M1.(a) M1 $550 \times \frac{100}{95}$ = 579 g would be 100% mass

Allow alternative methods.

There are 4 process marks:

1

M2 So $\frac{579}{65}$ = 8.91 moles NaN_3

or

M1 $\frac{550}{65}$ = 8.46 moles NaN_3 (this is 95%)

M2 So 100% would be 8.46 × $\frac{100}{95}$ = 8.91 moles NaN_3

1: mass ÷ 65

2: mass or moles × 100 / 95 or × 1.05

3: moles NaN_3 × 2

4: moles $NaNH_2$ × 39

1

Then M3 Moles $NaNH_2$ = 8.91 × 2 = (17.8(2) moles)

1

M4 mass $NaNH_2$ = 17.8(2) × 39

1

M5 693 or 694 or 695 (g)

If 693, 694 or 695 seen to 3 sig figs award 5 marks

1

(b) M1 308 K and 150 000 Pa

1

M2 $n = \frac{PV}{RT}$ or $\frac{150\,000 \times 7.5 \times 10^{-2}}{8.31 \times 308}$

1

M3 = 4.4(0) or 4.395 moles N_2

Allow only this answer but allow to more than 3 sig figs

1

M4 Moles NaN_3 = 4.395 × $\frac{2}{3}$ (= 2.93)

M4 is for M3 × $\frac{2}{3}$

1

M5 Mass NaN_3 = (2.93) × 65

M5 is for moles M4 × 65

1

M6 = 191 g

Allow 190 to 191 g allow answers to 2 sig figs or more

1

(c) (i) 150 / 65 = 2.31 moles NaN_3 or 2.31 moles nitrous acid

1

Conc = 2.31 × $\frac{1000}{500}$

M2 is for M1 × 1000 / 500

1

4.6(1) or 4.6(2) (mol dm^{-3})

Only this answer

1

(ii) $3HNO_2 \longrightarrow HNO_3 + 2NO + H_2O$

Can allow multiples

1

(d) Ionic

If not ionic then CE = 0 / 3

1

Oppositely charged ions / Na^+ and N_3^- ions

Penalise incorrect ions here but can allow M3

1

Strong attraction between (oppositely charged) ions / lots of energy needed to overcome (strong) attractions (between ions)

M3 dependent on M2

1

(e) (i) $N \equiv N \longrightarrow N^-$

Only

1

(ii) CO_2 / N_2O / BeF_2 / HN_3

Allow other correct molecules

1

(iii) MgN_6

Only

1

[21]

M2.(a) Stage 1

M_r for $Mg(NO_3)_2$ = 148.3

Moles of $Mg(NO_3)_2$ = $\frac{3.74 \times 10^{-2}}{148.3}$ = 2.522×10^{-4} mol

Extended response calculation

1

Stage 2

Total moles of gas produced = 5/2 × moles of $Mg(NO_3)_2$

= 5/2 × 2.522×10^{-4} = 6.305×10^{-4}

If ratio in stage 2 is incorrect, maximum marks for stage 3 is 2

1

Stage 3

$PV = nRT$ so volume of gas $V = nRT / P$

1

$V = \frac{nRT}{P} = \frac{6.305 \times 10^{-4} \times 8.31 \times 333}{1.00 \times 10^{5}}$ = 1.745×10^{-5} m^3

1

V = $1.745 \times 10^{-5} \times 1 \times 10^{6}$ = 17.45 cm^3 = 17.5 (cm^3)

Answer must be to 3 significant figures (answer could be 17.4 cm^3 dependent on intermediate values)

1

(b) Some of the solid is lost in weighing product / solid is blown away with the gas

1

[6]

M3.(a) (i) Uses sensible scales.

*Lose this mark if the **plotted points** do not cover half of the paper.*

Lose this mark if the graph plot goes off the squared paper

Lose this mark if volume is plotted on the x-axis

1

All points plotted correctly

Allow ± one small square.

1

Smooth curve from 0 seconds to at least 135 seconds − the line must pass through or close to all points (± one small square).

Make some allowance for the difficulties of drawing a curve but do not allow very thick or doubled lines.

1

(ii) Any value in the range 91 to 105 s

Allow a range of times within this but not if 90 quoted.

1

(b) (i) Using pV = nRT

This mark can be gained in a correctly substituted equation.

1

$100\,000 \times 570 \times 10^{-6} = n \times 8.31 \times 293$

Correct answer with no working scores one mark only.

1

n = 0.0234 mol

Do not penalise precision of answer but must have a minimum of 2 significant figures.

1

(ii) Mol of $ZnCO_3$ = 0.0234

Mark consequentially on Q6

M1

1

Mass of $ZnCO_3$ = M1 × 125.4 = 2.9(3) or 2.9(4) g

If 0.0225 used then mass = 2.8(2) g

M2

1

(iii) Difference = (15.00 / 5) − Ans to b

If 2.87 g used then percentage is 4.3

M1

1

Percentage = (M1 / 3.00) × 100

Ignore precision beyond 2 significant figures in the final answer

If 2.82 g used from (ii) then percentage = 6.0

M2

1

(c) A reaction vessel which is clearly airtight round the bung

1

Gas collection over water or in a syringe

Collection vessel must be graduated by label or markings

Ignore any numbered volume markings.

1

[13]

M4.B

[1]