**M1.**(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*

**1**

(b) improvement:
use a plastic / polystyrene cup or add a lid

*accept use lagging / insulation*

**1**

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*

**1**

(c) 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

**6**

**[9]**

**M2.**(a) any **three** from:

- concentration of (salt) solution
- volume of (salt) solution

  *ignore amount of solution*
- **initial** temperature (of the solution)

  *ignore room temperature*
- surface area / form of metal
- moles of metal

  *allow mass / amount*

  *ignore time*

  *ignore size of tube*

**3**

(b) 20

**1**

32

**1**

12

*allow ecf*

**1**

(c) (i) four bars of correct height

*tolerance is + / - half square*

*3 correct for **1** mark*

**2**

bars labelled

**1**

(ii) *one variable* is non-continuous / categoric

*accept qualitative or discrete*

*accept no values between the metals*

**1**

(iii) magnesium

**1**

because biggest temperature change

*accept gives out most energy*

*ignore rate of reaction*

*dependent on first mark*

**1**

(iv) does not react / silver cannot displace copper

**1**

because silver not more reactive (than copper) **or** silver below copper in reactivity series

*do **not** accept silver is less reactive than copper sulfate*

**1**

(v) replace the copper sulfate

*could be implied*

**1**

with any compound of a named metal less reactive than copper

*allow students to score even if use an insoluble salt*

**1**

**[16]**

**M3.**(a) eg plastic (beaker) / insulation / lid / cover **or** any mention of enclosed

*any sensible modification to reduce heat loss*

*ignore prevent draughts*

*ignore references to gas loss*

*ignore bomb calorimeter*

**1**

(b) all the substances react **or** all (the substances) react fully / completely **or** heat evolved quickly **or** distribute heat

*'so they react' is insufficient for the mark*

*accept increase chances of (successful) collisions / collision rate increase*

*do **not** accept rate of reaction increase / make reaction faster*

**1**

(c) experiment 2 **and**
different / higher / initial / starting temperature

*accept experiment 2 **and** the room is hotter / at higher temperature*

*do **not** accept temperature change / results higher*

**1**

(d) temperature change does not fit pattern

*accept anomalous / odd **or** it is the lowest **or** it is lower than the others **or** it is different to the others*

*'results are different' is insufficient*

**1**

(e) 7 / 7.0

**1**

(f) (100 × 4.2 × 7) = 2940

*ecf from (e)*

**1**

(g) diagram A **and**
reaction exothermic / heat evolved / Δ H is negative / temperature rises

*accept energy is lost (to the surroundings)*

*accept energy of products lower than reactants*

*allow arrow goes downwards*

**1**

**[7]**

**M4.** (a) any **one** from:

- no method / electrolysis / equipment / technology
  *allow 'didn't know how to' **or** 'no knowledge'*
- aluminium is a very reactive metal
- high melting point
  *allow 'couldn't heat it enough'*
- potassium had not been discovered

**1**

(b) because <u>others</u> / <u>scientists</u> / <u>they</u> could not repeat the experiment
*ignore he could not repeat the experiment*

**or**
<u>others</u> / <u>they</u> could not obtain the same results

**1**

(c) reaction is endothermic **or**
reaction <u>takes in</u> heat / energy
*accept activation energy*
*ignore rate / high temperature*
*ignore bonds broken*

**1**

(d) (aluminium chloride + potassium) → aluminium + potassium chloride
*in either order*
*accept correct formulae*
*ignore metal*
*ignore balancing*

**1**

(e) when tested it had the properties of a metal
*accept a test for a metal property eg conductivity / reaction with acid*

**1**

properties were different (from other known metals)

*accept properties compared with other metals*

**1**

**[6]**

**M5.** (a) gives out energy **or** heat

**1**

(b) (i) *accept qualified answers in terms of volume of gas related to time*

fast initially

**1**

slows down

**1**

reaction stops

*accept reaction is now very slow*

**1**

(b) (ii) 21

**1**

(iii) 84

*correct answer with or without working = **2** marks*
*allow ecf from (b)(ii) correctly calculated for **2** marks*
*allow evidence of 21/25 **or** (b)(ii)/25 for **1** mark*

**2**

(c) because they / particles have more energy / move faster

*ignore particles move more / vibrate*

**1**

(and so) particles collide more often / more frequently **or** particles more likely to collide

*ignore collide faster*
*ignore more collisions*

**1**

(and) more of the collisions are successful **or** particles collide with more energy / harder **or** more of the particles have the activation energy

*accept more successful collisions*

**1**

**[10]**

**M6.** (a) gives out heat / energy

*allow release / loses*

*allow the products have less energy*

**or**

energy / heat transferred to the surroundings

*ignore temperature rises*

*allow more energy given out in forming bonds than taken in to break bonds*

**1**

(b) (i) speed up the reaction (owtte)

*accept changes the rate*

*accept lowers activation energy*

*accept increases <u>successful</u> collisions*

*accept allows reaction to take place at a lower temperature*

**1**

(ii) nitrogen ($N_2$) / oxygen ($O_2$) / products are safe **or** not harmful / pollutant / toxic / dangerous / damaging

*ignore releases nitrogen / oxygen unless qualified*

**or**

(harmful) nitrogen monoxide / NO is not released into the air.

*accept prevents / less acid rain*

*ignore greenhouse gas / ozone layer*

**1**

(iii) 2 and 2

*accept correct multiples or fractions*

**1**

(iv) idea of catalyst not being used up

*allow not changed by reaction*

*ignore catalyst does not take part*

*ignore catalyst not used in the reaction*

**1**

(v) idea of different reactions (require different catalysts)

*accept catalysts work for specific reactions*

*allow different gases*

**1**

(c) • smaller / very small / or any indication of very small / 1–100 nanometres / a few (hundred) atoms

*ignore just small*

*ignore size of the converter*

**1**

• big(ger) surface area

**1**

• less (catalyst) needed / small amount of catalyst needed

**1**

**[9]**