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^3 of oxygen measured at r.t.p to form sulfur dioxide.

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

$S(s) + O_2(g) \rightarrow SO_2(g)$

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

Number of moles of S given $= \frac{4.00}{32.0}$

$= 0.125$ mol (3 s.f.)

Number of moles of O_2 given $= \frac{48.0}{24.0}$

$= 2.00$ mol (3 s.f.)

Mole ratio of S : $O_2 = 1 : 1$

$= 0.125$ mol : 0.125 mol (< 2.00 mol given)

Since 0.125 mol of S is needed to react with 0.125 mol of O_2 but 2 mol of O_2 was given, O_2 is in excess.

Thus, S is the limiting reactant.

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

Mole ratio of S : $O_2 = 1 : 1$

$= 0.125$ mol : 0.125 mol

Volume of SO_2 produced $= 0.125 \times 24.0$

$= 3.00\ dm^3$ (3 s.f.)

Ans: (b) S (c) 3.00 dm^3

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_2O.

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

M_r of $CH_2O = 12 + 1 + 1 + 16$

$= 30.0$ (3 s.f.)

$n = 180 \div 30.0$

$= 6.00$ (3 s.f.)

Hence the molecular formula of the compound is $C_6H_{12}O_6$.

Ans: (a) CH_2O (b) $C_6H_{12}O_6$

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.

$Mg + 2HCl \rightarrow MgCl_2 + H_2$

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

Number of moles of Mg used = 1.20 ÷ 24

= 0.05 mol

Mass of $MgCl_2$ produced = 0.05 × 95 = 4.75 g

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

Number of moles of H_2 produced = 0.0500 mol (3 s.f.)

Volume of H_2 produced = 0.05 24 = 1.20 dm^3 (3 s.f.)

Ans: (b) 4.75 g (c) 1.20 dm^3

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.

$MgCl_2$ 95	NaOH 40
H_2SO_4 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.

$2Mg + O_2 \rightarrow 2MgO$

(b) Calculate the mass of magnesium ribbon used.

Mass of Mg = 20.58 – 20.10 = 0.48 g

(c) Find the volume of oxygen that reacted.

Number of moles of Mg = 0.48 ÷ 24

= 0.0200 mol (3 s.f.)

Number of moles of O_2 = 0.02 ÷ 2

= 0.0100 mol (3 s.f.)

Volume of O_2 = 0.01 x 24

= 0.240 dm^3 (3 s.f.)

Ans: (b) 0.48 g (c) 0.24 dm^3