Equilibrium 1

Name: Key
Period:

$$2\ H_2S_{(g)} \longleftrightarrow 2\ H_{2(g)} + S_{2(g)}$$

1. When heated, hydrogen sulfide gas decomposes according to the equation above. A 3.40 g sample of $H_2S_{(g)}$ is introduced into an evacuated rigid 1.25 L container. The sealed container is heated to 483 K, and $3.72 \bullet 10^{-2}$ mol of $S_{2(g)}$ is present at equilibrium.

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

$$K = \frac{[H_2]^2[S_2]}{[H_2S]^2}$$

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

(i) $H_{2(g)}$

(ii) $H_2S_{(g)}$

$$3.72 \cdot 10^{-2}\ mol\ S_2 \cdot \frac{2\ H_2}{1\ S_2} = 0.744 \cdot 10^{-2}\ mol\ H_2$$

$$\frac{0.744 \cdot 10^{-2}\ mol\ H_2}{1.25\ L} = 5.95 \cdot 10^{-2}\ M\ H_2$$

$$3.72 \cdot 10^{-2}\ mol\ S_2 \cdot \frac{2\ H_2S}{1\ S_2} = 0.744 \cdot 10^{-2}\ mol\ H_2S \text{ used up}$$

$$3.40\ g\ H_2S \cdot \frac{1\ mol}{34.076\ g} = 9.977 \cdot 10^{-2}\ mol\ H_2S \text{ start}$$

$$9.977 \cdot 10^{-2} - 0.744 \cdot 10^{-2} \quad 0.0254\ mol\ H_2S \text{ left}$$

$$\frac{0.0254\ mol\ H_2S}{1.25\ L} = 2.03 \cdot 10^{-2}\ M\ H_2S$$

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

$$K_c = \frac{[5.95 \cdot 10^{-2}]^2[0.02976]}{[2.03 \cdot 10^{-2}]^2} = 0.256$$

(d) Calculate the partial pressure of $S_{2(g)}$ in the container at equilibrium at 483 K.

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

(e) For the reaction $H_{2(g)} + 1/2 S_{2(g)} \longrightarrow H_2S_{(g)}$ at 483 K, calculate the value of the equilibrium constant, K_c.

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