

Question #60234, Chemistry, Other

Hydrogen bromide is formed by a reaction between Hydrogen gas and Bromine vapor in accordance with the following equation: $\text{H}_2 + \text{Br}_2 = 2\text{HBr}$

Calculate the equilibrium concentrations of all the gases if 0.40 mole H_2 and 0.60 mole of Br_2 are placed in a container 4.00 L.

Answer:

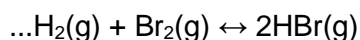
I = initial concentration; C = change; E = equilibrium

$K_{\text{(eq)}}$ for this reaction is 3.5.

$$0.40 \text{ mol H}_2 / 4.0\text{L} = 0.10 \text{ M H}_2$$

$$0.60 \text{ mol Br}_2 / 4.0\text{L} = 0.15 \text{ M Br}_2$$

We don't know the change, so we put x * the mole ratio.



$$\text{I} \dots 0.10 \text{ M} \dots 0.15 \text{ M} \dots \dots \dots 0 \text{ M}$$

$$\text{C} \dots -x \dots \dots \dots -x \dots \dots \dots +2x$$

$$\text{E} \dots 0.10-x \dots 0.15-x \dots \dots \dots 2x$$

Now since 3.5 is not puny, the x 's cannot be ignored. If K were to be, for example, $1 \cdot 10^{-5}$, then sure, ignore the x 's. But it's not so you can't.

$$K_{\text{(eq)}} = [\text{HBr}]^2 / [\text{H}_2][\text{Br}_2]$$

$$3.5 = [(2x)^2] / [(0.15-x)(0.10-x)]$$

$$3.5 = (4x^2) / (0.015 - 0.15x - 0.10x + x^2)$$

$$3.5 = (4x^2) / (0.015 - 0.25x + x^2)$$

$$0.0525 - 0.875x + 3.5x^2 = (4x^2)$$

$$0.0525 - 0.875x - 0.5x^2 = 0$$

$$-0.5x^2 - 0.875x + 0.0525 = 0$$

After solving the quadratic equation, we receive:

$$x_1 = -1.81; x_2 = 0.06$$

-1.81 is negative, so it will not be taken into further calculations.

$$2 \cdot 0.06 = 0.12 = 0.12 \text{ M HBr}$$

$$0.10 - 0.06 = 0.04 = 0.04 \text{ M H}_2$$

$$0.15 - 0.06 = 0.09 = 0.09 \text{ M Br}_2$$