

M1.(a) line goes up before it goes down

1

energy given out correctly labelled

1

activation energy labelled correctly

1

(b) electrostatic force of attraction between shared pair of negatively charged electrons

1

and both positively charged nuclei

1

(c) bonds formed =  $348 + 4(412) + 2(276) = 2548$  kJ / mol

1

bonds broken – bonds formed =  $612 + 4(412) + (\text{Br-Br}) - 2548 = 95$  kJ / mol

1

*Alternative approach without using C-H bonds*

*For step 1 allow =  $348 + 2(276) = 900$  kJ / mol*

*Then for step 2 allow  $612 + (\text{Br-Br}) - 900 = 95$  kJ / mol*

193 (kJ / mol)

1

*accept (+)193 (kJ / mol) with no working shown for 3 marks*

*-193(kJ / mol) scores 2 marks*

*allow ecf from step 1 and step 2*

(d) **Level 3 (5–6 marks):**

A detailed and coherent explanation is given, which demonstrates a broad understanding of the key scientific ideas. The response makes logical links between the points raised and uses sufficient examples to support these links. A conclusion is reached.

**Level 2 (3–4 marks):**

An explanation is given which demonstrates a reasonable understanding of the key scientific ideas. A conclusion may be reached but the logic used may not be clear or linked to bond energies.

**Level 1 (1–2 marks):**

Simple statements are made which demonstrate a basic understanding of some of the relevant ideas. The response may fail to make logical links between the points raised.

**0 marks:**

No relevant content.

**Indicative content**

Size and strength

- chlorine atoms have fewer electron energy levels / shells
- chlorine atoms form stronger bonds
- Cl–Cl bond stronger than Br–Br
- C–Cl bond stronger than C–Br

Energies required

- more energy required to break bonds with chlorine
- more energy given out when making bonds with chlorine
- overall energy change depends on sizes of energy changes

Conclusions

- if C–Cl bond changes more, then less exothermic
- if C–Cl bond changes more then more exothermic
- can't tell how overall energy change will differ as do not know which changes more.

6

[14]

M2.(a) because sulfur dioxide causes acid rain 1

which kills fish / aquatic life **or** dissolves / damages statues / stonework **or** kills / stunts growth of trees

*if no other mark awarded then award 1 mark for sulfur dioxide is toxic or causes breathing difficulties.*

1

(b) (i) electrons are lost 1

(ii)  $\text{Cu}^{2+} + 2\text{e}^{-} \rightarrow \text{Cu}$   
*allow  $\text{Cu}^{2+} \rightarrow \text{Cu} - 2\text{e}^{-}$*   
*ignore state symbols*

1

(iii) copper sulfate  
*allow any ionic copper compound* 1

(c) (lattice of) positive ions 1

delocalised electrons  
*accept sea of electrons* 1

(electrostatic) attraction between the positive ions and the electrons 1

electrons can move through the metal / structure **or** can flow  
*allow electrons can carry charge through the metal / structure*  
*if wrong bonding named or described or attraction between oppositely charged ions then do not award M1 or M3 – MAX 2* 1

(d) (copper compounds are absorbed / taken up by) plants  
*allow crops* 1

which are burned

1

the ash contains the copper compounds

*do not award M3 if the ash contains copper (metal)*

1

(e)

/ A <sub>r</sub>	55.6 / 63.5	16.4 / 56	28.0 / 32
moles	0.876	0.293	0.875
ratio	3	1	3
formula	Cu <sub>3</sub> FeS <sub>3</sub>		

*award 4 marks for Cu<sub>3</sub>FeS<sub>3</sub> with some correct working*

*award 3 marks for Cu<sub>3</sub>FeS<sub>3</sub> with **no** working*

*if the answer is not Cu<sub>3</sub>FeS<sub>3</sub> award up to 3 marks for correct steps from the table apply ecf*

*if the student has inverted the fractions award 3 marks for an answer of CuFe<sub>3</sub>S*

4

[16]

M3.(a) (i) the products are at a lower energy level than the reactants

*accept products have less energy / less energy at the end than the beginning*

1

(ii) because a catalyst provides an alternative / different pathway / mechanism / reaction route

*accept adsorption or 'increases concentration at the surface'  
ignore absorption*

1

(that has) lower activation energy

*allow weakens bonds*

*allow idea of increased successful collisions.*

*DO NOT ALLOW answers stating catalysts provide energy for M1 and M2*

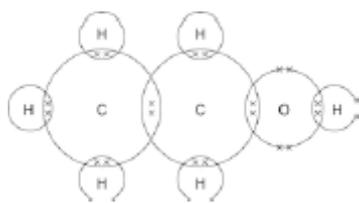
1

(b) one pair of electrons in each overlap (8 pairs in total)

*allow any combination of dots, crosses or other symbols*

1

the rest of the diagram correct with four non-bonding electrons on the oxygen giving a total of eight electrons in oxygen outer energy level.



*gains 2 marks*

1

(c) (i)  $\pm 3024$  (J)

*correct answer with or without working gains 3 marks*

*if the answer is incorrect, award up to 2 marks for the following steps:*

- $\Delta T = 14.4(^{\circ}\text{C})$
- $50 \times 4.2 \times 14.4$

*allow ecf for incorrect  $\Delta T$*

3

(ii) 0.015(2173913)

*correct answer with or without working gains 3 marks*

*if answer is incorrect, allow 1 mark each for any of the following steps up to a max of 2.*

- 0.70g
- $M_r$  of ethanol = 46
- $0.70 / 46$

*allow ecf in final answer for arithmetical errors*

3

(iii)  $\pm 198\,720$  (J / mole)

*c(i)  $\div$  c(ii)*

*allow ecf from (c)(i) and (c)(ii)*

*0.015 gives 201600*

*0.0152 gives 198947*

*0.01522 gives 198686*

1

(d) (as the molecules get bigger **or** the number of carbon atoms increases) the intermolecular forces

*allow intermolecular bonds*

1

(intermolecular forces) increase

*allow more / stronger (intermolecular forces)*

1

and therefore require more (heat) energy to overcome

*breaking covalent bonds or unspecified bonds max 1 mark (M3)*

1

[15]