



EXERCISE 3.7

QUESTION 1

Determine the:

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Gr 10 Physical Sciences 3-in-1

- 1.1 mass of 5 mol nitrogen gas
- 1.2 volume of 2,5 mol NH_3 at STP
- 1.3 mass of 112 cm^3 H_2S gas at STP
- 1.4 concentration of 3 mol of NaCl dissolved in 250 cm^3 water
- 1.5 concentration of 500 g of $\text{Fe}_2(\text{SO}_4)_3$ dissolved in 2 dm^3 water
- 1.6 mass of calcium chloride dissolved in water to give a 100 mL solution with a concentration of 0,2 $\text{mol} \cdot \text{dm}^{-3}$

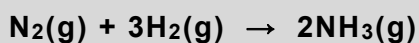
QUESTION 2

During a reaction, 58,5 g potassium reacts with enough hydrochloric acid to form potassium chloride and hydrogen gas.

- 2.1 Write a balanced equation for the reaction.
- 2.2 Calculate the number of moles of potassium that has reacted.
- 2.3 Calculate the mass of the hydrogen gas produced.
- 2.4 Calculate the volume of hydrogen gas produced at STP.

QUESTION 3

- 3.1 Two gases, hydrogen (H_2) and nitrogen (N_2), react to form ammonia gas (NH_3).



- 3.1.1 How many moles of ammonia will be produced from 1 mole of hydrogen gas?
- 3.1.2 Initially 10 cm^3 nitrogen and 24 cm^3 hydrogen are mixed in a container. The temperature and pressure remain constant. Calculate the volume of gas that will remain in the container after the reaction is completed.
- 3.2 In another experiment, 80 g of hydrogen gas reacts with nitrogen gas to form ammonia. Calculate the:
 - 3.2.1 number of moles of hydrogen gas that reacted
 - 3.2.2 volume of the nitrogen gas used at STP

EXERCISE ANSWERS

QUESTION 1

$$\begin{aligned} 1.1.1 \quad m &= nM \\ &= 5 \times 28 \\ &= 140 \text{ g} \end{aligned}$$

$$M(\text{N}_2) = 2 \times 14 = 28 \text{ g} \cdot \text{mol}^{-1}$$

$$\begin{aligned} 1.1.2 \quad V &= nV_m \\ &= 2,5 \times 22,4 \\ &= 56 \text{ dm}^3 \end{aligned}$$

$$V_m = 22,4 \text{ dm}^3 \text{ at STP}$$

$$\begin{aligned} 1.1.3 \quad n &= \frac{V}{V_m} \\ &= \frac{0,112}{22,4} \\ &= 0,005 \\ m &= nM \\ &= 0,005 \times 34 \\ &= 0,17 \text{ g} \end{aligned}$$

$$\begin{aligned} V(\text{H}_2\text{S}) &= 112 \text{ cm}^3 = 0,112 \text{ dm}^3 \\ V_m &= 22,4 \text{ dm}^3 \text{ at STP} \\ M(\text{H}_2\text{S}) &= (2 \times 1) + 32 = 34 \text{ g} \cdot \text{mol}^{-1} \end{aligned}$$

$$\begin{aligned} 1.1.4 \quad c &= \frac{n}{V} \\ &= \frac{3}{0,25} \\ &= 12 \text{ mol} \cdot \text{dm}^{-3} \end{aligned}$$

$$\begin{aligned} n(\text{NaCl}) &= 3 \\ V &= 250 \text{ cm}^3 = 0,25 \text{ dm}^3 \end{aligned}$$

$$\begin{aligned} 1.1.5 \quad n &= \frac{m}{M} \\ &= \frac{500}{400} \\ &= 1,25 \text{ mol} \end{aligned}$$

$$\begin{aligned} m(\text{Fe}_2(\text{SO}_4)_3) &= 500 \text{ g} \\ M(\text{Fe}_2(\text{SO}_4)_3) &= (2 \times 56) + 3[32 + (4 \times 16)] \\ &= 400 \text{ g} \cdot \text{mol}^{-1} \\ V &= 2 \text{ dm}^3 \end{aligned}$$

$$\begin{aligned} c &= \frac{n}{V} \\ &= \frac{1,25}{2} \\ &= 0,625 \text{ mol} \cdot \text{dm}^{-3} \end{aligned}$$

OR

$$\begin{aligned} c &= \frac{n}{V} = \frac{m}{MV} \\ &= \frac{500}{400 \times 2} \\ &= 0,625 \text{ mol} \cdot \text{dm}^{-3} \end{aligned}$$

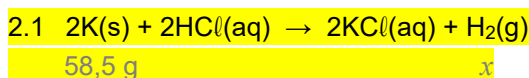
$$\begin{aligned} 1.1.6 \quad c &= \frac{n}{V} \\ n &= cV \\ &= 0,2 \times 0,1 \\ &= 0,02 \text{ mol} \end{aligned}$$

$$\begin{aligned} m &= nM \\ &= 0,02 \times 111 \\ &= 2,22 \text{ g} \quad \text{OR} \end{aligned}$$

$$\begin{aligned} c &= \frac{m}{MV} \\ m &= cMV \\ &= 0,2 \times 111 \times 0,1 \\ &= 2,22 \text{ g} \end{aligned}$$

$$\begin{aligned} c(\text{CaCl}_2) &= 0,2 \text{ mol} \cdot \text{dm}^{-3} \\ V &= 100 \text{ ml} \\ &= 100 \text{ cm}^3 = 0,1 \text{ dm}^3 \\ M(\text{CaCl}_2) &= 40 + (2 \times 35,5) \\ &= 111 \text{ g} \cdot \text{mol}^{-1} \end{aligned}$$

QUESTION 2



$$58,5 \text{ g} \quad x$$

$$\begin{aligned} 2.2 \quad n(\text{K}) &= \frac{m}{M} \\ &= \frac{58,5}{39} \\ &= 1,5 \text{ mol} \end{aligned}$$

2.3 $n(K : H_2)$ **OR** 2 mol K forms 1 mol H_2
 mole ratio from equation: 2 : 1 1,5 mol K forms 0,75 mol H_2
 moles given/asked: 1,5 : x
 solve for x : $\therefore \frac{1,5}{2} = \frac{x}{1}$
 $x = 0,75 \text{ mol}$

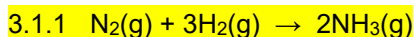
$m(H_2) = nM$
 $= 0,75 \times 2$
 $= 1,5 \text{ g}$

$M(H_2) = 2 \text{ g} \cdot \text{mol}^{-1}$

2.4 $V(H_2) = nV_m$
 $= 0,75 \times 22,4$
 $= 16,8 \text{ dm}^3$

$V_m = 22,4 \text{ dm}^3 \text{ at STP}$

QUESTION 3



$n(H_2 : NH_3)$

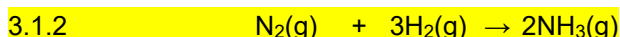
mole ratio from equation: 3 : 2

moles given/asked: 1 : x

solve for x : $\therefore \frac{1}{3} = \frac{x}{2}$

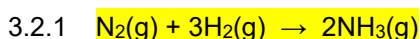
$x = \frac{2}{3}$

$\therefore \frac{2}{3} \text{ mol } NH_3 \text{ will be produced}$



n ratio	1	3	2
V(initial)	10 cm^3	24 cm^3	
V(react)	-8 cm^3	-24 cm^3	+16 cm^3
V(final)	2 cm^3	0 cm^3	16 cm^3

Total volume = 18 cm^3



x 80 g

$n(H_2) = \frac{m}{M}$

$m(H_2) = 80 \text{ g}$

$= \frac{80}{2}$

$= 40 \text{ mol}$



mole ratio from equation: 3 : 1

moles given/asked: 40 : x

solve for x : $\therefore \frac{40}{3} = \frac{x}{1}$

$x = 13,33 \text{ mol}$

$n(N_2) = \frac{V}{V_m}$

$\therefore 13,33 = \frac{V}{22,4}$

$\therefore V(N_2) = 13,33 \times 22,4$

$= 298,67 \text{ dm}^3 N_2$

REMEMBER

At the same temperature and pressure, the molar ratio and volume ratio of a gas is the same.



NOTE

Remember to always convert the given quantity of a specific substance to mol ① → then use the molar ratio between the substances to find the number of moles of the substance inquired about ② → then convert the number of moles to the specific quantity of this substance. ③

