

Mark schemes

Q1.

- (a) Bright light / white light / white powder/ash/solid 1
- $\text{Mg(s)} + \text{H}_2\text{O(g)} \rightarrow \text{MgO(s)} + \text{H}_2\text{(g)}$
State symbols essential 1
- (b) M1: Attraction between (lattice of) Mg^{2+} ions
M1 attraction between nucleus and delocalised electrons or between + ions and delocalised electrons 1
- M2: And delocalised electrons
M2 outer shell electrons delocalised 1
- (c) (Giant) ionic lattice / lots of Mg^{2+} and Cl^- ions 1
- Strong (electrostatic) forces of attraction 1
- Between Mg^{2+} and Cl^- ions
Allow oppositely charged ions 1
- (d) Indigestion relief / laxative / neutralise (excess stomach) acid
Allow milk of magnesia 1
- [8]**

Q2.**c**

In medicine to produce an X-ray image 1

[1]

Q3.

- (a) Mg^{2+} has a higher charge than Na^+ / Mg^{2+} ions are smaller / Mg^{2+} has a greater charge density / Mg atoms smaller than Na atoms / Mg has more delocalised electrons than Na
Allow
Mg has a higher nuclear charge 1

Stronger attraction to delocalised sea of electrons / stronger metallic bonding

Not attraction for outer electrons

1



Allow multiples

1

Mg changes oxidation state from 0 to +2 so electrons are lost / Ti changes oxidation state from +4 to 0, so gains electrons

Allow

Oxidation state of Mg increases so it is a reducing agent

1

(c) Observation with MgCl_2 : (slight) white ppt

1

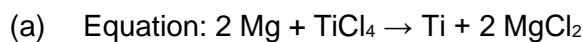
Observation with BaCl_2 : no (visible) change / colourless solution / no reaction

Do not allow nothing / no observation

1

[6]

Q4.



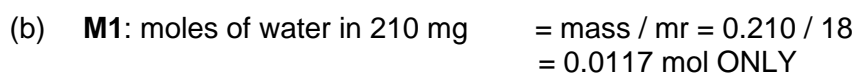
Allow multiples / ignore ss

1

Role: Reducing agent

Allow electron donor (not electron pair donor)

1



Equal to moles of magnesium hydroxide produced in stage one

M2: mass of $\text{Mg}(\text{OH})_2 = 0.0117 \times 58.3 = 0.680$ g

M3: mass of MgO = $3.2 - 0.68$

= 2.52 g

M1 = moles of water

M2 = mass of $\text{Mg}(\text{OH})_2 = \mathbf{M1} \times 58.3$

M3 = subtraction = $3.2 - \mathbf{M2}$

M4 = answer to **M3** $\times 100/3.2$

Accept correct alternative methods such as

M1 = moles of water

M2 = mass of $\text{Mg}(\text{OH})_2 = \mathbf{M1} \times 58.3$

M3 = $\mathbf{M2} \times 100/3.2$

M4 = $100 - \mathbf{M3}$

M4: % of MgO = $2.52/3.2 \times 100 = 78.7\%$

M4: Allow 78.7 – 78.8 or 79 %

4

Q5.

C

[6]

Q6.

C

[1]

Q7.

A

[1]

Q8.

B

[1]

Q9.

A

[1]

Q10.

A

[1]

Q11.

B

[1]

Q12.

B

[1]

Q13.

(a) $1s^2 2s^2 2p^6 3s^2 3p^6 (4s^0)$

1

(b) **M1** In Ca^{+} (outer) electron(s) is further from nucleus

Or Ca^{+} loses electron from a higher (energy) orbital

Or $\text{Ca}^{(+)}$ loses electron from a 4(s) orbital or 4th energy level or 4th energy shell and $\text{K}^{(+)}$ loses electron from a 3(p) orbital or 3rd energy level or 3rd energy shell

Must be comparative

Allow converse arguments

1

M2 More shielding (in Ca^+)

1

(c) Be /Beryllium

1

(d) $\text{Mg}(\text{OH})_2$

1

(e) $\text{Ba}^{2+} + \text{SO}_4^{2-} \rightarrow \text{BaSO}_4$

Ignore state symbols

1

$n \text{BaCl}_2 (6/1000 \times 0.25) = 1.5 \times 10^{-3}$ and $n \text{Na}_2\text{SO}_4 = (8/1000 \times 0.15) = 1.2 \times 10^{-3}$

and BaCl_2 /barium chloride in excess

Working required or 3×10^{-4} of BaCl_2

1

10 cm^3 (of 0.15 mol dm^{-3} sodium sulfate)

or 0.01 dm^3

1

(f) **M1** Same electronic configuration / same number of electrons (in outer shell) / all have 37 electrons (1)

Ignore protons and neutrons unless incorrect numbers

Not just electrons determine chemical properties

1

$$\frac{86x + 87x + 88(100-2x)}{100} = 87.7$$

M2 $\frac{86x + 87x + 88(100-2x)}{100} = 87.7$

Alternative M2:

$$\frac{86 + 87 + 88y}{1 + 1 + y} = 87.7$$

$$1 + 1 + y$$

1

M3 $x = 10\%$ (or $x = 0.1$)

M3 $y = 8$

1

M4 (% abundance of 88 isotope is $100 - 2x10$) = $80(.0)\%$

M4 % of 88 isotope is $100 - 10y = 80(.0) \%$

Allow other alternative methods

1

(g) $^{138}\text{Ba}^+$ 1

(h) **M1** $\text{mass} = \frac{137 \times 10^{-3}}{6.022 \times 10^{23}} = 2.275 \times 10^{-25} \text{ (kg)}$
 Calculation of m in kg
 If not converted to kg, max 4
 If not divided by L lose M1 and M5, max 3 1

M2 $v^2 = \frac{2KE}{m} = \frac{2 \times 3.65 \times 10^{-16}}{2.275 \times 10^{-25}} = 3.2088 \times 10^9$
 For re-arrangement 1

M3 $v = \sqrt{2KE/m}$ ($v = 5.6646 \times 10^4$)
 For expression with square root 1

M4 $v = d/t$ or $d = vt$ or with numbers 1

M5 $d = (5.6646 \times 10^4 \times 2.71 \times 10^{-5}) = 1.53 - 1.54 \text{ (m)}$
 M5 must be to 3sf
 If not converted to kg, answer = 0.0485-0.0486
 (3sf). This scores 4 marks 1

Alternative method

M1 $m = \frac{137 \times 10^{-3}}{6.022 \times 10^{23}} = 2.275 \times 10^{-25}$
 M1 Calculation of m in kg 1

M2 $v = d/t$
 M2, M3 and M4 are for algebraic expressions or
 correct expressions with numbers 1

M3 $d^2 = \frac{KE \times 2 t^2}{m}$ 1

M4 $d = \sqrt{\frac{KE \times 2 t^2}{m}}$ ($= \sqrt{(3.65 \times 10^{-16} \times 2 \times (2.71 \times 10^{-5})^2 / 2.275 \times 10^{-25})}$) 1

M5 $d = 1.53 - 1.54 \text{ (m)}$
 M5 must be to 3sf 1

[18]

Q14.

c

[1]

Q15.

(a) BaCl_2 / Ba(OH)_2 / $\text{Ba(NO}_3)_2$ / BaX_2 or names*Ignore acidification but CE = 0/3 if H_2SO_4* *If reagent incorrect or blank then CE = 0/3**If Ba^{2+} or wrong formula, lose M1 and mark on*

1

colourless solution / no (visible) change (nvc) / no ppt / no (visible) reaction

Ignore nothing happens and no observation

1

white precipitate / white solid

1

(b) NaOH / sodium hydroxide / other Group 1 hydroxides*If reagent incorrect or blank then CE = 0/3**If reagent incomplete, lose M1 and mark on*

1

white precipitate / white solid

1

(white) ppt which dissolves in excess (NaOH)*If reagent is excess NaOH , allow colourless solution for M3*

1

Alternative Method

Name or formula of Group 1 carbonate

1

white precipitate / white solid

1

(white) precipitate and effervescence

1

[6]

Q16.

(a) CO_2 gas escapes or is lost

1

(b) Mass $\text{CO}_2 = 16.11 - 14.58 = 1.53 \text{ g}$

1

 $M_r \text{ CO}_2 = 44.0$

$$\text{Mol CO}_2 = 1.53 / 44.0 = 3.48 \times 10^{-2} \quad 1$$

$$\text{Mol SrCO}_3 = 3.48 \times 10^{-2} \quad 1$$

$$\text{Mass SrCO}_3 = \text{mol} \times M_r = 3.48 \times 10^{-2} \times 147.6$$

$$\text{Mass SrCO}_3 = 5.13 \text{ (g)}$$

1 mark for the answer and 1 for 3 sf precision

Allow 5.14 g (as a result of rounding) 2

(c) Percentage error = $\frac{0.01}{6.26} \times 100$
 = 0.160 (%) 1

(d) Original Mass SrO = 6.26 – 0.347 – 5.13
 = 0.783 g (or 783 mg)
 OR 6.26 – 0.347 – 4.85 = 1.063 g
Allow 0.773 g or 773 mg (from rounding error in part (b)) 1

Justification: All SrCO₃ reacted because heated to constant mass. 1



Al acts as a reducing agent 1

Sr is collected as a vapour because 1

Al₂O₃ is an ionic lattice and so has strong ionic attractions 1

Than Sr which is a metallic structure with (relatively) weaker bonding 1

[14]

Q17.



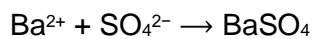
8 – 12 1

(b) Decrease 1

(c) BaCl₂

Allow Ba(NO₃)₂ or other soluble barium salt

1



*Allow equation if state symbols missing but
penalise if state symbols are incorrect*

1

(d) Strong attraction

1

Between positive and negative ions

1

[7]