

### 3E Chapter 7 Mole Concept and Stoichiometry Worksheet One Solutions

Modified June 2024

1. In an experiment, 4.0 g of sulfur was burnt in 48.0 dm<sup>3</sup> of oxygen measured at r.t.p to form sulfur dioxide.

(a) Write the equation for the reaction between sulfur and oxygen.



(b) What was the limiting reactant in this reaction?

$$\begin{aligned}\text{Number of moles of S given} &= \frac{4.00}{32.0} \\ &= 0.125 \text{ mol (3 s.f.)}\end{aligned}$$

$$\begin{aligned}\text{Number of moles of O}_2 \text{ given} &= \frac{48.0}{24.0} \\ &= 2.00 \text{ mol (3 s.f.)}\end{aligned}$$

$$\begin{aligned}\text{Mole ratio of S : O}_2 &= 1 : 1 \\ &= 0.125 \text{ mol} : 0.125 \text{ mol (< 2.00 mol given)}\end{aligned}$$

Since 0.125 mol of S is needed to react with 0.125 mol of O<sub>2</sub> but 2 mol of O<sub>2</sub> was given, O<sub>2</sub> is in excess.

Thus, S is the limiting reactant.

(c) Calculate the volume of sulfur dioxide formed at r.t.p.

$$\begin{aligned}\text{Mole ratio of S : O}_2 &= 1 : 1 \\ &= 0.125 \text{ mol} : 0.125 \text{ mol}\end{aligned}$$

$$\begin{aligned}\text{Volume of SO}_2 \text{ produced} &= 0.125 \times 24.0 \\ &= 3.00 \text{ dm}^3 \text{ (3 s.f.)}\end{aligned}$$

Ans: (b) S (c) 3.00 dm<sup>3</sup>

2. (a) A compound contains 40.0% carbon, 6.70% hydrogen and 53.3% oxygen. What is its empirical formula?

Let the mass of compound be 100 g.

Element	C	H	O
Mass / g	40	6.7	53.3
Relative atomic mass	12	1	16
Number of moles / mol	$\frac{40.0}{12.0} = 3.33$	$\frac{6.70}{1.00} = 6.70$	$\frac{53.3}{16.0} = 3.33$
Mole ratio	1	2	1

Hence, the empirical formula is CH<sub>2</sub>O.

- (b) Given that the compound has an  $M_r$  of 180, find its molecular formula.

$$M_r \text{ of CH}_2\text{O} = 12 + 1 + 1 + 16$$

$$= 30.0 \text{ (3 s.f.)}$$

$$n = 180 \div 30.0$$

$$= 6.00 \text{ (3 s.f.)}$$

Hence the molecular formula of the compound is C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>.

Ans: (a) CH<sub>2</sub>O (b) C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>

3. In an experiment, 1.20 g of magnesium was reacted with excess hydrochloric acid. Magnesium chloride and hydrogen gas were produced.

(a) Write a balanced chemical equation for this reaction.



(b) Calculate the mass of magnesium chloride produced in this reaction.

$$\begin{aligned}\text{Number of moles of Mg used} &= 1.20 \div 24 \\ &= 0.05 \text{ mol}\end{aligned}$$

$$\text{Mass of MgCl}_2 \text{ produced} = 0.05 \times 95 = 4.75 \text{ g}$$

(c) Calculate the volume of hydrogen gas produced at room temperature and pressure.

$$\text{Number of moles of H}_2 \text{ produced} = 0.0500 \text{ mol (3 s.f.)}$$

$$\text{Volume of H}_2 \text{ produced} = 0.05 \times 24 = 1.20 \text{ dm}^3 \text{ (3 s.f.)}$$

Ans: (b) 4.75 g (c) 1.20 dm<sup>3</sup>

4. (a) Define *relative atomic mass*.

The relative atomic mass of an element is the average mass of one atom of that element relative to the mass of an atom of carbon – 12.

(b) Define *relative molecular mass*.

The relative molecular mass of a molecular substance is the average mass of one molecule of that substance relative to the mass of an atom of carbon – 12.

(c) Calculate the relative molecular mass of the following substances.

MgCl <sub>2</sub> 95	NaOH 40
H <sub>2</sub> SO <sub>4</sub> 98	Nitrogen Gas 28

Ans: (Refer to solutions)

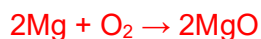
5. A magnesium ribbon was loosely coiled and placed in a weighed crucible. The crucible was heated to allow the magnesium to react with oxygen in the air to form magnesium oxide.

**Mass of Crucible / g : 20.10**

**Mass of Crucible With Magnesium / g : 20.58**

**Mass of Crucible With Magnesium Oxide / g : 20.90**

- (a) Write a balanced chemical equation for this reaction.



- (b) Calculate the mass of magnesium ribbon used.

$$\text{Mass of Mg} = 20.58 - 20.10 = 0.48 \text{ g}$$

- (c) Find the volume of oxygen that reacted.

$$\begin{aligned}\text{Number of moles of Mg} &= 0.48 \div 24 \\ &= 0.0200 \text{ mol (3 s.f.)}\end{aligned}$$

$$\begin{aligned}\text{Number of moles of O}_2 &= 0.02 \div 2 \\ &= 0.0100 \text{ mol (3 s.f.)}\end{aligned}$$

$$\begin{aligned}\text{Volume of O}_2 &= 0.01 \times 24 \\ &= 0.240 \text{ dm}^3 \text{ (3 s.f.)}\end{aligned}$$

Ans: (b) 0.48 g (c) 0.24 dm<sup>3</sup>