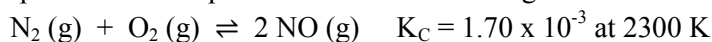


CHM152 – Chapter 13: Chemical Equilibrium – Homework

- Which one of these statements does not describe the equilibrium state?
 - Equilibrium is dynamic and there is no net conversion to reactants and products.
 - The concentration of the reactants is equal to the concentration of the products.
 - The concentration of the reactants and products reach a constant level.
 - The rate of the forward reaction is equal to the rate of the reverse reaction.
- Write K_C , the equilibrium equation for the forward reaction:
$$\underline{\quad} \text{CH}_4 (\text{g}) + \underline{\quad} \text{O}_2 (\text{g}) \rightleftharpoons \underline{\quad} \text{CO} (\text{g}) + \underline{\quad} \text{H}_2\text{O} (\text{g})$$
- Nitric oxide (NO) reacts with oxygen to form nitrogen dioxide. What is K_C for the forward reaction if the equilibrium concentration of NO is 0.200 M, O_2 is 0.100 M, and NO_2 is 0.250 M at 25°C?
- If $K_C = 1.5 \times 10^{-5}$ at 35°C is the equilibrium constant for the forward reaction what is K_C' for the reverse reaction at the same temperature?
- Write K_p' , the equilibrium equation for the reverse reaction:
$$\underline{\quad} \text{CH}_4 (\text{g}) + \underline{\quad} \text{O}_2 (\text{g}) \rightleftharpoons \underline{\quad} \text{CO} (\text{g}) + \underline{\quad} \text{H}_2\text{O} (\text{l})$$
- Calculate K_p' for the reaction in question #5 if the partial pressures are 0.122 atm for CH_4 , 0.333 atm for O_2 , and 0.564 atm for CO.
- What is K_C at 25°C for the reaction in problem #6?
- At a certain temperature, the reaction $\text{PCl}_5 (\text{g}) \rightleftharpoons \text{PCl}_3 (\text{g}) + \text{Cl}_2 (\text{g})$ has an equilibrium constant $K_C = 5.8 \times 10^{-2}$. If the initial concentrations are 0.200 M for PCl_5 , 0.100 M for PCl_3 , and 0.040 M for Cl_2 , which direction will the reaction shift until it reaches equilibrium? What are the equilibrium concentrations of all the species?
- The decomposition of sulfur trioxide is: $2 \text{SO}_3 (\text{g}) \rightleftharpoons \text{O}_2 (\text{g}) + 2 \text{SO}_2 (\text{g})$. If K_C is 0.200 at 1300 K, what is the partial pressure of SO_3 at equilibrium when $\text{O}_2 (\text{g})$ is 0.18 atm and $\text{SO}_2 (\text{g})$ is 0.25 atm?
- At a certain temperature the equilibrium constant, K_C , equals 0.11 for the reaction:
$$2 \text{HF} (\text{g}) \rightleftharpoons \text{F}_2 (\text{g}) + \text{H}_2 (\text{g})$$

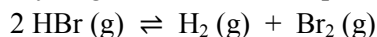
What is the equilibrium concentration of HF if 0.75 mol of H_2 and 0.75 mol of F_2 are initially mixed in a 2.0 L flask?

11. The air pollutant NO is produced in automobile engines from the high-temperature reaction



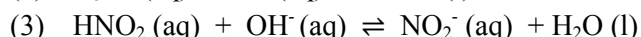
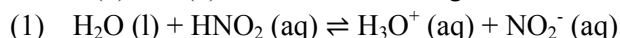
Calculate the equilibrium concentrations of N_2 , O_2 , and NO if 314 g of N_2 and 89.6 g of O_2 are initially placed in a 5.00 L flask.

12. Gaseous hydrogen bromide decomposes at elevated temperatures according to the following equation:



At a certain temperature a 5.00 L flask is initially filled only with 0.600 mol of HBr . What is the value of K_c at that temperature if the flask contains 0.104 mol of H_2 at equilibrium?

13. When reaction (1) and (2) below are added together, the result is reaction (3).

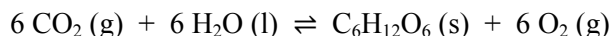


If $K_1 = 4.50 \times 10^{-4}$, and $K_2 = 1.00 \times 10^{14}$, find the equilibrium constant, K_3 .

14. Which of the following changes in reaction conditions will not alter the equilibrium concentrations?

- addition of an inert gas to the reaction mixture
- addition of reactants or products
- decreasing the pressure or volume
- increasing the temperature

15. The overall reaction for photosynthesis can be represented by the following equation:

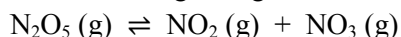


The enthalpy change for this reaction is 2802 kJ.

How will the equilibrium shift (right, left, no change) with the following changes:

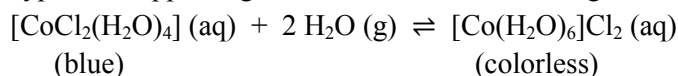
- increase in temperature
- increase the pressure of O_2
- remove CO_2
- add $\text{C}_6\text{H}_{12}\text{O}_6$

16. How will the following changes shift the equilibrium for the reaction:



- decreasing the amount of NO_3
- increasing the amount of N_2O_5
- increasing the pressure
- increasing the volume

17. A crude type of disappearing ink is based on the following exothermic equilibrium:



If the product solution is used to write on a piece of paper and the paper is allowed to partially dry, what can be done to bring out the colored handwriting?

- add water
- decrease the volume
- put the paper in the freezer
- put the paper in the oven