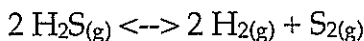


Equilibrium 1

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1. When heated, hydrogen sulfide gas decomposes according to the equation above. A 3.40 g sample of $\text{H}_2\text{S}(\text{g})$ is introduced into an evacuated rigid 1.25 L container. The sealed container is heated to 483 K, and $3.72 \cdot 10^{-2}$ mol of $\text{S}_2(\text{g})$ is present at equilibrium.

(a) Write the expression for the equilibrium constant, K_c , for the decomposition reaction represented above.

$$K = \frac{[\text{H}_2]^2 [\text{S}_2]}{[\text{H}_2\text{S}]^2}$$

(b) Calculate the equilibrium concentration, in mol L⁻¹, of the following gases in the container at 483 K.

(i) $\text{H}_2(\text{g})$

$$3.72 \cdot 10^{-2} \text{ mol S}_2 \cdot \frac{2 \text{H}_2}{1 \text{S}_2} = 0.744 \cdot 10^{-2} \text{ mol H}_2$$

(ii) $\text{H}_2\text{S}(\text{g})$

$$\frac{0.744 \cdot 10^{-2} \text{ mol H}_2}{1.25 \text{ L}} = 5.95 \cdot 10^{-2} \text{ M H}_2$$

$$3.72 \cdot 10^{-2} \text{ mol S}_2 \cdot \frac{2 \text{H}_2\text{S}}{1 \text{S}_2} = 0.744 \cdot 10^{-2} \text{ mol H}_2\text{S} \text{ used up}$$

$$3.40 \text{ g H}_2\text{S} \cdot \frac{1 \text{ mol}}{34.076 \text{ g}} = 9.977 \cdot 10^{-2} \text{ mol H}_2\text{S} \text{ starts}$$

$$9.977 \cdot 10^{-2} - 0.744 \cdot 10^{-2} = 0.0254 \text{ mol H}_2\text{S} \text{ left}$$

$$\frac{0.0254 \text{ mol H}_2\text{S}}{1.25 \text{ L}}$$

$$2.03 \cdot 10^{-2} \text{ M H}_2\text{S}$$

(c) Calculate the value of the equilibrium constant, K_c , for the decomposition reaction at 483 K.

$$K_c = \frac{[5.95 \cdot 10^{-2}]^2 [0.02476]}{[2.03 \cdot 10^{-2}]^2} = 0.256$$

(d) Calculate the partial pressure of $\text{S}_2(\text{g})$ in the container at equilibrium at 483 K.

$$P = \frac{3.72 \cdot 10^{-2} \text{ mol} \cdot 0.0821 \frac{\text{atm} \cdot \text{L}}{\text{mol} \cdot \text{K}} \cdot 483}{1.25 \text{ L}} = 1.18 \text{ atm}$$

(e) For the reaction $\text{H}_2(\text{g}) + 1/2 \text{S}_2(\text{g}) \rightarrow \text{H}_2\text{S}(\text{g})$ at 483 K, calculate the value of the equilibrium constant, K_c .

$$K_{\text{new}} = K^{-1/2} = (0.256)^{-1/2} = 1.98$$