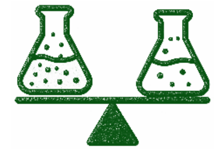
Equilibrium: ICE Tables

Read from **Lesson 2e:** [Analyzing Equilibrium Systems] in the **Chemistry Tutorial Section, Chapter 14** of **The Physics Classroom**.

ICE Tables

An ICE table is a helpful tool for determining equilibrium concentrations based on initial conditions. The acronym ICE stands for **Initial**, **Change**, and **Equilibrium**, corresponding to the three rows in the table.



- The **Initial** row lists the starting concentrations (or partial pressures) of all reactants and products in the chemical equation.
- The **Change** row shows how these values shift as the system approaches equilibrium, often using variables like *x* or *2x* to represent unknown changes.
- The **Equilibrium** row presents the final concentrations (or partial pressures) after the system has reached equilibrium.

Example: A 1.00 L flask is filled with 1.10 mol H_2 and 1.10 mol Br_2 at a certain temperature. The K_c for the reaction: $H_2\,(g) + Br_2\,(g) \rightleftarrows 2\,HBr$ at this temperature is 36.0. Determine the equilibrium concentrations.

	H_2	+	Br_2	$\rightleftarrows$	2HBr
Initial	**1.10 mol**		**1.10 mol**		**0.00**
Change	**-x**		**-x**		**+ 2x**
Equilibrium	**1.10-x**		**1.10 -x**		**2x**

$$K = \frac{[HBr]^2}{[H_2]\bullet[Br_2]} = 36.0 \Rightarrow 36.0 = \frac{(2x)^2}{(1.10\text{-}x)(1.10\text{-}x)} \Rightarrow \sqrt{36} = \sqrt{\frac{(2x)^2}{(1.10\text{-}x)\,(1.10\text{-}x)}}$$

$$6.0 = \frac{2x}{1.10\text{-}x} \Rightarrow 6\,(1.10\text{-}x) = 2x \Rightarrow 6.60 - 6.60x = 2x \Rightarrow 6.60 = 8.60x \Rightarrow x = 0.767$$

The equilibrium concentrations of H_2 and Br_2 = 1.10 -x = 1.10 – 0.767 = 0.333 mol → 0.333 mol /1.00 L = 0.333 M
The equilibrium concentrations of HBr = 2x = 2*0.767 = 1.53 mol → 1.53 mol/1.00 L = 1.53 M

Questions

1. A 5.0 L sealed flask initially contains 2.50 mol of NOBr gas. The system reaches equilibrium according to the following reaction: $2\,NOBr\,(g) \rightleftarrows 2\,NO\,(g) + Br_2\,(g)$. At equilibrium, the flask contains 1.50 mol of NOBr.
   a. Calculate the equilibrium concentrations of NOBr, NO, and Br_2.
   b. Determine the equilibrium constant, K_c, for the reaction.

Kinetics and Equilibrium

2. A reaction takes place in a sealed flask involving only gases A, B, and C at a constant temperature. The following ICE table summarizes the concentration changes as the system reaches equilibrium.

	A		Br		C
Initial	**2.00 M**		**0.00 M**		**0.00 M**
Change	**-1.20 M**		**+ 1.20 M**		**+ 0.60 M**
Equilibrium	**0.80 M**		**1.20 M**		**0.60 M**

a. Write the balanced chemical equation for the reaction.

b. Determine the equilibrium constant, K_c, for the reaction.

3. A 10.0 L sealed flask initially contains a mixture of 5.00 mol Cl_2 (g), 3.00 mol CO_2 (g), 3.00 mol CCl_4 (g) and 4.00 mol OCl_2 (g). The system reaches equilibrium according to the following reaction:
$4\ Cl_2(g) + CO_2(g) \rightleftarrows CCl_4(g) + 2\ OCl_2(g)$. At equilibrium, the concentration of CCl_4 (g) becomes 0.250 M.

a. Calculate the equilibrium concentrations of Cl_2, CO_2, CCl_4, and OCl_2.

b. Determine the equilibrium constant, K_c, for the reaction.