Mark schemes

Q1.

(a) Bright light / white light / white powder/ash/solid

1

$Mg(s) + H_2O(g) \rightarrow MgO(s) + H_2(g)$

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 <u>delocalised</u> 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]

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

(b) $2Mg + TiCl_4 \rightarrow 2MgCl_2 + Ti$

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.

(a) Equation: $2\ Mg + TiCl_4 \rightarrow Ti + 2\ MgCl_2$

Allow multiples / ignore ss

1

Role: Reducing agent

Allow electron donor (not electron pair donor)

1

(b) **M1**: moles of water in 210 mg = mass / mr = 0.210 / 18
= <u>0.0117</u> mol ONLY

Equal to moles of magnesium hydroxide produced in stage one

M2: mass of $Mg(OH)_2$ = 0.0117 x 58.3 = 0.680 g

M3: mass of MgO = 3.2 – 0.68

= 2.52 g

M1 *= moles of water*
M2 *= mass of $Mg(OH)_2$ =* ***M1*** *x 58.3*
M3 *= subtraction = 3.2 –* ***M2***
M4 *= answer to* ***M3*** *x 100/3.2*

Accept correct alternative methods such as
M1 *= moles of water*
M2 *= mass of $Mg(OH)_2$ =* ***M1*** *x 58.3*
M3 *=* ***M2*** *x 100/3.2*
M4 *= 100 –* ***M3***

M4: % of MgO = 2.52/3.2 x 100 = 78.7%

M4: *Allow 78.7 – 78.8 or 79 %*

4

[6]

Q5.

C

[1]

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 $Ca^{(+)}$ loses electron from a 4(s) orbital or 4th energy level or 4th energy shell and $K^{(+)}$ 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) $Mg(OH)_2$

1

(e) $Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$

Ignore state symbols

1

n $BaCl_2$ (6/1000 × 0.25) = 1.5×10^{-3} and n Na_2SO_4 = (8/1000 × 0.15) = 1.2×10^{-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 0.01dm^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

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

Alternative M2:

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

1

M3 x = 10% (or × = 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) $^{138}Ba^+$

1

(h) **M1** $\text{mass} = \frac{137 \times 10^{-3}}{6.022 \times 10^{23}}$ = 2.275×10^{-25} (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 $v^2 = \frac{2KE}{m} = \frac{2 \times 3.65 \times 10^{-16}}{2.275 \times 10^{-25}}$ = 3.2088×10^9

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 (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 $m = \frac{137 \times 10^{-3}}{6.022 \times 10^{23}}$ = 2.275×10^{-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 $d = \sqrt{\frac{KE \times 2t^2}{m}}$ ($= \sqrt{(3.65 \times 10^{-16} \times 2 \times (2.71 \times 10^{-5})^2 / 2.275 \times 10^{-25})}$)

1

M5 d = 1.53 – 1.54 (m)

M5 must be to 3sf

1

[18]

Q14.

C

[1]

Q15.

(a) $BaCl_2$ / $Ba(OH)_2$ / $Ba(NO_3)_2$ / 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

<u>white</u> precipitate / <u>white</u> solid

1

(white) ppt which dissolves in <u>excess</u> (NaOH)

If reagent is excess NaOH, allow colourless solution for M3

1

<u>Alternative Method</u>

Name or formula of Group 1 carbonate

1

<u>white</u> precipitate / <u>white</u> solid

1

(white) precipitate <u>and</u> effervescence

1

[6]

Q16.

(a) CO_2 gas escapes or is lost

1

(b) Mass CO_2 = 16.11 − 14.58 = 1.53 g

1

M_r CO_2 = 44.0

Mol CO_2 = 1.53 / 44.0 = 3.48×10^{-2}

1

Mol $SrCO_3$ = 3.48×10^{-2}

1

Mass $SrCO_3$ = mol × M_r = $3.48 \times 10^{-2} \times 147.6$

Mass $SrCO_3$ = 5.13 (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 = $^{0.01}/_{6.26} \times 100$

= 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 $SrCO_3$ reacted because heated to constant mass.

1

(e) $3SrO + 2Al \longrightarrow Al_2O_3 + 3Sr$

1

Al acts as a reducing agent

1

Sr is collected as a vapour because

1

Al_2O_3 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.

(a) $Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2$

1

8 − 12

1

(b) Decrease

1

(c) $BaCl_2$

Allow $Ba(NO_3)_2$ or other soluble barium salt

1

$Ba^{2+} + SO_4^{2-} \longrightarrow BaSO_4$

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]