# Junior Chemistry Challenge 2025

# Mark Scheme

**Question 1 – Multiple Choice**

a) **B** – $\frac{3}{2}n$

b) **A** – $Cu^{2+}$ and $CrO_4^{2-}$

c) **E** – Si

d) **E** – $Mg^{2+}$

e) **C** – The fractionating column provides a series of condensation and re-evaporation steps, creating a temperature gradient where components with lower boiling points rise further up the column.

f) **C** – 5

g) **E** – Twice the amount of $CO_2$ (g) produced in half the amount of time.

h) **C** – Mg

i) **D** – $NH_4NO_3$

j) **D** – $Cl_2$; $H_2$; NaOH

| Question | Answer | Additional Guidance | Mark |
|---|---|---|---|
| 2(a) | Oxidation **(1)** | | 1 |
| 2(b) | **1st Mark, multiplying each *m/z* by correct abundance:**<br>(24 x 100) + (25 x 20) + (26 x 20) = 3420<br><br>**2nd Mark, deducing total abundance:**<br>100 + 20 + 20 = 140<br><br>**3rd Mark, correct answer:**<br>3420/140 = 24.43 | The values 3420 and 140 do not need to be explicitly calculated to score M1 and M2 respectively.<br><br>Correct answer without working scores 3<br>ALLOW any level of precision except 24<br>34.2… scores 1 | 3 |

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| 2(c)(i) | One line at 63 *m/z* and one line at 65 *m/z* only **(1)**<br><br>63/65 line heights in a 70:30 ratio **(1)** | IGNORE any lines at 31.5 and 32.5 but cannot score the first mark if any other lines are present.<br><br>M2 dependent on M1<br><br>ALLOW points instead of lines | 2 |
| 2(c)(ii) | $^{63}Cu^{2+}$ **(1)**<br>OR<br>$^{63}Cu$ with z = 2 **(1)**<br><br>$^{65}Cu^{2+}$ **(1)**<br>OR<br>$^{65}Cu$ with z = 2 **(1)** | $Cu^{2+}$ with no clear isotopic distinction scores 1<br>'Both isotopes are 2+' OWTTE scores 2 | 2 |
| 2(d) | Peaks at 79 and 81 the same height/abundance/both have a relative abundance of 20 **(1)** | | 1 |
| 2(e) | $^{79}Br_2^+$ **(1)**<br><br>$^{79}Br^{81}Br^+$ **(1)**<br><br>$^{81}Br_2^+$ **(1)** | Just $Br_2^+$ with no reference to isotopes scores 1<br><br>Ions do not need charges to score the mark but REJECT if charge is incorrect (e.g. 2+)<br>Ions do not need to be explicitly assigned to peaks<br>ALLOW descriptions of ions e.g. 'an ion/molecule with two $^{79}Br$' etc. | 3 |

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| 2(f) | **1st Mark, probability of 158 peak**<br>158 *m/z*: Chance of 2 x $^{79}Br$ = 0.5 x 0.5 = 0.25<br><br>**2nd Mark, probability of 160 peak**<br>160 *m/z*: Chance of $^{79}Br^{81}Br$ and $^{81}Br^{79}Br$ =<br>0.5 x 0.5 + 0.5 x 0.5 = 0.5<br><br>**3rd Mark, probability of 162 peak**<br>162 *m/z*: Chance of 2 x $^{81}Br$ = 0.5 x 0.5 = 0.25 | | 3 |

| Question | Answer | Additional Guidance | Mark |
|---|---|---|---|
| 3(a) | Condense the air (into a liquid) **(1)**<br><br>(Fractional) distillation **(1)**<br><br>OR<br><br>Cool air down until first gas/oxygen/nitrogen condenses **(1)**<br><br>Then cool further until second gas/oxygen/nitrogen condense **(1)** | ALLOW turn into liquid/cool to liquid. Must be clear the air is being turned into liquid<br>M2 dependent on M1<br><br>Must be clearly a two-step process to separate the gases. | 2 |
| 3(b) | Increase the rate/make the reaction faster **(1)**<br>OR<br>Increase yield of/amount of $NH_3$ produced **(1)** | ALLOW form the product faster<br><br>ALLOW move position of equilibrium to the right/products | 1 |
| 3(c) | **4** $NH_3$ + **5** $O_2$ → **4** NO + **6** $H_2O$ **(1)** | ALLOW multiples | 1 |
| 3(d) | $N_2O_4$ **(1)** | | 1 |

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| 3(e) | Neutralisation **(1)** | | 1 |
| 3(f) | **1st Mark, correctly identifying the mass of N and the RAM of $NH_4NO_3$:**<br>$RFM(NH_4NO_3) = (14 \times 2) + (1 \times 4) + (16 \times 3) = 80$<br>AND<br>N in $NH_4NO_3 = 2 \times 14 = 28$<br><br>**2nd Mark, correctly calculating the % of N by mass:**<br>28/80 = 35% | The values 80 and 28 do not need to be explicitly calculated to score M1 and M2 respectively.<br><br>M2 must be a percent and not a decimal<br>14/80 = 17.5% scores 0 | 2 |
| 3(g) | **1st Mark, total mass of the mixture:**<br>$(14 \times 2) + (1 \times 4) + (16 \times 3) + (31 \times 2) + (16 \times 5) + (39 \times 2) + 16 = 316$<br><br>**2nd Mark, total mass of N, P, and K:**<br>N: $14 \times 2 = 28$<br>P: $31 \times 2 = 62$<br>K: $39 \times 2 = 78$<br><br>**3rd Mark, percent of N, P, K individually or combined:**<br>N: 28/316 = 8.9 %<br>P: 62/316 = 19.6 %<br>K: 78/316 = 24.7 %<br><br>OR<br><br>(28 + 62 + 78)/316 = 53.2 % | The values 316, 28, 62, and 78 do not need to be explicitly calculated to score M1 and M2 respectively.<br><br>ALLOW ECF for M3 only.<br>M3 must be a percent and not a decimal.<br>ALLOW any level of precision. | 3 |
| 3(h) | $2\ NH_4NO_3 \rightarrow 2\ N_2 + O_2 + 4\ H_2O$<br><br>Correct formulae **(1)**<br>Correctly balanced **(1)** | <br><br>ALLOW multiples<br>M2 dependent on M1 | 2 |

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| 3(i) | **1st Mark, conversion of mass of $NH_4NO_3$ to g OR conversion of energy to J/kg:**<br>2,750,000 kg x 1000 g $kg^{-1}$ = 2,750,000,000 g<br>OR<br>1673 J $g^{-1}$ x 1000 g $kg^{-1}$ = 1,673,000 J $kg^{-1}$<br><br>**2nd Mark, correct calculation of energy released:**<br>2,750,000,000 g x 1673 J $g^{-1}$ = 4.60 x $10^{12}$ J<br>OR<br>2,750,000 kg x 1,673,000 J $kg^{-1}$ = 4.60 x $10^{12}$ J | The values M1 do not need to be explicitly calculated<br><br>ALLOW any correct SI prefix or with or without standard form.<br>ALLOW missing or incorrect unit<br>Correct answer with no works scores 2<br><br>ALLOW precision from 2 sf. | 2 |