

The Mole Concept

Question 1 (2016 - Question 11 - Part a)

(a) (i) WHICH: **sulfur (S)** (1)

WHAT: **16 g S** (12)

$$\frac{20.2}{101} = \mathbf{0.2} \text{ moles KNO}_3 \quad (3)$$

$$\frac{24.0}{32} = \mathbf{0.75} \text{ moles S} \quad (3)$$

and

$$\frac{0.2 \times 5}{4} = \mathbf{0.25} \text{ moles S required to react with 0.2 moles KNO}_3 \quad (2)$$

$$0.75 - 0.25 = \mathbf{0.5(0)} \text{ moles S unused (in excess)} \quad (2)$$

$$0.5 \times 32 = \mathbf{16} \text{ g S unused} \quad (2)$$

or

$$\frac{0.75 \times 4}{5} = \mathbf{0.6(0)} \text{ moles KNO}_3 \text{ required to react with 0.75 moles S}$$

\Rightarrow 0.2 moles KNO₃ limiting

$$\frac{0.2 \times 5}{4} = \mathbf{0.25} \text{ moles S required to react with 0.2 moles KNO}_3 \quad (2)$$

$$0.75 - 0.25 = \mathbf{0.5(0)} \text{ moles S unused (in excess)} \quad (2)$$

$$0.5 \times 32 = \mathbf{16} \text{ g S unused} \quad (2)$$

or

$$\frac{0.2}{4} < \frac{0.75}{5} / 0.05 < 0.15 \quad \Rightarrow 0.2 \text{ moles KNO}_3 \text{ limiting}$$

$$\frac{0.2 \times 5}{4} = \mathbf{0.25} \text{ moles S required to react with 0.2 moles KNO}_3 \quad (2)$$

$$0.75 - 0.25 = \mathbf{0.5(0)} \text{ moles S unused (in excess)} \quad (2)$$

$$0.5 \times 32 = \mathbf{16} \text{ g S unused} \quad (2)$$

(ii) CALCULATE: **7.84 litres** (6)

$$\frac{0.2 \times 7}{4} / \frac{0.2 \times 2}{4} + \frac{0.2 \times 5}{4} = \mathbf{0.35} \text{ moles gas} \quad (3)$$
$$0.35 \times 22.4 = \mathbf{7.84} \text{ litres} \quad (3)$$

[Award final answer of **2.24 litres** and **5.60 litres** (5)]
[Use of 24 L as molar volume not acceptable here.]

WHAT: **9.4 g K₂O** (6)

$$\frac{0.2 \times 2}{4} = \mathbf{0.1} \text{ moles K}_2\text{O} \quad (3)$$
$$94^* \times 0.1 = \mathbf{9.4} \text{ g K}_2\text{O} \quad (3)$$

[*Addition must be shown for error to be treated as slip.]

Question 2 (2015 - Section B - Question 10 - Part c)

(c) (i) WHAT: amount containing **as many particles*** as //
the number of atoms in **0.012 kg (12 g) of carbon-12** /

or

amount containing the **Avogadro number (Avogadro constant, $L, 6 \times 10^{23}$)** //
of **particles** */

or

amount equal to the relative **formula (molecular) mass (M_r)** //
expressed in **grams** (2 × 3)
[* 'Atoms', 'molecules', 'ions', 'units' for 'particles' allowed.]

(ii) HOW: **0.4 mol** (6)

$$\frac{7.6}{76^*} = 0.10 = \mathbf{0.10} \text{ mol Mg}_2\text{Si} \quad (3) \quad \text{or} \quad \frac{4 \times 24 \times 7.6}{76^*} = \mathbf{9.6} \text{ g Mg} \quad (3)$$
$$0.10 \text{ mol Mg}_2\text{Si} \rightarrow 0.40 = \mathbf{0.4} \text{ mol Mg} \quad (3) \quad 9.6 \div 24 = \mathbf{0.4} \text{ mol Mg} \quad (3)$$

(iii) CALC: **0.4 mol** (3)

$$0.10 \text{ mol Mg}_2\text{Si} \rightarrow 0.40 = \mathbf{0.4} \text{ mol HCl} \quad (3) \quad \text{or}$$

$$\frac{4 \times 36.5}{76^*} \times 7.6 = 14.6 \div 36.5 = \mathbf{0.4} \text{ mol HCl} \quad (3)$$

WHAT: **19 g MgCl₂** (6)

$$0.10 \text{ mol Mg}_2\text{Si} \rightarrow 2 \times 0.10 = \mathbf{0.2} \text{ mol MgCl}_2 \quad (3)$$
$$95^{**} \times 0.20 = \mathbf{19} \text{ g MgCl}_2 \quad (3)$$

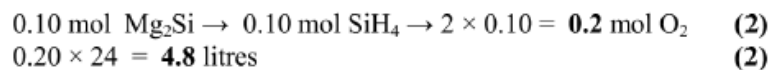
or

$$76^* \text{ g Mg}_2\text{Si} \rightarrow 2 \times 95^{**} / \mathbf{190} \text{ g MgCl}_2 \quad (3)$$

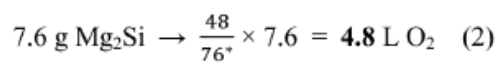
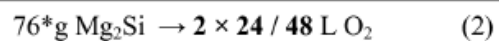
$$7.6 \text{ g Mg}_2\text{Si} \rightarrow 190 \div 10 = \mathbf{19} \text{ g MgCl}_2 \quad (3)$$

(iv) WHAT: **4.8 litres (4,800 cm³)**

(4)



or



[Use of 22.4 L as molar volume not acceptable here.]

[*Addition must be shown for error to be treated as slip.]

**Addition must be shown for error to be treated as slip.]

[1 mark deducted for incorrect rounding off, once only.]

Question 3 (2014 - Section B - Question 4 - Part (f))

- (f) WHAT: amount containing **as many particles*** as //
the number of atoms in **0.012 kg (12 g) of carbon-12** /
- or*
- amount containing the **Avogadro number (Avogadro constant, $L, 6 \times 10^{23}$)** //
of **particles** /
- or*
- amount equal to the relative **formula (molecular) mass (M_r)** //
expressed **in grams** (2 × 3)
[*Allow 'atoms', 'molecules', 'ions', 'units' for 'particles'.]

Question 4 (2008 - Section B - Question 11 - Part (b))

- (b) (i) MASS: **1144 g** (6)
- $143 \times 8 = 1144$ (6)
- (ii) MOLES: **26 mol** (6)
- $1144 \div 44$ (3) = 26 (3)
- To be accepted as a slip, some work must be shown in these calculations.*
- (iii) VOLUME: **624 l** (6)
- 26×24 (3) = 624 (3)
- SUV: **528 l** (7)

$264 \times 8 \div 44 \times 24 = 1152$ (4)	$264 - 143 = 121$ (3)	$2112 - 1144 = 968$ (3)	$48 - 26 = 22$ (3)
$1152 - 624 = 528$ (3)	$121 \times 8 \div 44 \times 24 = 528$ (4)	$968 \div 44 \times 24 = 528$ (4)	$22 \times 24 = 528$ (4)

[Note: subtraction step (3); other step(s) (4)]

[In part (iii), using 22.4 for 24 loses the 3 (4) marks for that step but the candidate is penalised once only. The same applies to the use of $PV = nRT$ except in cases where the correct answer is obtained.]