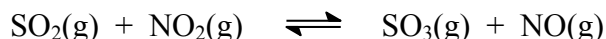


- Consider the following reaction.



An equilibrium mixture in a 1.00 L vessel was found to contain $[\text{SO}_2(\text{g})] = 0.800 \text{ M}$, $[\text{NO}_2(\text{g})] = 0.100 \text{ M}$, $[\text{SO}_3(\text{g})] = 0.600 \text{ M}$ and $[\text{NO}(\text{g})] = 0.400 \text{ M}$. If the volume and temperature are kept constant, what amount (in mol) of $\text{NO}(\text{g})$ needs to be added to the reaction vessel to give an equilibrium concentration of $\text{NO}_2(\text{g})$ of 0.300 M ?

From the chemical equation,

$$K_{\text{eq}} = \frac{[\text{SO}_3(\text{g})][\text{NO}(\text{g})]}{[\text{SO}_2(\text{g})][\text{NO}_2(\text{g})]}$$

As the original mixture is at equilibrium:

$$K_{\text{eq}} = \frac{[\text{SO}_3(\text{g})][\text{NO}(\text{g})]}{[\text{SO}_2(\text{g})][\text{NO}_2(\text{g})]} = \frac{(0.600)(0.400)}{(0.800)(0.100)} = 3.00$$

This equilibrium is now disturbed by the addition of $x \text{ M}$ of $\text{NO}(\text{g})$. To re-establish equilibrium, the reaction will shift to the left by an unknown amount y . The reaction table for this is:

	$\text{SO}_2(\text{g})$	$\text{NO}_2(\text{g})$		$\text{SO}_3(\text{g})$	$\text{NO}(\text{g})$
initial	0.800	0.100	\rightleftharpoons	0.600	$0.400 + x$
change	$+y$	$+y$		$-y$	$-y$
equilibrium	$0.800 + y$	$0.100 + y$		$0.600 - y$	$0.400 + x - y$

As $[\text{NO}_2(\text{g})] = 0.300 \text{ M}$ at the new equilibrium, $y = (0.300 - 0.100) \text{ M} = 0.200 \text{ M}$. Hence, the new equilibrium concentrations are:

$$[\text{SO}_2(\text{g})] = (0.800 + 0.200) \text{ M} = 1.000 \text{ M}$$

$$[\text{NO}_2(\text{g})] = 0.300 \text{ M}$$

$$[\text{SO}_3(\text{g})] = (0.600 - 0.200) \text{ M} = 0.400 \text{ M}$$

$$[\text{NO}(\text{g})] = (0.400 + x - 0.200) \text{ M} = (0.200 + x) \text{ M}$$

As the system is at equilibrium,

$$K_{\text{eq}} = \frac{[\text{SO}_3(\text{g})][\text{NO}(\text{g})]}{[\text{SO}_2(\text{g})][\text{NO}_2(\text{g})]} = \frac{(0.400)(0.200+x)}{(1.000)(0.300)} = 3.00$$

Solving this gives $x = 2.05 \text{ M}$. As the reaction is carried out in a 1.00 L container, this is also the number of moles required.

Answer: 2.05 mol