GCSE
CHEMISTRY
AQA - COMBINED SCIENCE
MARK SCHEME

C5
ENERGY CHANGES
TEST 2
(a) correct answer with or without working = 3 marks

M1: (bonds broken) = 2148 (kJ)

M2: (bonds made) = 2354 (kJ)

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

   *ecf*

   *ignore sign*

(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*

(a) electrical

(b) (i) 900

   *accept any answer between 840 and 960*

(ii) any one from:
- little demand
- few hydrogen cars
- *changeover from petrol to hydrogen will take time*

   *allow answers in terms of petrol*

(c) X on rising section of line

(a) (a reaction that) transfers energy to the surroundings

(b) [Diagram of energy graph]

   *
(c) \( 2 \times 16 = 32 \) 
\[ (\text{Mr} =) \ 44 \]
72.7 (%) 

(d) \( 2^2 \)

\textit{allow multiples} 

(e) 3.2 g of \( \text{O}_2 \) produced from 6.8 g of \( \text{H}_2\text{O}_2 \) 

\[ 32 \text{ (g)} \]

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(a) continuous

\textit{independent} 

(b) 31.5 – 24.0

7.5 \( (^\circ \text{C}) \)

\textit{an answer of 7.5 \( (^\circ \text{C}) \) scores 2 marks} 

(c) 25.5 – 26.0 cm\(^3\) 

(d) did not stir

\textit{or} 

did not wait long enough for the highest temperature to be reached 

\( \frac{40}{1000} \) \( \text{or} \ \frac{1}{20} \) 

\times 80 

3.2 (g) 

\textit{an answer of 3.2 (g) scores 3 marks}
(a) (i) 5.75 or 5.8
   correct answer with or without working gains 2 marks
   correct working showing addition of any four results and division by 4 gains 1 mark
   OR
   6(.04) for 1 mark
   2

(ii) use a polystyrene cup or lid
    accept insulate the beaker
to prevent energy/heat gain
    accept to prevent energy/heat transfer
do not accept energy/heat loss
   OR
   use a digital thermometer
    allow use a data logger
easier to read (to 0.1°C)
   1

(b) (as mass increases) the final temperature increases then stays constant
correct reference to a value above 8 g up to and including 10 g as mass when the trend changes
   1
   [7]

(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

\textit{ignore arrowheads}

enthalpy change labelled from reagents to products

\[ \text{Activation energy} \]

\[ \text{Enthalpy change } \Delta H \]

\textit{arrowhead must go from reagents to products only}

(ii) \( 2 \text{O}_2 \)

\( 2 \text{H}_2\text{O} \)

\textit{if not fully correct, award 1 mark for all formulae correct. ignore state symbols}

(iii) carbon monoxide is made

this combines with the blood / haemoglobin or prevents oxygen being carried in the blood / round body or kills you or is toxic or poisonous

\textit{dependent on first marking point}

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

\textit{accept bond breaking is endothermic}

energy is given out when bonds are made

\textit{accept bond making is exothermic}

the energy given out is greater than the energy taken in

\textit{this mark only awarded if both of previous marks awarded}
(d) (i) energy to break bonds = 1895

\[\text{calculation with no explanation max } = 2\]

energy from making bonds = 1998

\[1895 - 1998 = -103\]

or

to break bonds = 656
energy from making bonds = 759
\[656 - 759 = -103\]

allow:

\[\text{bonds broken } - \text{ bonds made } = \]

\[413 + 243 - 327 - 432 = -103 \text{ for 3 marks.}\]

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

1

[15]

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

the activation energy

(b) \[(4 \times 413) + (2 \times 498) = 2648\]

\[(2 \times 805) + (4 \times 464) = 3466\]

\[(3466 - 2648 =) 818 \text{ (kJ / mol)}\]

\[\text{allow max } 2 \text{ marks for one ecf}\]
(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
(d) \[ W > Y > X > Z \]

reason for position of \( W \) and \( Z \)

\( W \) reacts with most solutions whereas \( Z \) reacts with none of the solutions

reason for position of \( X \) and \( Y \)

\( Y \) is more reactive than \( X \) because \( Y \) reacts more with sulfuric acid

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

zinc is second most reactive because displaced by only one metal

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

they both are displaced by the most / three metals

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

(a) (i) \[ \Delta T = (64 - 17) = 47^\circ C \]

\[ 750 \times 4.2 \times 47 \]

allow ecf using their \( \Delta T \)

148 050

correct answer gains 3 marks with or without working

ignore sign

allow 148.05 kJ

allow 148 kJ
(ii) 1085.7

- correct answer gains 2 marks with or without working.
- allow answer in range 1080 – 1089 for 2 marks
- allow answer in range 1080000 – 1089000 for 1 mark
- if answer is incorrect allow $6/44 = 0.136$ mol for 1 mark
- allow $(44 \times \text{their (a)(i)})/(6 \times 1000)$ correctly calculated for 2 marks
- allow $(44 \times \text{their (a)(i)})/6$ correctly calculated for 1 mark

If they have used the given value of 144 000:
- Allow any answer in range 1051 - 1059 for 2 marks with or without working.
- allow any answer in range 1051000 – 1059000 for 1 mark

(iii) repeat the experiment and then calculate the mean

Any one from:

- use a lid
- insulate the beaker
  - do not allow flammable insulation
- stir
- prevent draughts

(iv) inaccuracies likely to have similar effects

- allow systematic errors

(b) (i) 8530

- correct answer gains 3 marks with or without working.
- If answer is incorrect;
  - $(6 \times 803) = 4818$ gains 1 mark
  - $(8 \times 464) = 3712$ gains 1 mark
- correct addition of their calculated values gains 1 mark (ecf)

(ii) $6481 - 8530 = (-) 2049$

- ignore sign
- allow ecf from (b)(i)

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