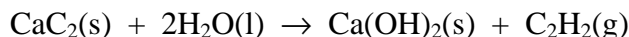


- Acetylene, C_2H_2 , can be produced by reacting calcium carbide, CaC_2 , with water:



A 1.000 g sample of CaC_2 is placed in a sealed vessel that contains 250.0 mL of $H_2O(l)$ and 250.0 mL of $N_2(g)$ at 1.000 atm, and allowed to react completely with the water. The final pressure in the sealed vessel at 22.0 °C is 2.537 atm. Determine the vapour pressure of water in the sealed vessel at 22.0 °C. Give your answer in mmHg. Ignore any change in the volume of the water.

Marks
4

The formula mass of CaC_2 is $(40.08 \text{ (Ca)} + 2 \times 12.01 \text{ (C)}) \text{ g mol}^{-1} = 64.1 \text{ g mol}^{-1}$.

The amount of CaC_2 in 1.000 g is therefore, $n = \frac{m}{M} = \frac{1.000}{64.1} = 0.01560 \text{ mol}$.

From the chemical equation, each mole of CaC_2 that reacts leads to one mole of $C_2H_2(g)$. Therefore, 0.0156 mol of $C_2H_2(g)$ is formed. The volume available to gas is 250.0 mL. Using the ideal gas equation, $pV = nRT$, the pressure due to this amount is therefore:

$$p_{C_2H_2} = \frac{nRT}{V} = \frac{(0.01560 \text{ mol}) \times (0.08206 \text{ L atm K}^{-1} \text{ mol}^{-1}) \times (22 + 273) \text{ K}}{0.250 \text{ L}}$$

$$= 1.511 \text{ atm}$$

As there is no change in the amount of $N_2(g)$, $p_{N_2} = 1.000 \text{ atm}$. Hence,

$$p_{\text{total}} = p_{H_2O} + p_{C_2H_2} + p_{N_2} = 2.537 \text{ atm}$$

$$p_{H_2O} + (1.511 \text{ atm}) + (1.000 \text{ atm}) = 2.537 \text{ atm}$$

Hence, $p_{H_2O} = 0.026 \text{ atm}$. As $1 \text{ atm} = 760 \text{ mmHg}$, this corresponds to.

$$p_{H_2O} = 0.026 \times 760 = 20 \text{ mmHg}$$

Answer: **20 mmHg**

The solubility of acetylene in water at 22.0 °C is small. If the temperature were raised, would you expect this solubility to increase or decrease?

The solubility of gases in water decreases with temperature. The dissolution of a gas is entropically disfavoured and only occurs because it is exothermic. Like all exothermic process, the process becomes less favourable at higher temperatures (Le Chatelier's principle).