M1. B

1

M2. B

1

M3. moles NaOH used = vol / 1000 × conc **(1)** = 21.7 *(if uses 25 here only scores first of first 4 marks)*/ 1000 × 0.112
= 0.00243 **(1)** (consider 0.0024 as an arithmetic error loses 1 mark)
(range 0.00242 to 0.00244)
moles HCl in 25 cm^3 = 0.00243 **(1)** (or 1 mol HCl reacts with 1 mol NaOH)
moles of HCl in 250 cm^3 = 0.0243 **(1)**
moles ZCl_4 = 0.0243 / 4 = 0.006075 **(1)** (or 0.006076 or 0.006 mark is for / 4)
M_r = mass / no. Moles **(1)** (method mark also 1.304 / 0.006075)
= 214.7 **(1)** (or 0.006 gives 217) *(allow 214 to 215)*
A_r = 214.7 – 142 = 72.7 **(1)** (217 gives 75, 142 is 35.5 × 4)
Therefore element is Germanium **(1)** (allow conseq correct from A_r)
(75 gives As)

If not / 4 C.E. from there on but can score 2 independent marks for (mass / moles / method and identity of element)
(for candidates who use $m_1v_1 = m_2v_2$ and calculate [HCl] = 0.0972 allow 1st 3 marks
if 25 and 21.7 wrong way round only award 1/3)

[9]

M4. D

1

M5. A

1

M6. (a) (i) 4.86×10^{-3}

1

(ii) 2.43×10^{-3}

(mark conseq on (a)(i))

1

(iii) 2.43×10^{-2}

(mark conseq on (a)(ii))

1

(iv) $3.01/2.43 \times 10^{-2}$

(mark conseq on (a)(iii))

1

124

(Do not allow 124 without evidence of appropriate calculation in (a)(iii))

1

(b) $M_r(Na_2CO_3) = 106$

$M_r\ (xH_2O) = 250 - 106 = 144$ *(mark conseq on M1)*

$x = 8$ *(mark conseq on M2)*

(Penalise sf errors once only)

3

(c) (i) PV = nRT

1

(ii) Moles $A_r = 325/39.9 = 8.15$

(accept $M_r = 40$)

1

$P = nRT/V = (8.15 \times 8.31 \times 298)/5.00 \times 10^{-3}$

$= 4.03 \times 10^{6}$ Pa or $= 4.03 \times 10^{3}$ kPa

Range = 4.02×10^{6} Pa to 4.04×10^{6} Pa

(If equation incorrectly rearranged, M3 & M4 = 0 If n =325, lose M2)

(Allow M1 if gas law in (ii) if not given in (i))

2

[12]

M7. (a) Moles HCl $= \frac{\text{mass}}{M_r} = \frac{19.6}{36.5}$ **(1)** (= 0.537)

Concentration $= \frac{0.537}{0.25}$ **(1)**

= 2.15 (mol dm^{-3}) **(1)**

Conseq on $\frac{\text{mass}}{M_r}$ correct

min 2 d.p. 2.14 to 2.15

Ignore units

A.E. lose one mark

3

(b) (i) $\frac{21.7}{1000} \times 0.263$ = 5.7**(1)** × 10^{-3} (mol) **(1)**

5.7 to 5.71 × 10^{-3}

(ii) $\frac{5.71 \times 10^{-3}}{2}$ = 2.85 × 10^{-3} (mol) **(1)**

Conseq

(iii) $\frac{0.394}{2.85 \times 10^{-3}}$ = 138 **(1)**

Conseq

(iv) *Relative atomic mass of **M***: 138 - 60 = 78 **(1)**

$\frac{78}{2}$ = 39 **(1)**

*Identify of **M***: Potassium or K or K^+ **(1)**

Conseq

If 78 = M_r then M = selenium

6

[9]

M8. B 1

M9. (a) (i) 75.0 × 10^{-3} × 0.500 = 0.0375 (mol) **(1)**

accept 0.037 or 0.038

(ii) 21.6 × 10^{-3} × 0.500 = 0.0108 (mol) **(1)**

accept 0.011

If both (i) and (ii) answers wrong, allow ONE process mark for both correct processes

(iii) 0.0375 - 0.0108 = 0.0267 (mol) **(1)**

Not conseq – must use figures shown

(iv) *Moles of $MgCO_3$* = 0.0267/2 = 0.01335 (mol) **(1)**

allow 0.0134 - 0.0133

Mass of $MgCO_3$ = 0.01335 × 84.3 **(1)**

allow 84

mark conseq on moles $MgCO_3$

= 1.125g **(1)**

accept 1.13g

mark conseq

Percentage $MgCO_3$ = 1.125/1.25 × 100 **(1)**

mark conseq (check for inversion)

= 90% **(1)**

mark conseq

range = 89.5 - 90.5%

If % expression inverted, lose M4 and M5

8

(b) (i) % oxygen = 38.0 **(1)**

Na = 36.5/23	S = 25.5/32(.1)	O = 38.0/16 **(1)**
= 1.587	= 0.794	= 2.375

= 2:1:3 **(1)**

If no % of oxygen Max 1 (allow M2 only)
If % for Na and S transposed, or atomic numbers used, M1 only available

(ii) $Na_2SO_3 + 2HCl \rightarrow 2NaCl + H_2O + SO_2$ **(1)**

allow multiples

allow $SO_3^{2-} + 2H^+ \rightarrow H_2O + SO_2$

4

[12]