

MARK SCHEME

GCSE

CHEMISTRY

AQA - TRIPLE SCIENCE

C5 - TEST 6

ENERGY CHANGES

Advanced

Mark schemes

- 1.** (a) (zinc has) lost electron(s)
accept loss of electrons 1
- (b) copper is the least reactive 1
- because it gave the most negative voltage when it was metal 2
or
it gave the biggest voltage with chromium
or
it gave the most positive voltage when it was metal 1 1
- (c) -0.7 V 1
- The voltage with chromium and copper is 1.2
accept use of other cell pairings such as tin with copper and tin with iron 1
- The voltage with chromium and iron is 0.5 and copper is less reactive (than iron) 1
- (d) hydrogen + oxygen = water 1
- (e) $\text{H}_2 \rightarrow 2\text{H}^+ + 2\text{e}^-$ 1
- $\text{O}_2 + 4\text{H}^+ + 4\text{e}^- \rightarrow 2\text{H}_2\text{O}$ 1
- [9]**
- 2.** (a) use a polystyrene cup instead of a (glass) beaker
allow insulate the beaker
allow use a lid 1
- minimises energy transfer from the surroundings
or
for better insulation 1
- (b) concentration of hydrochloric acid 1

- (c) $\frac{5.6 + 5.7 + 5.4}{3}$ 1
- = 5.6 (°C) 1
- ± 0.2 1
- (d) straight line from origin to (5.0, 6.4)
must not deviate to anomalous point 1
- horizontal line from (5.0, 6.4) to (8.0, 6.4)
must not deviate to anomalous point 1
- (e) as mass (of potassium hydrogencarbonate) increases, temperature decrease / change increases 1
- until 5 g (to 8 g) (of potassium hydrogencarbonate has been added)*
allow ecf from lines of best fit 1
- (because) the reaction has finished
or
(because) all the acid has reacted
or
(because) no more solid can react
or
(because) the solid is in excess 1
- (f) not stirred correctly 1

[12]

3.

- (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
- (ii) because a catalyst provides an alternative / different pathway / mechanism / reaction route
accept adsorption or 'increases concentration at the surface'
ignore absorption

1

1

(that has) lower activation energy

allow weakens bonds

allow idea of increased successful collisions.

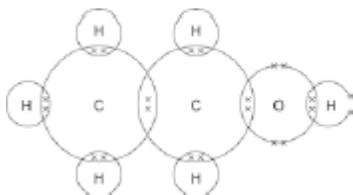
DO NOT ALLOW answers stating catalysts provide energy for M1 and M2

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) ± 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 ΔT

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]

4.

(a) $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$

allow multiples

1

(b) 3444 J

if answer incorrect:

one mark for temperature increase = 16.4 °C

one mark for mass of water = 50 g

ecf for one incorrect value gains two marks for correct calculation

no ecf for two incorrect values

3

(c) (i) 1276 (kJ per mole)

ignore + or -

if answer incorrect:

$[(5 \times 413) + 347 + 358 + 467] + [(3 \times 495)] = 4722$ (1 mark)

$[(4 \times 799) + (6 \times 467)] = 5998$ (1 mark)

correct subtraction of calculated energy values (1 mark)

3

(ii) because energy released when bonds form is greater than energy used when bonds broken

allow converse

if no mark awarded allow one mark for energy is used to break bonds

or

one mark for energy is released when bonds form

2

(iii) products line lower than reactants

1

activation energy labelled

1

overall energy change labelled

1

[12]

5.

(a) (i) (-)810

ignore sign

correct answer gains 3 marks with or without working

if the answer is incorrect look at the working up to a maximum of two

• *bonds broken = $(4 \times 414) + (2 \times 498) = 2652$ kJ*

• *bonds formed = $(2 \times 803) + (4 \times 464) = 3462$ kJ*

• *correct subtraction of their bonds formed from their bonds broken*

3

(ii) because energy needed to break the bonds

1

is less than the energy released when bonds are formed

1

(b) to provide activation energy

or

to break bonds

1

[6]

6.

(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 less, 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]

7.

- (a) circle round any one (or more) of the covalent bonds

any correct indication of the bond – the line between letters

1

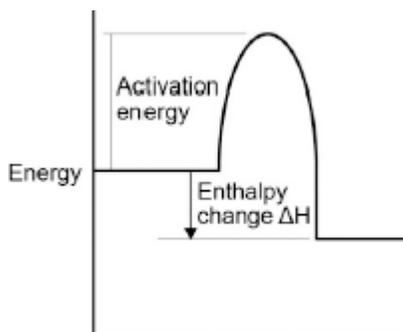
- (b) Methane contains atoms of two elements, combined chemically

1

- (c) (i) activation energy labelled from level of reagents to highest point of curve
ignore arrowheads

1

enthalpy change labelled from reagents to products



*arrowhead **must** go from reagents to products only*

1

- (ii) 2O_2

1



*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]