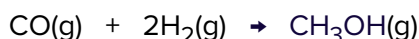


# CHEMISTRY CALCULATIONS WS 4

## Moles & Volume

- 1 Consider the following reaction for the synthesis of methanol:



- a. What volume of  $\text{H}_2$  reacts exactly with  $2.50 \text{ dm}^3$  of  $\text{CO}$ ?

$$V \text{ of } \text{H}_2 = 2 \times (V \text{ of } \text{CO}) = 5.0 \text{ dm}^3$$

- b. What volume of  $\text{CH}_3\text{OH}$  is produced?

$$2.5 \text{ dm}^3$$

- 2 a. Calculate the number of moles in  $250 \text{ cm}^3$  of  $\text{O}_2$  @ r.t.p.

$$\begin{array}{l} 1 \text{ mol is } 24 \text{ dm}^3 \\ x \text{ in } 250 \text{ cm}^3 \end{array} \quad x = \frac{1}{24000} \times 250 = 0.0104 \text{ mol}$$

- b. Calculate the volume of  $0.135 \text{ mol}$  of  $\text{CO}_2$  @ r.t.p.

$$V = 0.135 \times 24 \text{ dm}^3 = 3.24 \text{ dm}^3$$

- 3 Calculate the volume of carbon dioxide (@ r.t.p.) produced when  $10.01 \text{ g}$  of calcium carbonate decomposes according to the equation:

$$\begin{array}{l} M_r \text{ CaCO}_3 = 40.1 + 12 + 3(16) \\ = 100.1 \end{array}$$

$$n \text{ of } \text{CaCO}_3 = 0.1 \text{ mol}$$

$$n \text{ of } \text{CO}_2 = 0.1 \text{ mol}$$



$$\begin{array}{l} V \text{ of } \text{CO}_2 = 0.1 \times 24 \text{ dm}^3 \\ = 2.4 \text{ dm}^3 \end{array}$$

- 4 Potassium chlorate(V) decomposes when heated:

$$39.1 + 35.5 + 48 = 122.6$$



What mass of potassium chlorate(V) decomposes to produce  $100.0 \text{ cm}^3$  of oxygen gas measured @ r.t.p?

$$n \text{ O}_2 = \frac{100}{24000} = 0.00416 \text{ mol produced.}$$

$$n \text{ KClO}_3 = \frac{0.00416}{3} \times 2 = 0.00277 \text{ mol}$$

$$\begin{array}{l} \text{Mass of } \text{KClO}_3 = 122.6 \times 0.00277 \\ = 0.339 \text{ g reacted.} \end{array}$$

- 5 What volume of  $\text{SO}_2$  is obtained (measured @ r.t.p) when 1.000 kg of  $\text{As}_2\text{S}_3$  is heated in oxygen?

$$\text{Mr As}_2\text{O}_3 = 2(74.9) + 3(32.1) = 246.1$$

$$n = \frac{1000}{246.1} = 4.064 \text{ mol}$$

$$n \text{ of SO}_2 = \frac{4.064}{2} \times 6 = 12.19 \text{ mol}$$



$$\text{Vol of SO}_2 = 12.19 \times 24 \text{ dm}^3 = 292.56 \text{ dm}^3$$

- 6 a. Calculate the volume of  $\text{CO}_2$  produced when  $100\text{cm}^3$  of ethene burns in excess oxygen according to the equation:



$$1 : 2$$

$$1 \text{ mol} : 2 \text{ mol}$$

$$1 \text{ cm}^3 : 2 \text{ cm}^3$$

$$\text{V of CO}_2 = 200 \text{ cm}^3$$

- b. Calculate the volume of  $\text{NO}$  produced when  $2.0 \text{ dm}^3$  of oxygen is reacted with excess ammonia according to the equation:



$$5 : 4$$

$$2 : x$$

$$x = \frac{4 \times 2}{5} = 1.6 \text{ dm}^3$$

- 7 Determine the number of moles present in each of the following at standard temperature and pressure:

- a.  $0.240 \text{ dm}^3$  of  $\text{O}_2$

$$10.7 \times 10^{-3} \text{ mol}$$

- d.  $400.0 \text{ cm}^3$  of  $\text{N}_2$

$$17.9 \times 10^{-3} \text{ mol}$$

- b.  $2.00 \text{ dm}^3$  of  $\text{CH}_4$

$$89.2 \text{ mol}$$

- e.  $250.0 \text{ cm}^3$  of  $\text{CO}_2$

$$11.16 \times 10^{-3} \text{ mol}$$

- c.  $0.100 \text{ dm}^3$  of  $\text{SO}_2$

$$4.46 \times 10^{-3} \text{ mol}$$

8 Work out the volume of each of the following at standard temperature and pressure:

a. 0.100 mol C<sub>3</sub>H<sub>8</sub>

$$2.24 \text{ dm}^3$$

d. 0.8500 mol NH<sub>3</sub>

$$19.04 \text{ dm}^3$$

b. 100.0 mol SO<sub>3</sub>

$$2240 \text{ dm}^3$$

e. 0.600 mol O<sub>2</sub>

$$13.44 \text{ dm}^3$$

c. 0.270 mol N<sub>2</sub>

$$6.048 \text{ dm}^3$$

9 Sodium nitrate(V) decomposes according to the equation:



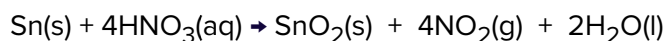
Calculate the volume (in cm<sup>3</sup>) of oxygen produced (measured @ r.t.p) when 0.820 g of sodium nitrate(V) decomposes.

$$n \text{ NaNO}_3 = \frac{0.82}{85} = 0.00964 \text{ mol}$$

$$n \text{ O}_2 = \frac{0.007592}{2} = 0.00482 \text{ mol}$$

$$V \text{ of O}_2 = 0.00482 \times 24000 \text{ cm}^3 \text{ mol}^{-1} = 115.8 \text{ cm}^3$$

10 Tin reacts with nitric acid according to the equation:



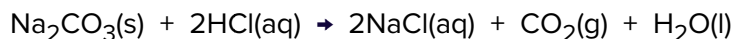
If 2.50g of tin are reacted with excess nitric acid what volume of NO<sub>2</sub> (in cm<sup>3</sup>) is produced @ r.t.p?

$$n \text{ of Sn} = \frac{2.5}{119} = 0.021 \text{ mol}$$

$$V \text{ NO}_2 = 24000 \times 0.0842 = 2.021 \text{ dm}^3$$

$$n \text{ NO}_2 = 4 \times 0.021 = 0.084 \text{ mol}$$

- 11** Calculate the mass of sodium carbonate that must be reacted with excess hydrochloric acid to produce 100.0 cm<sup>3</sup> of CO<sub>2</sub> @ r.t.p.



$$n \text{ of } \text{CO}_2 = \frac{100}{24000} = 0.004167 \text{ mol.}$$

$$n \text{ Na}_2\text{CO}_3 = 0.004167 \text{ mol}$$

$$\text{mass of Na}_2\text{CO}_3 = 0.004167 (23 \times 2 + 12 + 48)$$

$$= 0.4417 \text{ g is required}$$

- 12 a.** Oxygen (O<sub>2</sub>) can be converted to ozone (O<sub>3</sub>) by passing it through a silent electric discharge.



If 300 cm<sup>3</sup> of oxygen is used and 10% of the oxygen is converted to ozone, calculate the total volume of gas present at the end of the experiment.

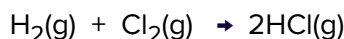
$$10\% \text{ of } 300 \text{ cm}^3 = 30 \text{ cm}^3$$



$$30 : 20 \rightarrow 20 \text{ cm}^3 + 270 \text{ that wasn't used.}$$

$$290 \text{ cm}^3 \text{ in all.}$$

- b.** Hydrogen reacts with chlorine according to the equation:



What is the total volume of gas present in the container at the end of the experiment if 100 cm<sup>3</sup> of hydrogen is reacted with 200 cm<sup>3</sup> of chlorine?

H<sub>2</sub> is the limiting agent and Cl<sub>2</sub> will be left in the tank at the end.



$$\text{Total Initial} = 100 + 200 = 300 \text{ cm}^3$$

$$\text{Reacted} = 200 \text{ cm}^3$$

$$\text{Produced} = 200 \text{ cm}^3$$

$$\text{Leftover} = (\text{P.i} - \text{R}) + \text{P}$$

$$= 300 - 200 + 200$$

$$= 300 \text{ cm}^3$$