

Moles, formulae, gas volumes and atom economy

Chemistry grades 11-12 (A Level · IB · Class 11-12) · Test answers (mark scheme)

Marks are awarded for method and for the final answer with the correct unit. Allow error carried forward when an earlier slip is used consistently. Answers with correct numbers but no units lose one mark.

Level: Chemistry grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** A Level 3.1.2

Question 1 Mass of potassium carbonate (2 marks)

$$M = 2 \times 39.1 + 12.0 + 3 \times 16.0 = 138.2 \text{ g mol}^{-1}. m = 0.0300 \times 138.2 = \mathbf{4.15 \text{ g}}.$$

Marking: 1 for M ; 1 for the mass with unit.

Question 2 Formula of an oxide of lead (3 marks)

$$n(\text{Pb}) = 2.07 \div 207 = 0.0100 \text{ mol}; n(\text{O}) = 0.32 \div 16.0 = 0.0200 \text{ mol}. \text{ Ratio } 1 : 2. \text{ Formula } \mathbf{PbO_2}.$$

Marking: 1 for each amount; 1 for the ratio and formula.

Question 3 Graph of gas volume (4 marks)

a. About **2.49 dm³** (accept 2.4 to 2.6).

b. V is directly proportional to the kelvin temperature.

$$c. V = 3.32 \times 10^{-3} \text{ m}^3, T = 400 \text{ K}, p = 1.00 \times 10^5 \text{ Pa}. n = pV \div RT = (1.00 \times 10^5 \times 3.32 \times 10^{-3}) \div (8.31 \times 400) = 332 \div 3324 = \mathbf{0.100 \text{ mol}}.$$

Marking: (a) 1; (b) 1; (c) 1 for conversion, 1 for the result.

Question 4 Atom economy of oxygen (3 marks)

$$\text{Total mass of products} = 2 \times 18.0 + 32.0 = 68.0. \text{ Atom economy} = 32.0 \div 68.0 \times 100 = \mathbf{47.1 \%}, \text{ which is low, since more than half the mass goes into water.}$$

Marking: 1 for the total; 1 for the value; 1 for the comment.

Question 5 Molecular formula (2 marks)

$$\text{Mass of } \text{CH}_2 = 14.0. 84.0 \div 14.0 = 6. \text{ The molecular formula is } \mathbf{C_6H_{12}}.$$

Marking: 1 for the factor 6; 1 for the formula.

Question 6 Volume of a gas (3 marks)

$p = 2.00 \times 10^5 \text{ Pa}$. $V = nRT \div p = (0.500 \times 8.31 \times 300) \div (2.00 \times 10^5) = 6.23 \times 10^{-3} \text{ m}^3 =$
6.23 dm³.

Marking: 1 for conversion of p; 1 for substitution; 1 for the answer with unit.

Question 7 Percentage yield (2 marks)

$\text{Yield} = 4.50 \div 6.00 \times 100 =$ **75.0 %**.

Marking: 1 for the ratio; 1 for the answer.

Question 8 Why atom economy matters (1 mark)

Less waste is produced, so fewer by-products need disposal and fewer resources are used per tonne of **useful product**.

Marking: 1 for less waste or fewer resources.