

MARK SCHEME

GCSE

CHEMISTRY

AQA - TRIPLE SCIENCE

C5 - TEST 4

ENERGY CHANGES

Intermediate

Mark schemes

1.

- (a) all 4 metals labelled and suitable scale on y-axis

magnesium value must be at least half the height of the grid

1

all bars correctly plotted

allow a tolerance of $\pm\frac{1}{2}$ a small square

ignore width and spacing of bars

allow 1 mark if copper not included and other 3 bars plotted correctly

1

- (b) temperature increases

allow (because) energy / 'heat' is transferred to the surroundings

allow energy / 'heat' is given out

or

temperature does not decrease

allow energy / 'heat' is not taken in (from the surroundings)

allow the energy of the products is less than the energy of the reactants

1

ignore because it is exothermic

ignore references to copper

- (c) suitable method described

1

the observations / measurements required to place in order

dependent on a suitable method

1

an indication of how results would be used to place the unknown metal in the reactivity series

1

a control variable to give a valid result

1

approaches that could be used

approach 1:

add the unknown metal to copper sulfate solution (1)

measure temperature change (1)

place the metals in order of temperature change (1)

any **one** from (1):

- same volume of solution
- same concentration of solution
- same mass / moles of metal
- same state of division of metal

approach 2:

add the metal to salt solutions of the other metals

or

heat the metal with oxides of the other metals (1)

measure temperature change (only if salt solutions used)

or

observe whether a chemical change occurs (1)

place the metals in order of temperature change **or**

compare whether there is a reaction to place in correct order (1)

any **one** from (1):

- same volume of salt solutions
- same concentration of salt solutions
- same (initial) temperature of salt solutions
- same mass / moles of metal **or** metal oxide
- same state of division of metal **or** metal oxide

approach 3:

add all of the metals to an acid (1)

measure temperature change or means of comparing rate of reaction (1)

place the metals in order of temperature change or rate of reaction (1)

any **one** from (1):

- same volume of acid
- same concentration of acid
- same (initial) temperature of acid
- same mass / moles of metal
- same state of division of metal

approach 4:

set up electrochemical cells with the unknown metal as one electrode and each of the other metals as the other electrode (1)

measure the voltage of the cell (1)

place the metals in order of voltage (1)

any **one** from (1):

- same electrolyte
- same concentration of electrolyte
- same (initial) temperature of acid
- same temperature of electrolyte

(d) correct shape for exothermic reaction

the reactant and product lines needed not be labelled

*do **not** accept incorrectly labelled reactant and product lines*

1

labelled activation energy

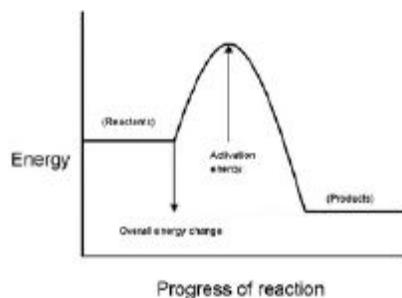
1

labelled (overall) energy change

1

ignore arrow heads

an answer of:



scores 3 marks

[10]

2.

(a) the chemical reaction is reversible

1

(b) any **two** from:

- type of electrode
- electrolyte
- concentration of electrolyte
- temperature

2

(c) $\text{H}_2 + 2\text{OH}^- \rightarrow 2\text{H}_2\text{O} + 2\text{e}^-$

allow multiples

1

- (d) contains OH⁻ ions 1
- (e) (bonds broken)
- $$((6 \times 412) + (2 \times 360) + (2 \times 464) + (3 \times 498)) = 5614$$
- 1
- (bonds made)
- $$((4 \times 805) + (8 \times 464)) = 6932$$
- 1
- (overall energy change)
- $$(6932 - 5614) = -1318 \text{ (kJ / mol)}$$
- 1
- allow ecf from marking point 1 and / or marking point 2*
- an answer of 1318 (kJ / mol) scores 3 marks*

[8]

3.

- (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 1
- ignore just "repeat"*
- around the turning point **or** between 20 cm³ and 32 cm³
- accept smaller ranges as long as no lower than 20 cm³ and no higher than 32 cm³*
- 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]

4.

(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 $(614 + 193 + (4 \times 413)) = 2459$ (kJ)

bonds formed $(348 + 276 + 276) = 900$ (kJ) or $348 + (2 \times 276) + (4 \times 413) = 2552$ (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

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5.

(a) electrical

1

(b) using hydrogen saves petrol / diesel / *crude oil*

allow crude oil is non-renewable

ignore hydrogen is renewable

1

using hydrogen (in fuel cells) does not cause pollution

accept no carbon dioxide produced

allow less carbon dioxide produced

allow hydrogen produces only water

1

(c) (i) (-)486

correct answer with or without working gains 3 marks

if answer is incorrect:

*(2 × 436) + 498 **or** 1370 gains 1 mark*

*4 × 464 **or** 1856 gains 1 mark*

correct subtraction of ecf gains 1 mark

3

(ii) products lower than reactants

1

reaction curve correctly drawn

1

activation energy labelled

1

[9]

6.

(a) (i) energy / heat of products less than energy of reactants

allow converse

allow products are lower than reactants

allow more energy / heat given out than taken in

allow methanol is lower

allow energy / heat is given out / lost

allow ΔH is negative

1

- (ii) lowers / less activation energy
allow lowers energy needed for reaction
or it lowers the peak/ maximum
*do **not** allow just 'lowers the energy'*

1

- (b) (i) $(8 \times 435) + 497 = 3977$
accept: bonds broken: $(2 \times 435) + 497 = 1367$

1

$(6 \times 435) + (2 \times 336) + (2 \times 464) = 4210$
bonds made: $(2 \times 336) + (2 \times 464) = 1600$

1

$3977 - 4210 = (-) 233$
energy change:
 $1367 - 1600 = (-) 233$
ignore sign
allow ecf
correct answer (233) = 3 marks with or without working

1

- (ii) energy released forming (new) bonds is greater than energy needed to break (existing) bonds
allow converse
*do **not** accept energy needed to form (new) bonds greater than energy needed to break (existing) bonds*

1

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7.

- (a) neutron(s)
answers can be in either order

1

proton(s)

1

- (b) same number (17) protons **or** same number electrons
if candidate chooses to quote numbers, they must be correct

1

different numbers of neutrons (^{35}Cl has 18 and ^{37}Cl has 20)

1

(c) (i) -184kJ / mol

correct answer with or without working gains 3 marks

allow 2 marks for 184 kJ / mol

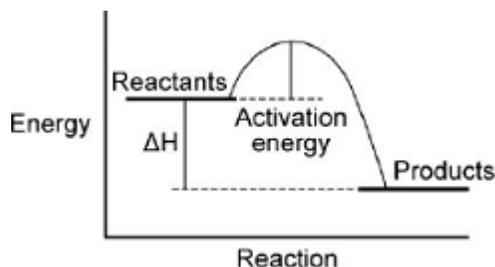
If answer incorrect award up to 2 marks for any two of the steps below:

- *bonds broken: $(436 + 242) = 678$ (kJ)*
- *bonds formed: $(2 \times 431) = 862$ (kJ)*
- *bonds broken – bonds formed*

allow ecf for arithmetical errors

3

(ii)



the reactants and the products at the correct level

ignore labels on the axes

1

ΔH correctly labelled

allow -538 if in correct place

1

E_a correctly labelled

correctly labelled endothermic reaction gains max. 2 marks

1

[10]

8.

(a) (i) $\Delta T = (64 - 17) = 47\text{ }^\circ\text{C}$

1

$750 \times 4.2 \times 47$

allow ecf using their ΔT

1

148 050

correct answer gains 3 marks with or without working

ignore sign

allow 148.05 kJ

allow 148 kJ

1

(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

2

(iii) repeat the experiment and then calculate the mean

1

any **one** from:

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

1

(iv) inaccuracies likely to have similar effects

allow systematic errors

1

(b) (i) 8530

correct answer gains 3 marks with or without working.

If answer is incorrect;

$(6 \times 803) = \underline{4818}$ gains 1 mark

$(8 \times 464) = \underline{3712}$ gains 1 mark

correct addition of their calculated values gains 1 mark (ecf)

3

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

ignore sign

allow ecf from (b)(i)

1

[12]

9.

(a) energy of product greater than energy of reactants

allow converse

allow energy = heat

*do **not** accept temperature for energy*

allow product / nitrogen oxide is higher than reactants

allow less energy / heat given out than taken in

allow energy / heat is taken in / gained

allow ΔH is positive

1

(b) (minimum) energy needed to start the reaction / overcome energy barrier

accept (minimum) energy needed for a collision to be successful

1

(c) (i) *correct answer with or without working= 3 marks*

bonds broken = $945 + 498 = 1443$ (kJ)

1

bonds made = $2 \times 630 = 1260$ (kJ)

1

energy change = $1443 - 1260 = (+) 183$

ignore sign

allow ecf

1

(ii) energy released forming new bonds is less than energy needed to break existing bonds

allow converse

accept energy change (ΔH) is + / positive

*do **not** accept energy needed to form new bonds is less than energy needed to break existing bonds*

1

[6]