C7 Energy changes Exam pack and mark scheme

Name: _____

Class: _____

Date: _____

Time: **92 minutes**

Marks: **92 marks**

Comments:

1 Some cars are powered by hydrogen fuel cells.

Figure 1

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

Draw a ring around the correct answer.

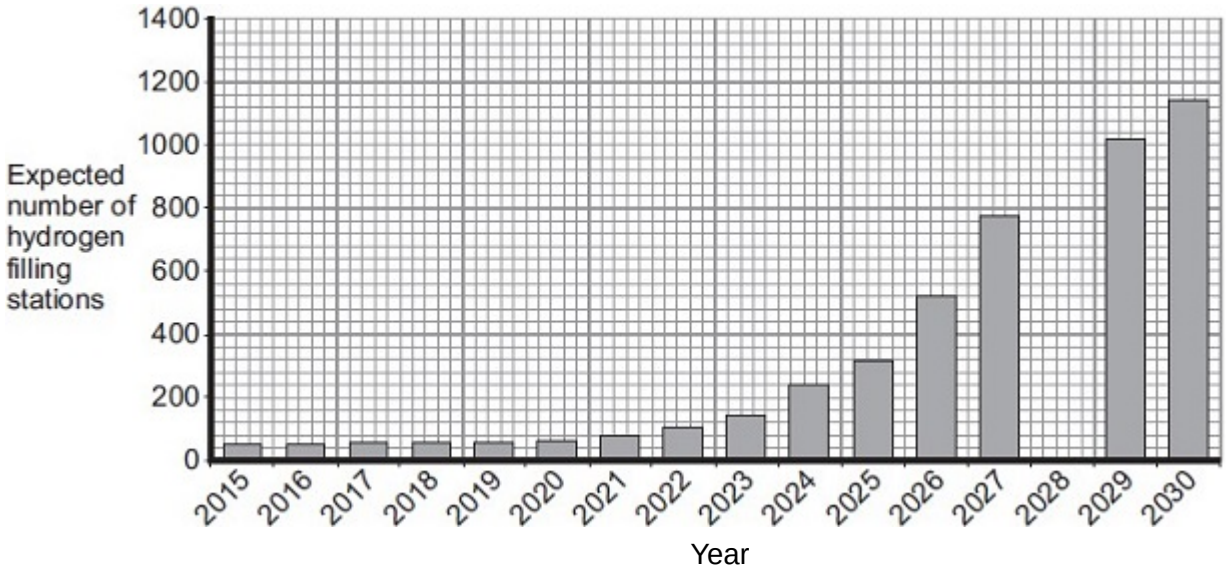
chemical **electrical** **light**

(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



(i) Suggest the total number of hydrogen filling stations expected in 2028.

.....

(1)

(ii) The number of hydrogen filling stations will still be very low compared with the number of petrol filling stations.

Suggest **one** reason why.

.....

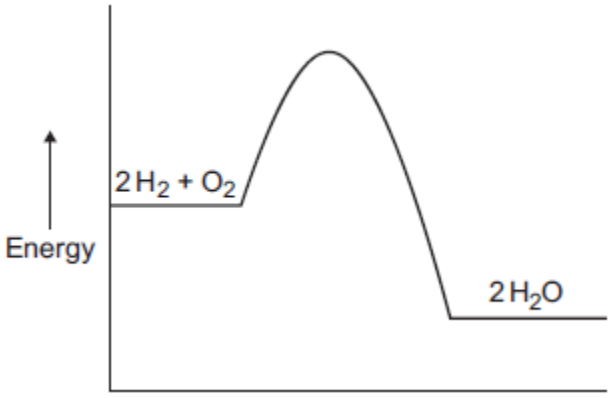
.....

(1)

(c) Hydrogen reacts with oxygen to produce water.

The energy level diagram for this reaction is shown in **Figure 3**.

Figure 3



Mark clearly with a cross (**x**) on **Figure 3** where bond breaking happens.

(1)
(Total 4 marks)

2

Kelp is a seaweed.

Kelp can be burned to give out energy.

© Ethan Daniels/Shutterstock

(a) Draw a ring around the correct answer to complete each sentence.

Reactions which give out energy are

endothermic.
exothermic.
reversible.

(1)

(b) Which **two** of the following questions **cannot** be answered by scientific experiments alone?

Tick (✓) **two** boxes.

Question	Tick (✓)
How much carbon dioxide is produced when 100 g of kelp is burned?	
Does kelp give out more heat energy than coal when burned?	
Should people use kelp instead of oil as an energy source?	
Will kelp be more popular than coal in the next 10 years?	

(2)

(c) Potassium iodide can be produced from kelp.

(i) Potassium can be reacted with iodine to produce potassium iodide.

potassium + iodine → potassium iodide

The diagram shows how this happens.

Only the outer electrons are shown.

The dots (●) and crosses (×) are used to represent electrons

Use the diagram to help you answer this question.

Describe, as fully as you can, what happens when potassium reacts with iodine to produce potassium iodide.

To get full marks you should use the words atom, electron and ion in your answer.

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(4)

(ii) Potassium iodide reacts with lead nitrate.

$2\ KI(aq) + Pb(NO_3)_2(aq) \rightarrow 2\ KNO_3(aq) + PbI_2(s)$

Why is this reaction a precipitation?

.....

.....

(1)

(iii) How can the precipitate be removed from the reaction mixture?

.....

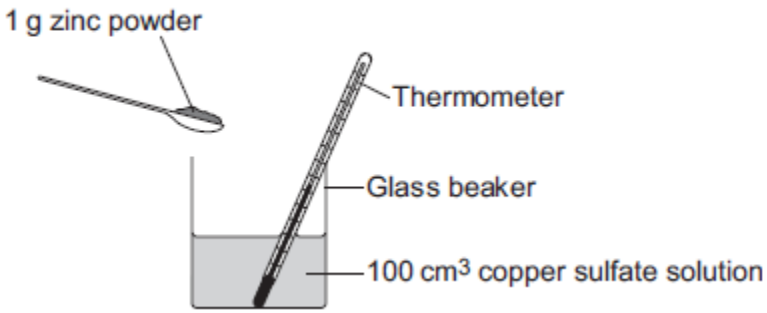
.....

(1)

(Total 9 marks)

3 A student investigates the energy released when zinc powder reacts with copper sulfate solution.
The student uses the apparatus shown in **Figure 1**.

Figure 1



The student:

- measures 100 cm^3 copper sulfate solution into a beaker
- measures the temperature of the copper sulfate solution
- puts 1 g zinc powder into the beaker
- stirs the mixture with a thermometer
- measures the highest temperature.

The student's results were:

Starting temperature = 21 °C
Highest temperature = 32 °C

(a) (i) Calculate the change in temperature.

.....

Change in temperature = ... °C

(1)

(ii) Calculate the energy released in the reaction.

Use the equation

$$\text{energy released in J} = \text{volume of solution in } cm^3 \times 4.2 \times \text{temperature change in °C}$$

.....

.....

Energy released = ... J

(2)

(b) The reaction of zinc with copper sulfate is exothermic.

How can you tell from the student's results that the reaction is exothermic?

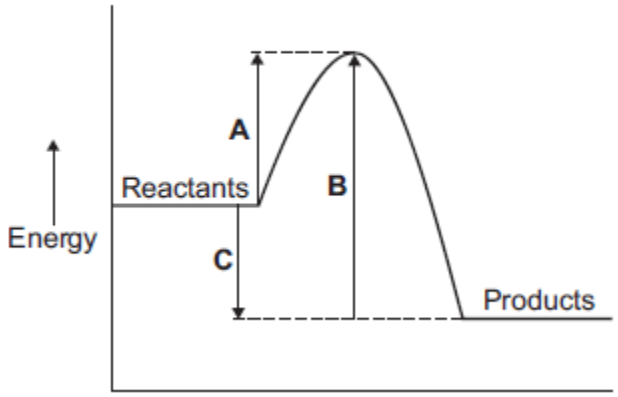
.....

.....

(1)

(c) The energy diagram for the reaction is shown in **Figure 2**.

Figure 2



(i) How can you tell from the energy diagram that the reaction is exothermic?

.....

.....

(1)

(ii) Which arrow shows the activation energy in **Figure 2**?

Tick (✓) **one** box.

A ☐

B ☐

C ☐

(1)
(Total 6 marks)

4 Hydrogen peroxide decomposes slowly to give water and oxygen.

The reaction is *exothermic*.

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

(a) In an *exothermic* reaction, energy is given out.

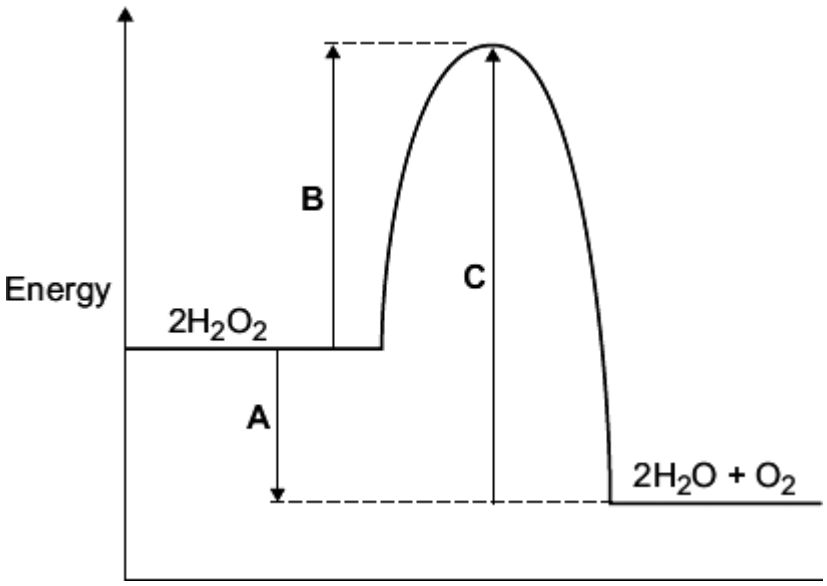
Draw a ring around the correct answer to complete the sentence.

In an *exothermic* reaction, the temperature

- goes down.
- goes up.
- stays the same.

(1)

(b) The energy level diagram for this reaction is shown below.



The energy changes, **A**, **B** and **C**, are shown on the diagram.

Use the diagram to help you answer these questions.

(i) Which energy change, **A**, **B** or **C**, is the activation energy?

(1)

(ii) Which energy change, **A**, **B** or **C**, shows that this reaction is exothermic?

(1)

(iii) Hydrogen peroxide decomposes quickly when a small amount of manganese(IV) oxide is added.

Draw a ring around the correct answer to complete each sentence.

Hydrogen peroxide decomposes quickly because

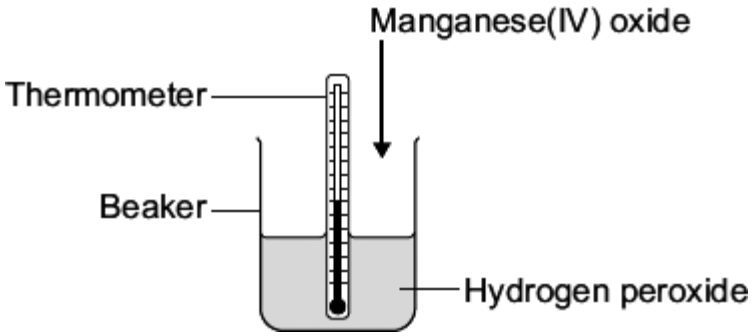
manganese(IV) oxide is	a catalyst.
	an element.
	a solid.

The manganese(IV) oxide has lowered the	activation energy.
	boiling point.
	temperature.

(2)

(c) A student did an experiment to find the amount of energy produced when hydrogen peroxide solution is decomposed using manganese(IV) oxide.

The apparatus the student used is shown in the diagram.



The student first measured the temperature of the hydrogen peroxide. Then the student added the manganese(IV) oxide, stirred the mixture and recorded the highest temperature.

(i) Suggest why the student stirred the mixture before recording the highest temperature.

.....

.....

(1)

(ii) The biggest error in this experiment is heat loss.

Suggest how the student could change the apparatus so that less heat is lost.

.....

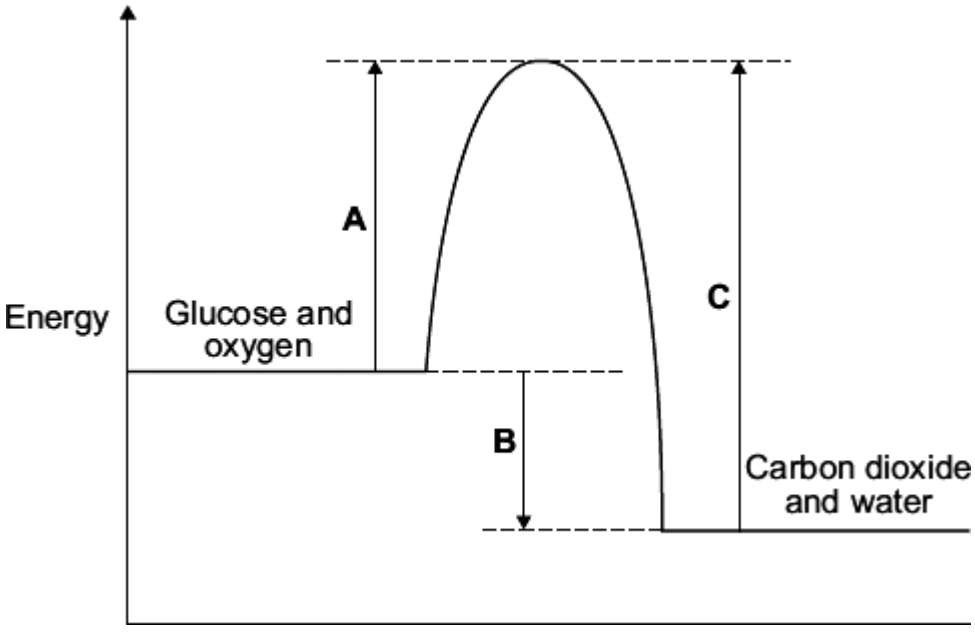
.....

(1)
(Total 7 marks)

5 Food provides chemicals and energy to keep your body working. In your body, energy is released by respiration when glucose, $C_6H_{12}O_6$, reacts with oxygen.

$$C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O$$

(a) The energy level diagram for the reaction of glucose with oxygen is shown.



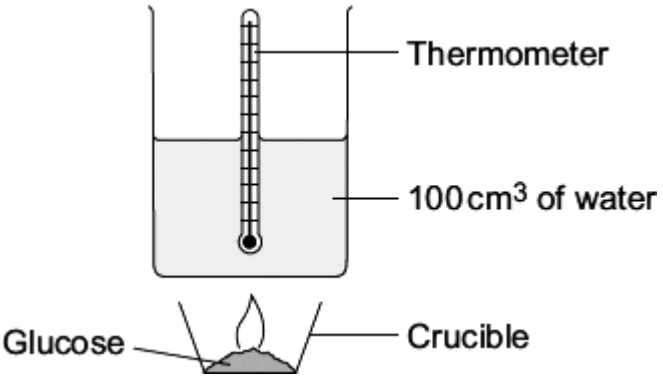
(i) Which energy change, **A**, **B** or **C**, represents the activation energy?

(1)

(ii) Which energy change, **A**, **B** or **C**, shows that the reaction is exothermic?

(1)

(b) A student did an investigation to find the amount of energy released when 1 g of glucose burns in air.



The student:

- recorded the room temperature
- placed 1 g of glucose into the crucible
- set up the equipment as shown in the diagram
- lit the glucose
- recorded the highest temperature of the water.

(i) One of the main errors in this experiment is energy loss to the surroundings.

Suggest **one** way that the equipment could be changed to reduce this energy loss.

.....

.....

(1)

(ii) The room temperature was 20 °C and the highest temperature recorded was 42 °C.
Use these temperature readings to calculate how much energy is released when 1 g of glucose burns.
The equation that you need to use is:

Energy released in joules = 100 × 4.2 × temperature change

Show clearly how you work out your answer.

.....

.....

.....

Burning 1 g of glucose releases ..... joules

(2)

(iii) The amount of energy released by 1 g of glucose should be 16 000 J.

Apart from energy loss to the surroundings, suggest **two** other reasons why the student's value was less than expected.

1 .....

.....

2 .....

.....

(2)

(c) Suggest **one** reason why food labels provide information about the energy released by the food.

.....

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(1)

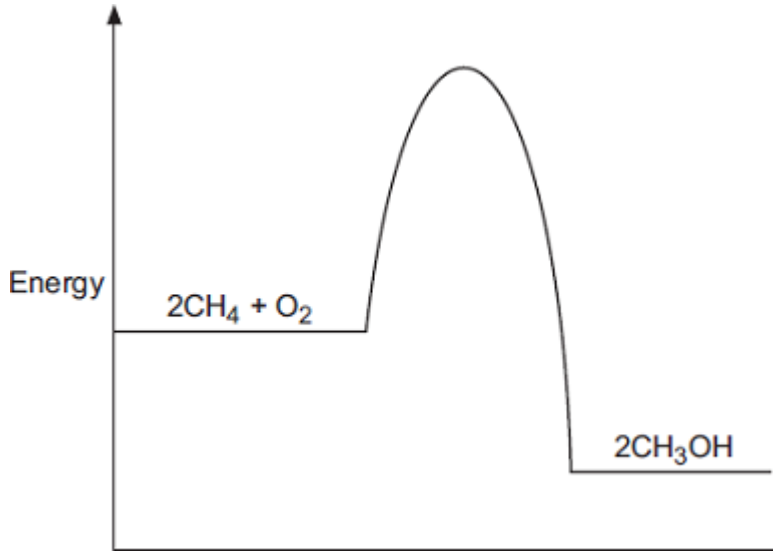
(Total 8 marks)

6 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:

$$2\,CH_4 + O_2 \longrightarrow 2\,CH_3OH$$

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



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

.....

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(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?

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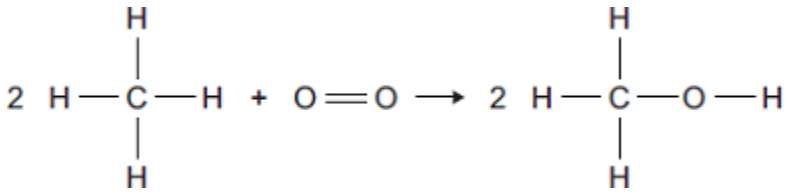
(1)

(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

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Energy change = ... kJ

(3)

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

.....

.....

(1)

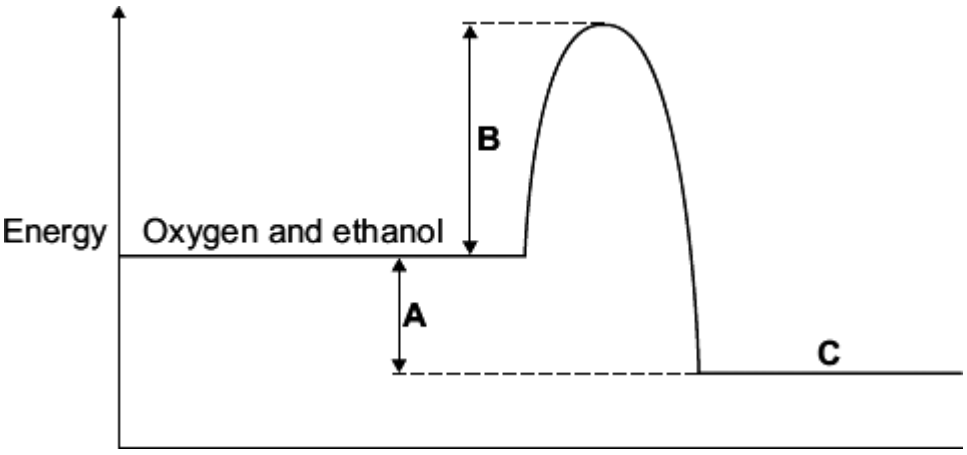
(Total 6 marks)

7 V2 rockets were used during the Second World War.

By aronsson [CC BY-SA 2.0], via Flickr

V2 rockets were powered by liquid oxygen and ethanol. Oxygen and ethanol react to produce carbon dioxide and water.

The energy level diagram represents the energy changes during this reaction.



(a) On the energy level diagram what is represented by the letter:

A .....

B .....

C .....

(3)

(b) What type of reaction is represented by this energy level diagram?

.....

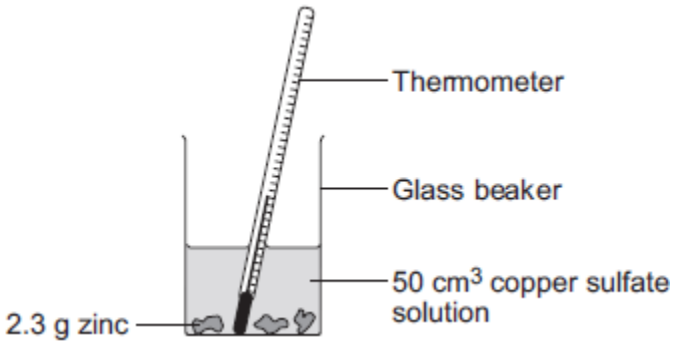
.....

(1)
(Total 4 marks)

8 A student investigated the temperature change when zinc reacts with copper sulfate solution.

The student used a different concentration of copper sulfate solution for each experiment.

The student used the apparatus shown below.



The student:

- measured 50 cm^3 copper sulfate solution into a glass beaker
- measured the temperature of the copper sulfate solution
- added 2.3 g zinc
- measured the highest temperature
- repeated the experiment using copper sulfate solution with different concentrations.

The equation for the reaction is:

$Zn(s) + CuSO_4(aq) \longrightarrow Cu(s) + ZnSO_4(aq)$

zinc + copper sulfate solution $\longrightarrow$ copper + zinc sulfate solution

(a) The thermometer reading changes during the reaction.

Give **one** other change the student could **see** during the reaction.

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.....

(1)

(b) Suggest **one** improvement the student could make to the apparatus.

Give a reason why this improves the investigation.

Improvement .....

.....

Reason .....

.....

(2)

(c) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

The student's results are shown in the table.

Table

Experiment number	Concentration of copper sulfate in moles per dm^3	Increase in temperature in °C
1	0.1	5
2	0.2	10
3	0.3	12
4	0.4	20
5	0.5	25
6	0.6	30
7	0.7	35
8	0.8	35
9	0.9	35
10	1.0	35

Describe **and** explain the trends shown in the student's results.

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(6)
(Total 9 marks)

9 During a thunderstorm lightning strikes the Eiffel Tower.

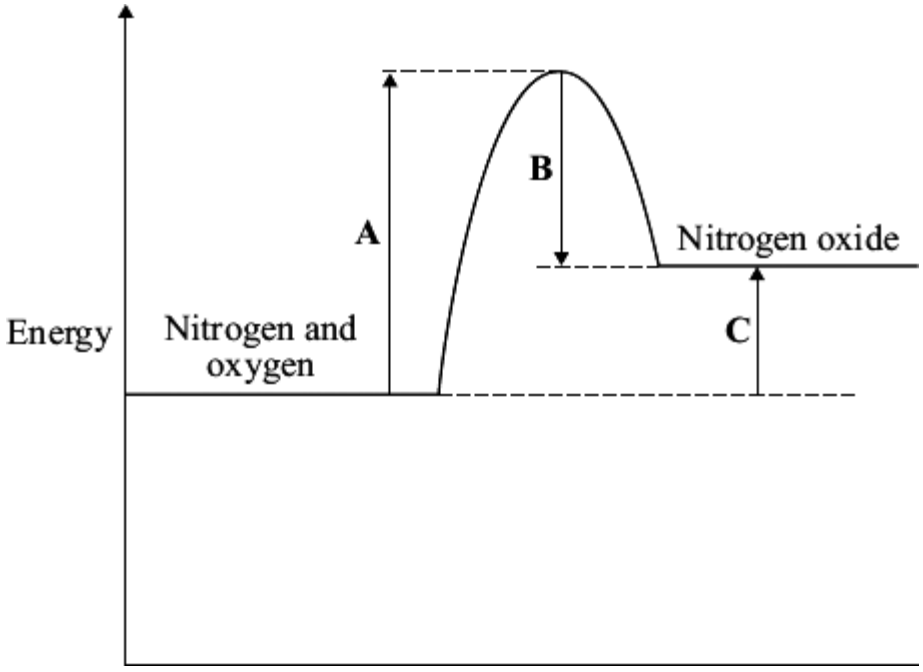
By M. G. Loppé [Public domain], via Wikimedia Commons

In lightning the temperature can reach 30 000 °C. This causes nitrogen and oxygen in the air to react, producing nitrogen oxide. This reaction has a high *activation energy* and is *endothermic*.

An equation that represents this endothermic reaction is:

$$N_2 \quad + \quad O_2 \quad \rightarrow \quad 2NO$$

The energy level diagram for this reaction is given below.



(a) The energy level diagram shows that this reaction is *endothermic*.

Explain how.

.....

.....

(1)

(b) What is meant by the term *activation energy*?

.....

.....

(1)

(c) The equation showing the structural formulae of the reactants and products is

$$N \equiv N \quad + \quad O = O \quad \rightarrow \quad 2\ N = O$$

Bond	Bond energy in kJ
N ≡ N	945
O = O	498
N = O	630

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

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.....

Energy change = ... kJ

(3)

(ii) In terms of bond energies, explain why this reaction is endothermic.

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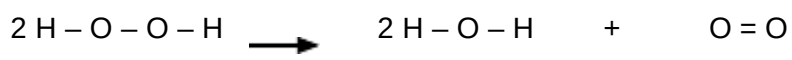
(1)

(Total 6 marks)

10 Hydrogen peroxide is often used to bleach or lighten hair.

Hydrogen peroxide slowly decomposes to produce water and oxygen.

(a) The equation for the reaction can be represented using structural formulae.



Use the bond energies in the table to help you to calculate the energy change for this reaction.

Bond	Bond energy in kJ per mole
H – O	464
O – O	146
O = O	498

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.....

Energy change = ... kJ

(3)

(b) Explain, in terms of bond making and bond breaking, why the reaction is exothermic.

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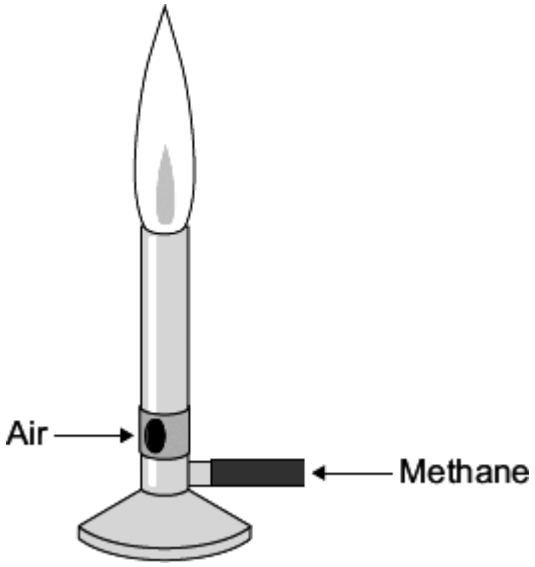
(1)

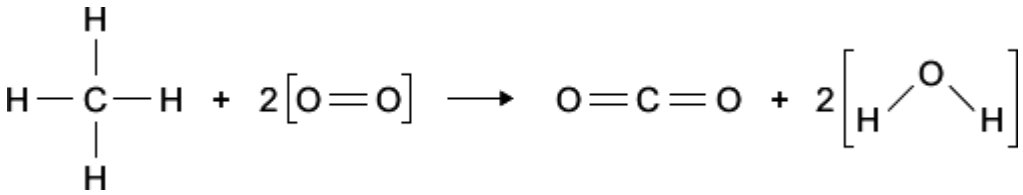
(Total 4 marks)

11 A Bunsen burner releases heat energy by burning methane in air.



(a) Methane (CH_4) reacts with oxygen from the air to produce carbon dioxide and water.

(i) Use the equation and the bond energies to calculate a value for the energy change in this reaction.



Bond	Bond energy in kJ per mole
C — H	414
O = O	498
C = O	803
O–H	464

.....

.....

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.....

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.....

Energy change = ... kJ per mole

(3)

(ii) This reaction releases heat energy.

Explain why, in terms of bond energies.

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.....

.....

(2)

(b) If the gas tap to the Bunsen burner is turned on, the methane does not start burning until it is lit with a match.

Why is heat from the match needed to start the methane burning?

.....

.....

(1)
(Total 6 marks)

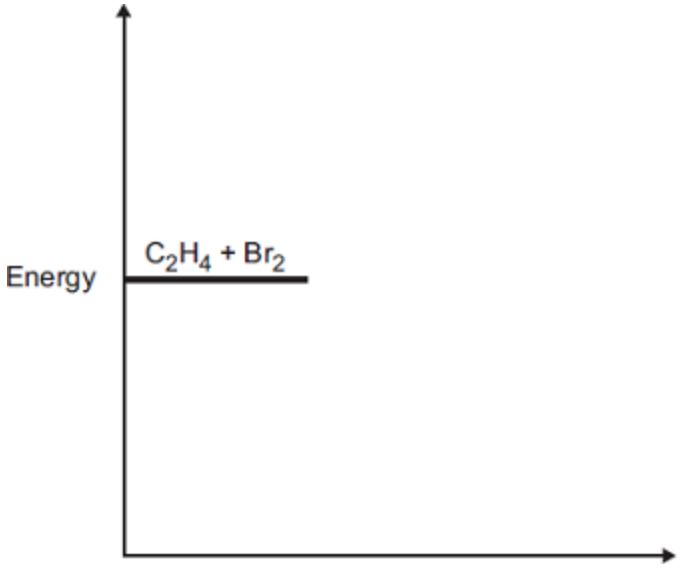
12 The equation for the reaction of ethene and bromine is:

$$C_2H_4(g) + Br_2(l) \longrightarrow C_2H_4Br_2(l)$$

The reaction is exothermic.

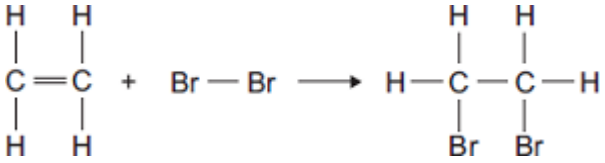
(a) Complete the energy level diagram.

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.

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.....

Enthalpy change (ΔH) = ... kJ per mole

(3)

(ii) The reaction is exothermic.

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

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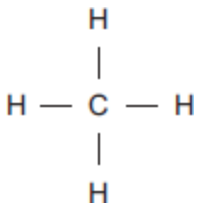
.....

(2)

(Total 8 marks)

13 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. ☐

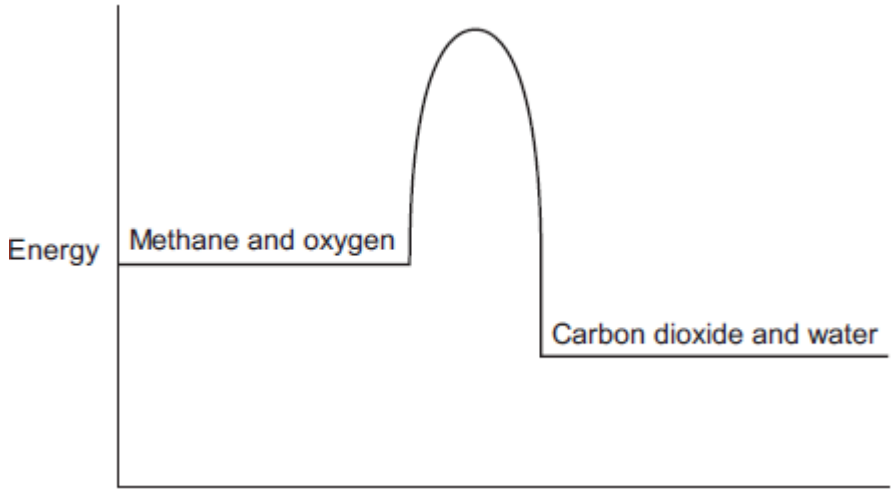
(1)

(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.

$$CH_4 + \text{.....} \longrightarrow CO_2 + \text{.....}$$

(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)

1 (a) electrical

1

(b) (i) 900

accept any answer between 840 and 960

1

(ii) any **one** from:

- little demand
- few hydrogen cars
- *changeover from petrol to hydrogen will take time*

allow answers in terms of petrol

1

(c) X on rising section of *line*

1

[4]

2 (a) exothermic

1

(b) 'Should people use kelp instead of oil as an energy source?'

1

'Will kelp be more popular than coal in the next 10 years?'

1

(c) (i) any **four** from:

*If atom or ion omitted = max **3***

sharing / covalent / metallic
*= max **3***

ignore reference to full outer shells

- potassium (atom) loses (an electron) and iodine (atom) gains (an electron)
- 1 electron
- iodide (ion) has negative charge

allow iodine ion

- potassium (ion) has positive charge
- electrostatic attraction **or** ionic bonding

*accept stable (structure) **or** noble gas (structure)*

4

(ii) because a solid is formed (from two aqueous solutions)

1

(iii) filtering **or** centrifuging **or** decanting

1

[9]

3

(a) (i) 11

1

(ii) 4620 (J)

*correct answer gains **2** marks with or without working*

*allow 4.62kJ for **2** marks*

if answer is incorrect:

*100 × 4.2 × 11 gains **1** mark*

or

*100 × 4.2 × (their temp. rise) gains **1** mark*

or

*100 × 4.2 × (their temp. rise) correctly calculated gains **2** marks*

2

(b) the temperature increases

allow gets hotter

allow heat / energy is given off

1

(c) (i) (energy of) products lower than (energy of) reactants

allow converse

allow arrow C points downwards

1

(ii) A

1

[6]

4

(a) goes up

1

(b) (i) B

1

(ii) A

1

(iii) a catalyst

1

activation energy

1

(c) (i) eg (ensures) complete reaction

allow spread heat / energy

or even heating

allow mixes properly or mix them together or to get correct temperature

ignore dissolves

1

(ii) lid (on beaker)

accept cover beaker

or

insulate (beaker) / use a plastic cup

1

[7]

5 (a) (i) A

1

(ii) B

1

(b) (i) put a lid on (beaker)

any addition to the equipment that would prevent energy loss

or
insulate (top or sides of) beaker

or
use screens to prevent draughts

allow bomb calorimeter

*do **not** allow polystyrene cup*

ignore 'move the crucible'

1

(ii) (temperature change =) 22°C

*correct answer is **2** marks with or without working*

1

(100 × 4.2 × 22 =) 9240

allow ecf from their 22

1

(iii) any **two** from:

- a specified
  human/measurement error
  ignore 1g of glucose insufficient
  ignore 100cm^3 of water too much
  ignore calculation error
  ignore not repeated / anomalous results

- water should be stirred
  allow thermometer in fixed position

- not all of the glucose burns
  allow glucose was impure

- energy used to heat the
  beaker / container
  ignore light energy / evaporation

- recorded the room temperature (at the beginning)
  allow room temperature was higher/different to the temperature of the (cold) water
  allow did not measure the water temperature at the beginning

2

(c) any **one** from:

- for dietary information
  allow consequences of diet
  allow for nutritional information
  allow eat healthily
  ignore balanced diet
  ignore to know how much energy is taken in

- different foods produce
  different amounts of energy

- legal requirement

1

[8]

6

(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 × 435) + 497 = 3977

accept: bonds broken: (2 × 435) + 497 = 1367

1

(6 × 435) + (2 × 336) + (2 × 464) = 4210

bonds made: (2 × 336) + (2 × 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]

7

(a) A = energy / enthalpy change / difference

allow heat change ***or*** *ΔH*

allow energy released

1

B = activation energy / EA

allow definition of activation energy

1

C = carbon dioxide and water

accept products

1

(b) exothermic

allow combustion / redox / oxidation

ignore reduction / burning

1

[4]

8

(a) any **one** from:

- solution becomes colourless or colour fades
- zinc becomes bronze / copper coloured

allow copper (forms) or a solid (forms)

- zinc gets smaller

allow zinc dissolves

- bubbles or fizzing.

ignore precipitate

1

(b) improvement:
use a plastic / polystyrene cup or add a lid

accept use lagging / insulation

1

reason - must be linked
reduce / stop heat loss
OR
improvement:
use a digital thermometer

allow use a data logger

reason - must be linked
more accurate or easy to read or stores data

allow more precise or more sensitive

ignore more reliable

ignore improvements to method, eg take more readings

1

(c) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking Guidance and apply a 'best–fit' approach to the marking.

0 marks
No relevant content

Level 1 (1−2 marks)
There is a statement about the results.

Level 2 (3−4 marks)
There are statements about the results. These statements may be linked or may include data.

Level 3 (5−6 marks)
There are statements about the results with at least one link and an attempt at an explanation.

Examples of chemistry points made in the response:
Description:
Statements
Concentration of copper sulfate increases
Temperature change increases
There is an anomalous result
The temperature change levels off
Reaction is exothermic

Linked Statements
Temperature change increases as concentration of copper sulfate increases
The temperature change increases, and then remains constant
After experiment 7 the temperature change remains constant

Statements including data
The trend changes at experiment 7
Experiment 3 is anomalous

Attempted Explanation
Temperature change increases because rate increases
Temperature change levels off because the reaction is complete

Explanation
As more copper sulfate reacts, more heat energy is given off
Once copper sulfate is in excess, no further heat energy produced

6

[9]

9

(a) energy of product greater than energy of reactants

allow converse

allow energy = heat

*do **not** accept temperature for energy*

allow product / nitrogen oxide is higher than reactants

allow less energy / heat given out than taken in

allow energy / heat is taken in / gained

allow ∆ H is positive

1

(b) (minimum) energy needed to start the reaction / overcome energy barrier

accept (minimum) energy needed for a collision to be successful

1

(c) (i) *correct answer with or without working= **3** marks*

bonds broken = 945 + 498 = 1443 (kJ)

1

bonds made = 2 × 630 = 1260 (kJ)

1

energy change = 1443 - 1260 = (+) 183

ignore sign

allow ecf

1

(ii) energy released forming new bonds is less than energy needed to break existing bonds owtte

allow converse

accept energy change (∆H) is + / positive

*do **not** accept energy <u>needed to form new bonds</u> is less than energy needed to break existing bonds*

1

[6]

10

(a) *correct answer with or without working = **3** marks*

M1: (bonds broken) = 2148 (kJ)

1

M2: (bonds made) = 2354 (kJ)

1

M3: change in energy
= (-) 206 (kJ)

ecf

ignore sign

1

(b) energy released from forming new bonds is greater than energy needed to break existing bonds

allow the energy needed to break bonds is less than the energy released in forming bonds

*do **not** accept energy needed to form bonds*

1

[4]

11 (a) (i) (-)810

ignore sign

*correct answer gains **3** marks with or without working*

*if the answer is incorrect look at the working up to a maximum of **two***

- *bonds broken = (4 × 414) + (2×498) = 2652 kJ*
- *bonds formed = (2x803) + (4x464) = 3462 kJ*
- *correct subtraction of their bonds formed from their bonds broken*

3

(ii) because energy needed to break the bonds

1

is less than the energy released when bonds are formed

1

(b) to provide activation energy

or

to break bonds

1

[6]

12 (a) products are at a lower energy level than reactants

if candidate has drawn a profile for an endothermic reaction penalise first marking point only

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 × 413)) = 2459(kJ)*

*bonds formed (348 + 276 + 276) = 900(kJ) **or** 348 + (2 × 276) + (4 × 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]

13 (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

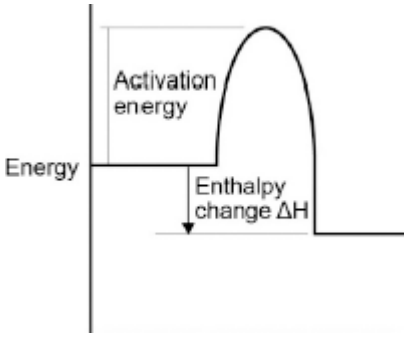
1

(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 O_2

1

2 H_2O

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

ignore state symbols

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

dependent on first marking point

1

(iv) energy is taken in / required to break bonds

accept bond breaking is endothermic

1

energy is given out when bonds are made

accept bond making is exothermic

1

the energy given out is greater than the energy taken in

this mark only awarded if both of previous marks awarded

1

(d) (i) energy to break bonds = 1895

calculation with no explanation max = 2

1

energy from making bonds = 1998

1

1895 − 1998 (= −103)
or
energy to break bonds = 656
energy from making bonds = 759
656 − 759 (= −103)

allow:

bonds broken − bonds made =

413 + 243 − 327 − 432 = -103 for 3 marks.

1

(ii) The C — Br bond is weaker than the C — Cl bon

1

[15]