Question #60234, Chemistry, Other

Hydrogen bromide is formed by a reaction between Hydrogen gas and Bromine vapor in accordance with the following equation: $H_2 + Br_2 = 2HBr$

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

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

0.40 mol H_2 / 4.0L = 0.10 M H_2

0.60 mol Br_2 / 4.0L = 0.15 M Br_2

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

...$H_2(g) + Br_2(g) \leftrightarrow 2HBr(g)$

I...0.10 M...0.15 M.....0 M

C..-x.....-x.....+2x

E..0.10-x...0.15-x.....2x

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

$K_{(eq)} = [HBr]^2 / [H_2][Br_2]$

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

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

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

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

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

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

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.

$2 \cdot 0.06 = 0.12 = 0.12$ M HBr

$0.10 - 0.06 = 0.04 = 0.04$ M H_2

$0.15 - 0.06 = 0.09 = 0.09$ M Br_2