UK Chemistry Olympiad support resources: introductory questions mark scheme

1. The question about air

(a)
   (i) Molar mass of $N_2 = 2(14.01) = 28.02$ g mol$^{-1}$; Molar mass of $O_2 = 2(16.00) = 32.00$ g mol$^{-1}$; Molar mass of $Ar = 39.95$ g mol$^{-1}$
   (ii) Mass of 1 mole of air = 29.0 g to three significant figures

(b)
   (i) Volume of the troposphere = $5.11 \times 10^{21}$ dm$^3$
   (ii) Mass of air in the troposphere = $6.17 \times 10^{21}$ g
      If other values given in question were used then:

<table>
<thead>
<tr>
<th>Volume of troposphere/dm$^3$</th>
<th>Molar mass of air / g mol$^{-1}$</th>
<th>Mass of air in troposphere / g</th>
</tr>
</thead>
<tbody>
<tr>
<td>$5.11 \times 10^{21}$</td>
<td>30.0</td>
<td>$6.38 \times 10^{21}$</td>
</tr>
<tr>
<td>$6.00 \times 10^{21}$</td>
<td>29.0</td>
<td>$7.24 \times 10^{21}$</td>
</tr>
<tr>
<td>$6.00 \times 10^{21}$</td>
<td>30.0</td>
<td>$7.49 \times 10^{21}$</td>
</tr>
</tbody>
</table>

(c)
   (i) $Mg + \frac{1}{2} O_2 \rightarrow MgO$
   (ii) Minimum volume of air = $23.5$ dm$^3$

(d)
   (i) $3Mg + N_2 \rightarrow Mg_3N_2$
   (ii) $100 - x$
   (iii) $MgO: \quad \frac{40.31}{24.31} \cdot x$
   $Mg_3N_2: \quad \frac{100.95(100-x)}{3(24.31)}$
      (allow equivalent expressions)
   (iv) Mass of Mg which reacts to form $MgO = 78.8$ g
2. The question about bromine and its isotopes

(a)  
(i) 0.25 (allow 25%)  
(ii) 0.25 (allow 25%)  
(iii) 0.5 (allow 50%)  

(b)  
Abundance of bromine-79 = 60%  
Abundance of bromine-81 = 40%  

(c)  
(i) 247, 248, 249, 250, 251, 252, 253 and 254 (allow 247–254)  
(ii) 0.125 (allow 12.5%)  
(iii) 0.375 (allow 37.5%)  
(iv) 0.3 (allow 30%)  

(d)  
(i) C₆H₅O  
(ii)  

![Structure A](image)  

(e)  
CHBr₃  

![Structure B](image)