Mark schemes

(a) 31

(b) (i) any two from:
- incorrect reading of thermometer / temperature
- incorrect measurement of volume of acid
- incorrect measurement of volume of alkali ( burette).

(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”)

(c) (i) temperature increases

(ii) no reaction takes place or all acid used up or potassium hydroxide in excess
    cool / colder potassium hydroxide absorbs energy or lowers temperature
    ignore idea of heat energy being lost to surroundings

(iii) take more readings
    ignore just “repeat”
    around the turning point or between 20 cm$^3$ and 32 cm$^3$
    accept smaller ranges as long as no lower than 20 cm$^3$ and no higher than 32 cm$^3$

(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 × 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)
(e) same amount of energy given out

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

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

any correct indication of the bond – the line between letters

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

(i)  activation energy labelled from level of reagents to highest point of curve

*ignore arrowheads*

enthalpy change labelled from reagents to products

![Diagram showing activation energy and enthalpy change](image)

*arrowhead must go from reagents to products only*

(ii) 2 O\textsubscript{2}

2 H\textsubscript{2}O

*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

*dependent on first marking point*

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

*accept bond breaking is endothermic*

energy is given out when bonds are made

*accept bond making is exothermic*

the energy given out is greater than the energy taken in

*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

\[ 1895 - 1998 = -103 \]

\textit{or}

energy 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

[15]

(a) any one from:

- solution becomes colourless or colour fades
- zinc becomes bronze / copper coloured
  
  allow copper (forms) or a solid (forms)
- zinc gets smaller
  
  allow zinc dissolves
- bubbles or fizzing.
  
  ignore precipitate

(b) improvement:

use a plastic / polystyrene cup or add a lid

accept use lagging / insulation

reason - must be linked
reduce / stop heat loss

OR

improvement:

use a digital thermometer

allow use a data logger

reason - must be linked
more accurate or easy to read or stores data

allow more precise or more sensitive
ignore more reliable
ignore improvements to method, eg take more readings
Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking Guidance and apply a ‘best–fit’ approach to the marking.

0 marks
No relevant content

Level 1 (1–2 marks)
There is a statement about the results.

Level 2 (3–4 marks)
There are statements about the results. These statements may be linked or may include data.

Level 3 (5–6 marks)
There are statements about the results with at least one link and an attempt at an explanation.

Examples of chemistry points made in the response:
Description:
Statements
Concentration of copper sulfate increases
Temperature change increases
There is an anomalous result
The temperature change levels off
Reaction is exothermic

Linked Statements
Temperature change increases as concentration of copper sulfate increases
The temperature change increases, and then remains constant
After experiment 7 the temperature change remains constant

Statements including data
The trend changes at experiment 7
Experiment 3 is anomalous

Attempted Explanation
Temperature change increases because rate increases
Temperature change levels off because the reaction is complete

Explanation
As more copper sulfate reacts, more heat energy is given off
Once copper sulfate is in excess, no further heat energy produced
(a) (i) 11

(ii) 4620 (J)
correct answer gains 2 marks with or without working
allow 4.62kJ for 2 marks
if answer is incorrect:
100 × 4.2 × 11 gains 1 mark
or
100 × 4.2 × (their temp. rise) gains 1 mark
or
100 × 4.2 × (their temp. rise) correctly calculated gains 2 marks

(b) the temperature increases
allow gets hotter
allow heat / energy is given off

(c) (i) (energy of) products lower than (energy of) reactants
allow converse
allow arrow C points downwards

(ii) A

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(a) (i) nothing can enter and nothing can leave the reaction
allow sealed reaction vessel

(ii) forward and backward reactions have same rate
so there is no (overall) change in quantities of reactants and products
allow concentrations of reactants and products

(b) (i) natural gas
allow methane / CH₄
allow fossil fuels / hydrocarbons
allow water

(ii) provides an alternative reaction pathway
which has a lower activation energy
ignore references to collisions
(iii) the amount (of ammonia) increases

   *allow yield increases*

the equilibrium moves to the side (of the equation) with fewer (gaseous) molecules / moles

   *allow it favours the forward reaction*

(c) (i) vertical arrow from reactants to maximum

(ii) (energy of) products higher than (energy of) reactants

   *allow converse*

(iii) amount of hydrogen iodide decreases

   equilibrium moves in the direction of the endothermic reaction

   *allow it favours the forward reaction*

(a) (i) any one from:

   • incorrect measurement of temperature or volume
   • incorrect recording of temperature
   • failure to stir
   • heat loss

   *ignore faulty equipment*

(ii) 32 - 33

(iii) 55

(iv) 20

(v) 4620

   *allow 4.62 kJ for 2 marks*

J / joules

   *allow kJ if evidence of dividing by 1000
mark independently, but if a numerical answer has been divided by 1000 must be kJ.*

   *allow ecf from their answers to (iii) and (iv)*

(b) twice as much energy released
but twice as much water to heat

*allow more energy released but more water to heat for 2 marks*

if no other mark awarded, allow twice the amount of hydrochloric acid used for 1 mark

(a) (i) covalent

(ii) increases the rate of reaction

(b) (i) the reaction is reversible

(ii) at lower pressure the molecules will be further apart

so there will be fewer collisions per unit time

*accept frequency of collisions lower*

(iii) as the temperature increases, the yield of the reaction increases

(iv) 2 molecules / volumes become 4 or more molecules / volumes of product than reactant
0 marks
No relevant content

Level 1 (1 – 2 marks)
Candidate has written about some basic points from the table but has not added any extra knowledge. Candidate may have included advantages or disadvantages.

Level 2 (3 – 4 marks)
Candidate has attempted an evaluation using points from the table and their own knowledge. Candidate has included advantages and disadvantages.

Level 3 (5 – 6 marks)
Candidate has given an evaluation that includes both advantages and disadvantages. Candidate has clearly linked points from the table with their own knowledge and uses appropriate scientific terminology.

examples of the points made in the response

Advantages of using hydrogen:
• its combustion only produces water
• combustion of hydrogen does not produce carbon dioxide or does not contribute to climate change
• petrol requires much more oxygen to burn so partial combustion is possible producing carbon monoxide
• combustion of hydrogen does not produce any particulates or does not contribute to global dimming
• petrol comes from a non-renewable source or there are renewable ways of producing hydrogen, eg electrolysis of water.

Disadvantages of using hydrogen:
• hydrogen has to be stored at high pressure or risk of explosion or larger volume needed for storage.
• much less energy produced from the combustion of hydrogen or need to refuel more often
• most methods of producing hydrogen need fossil fuels.

(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

activation energy correctly drawn and labelled

ΔH correctly labelled
(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

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

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[8]