3. Material Shift Required

1.00 mole of H_2 gas and **0.250** mole S_2 are is placed in a closed 2.00 liter container
Assuming no H_2S is originally present,
determine the concentrations of all species after equilibrium is reached.

Excess **Limiting**

$$2\ H_2S_{(g)} \leftrightarrow \boxed{2\ H_{2(g)}} + \boxed{1\ S_{2(g)}}$$

Initial Moles **0.00 moles** ← **Material Shift** **1.00 mole** **0.250 mole**

NOT A ***2 : 1 ratio***

H₂ Limiting Determination

$$\frac{1.00 \text{ mole } H_2}{1} \times \overset{\text{Mole ratio}}{\frac{2 \text{ mole } H_2S}{2 \text{ mole } H_2}} = \boxed{\begin{array}{c}1.00 \text{ mole } H_2S \\ \text{Larger} \Rightarrow \text{Excess}\end{array}}$$

S₂ Limiting Determination

$$\frac{0.250 \text{ mole } S_2}{1} \times \overset{\text{Mole ratio}}{\frac{2 \text{ mole } H_2S}{1 \text{ mole } S_2}} = \boxed{\begin{array}{c}0.500 \text{ mole } H_2S \\ \text{Smaller} \Rightarrow \text{Limiting}\end{array}}$$

Left-over H₂ Determination

$$\frac{0.250 \text{ mole } S_2}{1} \times \overset{\text{Mole ratio}}{\frac{2 \text{ mole } H_2}{1 \text{ mole } S_2}} = 0.500 \text{ mole } H_{2\ \text{consumed}}$$

$$\text{Left-over } H_2 = \frac{\begin{array}{r}1.00 \text{ mole } H_{2\ \text{initially}} \\ -\ 0.500 \text{ mole } H_{2\ \text{consumed}}\end{array}}{0.500 \text{ mole } H_{2\ \text{leftover}}}$$

$$K_C = 1.67 \times 10^{-7}$$

Small K_C ⇒ Favors Reactants

Initially, only <u>products</u> are present.

Shifts strongly to the left (reactants).

Can't use X ~ 0 assumption.

Nasty math ahead.

Material Shift:
Convert product to reactant

3. Material Shift Required

1.00 mole of H_2 gas and 0.250 mole S_2 are is placed in a closed 2.00 liter container
Assuming no H_2S is originally present,
determine the concentrations of all species after equilibrium is reached.

$$2\ H_2S_{(g)} \leftrightarrow 2\ H_{2(g)} + 1\ S_{2(g)} \qquad K_C = 1.67 \times 10^{-7}$$

	$2\ H_2S_{(g)}$	$\leftrightarrow$	$2\ H_{2(g)}$	$+\ 1\ S_{2(g)}$
	0.500 mol/2.00L	SHIFT	**0.500 mol$_{leftover}$/2.00L**	**0.000 mol/2.00L**
I	**0.250 M**	→	**0.250 M**	**0.000 M**
C	-2X		+2X	+X
E	0.250 - 2X		0.250 +2X	X

$$\frac{[H_2]^2\ [S_2]}{[H_2S]^2} = \frac{(0.250 + \overset{X = 0}{2X})^2\ X}{(0.250 - \underset{X = 0}{2X})^2} = \boxed{\frac{(0.250)^2\ X}{(0.250)^2} = \mathbf{1.67 \times 10^{-7}}}$$

$$\mathbf{X = 1.67 \times 10^{-7}}$$

3. Material Shift Required

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

$K_C = 1.67 \times 10^{-7}$

	$2\ H_2S_{(g)}$	$2\ H_{2(g)}$	$S_{2(g)}$
E	(0.250 - 2X)	(0.250 + 2X)	X

$X = 1.67 \times 10^{-7}$

i. Equilibrium Concentrations

$[H_2S]_{eq} = 0.250 – 2X = 0.250$ M

$[H_2]_{eq} = 0.250 +2X = 0.250$ M

$[S_2]_{eq} = X = 1.67 \times 10^{-7}$ M

…most of material shifted reactant remains.

…only small changes to product amounts

ii. 5% check

$(0.250 – 2X)^2$

$$\frac{2X}{0.250} \times 100 = 0.000001336\ \%$$

0.000001336% < 5% ☺

iii. Equilibrium Check

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

$$\frac{(0.250)^2\ (1.67 \times 10^{-7})}{(0.250)^2}$$

$= 1.67 \times 10^{-7} = K_C$ ☺