Exothermic and Endothermic Reactions

Mark Scheme

Level	GCSE (9-1)
Subject	Combined Science: Trilogy - Chemistry
Exam Board	AQA
Topic	5.5 Energy Changes
Sub-Topic	Exothermic and Endothermic Reactions
Difficulty Level	Gold Level
Booklet	Mark Scheme

Time Allowed: **59 minutes**

Score: **/58**

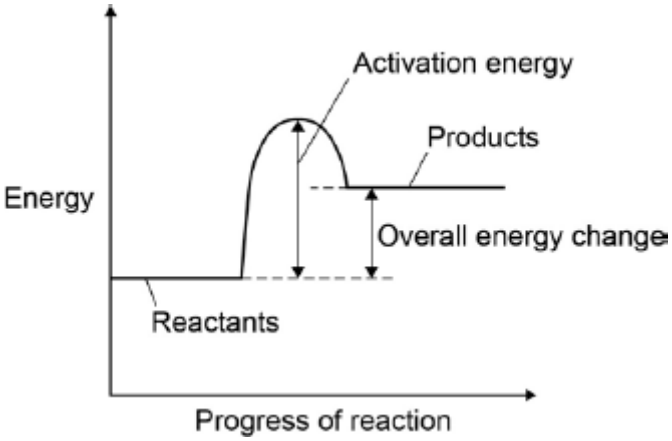
Percentage: **/100**

Grade Boundaries:

M1.(a) the relative energies of the reactants, products and the overall energy change

1

the activation energy



1

(b) (4 × 413) + (2 × 498) = 2 648

1

(2 × 805) + (4 × 464) = 3 466

1

(3466 − 2648 =) 818 (kJ / mol)

1

*allow max **2** marks for one ecf*

(c) **Level 3 (5–6 marks):**
A coherent method is described with relevant detail, which demonstrates a broad understanding of the relevant scientific techniques and procedures. The steps in the method are logically ordered with the dependent and control variables correctly identified. The method would lead to the production of valid results.

Level 2 (3–4 marks):
The bulk of a method is described with mostly relevant detail, which demonstrates a

reasonable understanding of the relevant scientific techniques and procedures. The method may not be in a completely logical sequence and may be missing some detail.

Level 1 (1–2 marks):
Simple statements are made which demonstrate some understanding of some of the relevant scientific techniques and procedures. The response may lack a logical structure and would not lead to the production of valid results.

0 marks:
No relevant content

Indicative content

Named apparatus

- thermometer
- measuring cylinder
- stirring rod
- spatula
- plastic cup (with lid) or beaker
- stopwatch
- filter paper or watch glass
- balance

Method

- weigh the same mass of each metal in each same state of division eg powder
- measure a set volume of sulfuric acid into a plastic cup or beaker
- measure and record the temperature of the sulfuric acid
- add metal W into the plastic cup or beaker
- stir and record the highest temperature or record the temperature after a set time
- calculate the increase in temperature
- repeat the method for metals X, Y and Z
- repeat for each metal at least three times to calculate a mean

Safe use

- comment on safe use should include wearing safety glasses

6

(d) **W**>**Y**>**X**>**Z**

1

reason for position of **W** and **Z**

W *reacts with most solutions whereas* ***Z*** *reacts with none of the solutions*

1

reason for position of **X** and **Y**

***Y** is more reactive than **X** because **Y** reacts more with sulfuric acid*

1

(e) magnesium is most reactive because not displaced by any metal

1

zinc is second most reactive because displaced by only one metal

1

copper and hydrogen cannot be placed in order of reactivity or are least reactive because

1

they both are displaced by the most / three metals

1

experiment – add sulfuric acid to copper because copper is less reactive than hydrogen
then copper would not react with sulfuric acid to displace hydrogen

1

[19]

M2.(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

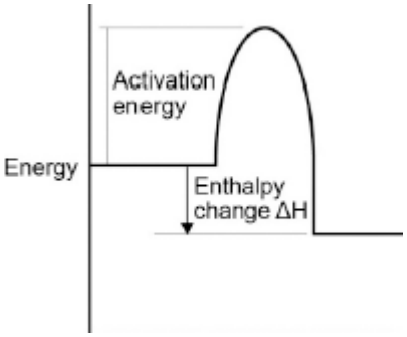
1

(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 bond

1

[15]

M3.(a) (i) any **one** from:

- incorrect measurement of temperature or volume
- incorrect recording of temperature
- failure to stir
- heat loss

ignore faulty equipment

1

(ii) 32 - 33

1

(iii) 55

1

(iv) 20

1

(v) 4620

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

1

J / joules

allow kJ if evidence of dividing by 1000

mark independently, but if a numerical answer has been divided by 1000 must be kJ.

allow ecf from their answers to (iii) and (iv)

1

(b) twice as much energy released

1

but twice as much water to heat

*allow more energy released but more water to heat for **2 marks***

*if no other mark awarded, allow twice the amount of hydrochloric acid used for **1 mark***

1

[8]

M4.(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]

M5.(a) the forward and backward reactions occur
allow reversible

1

at (exactly) the same rate

1

in a closed system
allow therefore the concentrations / amounts of the reactants and products remain the same

1

(b) (i) increasing the temperature would lower the yield of ethanol **or** the (position of) equilibrium moves to the left
*if student has stated that increasing the temperature increases the yield then award **0** marks*

1

since the backwards reaction is endothermic **or** the forward reaction is exothermic

1

(ii) increasing the pressure would increase the yield of ethanol **or** the (position of) equilibrium moves to the right

*if student has stated that increasing the pressure decreases the yield then award **0** marks*

1

because the position (of equilibrium) moves in the direction of the lower number of moles (of gas)

2 (moles / molecules / volumes / particles) on lhs / 1 (mole / molecule / volume / particle) on rhs

1

(c) (a catalyst) provides an alternative pathway

1

with lower activation energy

or

(a catalyst) lowers the activation energy (1)

so less energy is needed to react **or** more particles react (1)

1

[9]