

ICE Charts

A useful tool in solving equilibrium problems is an ICE chart, where:

- "I" stands for the initial concentrations.
- "C" represents the change in the concentrations as the system moves towards equilibrium.
- "E" represents the equilibrium concentrations.

To Create an ICE Chart

1. Place initial concentrations of each molecule on the first row, making sure they are expressed in moles/liter.
2. In the second row write the change in concentrations according to the balanced equation:
 - let "x" stand for the change in concentrations
 - give the reactants a negative sign and the products a positive sign to show the decrease or increase in concentration, respectively
 - use coefficients to indicate if more than one molecule is involved
3. In the last row add the initial concentrations plus the change in concentrations.

Example: 0.20 moles of N_2O_4 were initially placed into a 2.0 sealed flask and allowed to reach equilibrium according to: $N_2O_4(g) \rightleftharpoons 2NO_2(g)$. At equilibrium, the amount of N_2O_4 was measured as 0.018 moles. Calculate the equilibrium concentration of NO_2 and then find K_{eq} .

	$N_2O_4(g)$	\rightleftharpoons	$2NO_2(g)$
I	0.10		0
C	-x		+2x
E	$0.10 - x$		$+2x$

① Calculate Molarity
 $[N_2O_4] = \frac{0.20 \text{ mol}}{2.0 \text{ L}} = 0.10 \text{ M}$

assume $[NO_2] = 0$

② write the change in conc'ns noting reactants get "used up" to make products

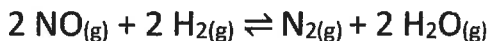
③ add I + C

④ find x given $[N_2O_4] = 0.018 \text{ @ eq}$
 $[N_2O_4] = \frac{0.018 \text{ mol}}{2.0 \text{ L}} = 0.009 \text{ M}$
 $0.10 - x = 0.009$
 $\therefore -x = -0.091$
 $x = 0.091 \text{ M}$

⑤ sub x into NO_2 expression
 $[NO_2] = 2x = 2 \times 0.091 = 0.18 \text{ M}$

⑥ solve for K_{eq}
 $K_{eq} = \frac{[NO_2]^2}{[N_2O_4]} = \frac{[0.18]^2}{[0.009]} = 3.6$

Example: A mixture of 0.100 moles NO, 0.050 moles H₂ and 0.100 moles H₂O was placed into a 1.0 L closed container and allowed to reach equilibrium according to:



There was no N₂ present initially. At equilibrium, the amount of NO was found to be 0.062 moles. Calculate K_{eq}.

	2 NO(g)	2 H ₂ (g)	N ₂ (g)	2 H ₂ O(g)
I	0.10	0.050	0	0.10
② C	-2x	-2x	+x	+2x
③ E	0.1-2x	0.05-2x	x	0.10+2x

$$\begin{aligned} \textcircled{5} [\text{NO}] &= 0.062 \text{ M} \\ [\text{H}_2] &= 0.05 - 2x \\ &= 0.05 - 2(0.019) \\ &= 0.012 \text{ M} \end{aligned}$$

$$[\text{N}_2] = x = 0.019 \text{ M}$$

$$\begin{aligned} [\text{H}_2\text{O}] &= 0.10 + 2x \\ &= 0.10 + 2(0.019) \\ &= 0.138 \text{ M} \end{aligned}$$

① Calculate Molarity

$$[\text{NO}] = \frac{0.10 \text{ mol}}{1 \text{ L}} = 0.10 \text{ M}$$

$$[\text{H}_2] = 0.050 \text{ M}$$

$$[\text{N}_2] = 0$$

$$[\text{H}_2\text{O}] = 0.10 \text{ M}$$

$$\textcircled{4} [\text{NO}] = \frac{0.062 \text{ mol}}{1 \text{ L}} = 0.062 \text{ M}$$

$$0.1 - 2x = 0.062$$

$$-2x = -0.038$$

$$\frac{-2}{-2} \quad \frac{-0.038}{-2}$$

$$x = 0.019 \text{ M}$$

$$\begin{aligned} \textcircled{6} K_{eq} &= \frac{[\text{N}_2][\text{H}_2\text{O}]^2}{[\text{NO}]^2[\text{H}_2]^2} \\ &= \frac{[0.019][0.138]^2}{[0.062]^2[0.012]^2} \\ &= 653.7 \end{aligned}$$

$$K_{eq} = 650$$