**M1.**B

**[1]**

**M2.**B

**[1]**

**M3.**(a) (i) $2.16 \div 241.8 = \underline{0.00893}$ or $8.93 \times 10^{-3}$ (mol)

*Penalise if not 3 significant figures.*

**1**

(ii) $n(O_2) = 0.00893 \underline{\times 0.75}$ (= 0.00670 mol)

*Allow part(i) <u>× 0.75</u> .*

**1**

(iii) M1 = T = 566 K and P = 100 000 Pa

*If M1 incorrect can only score M2 and M3.*

**1**

M2 = Moles $NO_2$ = 0.0268 (mol)

*If M2 incorrect can only score M1 and M3.*

*Allow moles of $NO_2$ = student's answer to part (i) × 3.*

***OR** part (ii) × 4 and consequential M4.*

*Minimum of 2 significant figures.*

**1**

M3 = $V = \frac{nRT}{p}$ **OR** = $\frac{0.0268 \times 8.31 \times 566}{100\,000}$

*If M3 incorrect can only score M1 and M2.*

**1**

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

*Allow minimum of 2 significant figures.*

*Allow no units but incorrect units loses M4.*

***If 0.00642 moles used:***

*M2 = Moles $NO_2$ = 0.0193 mol.*

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

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

**1**

(b) (Thermal) decomposition

*Do not allow catalytic decomposition.*

**1**

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

*Allow no other solid (or liquid) product.*

**1**

**[8]**

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

*M1 and M2 are process marks*

**1**

Mol $HNO_3$ = 0.0393 × 8 / 3 = 0.105 mol

*Allow mark for M1 × 8/3 or M1 × 2.67*

**1**

Vol $HNO_3$ = 0.105 / 2 = 0.0524 ($dm^3$)

*Accept range 0.0520 to 0.0530*

*No consequential marking for M3*

*Answer to 3 sig figs required*

**1**

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

**1**

n = pV/RT (= $\underline{101000 \times 638 \times 10^{-6}}$) ( 8.31 × 298 )

*Can score M2 with incorrect conversion of p and V*

*If T incorrect lose M1 and M3*

**1**

$\underline{0.026}$(0) (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**

(c) (i) $2Pb(NO_3)_2(s) \rightarrow 2\ PbO(s) + 4NO_2(g) + (1)O_2(g)$

*Allow multiples*

*Allow fractions*

**1**

(ii) Decomposition not complete / side reactions / by-products / some ($NO_2$) escapes / not all reacts / impure $Pb(NO_3)_2$

*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 (Pa) and V = 5.00 x $10^{-3}$ ($m^3$)

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

**1**

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

*M2 is correct rearrangement of PV = nRT*

**1**

= 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*

**1**

Mass of $B_2O_3$ = 0.0404 x 69.6

*M4 is for their answer to M3 x 69.6*

**1**

= 2.81 (g)

*M5 is for their answer to 3 sig figures.*

*2.81 (g) gets 5 marks.*

**1**

(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 x 3 (= 1.105 moles HCl)

*Allow their $BCl_3$ moles x 3*

**1**

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

*Allow moles of HCl × 1000 / 500*

**1**

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

*Allow 2.2*

*Allow 2 significant figures or more*

**1**

(ii) $H_3BO_3 + 3NaOH \rightarrow Na_3BO_3 + 3H_2O$

*Allow alternative balanced equations to form acid salts.*

*Allow $H_3BO_3 + NaOH \rightarrow NaBO_2 + 2H_2O$*

**1**

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

*Mark is for both $M_r$ 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*

**1**

| B | Cl |
|---|---|
| 13.2 | 86.8 |
| 10.8 | 35.5 |

| *B* | *Cl* |
|---|---|
| 21.6 | 142 |
| 10.8 | 35.5 |

**1**

1.22 2.45 or ratio 1:2 or $BCl_2$

*2:4 ratio*

**1**

$BCl_2$ has $M_r$ of 81.8 so
81.8 x 2 = 163.6
Formula = $B_2Cl_4$

*$B_2Cl_4$*

*Allow 4 marks for correct answer with working shown.*

*Do not allow $(BCl_2)_2$*

**1**

**[20]**

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

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

**1**

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

*If not rearranged correctly then cannot score M2 and M3*

**1**

n(total) = 174(.044)

**1**

n (NO) = <u>69.6</u>

*Allow student's M3 × 4 / 10 but must be to 3 significant figures*

**1**

(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 × 46 = 8117.62

*M1 is for the answer to (b)(i) × 46. But lose this mark if 46 ÷ 2 at any stage*
*However if 92 ÷ 2 allow M1*

**1**

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

*M2 is for M1 × 80 / 100*

**1**

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

*M3 is for the answer to M2 ÷ 1000 to min 2 significant figures (kg)*

***OR***

If 163 mol used:
163 × 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**

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

*Allow 1.447 − 1.5 (mol dm$^{-3}$) for 2 marks*

**1**

(d) $NO_2$ contributes to acid rain / is an acid gas / forms $HNO_3$ / $NO_2$ is toxic / photochemical smog

*Ignore references to water, breathing problems and ozone layer.*
*Not greenhouse gas*

**1**

(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]**