

Mark schemes

- 1** (a) 0.155 g per 100 cm³
- M1**
- Allow 0.153 – 0.157*
- 1
- (0.155 / 74.1) × 10 = 0.0209 mol dm⁻³
- M2**
- Allow 0.0206 – 0.0212*
- 1
- Answer to 3 significant figures
- M3**
- The correct answer only loses M1*
- 1
- (b) Take a known volume of the saturated solution
- 1
- Evaporate the filtrate to dryness
- Allow titrate with dilute HCl or HNO₃*
- 1
- Weigh the residue
-of known / specified concentration*
Ignore any references to indicators
- 1
- [6]**
- 2** (a) **M1** Used in a barium meal / barium swallow / barium enema
- OR** (used to absorb) X-rays
- Credit a correct reference to **M1** written in the explanation in **M2** unless contradictory.*
- M2** BaSO₄ / barium sulfate / it is insoluble
- For **M2** penalise obvious reference to barium or to barium ions being insoluble.*
- 2
- (b) Mg(OH)₂ + 2HCl → MgCl₂ + 2H₂O
- Or multiples.*
Ignore state symbols.
- 1

- (c) It / magnesium hydroxide is insoluble / insufficiently soluble / sparingly soluble / less soluble than barium hydroxide / forms low concentration solutions

Weak alkali alone is insufficient.

Formation of a precipitate needs explanation.

1

- (d) $\text{TiCl}_4 + 2\text{Mg} \longrightarrow 2\text{MgCl}_2 + \text{Ti}$

Or multiples.

Ignore state symbols.

1

- (e) **M1** Hydrogen / H_2 produced

OR an equation to produce hydrogen / H_2



*For **M1***

Do not penalise an incorrect equation; the mark is for H_2 or hydrogen.

*Award one mark only for 'exothermic reaction with steam / H_2O ' for a student who has not scored **M1***

M2 requires correct **M1**

risk of explosion

OR forms explosive mixture (with air)

OR (highly) flammable

Ignore 'violent' reaction.

2

[7]

3

- (a) (i) $\text{SrCl}_2(\text{aq}) + \text{Na}_2\text{SO}_4(\text{aq}) \rightarrow \text{SrSO}_4(\text{s}) + 2\text{NaCl}(\text{aq})$

Allow multiples, including fractions.

Allow ionic equations.

Lose this mark if any of the state symbols are missing or incorrect.

1

- (ii) Add nitric acid to the mixture (until in excess)

Do not allow any suggestion that the solution is an emetic.

1

Filter (to isolate strontium sulfate)

1

- (b) Insoluble barium sulfate is formed

Allow 'removes barium ions as a precipitate' .

1

- (c) Add silver nitrate, then dilute ammonia (solution) **M1**
Do not allow answers which imply silver nitrate and ammonia are added at the same time.
 Allow 'add silver nitrate, then concentrated ammonia (solution)'.
 Can score **M1** in the answer for **M3**

1

Cream precipitate **M2**

Allow 'off white precipitate'.

1

No visible change or precipitate dissolves slightly in dilute ammonia **M3**

Allow 'soluble / colourless solution / precipitate dissolves in concentrated ammonia'.

Allow 3 marks for:

*Add dilute ammonia (solution), then silver nitrate **M1***

*No visible change **M2***

*Cream / off white precipitate with silver nitrate **M3***

1

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4

- (a) (i) 1.08×10^{-2}

Do not penalise precision but must be to at least 2 significant figures.

Do not accept 1×10^{-2}

1

- (ii) $5.4(0) \times 10^{-3}$

Allow (i) / 2

Do not penalise precision but must be to at least 2 significant figures.

1

- (iii) 266.6

Lose this mark if answer not given to 1 decimal place.

1

- (iv) mass = $5.4(0) \times 10^{-3} \times 266.6 = 1.44$ g **M1**

Allow (ii) \times (iii).

1

percentage = $1.44 \times 100 / 2.25 = 64.0$ **M2**

*Allow consequential answer from **M1***

Lose this mark if answer not given to 3 significant figures.

*Correct answer with no working scores **M2** only.*

1

- (v) 1 Would give an incorrect / too large mass (of silver chloride)

Do not allow 'to get an accurate result' without qualification.

1

2 To remove soluble impurities / excess silver nitrate (solution) / strontium nitrate (solution)

Do not allow 'to remove impurities'.

Do not allow 'to remove excess strontium chloride solution'.

1



Allow $\text{Mg}^{2+}(\text{aq}) + 2\text{OH}^{-}(\text{aq}) \rightarrow \text{Mg}^{2+}(\text{OH})_2(\text{s})$

Allow multiples, including fractions.

Lose mark if state symbols are missing or incorrect.

Lose mark if incorrect charge on an ion.

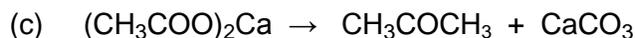
1

(ii) Does not produce CO_2 / gas which distends stomach / does not produce wind / does not increase pressure in stomach

Allow 'prevents flatulence' and 'prevents burping'.

Do not allow 'gas' without qualification.

1



Allow multiples.

Allow propanone as $\text{C}_3\text{H}_6\text{O}$

Allow $(\text{CH}_3\text{COO}^{-})_2\text{Ca}^{2+} \rightarrow \text{CH}_3\text{COCH}_3 + \text{Ca}^{2+}\text{CO}_3^{2-}$

1

(d) Ca (salt) - no visible change with sodium chromate(VI) **M1**

Allow 'yellow solution formed' or 'no ppt. forms'.

*Allow **M1** and **M2** in any order.*

1

Sr and Ba (salts) give (yellow) precipitate with sodium chromate(VI) **M2**

Lose this mark if precipitate has an incorrect colour.

1

Sr precipitate (chromate(VI)) dissolves in ethanoic acid / Ba precipitate (chromate(VI)) does not dissolve in ethanoic acid **M3**

*If ethanoic acid is added first, allow access to **M1** and **M3**.*

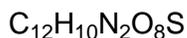
1

(e) C 42.09 / 12, H 2.92 / 1, N 8.18 / 14, O 37.42 / 16 and S 9.39 / 32.1

Accept any other correct method of working.

If relative atomic mass has been divided by the percentage composition is used then $\text{CE} = 0 / 2$

1



Correct answer with no working scores 1 mark only.

1

[15]

5

- (a) (Measure the) volume of gas / mass of the container + contents

1

Suitable named piece of equipment

Gas syringe (or inverted burette or measuring cylinder, as long as student has referred to the cylinder being filled with water) / balance.

Equipment must be correct for the measurement stated.

1

- (b) Any **one** of:

- Mass of magnesium
Allow amount of magnesium.
- Surface area of magnesium

1

- (c) (i) Gravity: Conical flask or beaker and funnel /

Vacuum: Sealed container with a side arm and Buchner or Hirsch funnel

Must be either gravity filtration (with a V-shaped funnel) or vacuum filtration (with a side-arm conical flask) appropriately drawn.

1

Filter paper

Must show filter paper as at least two sides of a triangle (V-shaped) for gravity filtration or horizontal filter paper for vacuum filtration.

1

- (ii) Wash with / add (a small amount of cold) water
Ignore filtering.

1

[6]

6

(a) **M1 (could be scored by a correct mathematical expression)**

Correct answer to the calculation gains all of M1, M2 and M3

$$\text{M1 } \Delta H = \Sigma \Delta H_f(\text{products}) - \Sigma \Delta H_f(\text{reactants})$$

Credit 1 mark for - 101 (kJ mol⁻¹)

OR a correct cycle of balanced equations

$$\begin{aligned} \text{M2} &= - 1669 - 3(- 590) \\ &= - 1669 + 1770 \\ &\text{(This also scores M1)} \end{aligned}$$

$$\text{M3} = + 101 \text{ (kJ mol}^{-1}\text{)}$$

Award 1 mark ONLY for - 101

For other incorrect or incomplete answers, proceed as follows

- *check for an arithmetic error (AE), which is either a transposition error or an incorrect multiplication; this would score 2 marks (M1 and M2)*
- *If no AE, check for a correct method; this requires either a correct cycle with 3Sr and 2Al OR a clear statement of M1 which could be in words and scores **only M1***

M4 - Using powders

Any **one** from

- To increase collision frequency / collisions in a given time / rate of collisions
- To increase the surface contact / contact between the solids / contact between (exposed) particles

Ignore dividing final answer by 3

Penalise M4 for reference to molecules.

5

M5 Major reason for expense of extraction

Any **one** from

- Aluminium is extracted by electrolysis OR aluminium extraction uses (large amounts of) electricity
- Reaction / process / It / the mixture requires heat
- It is endothermic

- (b) Calcium has a higher melting point than strontium, because

Ignore general Group 2 statements.

Correct reference to size of cations / proximity of electrons

M1 (For Ca) delocalised electrons closer to cations / positive ions / atoms / nucleus

OR cations / positive ions / atoms are smaller

OR cation / positive ion / atom or it has fewer (electron) shells / levels

Penalise M1 if either of Ca or Sr is said to have more or less delocalised electrons OR the same nuclear charge.

Ignore reference to shielding.

Relative strength of metallic bonding

M2 (Ca) has stronger attraction between the cations / positive ions / atoms / nucleus and the delocalised electrons

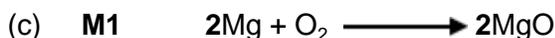
OR

stronger metallic bonding

(assume argument refers to Ca but credit converse argument for Sr)

CE= 0 for reference to molecules or Van der Waals forces or intermolecular forces or covalent bonds.

2



Credit multiples of the equations.

M3 Magnesium hydroxide is used as an antacid / relieve indigestion (heartburn) / neutralise (stomach) acidity / laxative

Not simply "milk of magnesia" in M3

3

[10]

7

- (a) As concentration increases the amount of heat given out increases / temperature increases **(M1)**

Any order.

Ignore references to an exothermic reaction.

1

More successful collisions or reactions in a given time **OR** more particles have the activation energy **(M2)**

Allow could be a second / n^{th} order reaction.

1

(An increase in temperature or more heat given out) increases the rate of a reaction **(M3)**

1

- (b) The magnesium is coated with an oxide / MgO **(M1)**

Allow magnesium hydroxide.

1

MgO / the coating / the corrosion product has to be removed before Mg will react
OR Mg and MgO / the coating / the corrosion product react at different rates
OR Initially MgO / the coating / the corrosion product reacts not Mg (**M2**)

Ignore inert coating.

1

(c) Any **two** from:

Any order.

Slower with hot water or faster with steam

The hot water produces $\text{Mg}(\text{OH})_2$ / the hydroxide **OR** steam produces MgO / the oxide

(Slow) bubbling with hot water **OR** bright white light / flame / white solid with steam

2 max

(d) Magnesium sulfate is soluble and calcium sulfate is insoluble / slightly soluble / magnesium sulfate is more soluble / calcium sulfate is less soluble / correct trend in solubility (**M1**)

Any order.

M1 requires a comparison of the two solubilities.

Calcium sulfate coats the surface of the calcium (**M2**)

Coating prevents further contact with / reaction by the acid (**M3**)

'Calcium sulfate forms a protective coating' scores M2 only.

3

[10]

8

Mg^{2+} and Cl^-

Do not allow names.

[1]

9

(a) (i) Change in concentration (of a substance / reactant / product) in unit time / given time / per (specified) unit of time

*This may be written mathematically **OR** may refer to the gradient of a graph of concentration / volume against time*

OR

Amount of substance formed / used up in unit time / given time / per (specified) unit of time

Ignore additional information including reference to collisions

1

(ii) At **W**

M1 (QoL)

The rate / it is zero

M2

The magnesium has all reacted / has been used up
Ignore reference to the acid being used up

OR

No more collisions possible between acid and Mg

OR

Reaction is complete / it has stopped

OR

No more hydrogen / product is produced

2

(iii) M1

Twice / double as many particles / hydrogen ions (in a given volume)
Penalise reference to (hydrochloric acid) molecules in M1
Penalise reference to "HCl particles" in M1

OR

Twice / double as much hydrochloric acid

M2

Twice / double as many effective / successful collisions (in a given time)

OR

Twice / double as many collisions with either sufficient energy to react **OR** with
 $E \geq E_a$

OR

double the successful / effective collision frequency

2

(b) (i) The activation energy is the minimum energy for a reaction to go / start

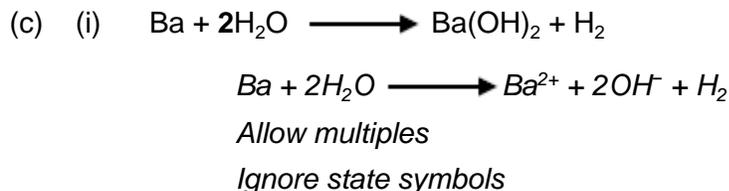
OR

Minimum energy for a successful/ effective collision

1

- (ii) M1 Products lower than reactants on the profile
Mark independently
- M2 Activation energy (E_a) shown and labelled correctly from reactants to peak of curve
Mark independently

2



1

- (ii) M1 $Ba^{2+} + SO_4^{2-} \longrightarrow BaSO_4$
Ignore state symbols in M1
Not multiples in M1
- M2 White precipitate / solid
Extra ions must be cancelled
Penalise contradictory observations in M2

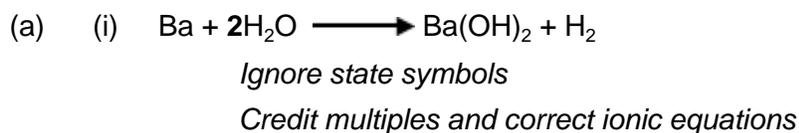
2

- (iii) M1 Barium meal / barium swallow / barium enema
Accept a correct reference to M1 written in the explanation in M2, unless contradictory
- OR** used in X-rays **OR** to block X-rays **OR** X-ray contrast medium **OR** CT scans
- M2 BaSO₄ / barium sulfate is insoluble (and therefore not toxic)
For M2 NOT barium ions
NOT barium
NOT barium meal and NOT "It"
Ignore radio-tracing

2

[13]

10



1

- (ii) (Reactivity with water) increase(s) / increasing / increased (down the Group / from Mg to Ba)
Accept "greater" or "gets more" or similar words to that effect.
Ignore reference to "increase in solubility / gets more soluble"

1

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

Accept $\text{Mg}^{2+}(\text{OH})_2$ / $\text{Mg}(\text{HO})_2$

Insist on brackets and correct case

1

(c) **M1** Barium meal / barium swallow / barium enema or (internal) X-ray or to block X-rays

M2 BaSO_4 / barium sulfate is insoluble (and therefore not toxic)

*Accept a correct reference to **M1** written in the explanation in **M2**, unless contradictory*

*For **M2** NOT barium ions*

NOT barium

NOT barium meal and NOT "It"

Ignore radio-tracing

2

[5]