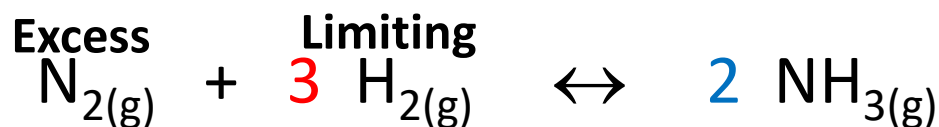


# 4. Material Shift Required (Large $K_c$ )

0.250 moles of  $N_{2(g)}$ , 0.500 moles of  $H_{2(g)}$  and 0.100 moles of  $NH_3$  are placed in a 1.50 L closed container.

Determine the concentrations of all species after equilibrium is reached.



Initial Moles

0.250 moles    0.500 mole

0.100 mole  
More Product coming!

NOT A 1 : 3 ratio

$N_2$  Limiting Determination

$$\frac{0.250 \text{ mole } N_2}{1} \times \frac{2 \text{ mole } NH_3}{1 \text{ mole } N_2} = 0.500 \text{ mole } NH_3$$

*Larger  $\Rightarrow$  Excess*

$H_2$  Limiting Determination

$$\frac{0.500 \text{ mole } H_2}{1} \times \frac{2 \text{ mole } NH_3}{3 \text{ mole } H_2} = 0.333_{33} \text{ mole } H_2S$$

*Smaller  $\Rightarrow$  Limiting*

Left-over  $N_2$  Determination

$$\frac{0.500 \text{ mole } H_2}{1} \times \frac{1 \text{ mole } N_2}{3 \text{ mole } H_2} = 0.166_{66} \text{ mole } N_2 \text{ consumed}$$

$$K_c = 3.70 \times 10^8$$

Large  $K_c \Rightarrow$  Favors Products

Initially, a lot of reactant is present.

Shifts strongly to the right (products).

Adds to the pre-existing 0.100 moles

Can't use  $X \sim 0$  assumption.

Nasty math ahead.

Material Shift:


Convert reactant to product

$$0.250 \text{ mole } N_2 \text{ initially} - 0.166_{66} \text{ mole } N_2 \text{ consumed}$$

Left-over  $N_2 = 0.083_{33} \text{ mole } N_2 \text{ leftover}$

## 4. Material Shift Required (Large $K_C$ )

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	<b>Excess</b>	+	<b>Limiting</b>			
	$N_{2(g)}$		$3 H_{2(g)}$	$\leftrightarrow$	$2 NH_{3(g)}$	
<b>Initial Moles</b>	<b>0.250 moles</b>		<b>0.500 mole</b>	<b>Material Shift</b> 	<b>0.100 mole</b>	
<b>Material Shift</b>	<b>-0.166<sub>66</sub> mole</b>		<b>-0.500 mole</b>		<b>+0.333<sub>33</sub> mole</b>	
<b>Final Moles</b>	<b>0.08333 moles</b>		<b>0.000 moles</b>		<b>0.433<sub>33</sub> moles</b>	

$$K_C = 3.70 \times 10^8$$

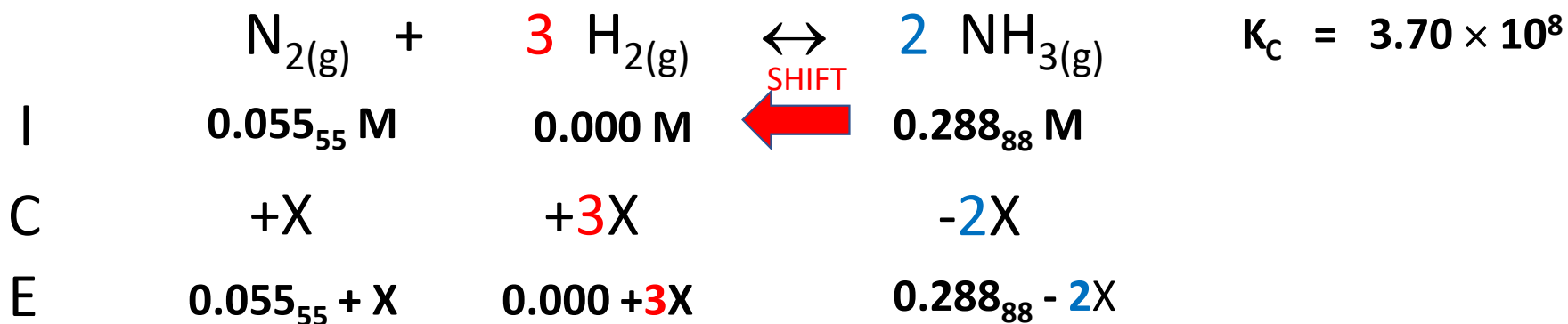
**PRODUCTS!**

<b>Initial</b>	0.083 <sub>33</sub> mols/1.50 L	0.00 mols/1.50 L	0.433 <sub>33</sub> mols/1.50 L	<p>Since there is no <math>H_2</math> on the reactant side, the reaction is shifted as far right as is possible</p> <p>The <math>X \sim 0</math> assumption will be valid.</p>
	<b>0.055<sub>55</sub> M</b>	<b>0.000 M</b>	<b>0.288<sub>88</sub> M</b>	



## 4. Material Shift Required (Large $K_C$ )

0.250 moles of  $N_{2(g)}$ , 0.500 moles of  $H_{2(g)}$  and 0.100 moles of  $NH_3$  are placed in a 1.50 L closed container. Determine the concentrations of all species after equilibrium is reached.



$$\frac{[NH_3]^2}{[N_2][H_2]^3} = \frac{(0.288_{88} - 2X)^2}{(3X)^3 (0.055_{55} + X)}$$

X = 0  
X = 0

Solve for "X"

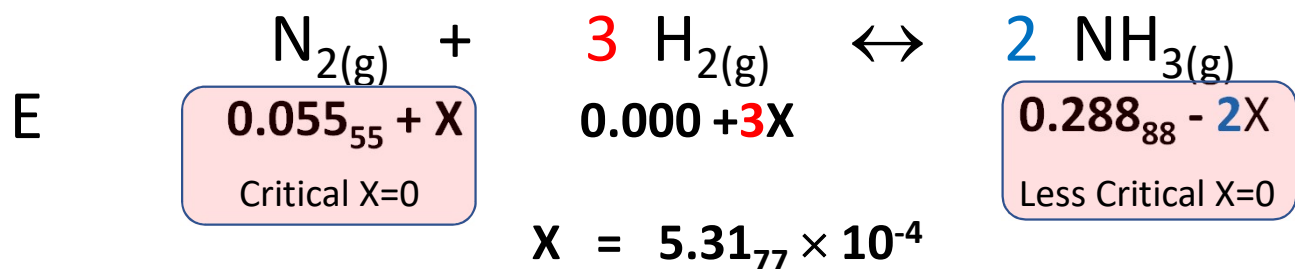
$$= \frac{(0.288_{88})^2}{(3X)^3 (0.055_{55})} = 3.70 \times 10^8$$

$$X = 5.3_{177} \times 10^{-4}$$



## 4. Material Shift Required (Large $K_C$ )

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Determine the concentrations of all species after equilibrium is reached.



$$K_C = 3.70 \times 10^8$$

### i. Equilibrium Concentrations

$$[N_2]_{eq} = 0.055_{02} + X = 0.055_{55} \text{ M}$$

$$[H_2]_{eq} = 0.00 + 3X = 1.59_{53} \times 10^{-3} \text{ M}$$

$$[NH_3]_{eq} = 0.288_8 - 2X = 0.287_{73} \text{ M}$$

...most of material shifted product remains.

...only small changes to reactant amounts

### ii. 5% check

Most Critical:  $(0.055 + X)$

$$\frac{X}{0.055} \times 100 = 1\%$$

$$1\% < 5\% \text{ 😊}$$

### iii. Equilibrium Check

$$\frac{[NH_3]^2}{[N_2][H_2]^3} = \frac{(0.287_{73})^2}{(0.055_{55})(1.59_{53} \times 10^{-3})^3}$$

$$= 3.67 \times 10^8 = K_C \text{ 😊}$$