**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) any **two** from:

- copper / ores are running out / harder to find
- there are no / very small amounts of high-grade copper ores left
- copper metal is in demand
- copper is expensive
- now economical to extract copper from low-grade ores

  *it = copper*

  *allow new methods of extraction e.g. bioleaching and phytomining*

  *allow high-grade ores are running out for **2** marks*

**2**

(b) (i) large amounts / 98% of rock to dispose of as waste

*accept contains toxic (metal) compounds / bioleacher*

**or**waste rock takes up a lot of space

**1**

(ii) (copper sulfide reacts with oxygen to) produce sulfur dioxide / $SO_2$

*allow (sulfur reacts with oxygen to) produce sulfur dioxide / $SO_2$*

**1**

that causes acid rain

*allow description of effects of acid rain **or** sulfur dioxide*

*if no other mark awarded allow $CO_2$ produced which causes global warming **or** $CO_2$ produced by burning fuel or heating the furnace for **1** mark*

**1**

(iii) any **one** from:

- large amounts of fuels / energy used (for the furnace and electrolysis)

  *allow large amounts of electricity needed*

  *ignore high temperature / electrolysis unqualified*

- (the extraction has) many steps / stages / processes

  *allow (extraction) is a long process / takes a lot of time*

- large amounts of ore / material have to be mined
  *allow ores contain a low percentage of copper*

**1**

(iv) (copper ions move towards) the negative electrode */ cathode*

**1**

because copper ions / $Cu^{2+}$ are positively charged **or** are oppositely charged **or** copper ions need to gain electrons

*allow because metal ions are positive **or** opposites attract*

**1**

(v) (growing) plants

**1**

**[9]**

**M4.**(a) (i) hydrogen

*accept $H_2$*

*allow H*

**1**

(ii) hydroxide

*accept $OH^-$*

*allow OH*

*do **not** accept lithium hydroxide*

***1***

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

*'it' = potassium*

*potassium:*

*accept converse for lithium*

- *reacts / dissolves faster*

  *allow reacts more vigorously / quickly / violently / explodesignore reacts more*

- *bubbles / fizzes faster*

  *allow fizzes more*

  *allow more gas*

- *moves faster (on the surface)*

  *allow moves more*

- *melts*

  *allow forms a sphere*

- *produces (lilac / purple) flame*

  *allow catches fire / ignites*

  *do **not** accept other colours*

***2***

***[4]***

***M5.*** *(a) (i) reduction*

*accept redox / smelting*

***1***

*(ii) 3 4 3*

**1**

(b) (i) 55

*ignore other units*

(ii) Water

*accept sodium hydroxide*

*accept correct formulae $H_2O$ or NaOH*

**1**

(iii) any **one** from:

- save energy / fuel for transporting the ore
  *accept less (cost of) transport allow transported quickly*
- (old) quarries nearby for waste/red mud

**1**

(c) **Environmental**

any **one** from:

- less mining / quarrying (of bauxite)
  *allow loss of habitat / less qualified noise pollution*
- less landfill space needed / used
  *allow less red mud / waste*
- less use of fossil fuels / energy
- less carbon dioxide produced

**1**

**Ethical or social**

any **one** from:

- saves resources

  *allow using resources more than once*

- creates (local) employment

  *if answers reversed and both correct award **1** mark*

- more people aware of the need for recycling

  *allow less qualified noise pollution if not given in environmental*

**1**

**[7]**

**M6.** (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]**

**M7.** (a) (i) contains enough metal to <u>make it economical</u> to extract

**1**

(ii) Fe (+) $CO_2$

*formula of both products must be correct*

**1**

($Fe_2O_3$) (+) ....3....(CO)

→

.....2.....(Fe) (+) .....3...($CO_2$)

*balancing correct*

*allow correct balancing using $Fe_2$*

**1**

(iii) reduction

*accept redox*

**1**

(b) (i) oxygen <u>reacts</u> with the carbon to produce carbon dioxide

*allow carbon monoxide for carbon dioxide*

**1**

**OR**

carbon dioxide is produced (1)

which escapes as a gas (1)

**1**

(ii) to give steels with <u>different</u> / particular properties or for <u>different</u> / <u>particular</u> uses

*ignore to make different alloys*

**1**

(c) copper is very expensive

*accept the metal (iron / steel) costs less than copper*

*ignore energy*

**1**

because copper ores are 'low grade' / running out

*allow copper is rare*

*ignore nickel*

**1**

**[9]**