

M1.B

[1]

M2.B

[1]

M3.(a) (i) $2.16 \div 241.8 = \underline{0.00893}$ or 8.93×10^{-3} (mol)
Penalise if not 3 significant figures.

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(ii) $n(\text{O}_2) = 0.00893 \times \underline{0.75}$ (= 0.00670 mol)
Allow part(i) $\times 0.75$.

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(iii) M1 = T = 566 K and P = 100 000 Pa
If M1 incorrect can only score M2 and M3.

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M2 = Moles $\text{NO}_2 = 0.0268$ (mol)
If M2 incorrect can only score M1 and M3.
Allow moles of $\text{NO}_2 = \text{student's answer to part (i)} \times 3$.
OR part (ii) $\times 4$ and consequential M4.
Minimum of 2 significant figures.

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$$M3 = V = \frac{nRT}{P} \quad \text{OR} = \frac{0.0268 \times 8.31 \times 566}{100\,000}$$

If M3 incorrect can only score M1 and M2.

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$$M4 = 0.00126 \text{ (m}^3\text{) or } 1.26 \times 10^{-3} \text{ (m}^3\text{)}$$

Allow minimum of 2 significant figures.

Allow no units but incorrect units loses M4.

If 0.00642 moles used:

$$M2 = \text{Moles NO}_2 = 0.0193 \text{ mol.}$$

$$M3 = V = \frac{nRT}{P} = \frac{0.0193 \times 8.31 \times 566}{100\,000}$$

$$M4 = 9.06 \times 10^{-4} \text{ (m}^3\text{) allow } 9.06 \text{ to } 9.08 \times 10^{-4}.$$

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- (b) (Thermal) decomposition

Do not allow catalytic decomposition.

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- (c) Other products are gases / other products escape easily

Allow no other solid (or liquid) product.

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[8]

M4.(a) Mol Pb = $8.14 / 207(.2)$ (= 0.0393 mol)

M1 and M2 are process marks

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$$\text{Mol HNO}_3 = 0.0393 \times 8 / 3 = 0.105 \text{ mol}$$

Allow mark for M1 $\times 8/3$ or M1 $\times 2.67$

1

$$\text{Vol HNO}_3 = 0.105 / 2 = 0.0524 \text{ (dm}^3\text{)}$$

Accept range 0.0520 to 0.0530

No consequential marking for M3

Answer to 3 sig figs required

1

- (b) 101000 (Pa) and $638 \times 10^{-6} \text{ (m}^3\text{)}$

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$$n = \frac{pV}{RT} \quad (= \frac{101000 \times 638 \times 10^{-6}}{8.31 \times 298})$$

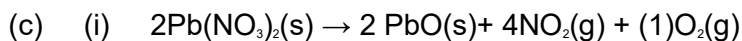
Can score M2 with incorrect conversion of p and V
If T incorrect lose M1 and M3

1

$$0.026(0) \text{ (mol)}$$

If answer correct then award 3 marks
Allow answers to 2 sig figs or more
26.02 = 1
If transcription error lose M3 only

1



Allow multiples
Allow fractions

1

(ii) Decomposition not complete / side reactions / by-products / some (NO_2) escapes / not all reacts / impure $\text{Pb}(\text{NO}_3)_2$

Ignore reversible / not heated enough / slow

1

(iii) Hard to separate O_2 from NO_2 / hard to separate the 2 gases

Allow mixture of gases
Not 'all products are gases'

1

[9]

M5. (a) $P = 100\,000 \text{ (Pa)}$ and $V = 5.00 \times 10^{-3} \text{ (m}^3\text{)}$

M1 is for correctly converting P and V in any expression or list Allow 100 (kPa) and 5 (dm^3) for M1.

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$$n = \frac{PV}{RT} = \frac{100\,000 \times 5.00 \times 10^{-3}}{8.31 \times 298}$$

M2 is correct rearrangement of $PV = nRT$

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= 0.202 moles (of gas produced)
This would score M1 and M2.

Therefore $\frac{0.202}{5} = 0.0404$ moles B_2O_3
M3 is for their answer divided by 5

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Mass of $B_2O_3 = 0.0404 \times 69.6$
M4 is for their answer to M3 x 69.6

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= 2.81 (g)
*M5 is for their answer to 3 sig figures.
2.81 (g) gets 5 marks.*

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(b) $B + 1.5 Cl_2 \rightarrow BCl_3$
Accept multiples.

1

3 bonds

1

Pairs repel equally/ by the same amount
Do not allow any lone pairs if a diagram is shown.

1

(c) (i) $43.2/117.3 (= 0.368$ moles $BCl_3)$

1

$0.368 \times 3 (= 1.105$ moles HCl)
Allow their BCl_3 moles x 3

1

$$\text{Conc HCl} = \frac{1.105 \times 1000}{500}$$

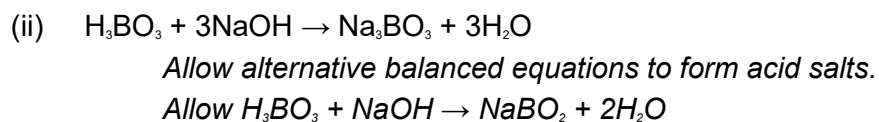
Allow moles of HCl × 1000 / 500

1

$$= \underline{2.20 \text{ to } 2.22} \text{ mol dm}^{-3}$$

Allow 2.2
Allow 2 significant figures or more

1



1

(d) $\frac{10.8}{120.3} (\times 100)$

Mark is for both M, values correctly as numerator and denominator.

1

8.98(%)
Allow 9(%)

1

Sell the HCl

1

(e) Alternative method

Cl = 86.8%
Cl = 142 g

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B	Cl	
$\frac{13.2}{10.8}$	$\frac{86.8}{35.5}$	
	<i>B</i>	<i>Cl</i>
	$\frac{21.6}{10.8}$	$\frac{142}{35.5}$

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1.22 2.45 or ratio 1:2 or BCl₂
 2:4 ratio

1

BCl₂ has *M_r* of 81.8 so
 81.8 x 2 = 163.6
 Formula = B₂Cl₄



Allow 4 marks for correct answer with working shown.

Do not allow (BCl₂)₂

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[20]

M6.(a) P = 100 000 Pa and T = 298 K

*Wrong conversion of V or incorrect conversion of P / T lose
 M1 + M3*

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$$n = \frac{PV}{RT} \text{ or } \frac{100\,000 \times 4.31}{8.31 \times 298}$$

If not rearranged correctly then cannot score M2 and M3

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n(total) = 174(.044)

1

n (NO) = 69.6

Allow student's $M3 \times 4 / 10$ but must be to 3 significant figures

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(b) (i) $\frac{3000}{17}$

Allow answer to 2 significant figures or more

1

176.5

Allow 176 – 177

But if answer = 0.176 – 0.18 (from 3 / 17) then allow 1 mark

1

(ii) $176.47 \times 46 = 8117.62$

M1 is for the answer to (b)(i) $\times 46$. But lose this mark if $46 \div 2$ at any stage

However if $92 \div 2$ allow M1

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$$8117.62 \times \frac{80}{100} (= 6494 \text{ g})$$

M2 is for $M1 \times 80 / 100$

1

$$\frac{6494}{1000} = 6.5$$

M3 is for the answer to $M2 \div 1000$ to min 2 significant figures (kg)

OR

If 163 mol used:

$$163 \times 46 = 7498 (1)$$

$$7498 \times \frac{80}{100} = 5998.4 \text{ g}(1)$$

6.00 kg (1)

1

(c) $0.543 \times \frac{2}{3} (=0.362)$
if not $\times \frac{2}{3}$ CE = 0/2

1

$$0.362 \times \frac{1000}{250} = 1.45 \text{ (mol dm}^{-3}\text{)}$$

Allow 1.447 – 1.5 (mol dm⁻³) for 2 marks

1

- (d) NO₂ contributes to acid rain / is an acid gas / forms HNO₃ / NO₂ is toxic / photochemical smog

Ignore references to water, breathing problems and ozone layer.

Not greenhouse gas

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- (e) Ensure the ammonia is used up / ensure complete reaction or combustion

OR

Maximise the yield of nitric acid or products

1

- (f) Neutralisation

Allow acid vs alkali or acid base reaction

1

[14]