

Equilibrium Calculations Practice I

1. Suppose that 2.00 mol of HI in a 1.00 L flask at 425 °C react to produce H₂ and I₂. When equilibrium is reached the concentration of H₂ and I₂ are determined each to be 0.214 mol/L. What is the equilibrium constant?
2. For the reaction:
$$\text{N}_2(\text{g}) + 3 \text{H}_2(\text{g}) \rightleftharpoons 2 \text{NH}_3(\text{g})$$
 If the initial [N₂] = 0.32 M, and the initial [H₂] = 0.60 M. At equilibrium [H₂] = 0.30 M What is K_c?
3. For the reaction:
$$\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2 \text{HI}(\text{g})$$
 K_c = 55.6. If the initial [H₂] = 0.200 M, and the initial [I₂] = 0.200 M, what is the equilibrium [HI]?
4. For the reaction:
$$\text{H}_2(\text{g}) + \text{CO}_2(\text{g}) \rightleftharpoons \text{H}_2\text{O}(\text{g}) + \text{CO}(\text{g})$$
 K_c = 0.771. If 0.0100 mol each of CO₂ and H₂(g) are mixed in a 1.0 L container, what are the concentration of all the substances at equilibrium?
5. K_c = 64 for the reaction:
$$\text{N}_2(\text{g}) + 3 \text{H}_2(\text{g}) \rightleftharpoons 2 \text{NH}_3(\text{g})$$
 At a certain temperature. Suppose it was found that an equilibrium mixture of these gases contained 0.360 M NH₃ and 0.0192 M N₂. What was the concentration of H₂ in the mixture?
6. At a certain temperature K_c = 0.18 for the equilibrium:
$$\text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g}) \rightleftharpoons \text{PCl}_5(\text{g})$$
 Suppose the reaction vessel at this temperature contained these gases at the following concentrations:
[PCl₃] = 0.0420 M [Cl₂] = 0.0240 M, [PCl₅] = 0.00500 M
a) Is the system at equilibrium?
b) If not, which direction will the equilibrium have to proceed in order to attain equilibrium?
7. For the following reaction:
$$\text{CH}_4(\text{g}) + \text{H}_2\text{O}(\text{g}) \rightleftharpoons \text{CO}(\text{g}) + 3 \text{H}_2(\text{g})$$
 At 1500 °C, the equilibrium mixture of these gases is:
[CO] = 0.300 mol dm⁻³ [H₂] = 0.800 mol dm⁻³ [CH₄] = 0.400 mol dm⁻³
At 1500 °C, K_c = 5.67, what is the equilibrium concentration of H₂O(g)?
8. For the reaction:
$$\text{CO}(\text{g}) + \text{H}_2\text{O}(\text{g}) \rightleftharpoons \text{CO}_2(\text{g}) + \text{H}_2(\text{g})$$
 K_c = 4.06 at 500 °C, and the initial concentration of both CO(g), and of H₂O(g) is 0.100 mol dm⁻³. Determine the equilibrium concentration of all the reactants and products at this temperature.
9. In an equilibrium mixture of the reaction:
$$\text{PCl}_5(\text{g}) \rightleftharpoons \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g})$$
 at 250 °C in a 2.0 dm³ vessel, there is 0.15 mol of PCl₃ and 0.090 mol of Cl₂.
K_c = 0.19 mol dm⁻³ at 250 °C.
a) Calculate the amount of PCl₅ present at equilibrium.
b) Calculate the mass of PCl₅ present at equilibrium.

Equilibrium Calculations II

1. $\text{SO}_2(\text{g}) + \text{NO}_2(\text{g}) \rightleftharpoons \text{SO}_3(\text{g}) + \text{NO}(\text{g})$
- a) At equilibrium $[\text{SO}_2] = 4.1 \text{ M}$, $[\text{NO}] = 0.5 \text{ M}$, $[\text{SO}_3] = 3.0$, $[\text{NO}_2] = 0.5 \text{ M}$ Calculate K.
- b) In another experiment, 8.00 mol of SO_2 and 4.00 mol of NO_2 are placed in a 2.00 L flask and are allowed to reach equilibrium, and the concentration of SO_3 at equilibrium is 0.4 mol. Calculate K.
- a) $\text{A}(\text{g}) + \text{B}(\text{g}) \rightleftharpoons \text{C}(\text{g}) + \text{D}(\text{g})$
- b) 0.80 mol of A and 0.80 mol of B are placed in a 1.0 L flask and react until equilibrium is reached. Analysis reveals that 0.60 mol of both C and D are present. Calculate the equilibrium concentrations of A, B, C, and D, and then calculate K.
- c) In another experiment, the initial concentrations of A and B are 2.0 M and 2.0 M respectively. Calculate the equilibrium concentrations of A, B, C and D.
3. $\text{A}(\text{g}) + \text{B}(\text{g}) \rightleftharpoons \text{C}(\text{g}) + \text{D}(\text{g}) \quad K = 4.0$
- If the initial concentrations of A and B are 0.4 M and 0.4 M respectively. Calculate the equilibrium concentration of all relevant compounds.
4. At the temperature of 660 K, the reaction:
- $$\text{SO}_2(\text{g}) + \text{NO}_2(\text{g}) \rightleftharpoons \text{SO}_3(\text{g}) + \text{NO}(\text{g}) \quad K = 85.0$$
- A reaction flask at 660 K contains gases at the following concentrations:
 $[\text{SO}_2] = 0.0025 \text{ M}$, $[\text{NO}_2] = 0.0035 \text{ M}$, $[\text{NO}] = 0.025 \text{ M}$, $[\text{SO}_3] = 0.0400 \text{ M}$
- a) Is the system at equilibrium?
 b) If not which direction will the reaction have to go to attain equilibrium?
5. Calculate the equilibrium concentration of NH_3 for the reaction:
- $$\text{N}_2(\text{g}) + 3 \text{H}_2(\text{g}) \rightleftharpoons 2 \text{NH}_3(\text{g})$$
- The equilibrium concentrations for the reactants are $[\text{N}_2] = 0.45 \text{ M}$ and $[\text{H}_2] = 1.10 \text{ M}$, K is 1.7×10^{-2} .
6. At 373 K, the following reaction has an equilibrium constant, $K = 2.2 \times 10^{-10}$
- $$\text{COCl}_2(\text{s}) \rightleftharpoons \text{CO}(\text{g}) + \text{Cl}_2(\text{g})$$
- If 1.00 mol of phosgene, COCl_2 , is placed in a 10.0 L flask, calculate the concentration of carbon monoxide, CO, at equilibrium.
7. At 1000 °C, for the reaction:
- $$2 \text{H}_2\text{O}(\text{g}) \rightleftharpoons 2 \text{H}_2(\text{g}) + \text{O}_2(\text{g})$$
- $K_c = 7.32 \times 10^{-18} \text{ mol dm}^{-3}$, what will be the $[\text{H}_2(\text{g})]$ at equilibrium if 1.00 mol of $\text{H}_2\text{O}(\text{g})$ are placed in a 10.0 L vessel?
8. For the equilibrium:
- $$2 \text{HBr}(\text{g}) \rightleftharpoons \text{Br}_2(\text{g}) + \text{H}_2(\text{g})$$
- $K_c = 0.190 \text{ mol dm}^{-3}$ at 250 °C. 2.085g of $\text{HBr}(\text{g})$ was heated to 250 °C in a sealed container of 500 cm^3 capacity and maintained at this temperature until equilibrium was established. Calculate the concentration of the reactants and the products.
9. In an experiment for the following equilibrium system at 25 °C :
- $$\text{CH}_3\text{COOH}(\text{l}) + \text{C}_2\text{H}_5\text{OH}(\text{l}) \rightleftharpoons \text{CH}_3\text{COOC}_2\text{H}_5(\text{l}) + \text{H}_2\text{O}(\text{l}); \quad K_c = 4.00$$
- The equilibrium concentrations are determined to be:
 $[\text{CH}_3\text{COOH}] = 0.330 \text{ mol}$, $[\text{CH}_3\text{COOC}_2\text{H}_5] = 0.660 \text{ mol}$, $[\text{H}_2\text{O}] = 0.660 \text{ mol}$
 What amount of $\text{C}_2\text{H}_5\text{OH}$ is present at 25 °C?