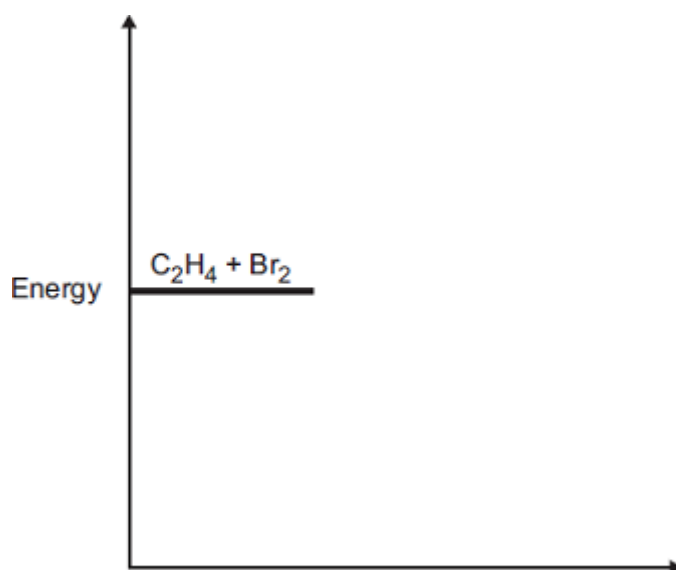


The reaction is exothermic.

(a) Complete the energy level diagram.

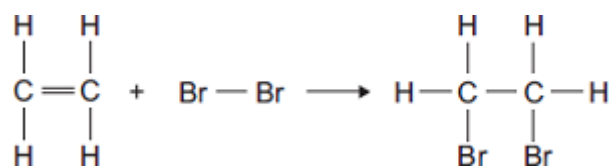
You should label:

- 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)

Mark schemes

Q1.

(a) (i) 42 000

correct answer gains 2 marks with or without working

allow 42 kJ

*if answer incorrect : correct substitution $500 \times 4.2 \times 20$
gains 1 mark*

2

(ii) any **two** from:

- eye protection
- lab coat
- heat-proof mat
- (heat-proof) gloves
- (long) hair tied back
- stand up
- secure the beaker

2

(iii) Stir the water before measuring the temperature.

1

Place a lid on the beaker.

1

(b) the products \rightarrow S

1

the activation energy \rightarrow Q

1

the energy released by the reaction \rightarrow P

1

(c) carbon dioxide produced

it = propane

allow converse arguments

*allow greenhouse gas / global warming / atmospheric
pollution*

(crude oil / propane) non-renewable

1

allow crude oil running out

1

[11]

Q2.

- (a) the bag gets cold because heat energy is taken in from the surroundings 1
- (b) endothermic 1
- (c) any **two** from:
- mix / spread (the ammonium nitrate and water)
 - dissolve faster(*)
 - get cold faster **or** so the whole bag gets cold(*)
(*)allow increase rate **or** quicker reaction
 - particles collide more **or** more collisions
- 2
- [4]**

Q3.

- (a) measuring cylinder 1
- (b) use a polystyrene cup
allow insulate the beaker and / or use a lid 1
- better insulator
- or**
- reduces energy transfer from the surroundings 1
- (c) starting temperature of hydrochloric acid 1
- volume of hydrochloric acid 1
- (d) 21.4 (°C) 1
- (e) 15.8 (°C) to 16.1 (°C)
allow 16.1 (°C) to 15.8 (°C) 1
- $\frac{16.1 + 15.8 + 15.9}{3}$
- (f) 15.9 (°C)
an answer of 15.9(333..) (°C) scores 2 marks 1
allow 15.9(333..) (°C) 1
- (g) temperature decreases

1

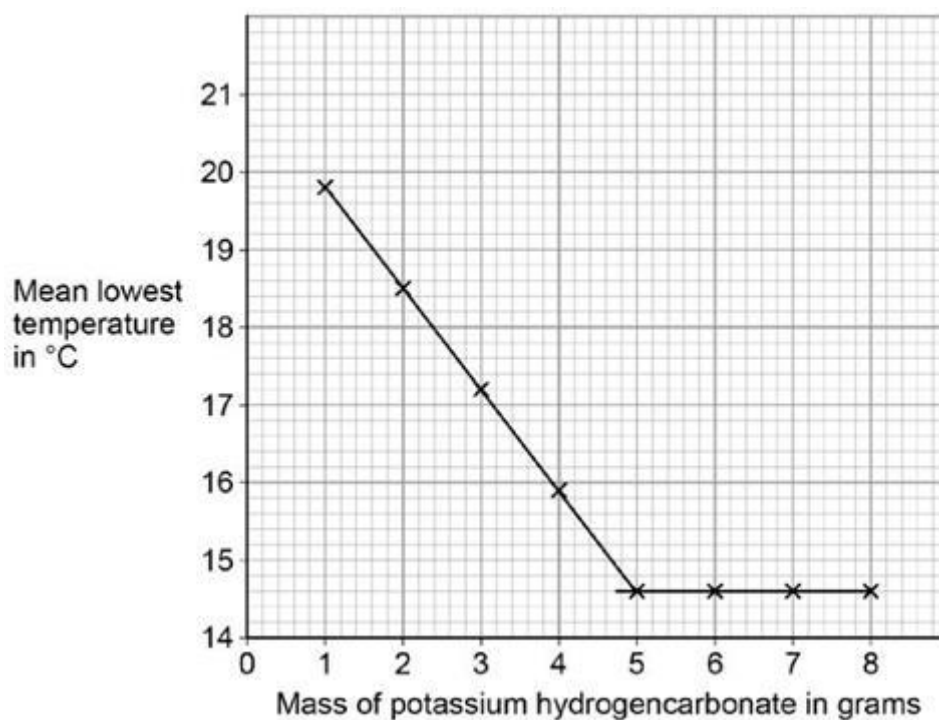
- (h) straight line from (1.0, 19.8) to (5.0, 14.6)
ignore continuation of line in either direction

1

horizontal straight line from (5.0, 14.6 to 8.0, 14.6)
ignore continuation of line in either direction

1

the answer below scores **2** marks



- (i) (lowest) temperature decreases

1

to 14.6 °C
or
 until 5 g added

1

then no change to temperature (after 5 g solid added)
or
 then temperature remains at 14.6 °C (after 5 g solid added)

1

[15]

Q4.

- (a) water / H₂O
allow steam or hydrogen oxide

1

- (b) (i) A

1

(ii)	exothermic	1
	products (energy) lower than reactants (energy)	1
(iii)	1860 (kJ)	1
(c) (i)	22.5	1
	38.7	1
	16.2	
	<i>allow ecf for correct subtraction</i>	1
(ii)	50 (g)	1
(iii)	20.1 (kJ)	
	<i>allow propanol</i>	
	<i>ignore 3</i>	1
(iv)	as the number of carbon atoms (in one molecule of alcohol) increases the heat energy given out increases (when the alcohol is burned)	1
(v)	any two from:	
	• no lid	
	• no insulation	
	• no draught shield	
	<i>Allow heat / energy loss to surroundings for any one of these marks</i>	
	• incomplete combustion	
	• inaccurate measurement	
	• no repeats (to calculate a mean)	2
(iv)	-O-H	1
		[14]

Q5.

(a)	the chemical reaction is reversible	1
(b)	any two from:	
	• type of electrode	
	• electrolyte	
	• concentration of electrolyte	
	• temperature	2

- (c) $\text{H}_2 + 2\text{OH}^- \rightarrow 2\text{H}_2\text{O} + 2\text{e}^-$
allow multiples 1
- (d) contains OH^- ions 1
- (e) (bonds broken)
 $((6 \times 412) + (2 \times 360) + (2 \times 464) + (3 \times 498)) = 5614$ 1
- (bonds made)
 $((4 \times 805) + (8 \times 464)) = 6932$ 1
- (overall energy change)
 $(6932 - 5614) = -1318 \text{ (kJ / mol)}$
allow ecf from marking point 1 and / or marking point 2 1
an answer of 1318 (kJ / mol) scores 3 marks
- [8]**

Q6.

- (a) eg plastic (beaker) / insulation / lid / cover **or** any mention of enclosed
any sensible modification to reduce heat loss
ignore prevent draughts
ignore references to gas loss
ignore bomb calorimeter 1
- (b) all the substances react **or** all (the substances) react fully / completely **or**
 heat evolved quickly **or** distribute heat
'so they react' is insufficient for the mark
accept increase chances of (successful) collisions /
collision rate increase
*do **not** accept rate of reaction increase / make reaction*
faster 1
- (c) experiment 2 **and**
 different / higher / initial / starting temperature
*accept experiment 2 **and** the room is hotter / at higher*
temperature
*do **not** accept temperature change / results higher* 1
- (d) temperature change does not fit pattern
*accept anomalous / odd **or** it is the lowest **or** it is lower*
*than the others **or** it is different to the others*
'results are different' is insufficient 1
- (e) 7 / 7.0 1

- (f) $(100 \times 4.2 \times 7) = 2940$
ecf from (e) 1
- (g) diagram A **and**
reaction exothermic / heat evolved / ΔH is negative / temperature rises
accept energy is lost (to the surroundings)
accept energy of products lower than reactants
allow arrow goes downwards 1

[7]

Q7.

- (a) (i) energy / heat of products less than energy of reactants
allow converse
allow products are lower than reactants
allow more energy / heat given out than taken in
allow methanol is lower
allow energy / heat is given out / lost
allow ΔH is negative 1
- (ii) lowers / less activation energy
allow lowers energy needed for reaction
or it lowers the peak/ maximum
*do **not** allow just 'lowers the energy'* 1
- (b) (i) $(8 \times 435) + 497 = 3977$
accept: bonds broken: $(2 \times 435) + 497 = 1367$ 1
- $(6 \times 435) + (2 \times 336) + (2 \times 464) = 4210$
bonds made: $(2 \times 336) + (2 \times 464) = 1600$ 1
- $3977 - 4210 = (-) 233$
energy change:
 $1367 - 1600 = (-) 233$
ignore sign
allow ecf
correct answer (233) = 3 marks with or without working 1
- (ii) energy released forming (new) bonds is greater than energy needed to break (existing) bonds
allow converse
*do **not** accept energy needed to form (new) bonds*
greater than energy needed to break (existing) bonds 1

[6]

Q8.

- (a) electrical

1

- (b) using hydrogen saves petrol / diesel / *crude oil*
allow crude oil is non-renewable
ignore hydrogen is renewable

1

using hydrogen (in fuel cells) does not cause pollution
accept no carbon dioxide produced
allow less carbon dioxide produced
allow hydrogen produces only water

1

- (c) (i) (-)486

correct answer with or without working gains 3 marks

if answer is incorrect:

(2 × 436) + 498 or 1370 gains 1 mark

4 × 464 or 1856 gains 1 mark

correct subtraction of ecf gains 1 mark

3

- (ii) products lower than reactants

1

reaction curve correctly drawn

1

activation energy labelled

1

[9]**Q9.**

- (a)
- $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$

allow multiples

1

- (b) 3444 J

if answer incorrect:

one mark for temperature increase = 16.4 °C

one mark for mass of water = 50 g

ecf for one incorrect value gains two marks for correct calculation

no ecf for two incorrect values

3

- (c) (i) 1276 (kJ per mole)

ignore + or -

if answer incorrect:

[(5 × 413) + 347 + 358 + 467] + [(3 × 495)] = 4722 (1 mark)

[(4 × 799) + (6 × 467)] = 5998 (1 mark)

correct subtraction of calculated energy values (1 mark)

3

- (ii) because energy released when bonds form is greater than energy used when bonds broken

allow converse

if no mark awarded allow one mark for energy is used to

break bonds

or

one mark for energy is released when bonds form

2

- (iii) products line lower than reactants

1

activation energy labelled

1

overall energy change labelled

1

[12]

Q10.

- (a) circle round any one (or more) of the covalent bonds

any correct indication of the bond – the line between letters

1

- (b) Methane contains atoms of two elements, combined chemically

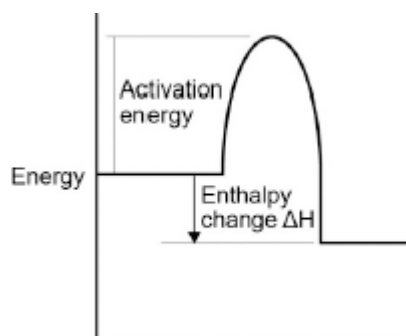
1

- (c) (i) activation energy labelled from level of reagents to highest point of curve

ignore arrowheads

1

enthalpy change labelled from reagents to products



*arrowhead **must** go from reagents to products only*

1

- (ii) 2 O₂

1

2 H₂O

if not fully correct, award 1 mark for all formulae correct.

	<i>ignore state symbols</i>	1
(iii)	carbon monoxide is made	1
	this combines with the blood / haemoglobin or prevents oxygen being carried in the blood / round body or kills you or is toxic or poisonous <i>dependent on first marking point</i>	1
(iv)	energy is taken in / required to break bonds <i>accept bond breaking is endothermic</i>	1
	energy is given out when bonds are made <i>accept bond making is exothermic</i>	1
	the energy given out is greater than the energy taken in <i>this mark only awarded if both of previous marks awarded</i>	1
(d) (i)	energy to break bonds = 1895 <i>calculation with no explanation max = 2</i>	1
	energy from making bonds = 1998	1
	1895 – 1998 (= –103) or energy to break bonds = 656 energy from making bonds = 759 656 – 759 (= –103) <i>allow:</i> <i>bonds broken – bonds made =</i> <i>413 + 243 – 327 – 432 = -103 for 3 marks.</i>	1
(ii)	The C — Br bond is weaker than the C — Cl bond	1
		[15]

Q11.

(a)	products are at a lower energy level than reactants <i>if candidate has drawn a profile for an endothermic reaction penalise first marking point only</i>	1
	activation energy correctly drawn and labelled	1
	ΔH correctly labelled	1

(b) (i) -93 (kJ per mole)

correct answer with or without working gains 3 marks

allow 2 marks for +93 kJ per mole

if any other answer is seen award up to 2 marks for any two of the steps below:

*bonds broken $(614 + 193) = 807$ (kJ) **or** $(614 + 193 + (4 \times 413)) = 2459$ (kJ)*

*bonds formed $(348 + 276 + 276) = 900$ (kJ) **or** $348 + (2 \times 276) + (4 \times 413) = 2552$ (kJ)*

bonds broken – bonds formed

allow ecf for arithmetical errors

3

(ii) more energy is released when the bonds (in the products) are formed

1

than is needed to break the bonds (in the reactants)

*if no other marks gained, allow 1 mark for energy released for bond making **and** energy used for bond breaking*

1

[8]