

Advanced Keg Calculation

An 80.0L reaction flask is used for the gas phase equilibrium $2A \rightleftharpoons B$ If the initial $[A] = 0.5 \text{ mol/L}$ and the K_{eq} for this reaction is 0.0125, find all final concentrations.

$2A \rightleftharpoons B$		
Initial []	0.5 mol/L	\emptyset
Initial amount	40 mol	\emptyset
Final amount	$40 - 2x$	x
Final []	$\frac{40 - 2x}{80}$	$\frac{x}{80}$

80.0L flask

Let x represent the amount of B that forms

$$K_{eq} = \frac{[B]}{[A]^2}$$

$$0.0125 = \frac{\frac{x}{80}}{\left(\frac{40 - 2x}{80}\right)^2}$$

$$0.0125 = \left(\frac{x}{80}\right) \left(\frac{80}{40 - 2x}\right) \left(\frac{80}{40 - 2x}\right)$$

$$0.0125(4x^2 - 160x + 1600) = 80x$$

$$0.05(x^2 - 40x + 400) = 80x$$

$$\rightarrow x^2 - 40x + 400 = 1600x$$

$$x^2 - 1640x + 400 = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{1640 \pm \sqrt{(-1640)^2 - 4(1)(400)}}{2(1)}$$

$$x = \frac{1640 \pm 1639.512}{2}$$

$$x = 0.244 \text{ or } x = 1639.8$$

extraneous
(too large)

$$[A] = \frac{40 - 2x}{80} \quad [B] = \frac{x}{80}$$

$$[A] = \frac{40 - 2(0.244)}{80} \quad [B] = \frac{0.244}{80}$$

$$[A] = 0.494 \text{ mol/L} \quad [B] = 0.00305 \text{ mol/L}$$

Check: $K_{eq} = \frac{[B]}{[A]^2}$

$$\text{L.S.} = 0.0125 \quad \text{R.S.} = \frac{0.00305}{(0.494)^2}$$

$$\text{R.S.} = 0.0125$$

$$\therefore \text{L.S.} = \text{R.S.} \quad \therefore \text{D}$$