## Limiting Reactant (Exercises)

### Example 2:

Calculate the maximum numbers of moles and grams of $H_2S$ than can form when 158g of aluminium sulfide reacts with 131g of water:

$$Al_2S_3 + H_2O \longrightarrow Al(OH)_3 + H_2S \text{ (unbalanced)}$$

What mass of the excess reactant remains?

### Solution :

- It is a limiting-reactant problem, since amounts of two reactants are given.

Balanced equation:

$$Al_2S_3 + 6H_2O \longrightarrow 2Al(OH)_3 + 3H_2S$$

$$n_{Al_2S_3} = \left(\frac{158\,g}{150.17\,g\,mol^{-1}}\right) = 1.05\,mol$$

$$n_{H_2O} = \left(\frac{131\,g}{18.02\,g\,mol^{-1}}\right) = 7.27\,mol$$

$M_r\,(Al_2S_3) = 150.17\,g\,mol^{-1}$
$M_r\,(H_2O) = 18.02\,g\,mol^{-1}$
$M_r\,(H_2S) = 34.09\,g\,mol^{-1}$

$$r_{theory} = \frac{n_{Al_2S_3}}{n_{H_2O}} = \frac{1}{6} = 0.167$$ (the ratio is from the balanced equation)

$$r_{experiment} = \frac{n_{Al_2S_3}}{n_{H_2O}} = \frac{1.05}{7.07} = 0.149$$

$r_{experiment}\,(0.149) < r_{theory}\,(0.167)$

Therefore, the numerator is a small value (ie. $Al_2S_3$ = limiting-reactant), whereas the denominator, $n_{H_2O}$ is a big value (ie. $H_2O$ is in excess)

Since $Al_2S_3$ = limiting-reactant

$$Al_2S_3 + 6H_2O \longrightarrow 2Al(OH)_3 + 3H_2S$$

1.05 mol — ? moles, ? grams

$$\frac{n_{H_2S}}{n_{Al_2S_3}} = \frac{3}{1} \Rightarrow n_{H_2S} = 3 \times n_{Al_2S_3}$$

$$= (3 \times 1.05)\text{ mols}$$

$$= \underline{3.15 \text{ mols (Ans)}}$$

$$m_{H_2S} = (3.15 \text{ mols})(M_r(H_2S))$$

$$= (3.15 \times 34.09)\text{g}$$

$$= \underline{107 \text{ g (Ans)}}$$

$$\frac{n_{H_2O}}{n_{Al_2S_3}} = \frac{6}{1} \Rightarrow n_{H_2O} = 6 \times n_{Al_2S_3}$$

$$\left(\frac{m_{H_2O}}{18.02 \text{ g mol}^{-1}}\right) = 6 \times 1.05 \text{ mol}$$

$$\therefore m_{H_2O} = (6 \times 1.05 \times 18.02)\text{g}$$

$$= 113 \text{ g}$$

$\therefore$ Mass of the excess water $= (131 - 113)\text{g}$

$$= \underline{18 \text{ g (Ans)}}$$

*Prepared by*
*V. Manoharan*
vmano@usm.my
manovv1955@yahoo.com
*04-6533888 ext 3566*