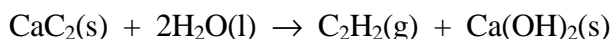


- Acetylene, C_2H_2 , is an important fuel in welding. It is produced in the laboratory when calcium carbide, CaC_2 , reacts with water:



For a sample of C_2H_2 collected over water, the total gas pressure was 748 mmHg and the volume was 543 mL. At the gas temperature ($23^\circ C$), the vapour pressure of water is 21 mmHg. What mass of acetylene was collected?

Marks
3

The total pressure is the sum of the partial pressures due to $C_2H_2(g)$ and $H_2O(g)$:

$$p_{\text{total}} = 748 \text{ mmHg} = p_{H_2O} + p_{C_2H_2} = (21 \text{ mmHg}) + p_{C_2H_2}$$

$$p_{C_2H_2} = (748 - 21) = 727 \text{ mmHg}$$

As 760 mmHg corresponds to 1 atm, $p_{C_2H_2} = \frac{727}{760} \text{ atm} = 0.957 \text{ atm}$. Using the ideal gas law, $pV = nRT$, the number of moles of C_2H_2 formed is:

$$n = \frac{pV}{RT} = \frac{(0.957 \text{ atm}) \times (0.543 \text{ L})}{(0.08206 \text{ L atm K}^{-1} \text{ mol}^{-1}) \times ((23 + 273) \text{ K})} = 0.0214 \text{ mol}$$

The molar mass of C_2H_2 is $(2 \times 12.01 \text{ (C)}) + (2 \times 1.008 \text{ (H)}) = 26.036 \text{ g mol}^{-1}$. This amount therefore corresponds to a mass of,

$$\begin{aligned} \text{mass} &= \text{number of moles} \times \text{molar mass} = 0.0214 \text{ mol} \times 26.036 \text{ g mol}^{-1} \\ &= 0.557 \text{ g} \end{aligned}$$

Answer: **0.557 g**

The solubility of acetylene in water at $22.0^\circ C$ 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).