Marks 3

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

$$CaC_2(s) + 2H_2O(l) \rightarrow C_2H_2(g) + Ca(OH)_2(s)$$

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 ^oC), the vapour pressure of water is 21 mmHg. What mass of acetylene was collected?

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

$$p_{total} = 748 \text{ mmHg} = p_{H_2O} + p_{C_2H_2} = (21 \text{ mmHg}) + p_{C_2H_2}$$
$$p_{C_2H_2} = (748 - 21) = 727 \text{ mmHg}$$

As 760 mmHg corresponds to 1 atm, $p_{C_2H_2} = \frac{727}{760}$ atm = 0.957 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 × 12.01 (C)) + (2 × 1.008 (H)) = 26.036 g mol^{-1}. This amount therefore corresponds to a mass of,

mass = number of moles × molar mass = 0.0214 mol × 26.036 g mol^{-1}
= 0.557 g

Answer: **0.557 g**

The solubility of acetylene in water at 22.0 ºC 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).