M1. (a) (i) 0.0212

Need 3 sig figs

Allow correct answer to 3 sig figs eg 2.12 x 10^{-2}

1

(ii) 0.0106

Mark is for (a)(i) divided by 2 leading to correct answer 2 sig figs

1

(iii) M_r = 100.1

1.06 g

Allow 100.1 as 'string'

Need 3 sig figs or more

Consequential on (a)(ii) x 100(.1)

2

(iv) Neutralisation or acid / base reaction

Allow acid / alkali reaction

Apply list principle

1

(b) (i) T = 304(K) and P = 100 000 (Pa)

Only T and P correctly converted

1

$\frac{100\,000 \times 3.50 \times 10^{-3}}{8.31 \times 304}$ OR $n = \frac{PV}{RT}$

1

0.139 (mol)

Allow 0.138 – 0.139

1

(ii) 0.0276 – 0.0278(mol)

Allow answer to (b)(i) divided by 5 leading to a correct answer

Allow 0.028

1

(c) 4.20 g $Ca(NO_3)_2$

1

$Ca(NO_3)_2\ H_2O$

$\frac{4.20}{164(.1)}$ $\frac{1.84}{18}$

Mark is for dividing by the correct Mr values
M2 and M3 dependent on correct M1

0.0256 0.102

M2 can be awarded here instead

1 : 3.98

$x = 4$

If $Ca(NO_3)_2.4H_2O$ seen with working then award 3 marks
Credit alternative method which gives $x = 4$

1

[12]

M2.(a) (i) Volume of crater-lake solution on x-axis

Do not penalise missing axes labels.
If axes unlabelled use data to decide.
Lose this mark if axes mis-labelled.

1

Sensible scales

*Lose this mark if **plotted points** do not cover at least half the paper or plot goes off the squared paper.*

1

All points plotted correctly +/– one square

1

(ii) Draws appropriate line of best fit, omitting point at 20 cm^3 / 15 cm^3

Lose this mark if the line deviated towards the anomalous result.

Lose this mark if the candidate's line is doubled or kinked.

Candidate does not have to extrapolate to the origin.

1

(iii) 16.5 cm^3 +/– 0.5 cm^3

Accept this answer only.

Do not mark consequentially on candidate's graph.

1

(iv) Value corresponding to 10 cm^3 crater-lake solution / 6.00 cm^3

Must have correct identity for explanation mark.

Accept results aren't concordant.

1

Greatest % error from use of burette

Accept difficult to be accurate with small volumes (owtte).

1

(b) (i) pV = nRT

Accept any correct rearrangement.

Ignore case.

1

(ii) V = 81.0×10^{-6} or 8.1×10^{-5}

1

n = $(1 \times 10^5 \times 81.0 \times 10^{-6}) / (8.31 \times 298)$

Mark consequentially on candidate's volume.

1

n = 3.27×10^{-3} (mol)

Correct answer without working scores one mark only.

Allow consequential mark using incorrect conversion.

Incorrect units lose this mark.

1

(iii) M_r $CaCO_3$ = 100.1 (M1)

Accept 100 (can score this mark in calculation for M2 and M3).

1

Moles $CaCO_3$ = (3.27 × 10^{-3} × 10) = 3.27 ×10^{-2} (M2)

Do not penalise lack of units.

Allow b(ii) × 10

Allow 1.25 × 10^{-3} × 10

1

Mass $CaCO_3$ = M1 × M2 (= 3.27 g)

Correct mass without working scores one mark only.

Allow 1.25 × 10^{-2} × 10 × 100.1= 12.5 g

1

(iv) (3.27 / 95) × 100

Accept (b(iii) / 95) × 100.

Do not penalise precision.

1

3.44 g

Do not penalise lack of units.

Using 12.5 g gives 13.2 g

Correct answer without working scores 2 marks.

1

(v) Abundant / readily available

Accept not caustic or alkaline.

Non-corrosive

Accept insoluble so safe to add in excess (owtte).

1

[17]

M3. (a) (i) $\underline{4.98 \times 10^{-3}}$

1

Only

(ii) 2.49×10^{-3}

Allow answer to (a)(i) ÷ 2

Allow answers to 2 or more significant figures

1

(iii) 2.49×10^{-2}

Allow (a)(ii) × 10

Allow answers to 2 or more significant figures

1

(iv) 138.2

3.44 divided by the candidate.s answer to (a)(iii)

138.2 or 138.1 (i.e. to 1 d.p.)

1

(v) (138 – 60) ÷ 2 = 39.1

Allow 39 – 39.1

Allow ((a)(iv) – 60) ÷ 2

1

K/potassium

Allow consequential on candidate's answer to (a)(iv) and (a)(v) if a group 1 metal

Ignore + sign

1

(b) PV = n RT or rearranged

If incorrectly rearranged CE = 0

1

$$T = \frac{0.022 \times 100000}{0.658 \times 8.31}$$

Correct M2 also scores M1

1

402(.3) K (or 129 °C)

allow 402-403K

or 129-130 °C
do not penalise °K
M3 must include units for mark

1

(c) Pressure build up from gas/may explode/stopper fly out/glass shatters/breaks

Penalise incorrect gas

1

(d) (i) M_r = 84.3

If 84 used, max 1

1

$\frac{6.27}{84.3} = 0.074(4)$

CE if not 84 or 84.3
Allow answers to 2 or more significant figures
M2 = 0.074-0.075

1

(ii) M1 M_r $MgSO_4$ = 120(.4)

allow 120.3 and 120.1
CE if wrong Mr

1

M2 Expected mass $MgSO_4$ = 0.074(4) × 120(.4) = 8.96 g

Allow 8.8 – 9.0 or candidate's answer to (d)(i) × 120(.4)

1

M3 95% yield = $\frac{8.96 \times 95}{100}$ = 8.51 g

Allow 8.3 – 8.6
M3 dependent on M2

Alternative method

M2 0.074(4) × 95/100 = 0.0707

M3 0.0707 × 120(.4) = 8.51 g

Allow (d)(i) × 95/100
Allow 8.3 – 8.6
M3 dependent on M2

1

[15]

M4. (a) (i) M_r MgO = 40.3

If used 40 then penalise this mark but allow consequential M2 (0.0185)

1

0.741/40.3 = 0.0184

0.018 with no M_r shown = 0
Penalise if not 3 sig figs in this clip only

1

(ii) 0.0184 × 5/2 = 0.0460

Allow 0.0459 to 0.0463
Allow their (a)(i) × 5/2 ie allow process mark of × 5/2 but insist on a correct answer being written down
Ignore sig figs

1

(b) pV = nRT

1

$$(V = \frac{0.402 \times 8.31 \times 333)}{100\,000})$$

If rearranged incorrectly then lose M1
If this expression correct then candidate has scored first mark

0.0111

1

Ignore units

11.1 (dm^3)

3 marks for 11.1 (dm^3)
However if 11.1 m^3 or cm^3 allow 2 (ie penalise wrong units in final answer)
Ignore sig figs- but must be 2 sig figs or greater

1

(c) (i) 0.0152 × 2 = 0.0304

Allow 0.03

1

(ii) 0.938 mol dm^{-3}

Allow range 0.92 – 0.94
Minimum 2 sig figs
Allow consequential marking from (c)(i)
Ignore units even if wrong

1

[8]