OXFORD

INTERNATIONAL AQA EXAMINATIONS

Topic Test: OxfordAQA International GCSE Chemistry 9202

Energy changes

Name: _____

Class: _____

Date: _____

Time: **51 minutes**

Marks: **51 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.

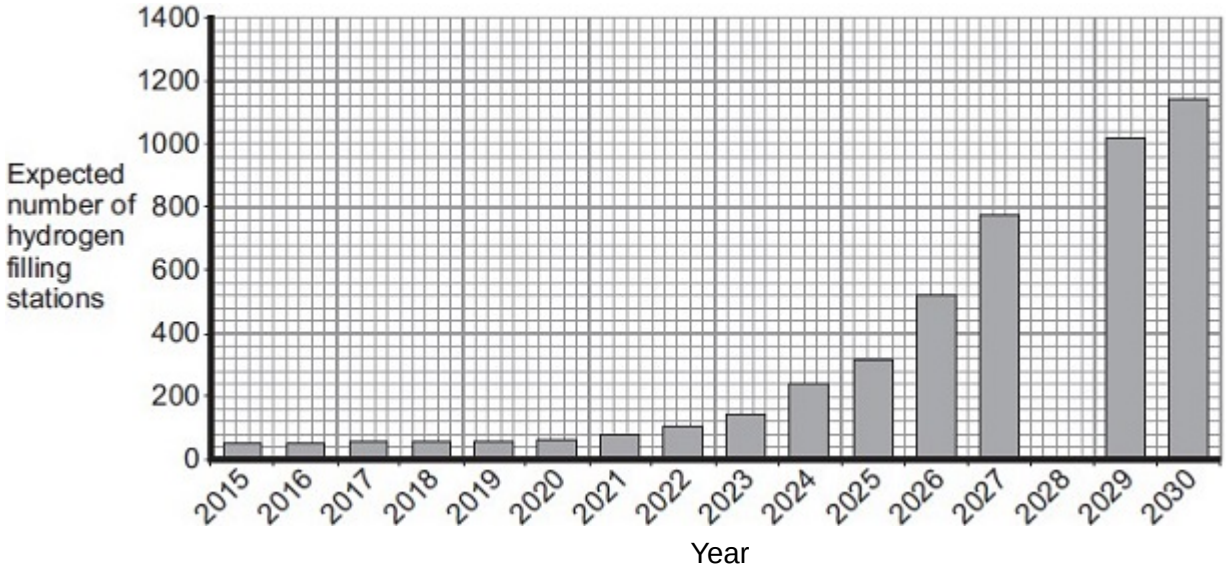
chemical **electrical** **light**

(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.

_____

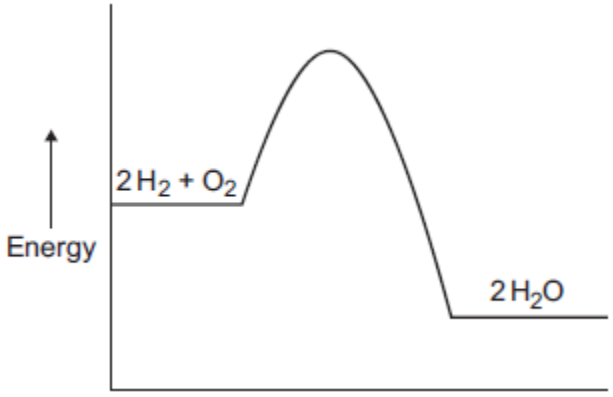
_____

(1)

(c) Hydrogen reacts with oxygen to produce water.

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

Figure 3



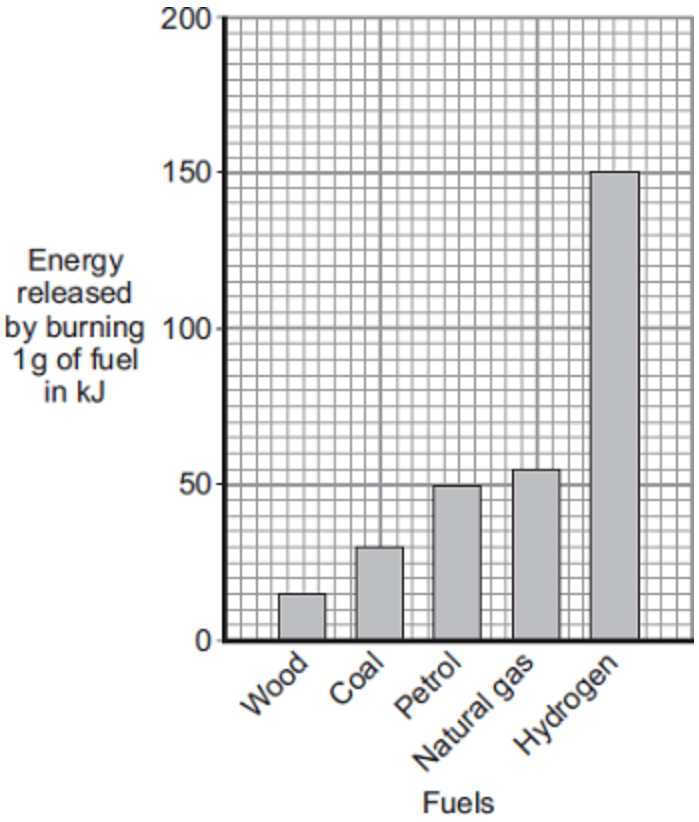
Mark clearly with a cross (**x**) on **Figure 3** where bond breaking happens.

(1)

(Total 4 marks)

2 Energy is released by burning fuels.

(a) The bar chart shows the energy in kilojoules, kJ, released by burning 1 g of five different fuels.



(i) Which fuel releases least energy by burning 1 g?

_____

(1)

(ii) How much energy is released by burning 1 g of coal?

Energy = _____ kJ

(1)

(iii) Calculate the mass of petrol that will release the same amount of energy as 1 g of hydrogen.

Use information from the bar chart to help you.

_____

_____

Mass = _____ g

(1)

(b) Coal burns in oxygen and produces the gases shown in the table.

Name	Formula
Carbon dioxide	CO_2
Water vapour	H_2O
Sulfur dioxide	SO_2

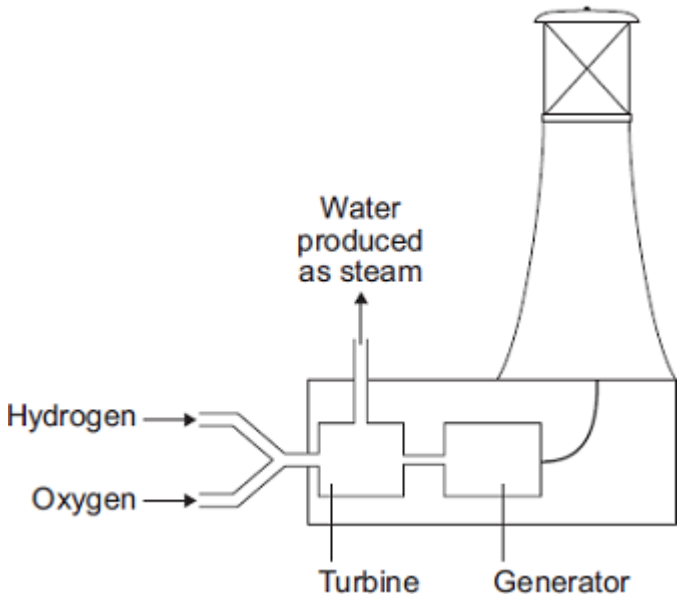
Use information from the table to name **one** element that is in coal.

_____

(1)

(c) Hydrogen can be made from fossil fuels.
Hydrogen burns rapidly in oxygen to produce water only.

A lighthouse uses electricity generated by burning hydrogen.



Suggest **two** advantages of using hydrogen as a fuel.

Use information from the bar chart and the diagram above to help you.

1. _____

_____

2. _____

_____

(2)

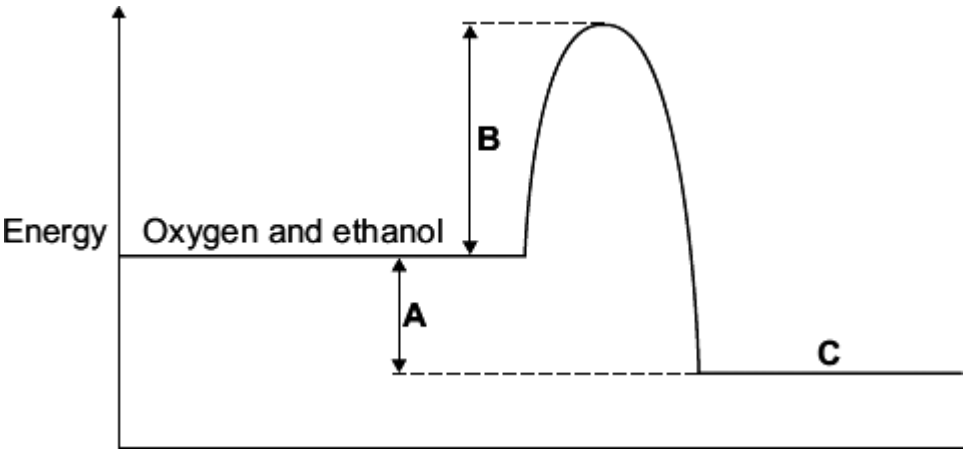
(Total 6 marks)

3 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)

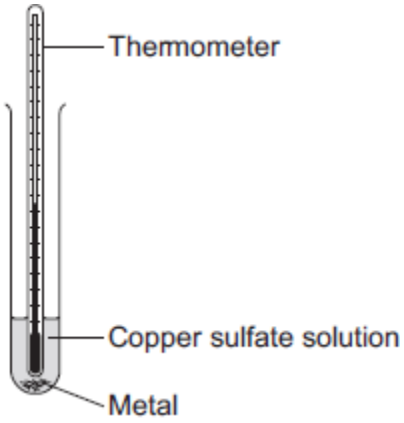
4 A student investigated displacement reactions of metals.

The student added different metals to copper sulfate solution and measured the temperature change.

The more reactive the metal is compared with copper, the bigger the temperature change.

The apparatus the student used is shown in **Figure 1**.

Figure 1



(a) State **three** variables that the student must control to make his investigation a fair test.

1. _____

2. _____

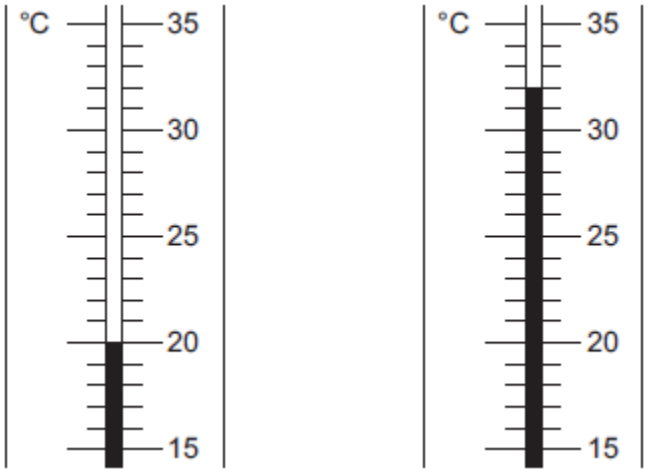
3. _____

(3)

(b) **Figure 2** shows the thermometer in one experiment before and after the student added a metal to the copper sulfate solution.

Figure 2

Before adding metal **After adding metal**



Use **Figure 2** to complete **Table 1**.

Table 1

Temperature before adding metal in °C	_____
Temperature after adding metal in °C	_____
Change in temperature in °C	_____

(3)

(c) The student repeated the experiment three times with each metal.

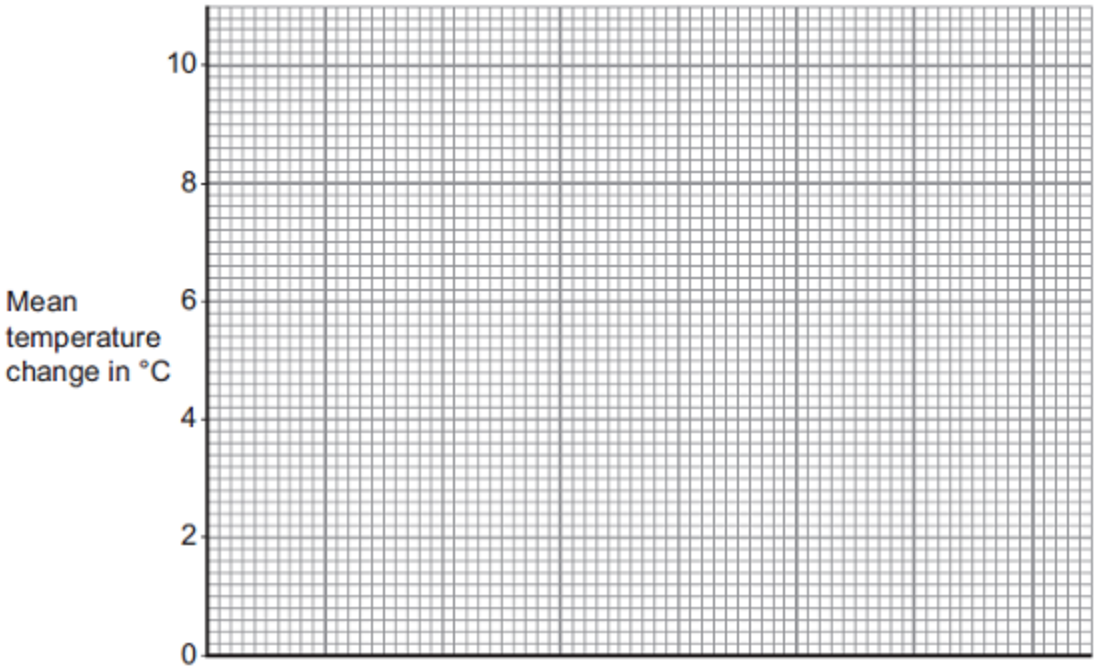
Table 2 shows the mean temperature change for each metal.

Table 2

Metal	**Mean temperature change in °C**
Cobalt	4.5
Gold	0.0
Magnesium	10.0
Nickel	3.0
Silver	0.0
Tin	1.5

(i) On **Figure 3**, draw a bar chart to show the results.

Figure 3



(3)

(ii) Why is a line graph **not** a suitable way of showing the results?

_____

_____

(1)

(iii) Use the results to work out which metal is the most reactive.

Give a reason for your answer.

Most reactive metal _____

Reason _____

_____

(2)

(iv) Explain why there was no temperature change when silver metal was added to the copper sulfate solution.

_____

_____

_____

_____

(2)

(v) It is **not** possible to put all six metals in order of reactivity using these results.

Suggest how you could change the experiment to be able to put all six metals into order of reactivity.

_____

_____

_____

_____

_____

(2)

(Total 16 marks)

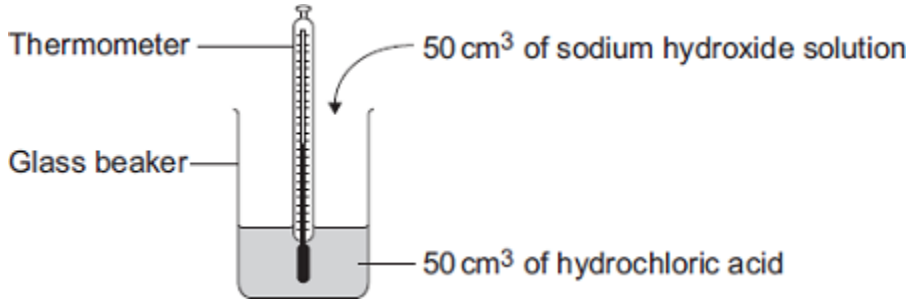
5 Read the information about energy changes and then answer the questions.

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 initial temperature.

The student then quickly added 50 cm^3 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.

Energy change in joules = 100 × 4.2 × 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.

Diagram A

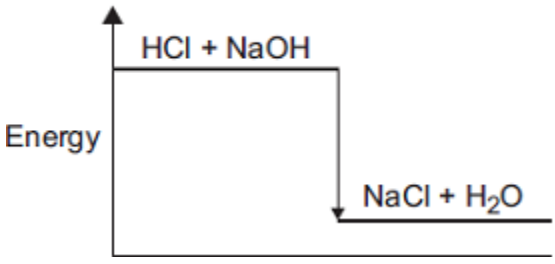
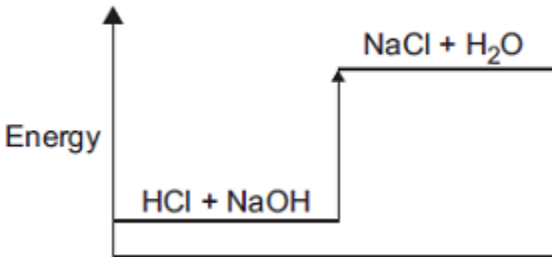


Diagram B



_____

_____

(1)

(Total 7 marks)

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

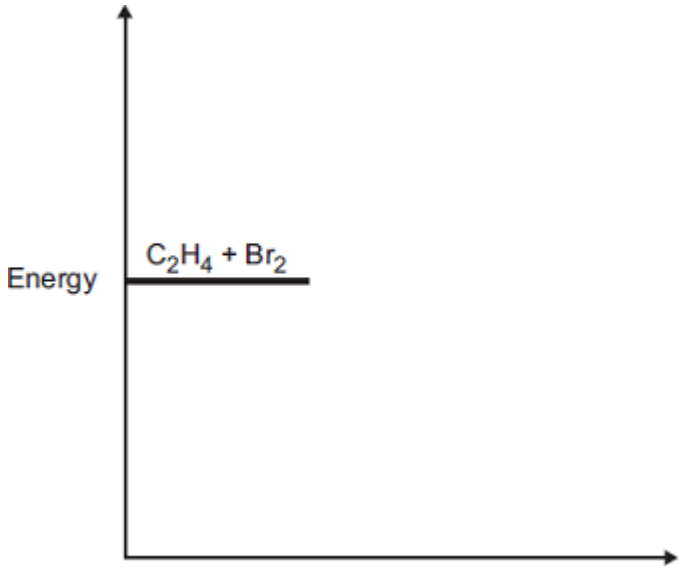
$$C_2H_4(g) + Br_2(l) \longrightarrow C_2H_4Br_2(l)$$

The reaction is exothermic.

(a) Complete the energy level diagram.

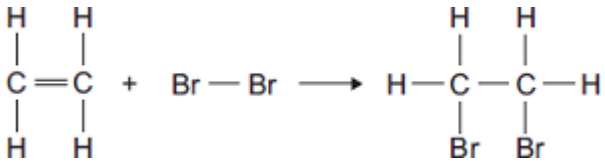
You should label:

- 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.

Enthalpy change (ΔH) = _____ kJ per mole

(3)

(ii) The reaction is exothermic.

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

(2)

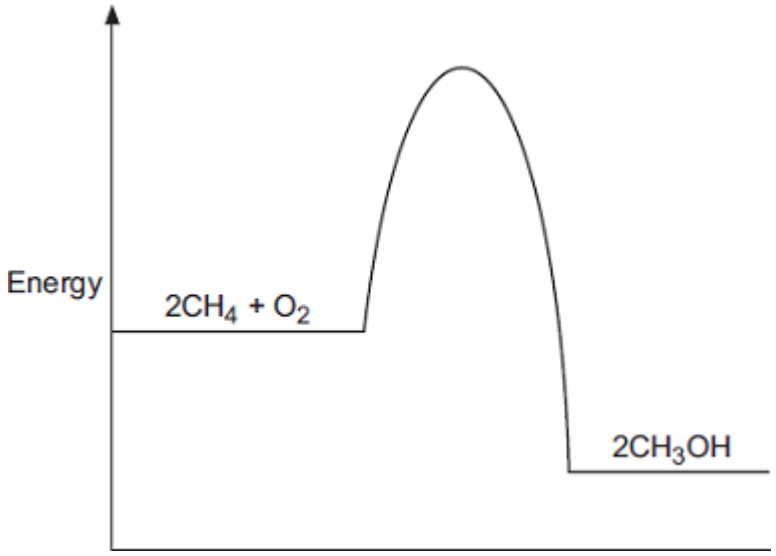
(Total 8 marks)

7 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?

_____

_____

_____

(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?

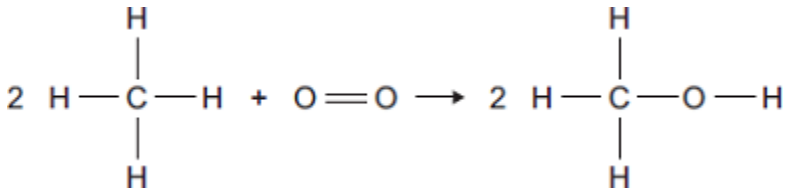
_____

_____

_____

(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)

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) (i) wood

1

(ii) 30 (kJ)

1

(iii) 3 / three (g)

1

(b) carbon / C

or hydrogen / H

or sulfur / S

allow oxygen / O

1

(c) releases most energy

accept releases a lot of energy / burns rapidly

ignore references to cost

1

no harmful gases / no or less pollution formed / no global warming / no climate change / no greenhouse gas

accept produces water (only) / steam

accept does not produce sulfur dioxide / carbon dioxide / carbon monoxide / particles / smoke

1

[6]

3

(a) A = <u>energy</u> / <u>enthalpy</u> 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]

4

(a) any **three** from:

- concentration of (salt) solution
- volume of (salt) solution

  ignore amount of solution
- **initial** temperature (of the solution)

  ignore room temperature
- surface area / form of metal
- moles of metal

  allow mass / amount

  ignore time

  ignore size of tube

3

(b) 20

1

32

1

12

allow ecf

1

(c) (i) four bars of correct height

tolerance is + / - half square

*3 correct for **1** mark*

2

bars labelled

1

(ii) *one variable* is non-continuous / categoric

accept qualitative or discrete

accept no values between the metals

1

(iii) magnesium

1

because biggest temperature change

accept gives out most energy

ignore rate of reaction

dependent on first mark

1

(iv) does not react / silver cannot displace copper

1

because silver not more reactive (than copper) **or** silver below copper in reactivity series

*do **not** accept silver is less reactive than copper sulfate*

1

(v) replace the copper sulfate

could be implied

1

with any compound of a named metal less reactive than copper

allow students to score even if use an insoluble salt

1

[16]

5 (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 × 4.2 × 7) = 2940

ecf from (e)

1

(g) diagram A **and**
reaction exothermic / heat evolved / Δ H is negative / temperature rises

accept energy is lost (to the surroundings)

accept energy of products lower than reactants

allow arrow goes downwards

1

[7]

6 (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]

7 (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]