

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 =  $348 + 4(412) + 2(276) = 2548 \text{ kJ / mol}$  1

bonds broken – bonds formed =  $612 + 4(412) + (\text{Br-Br}) - 2548 = 95 \text{ kJ / mol}$  1

*Alternative approach without using C-H bonds*

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

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

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) (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*

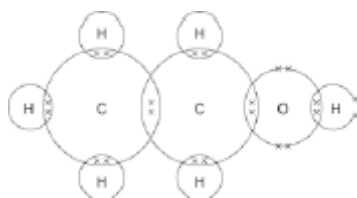
1

(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]

M3.(a) 31

1

(b) (i) any **two** from:

- incorrect reading of thermometer / temperature
- incorrect measurement of volume of acid
- incorrect measurement of volume of alkali (burette).

2

(ii) glass is a (heat) conductor **or** polystyrene is a (heat) insulator

*answer needs to convey idea that heat lost using glass **or** not lost using polystyrene*

*accept answers based on greater thermal capacity of glass (such as "glass absorbs more heat than polystyrene")*

1

(c) (i) temperature increases

1

(ii) no reaction takes place **or** all acid used up **or** potassium hydroxide in excess

1

cool / colder potassium hydroxide absorbs energy **or** lowers temperature

*ignore idea of heat energy being lost to surroundings*

1

(iii) take more readings

*ignore just "repeat"*

1

around the turning point **or** between 20 cm<sup>3</sup> and 32 cm<sup>3</sup>

*accept smaller ranges as long as no lower than 20 cm<sup>3</sup> and no higher than 32 cm<sup>3</sup>*

1

(d) 1.61 **or** 1.6(12903)

*correct answer with or without working scores **3***

*if answer incorrect, allow a maximum of **two** from:*

*moles nitric acid =  $(2 \times 25 / 1000) = 0.05$  for **1** mark*

*moles KOH = (moles nitric acid) = 0.05 for **1** mark*

*concentration KOH = 0.05 / 0.031*

*answer must be correctly rounded (1.62 is incorrect)*

3

(e) same amount of energy given out

1

which is used to heat a smaller total volume **or** mixture has lower thermal capacity

**or**

number of moles reacting is the same

but the total volume / thermal capacity is less

*if no other marks awarded award 1 mark for idea of reacting faster*

1

[14]

M4.(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

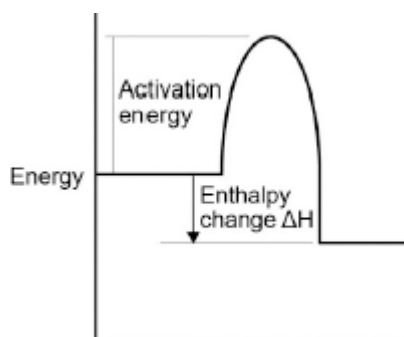
1

(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<sub>2</sub>

1

2 H<sub>2</sub>O

*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]