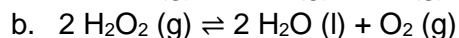
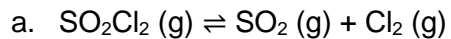


**Equilibrium.** These problems are from your textbook. More can be found in chapter 19.

1. (19.5) Write the equilibrium-constant expression ( $K_c$ ) for each of the following reactions.

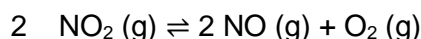


2. (19.11) Phosgene,  $\text{COCl}_2(\text{g})$ , a toxic gas used in the synthesis of a variety of organic compounds, decomposes according to



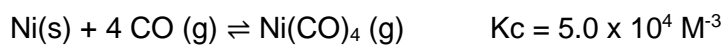
A sample of phosgene gas at an initial concentration of 0.500 M is heated at 527 °C in a reaction vessel. At equilibrium, the concentration of  $\text{CO}(\text{g})$  was found to be 0.046 M. Calculate the equilibrium constant for the reaction at 527 °C.

3. (19.14) Nitrogen dioxide decomposes at high temperatures according to the equation:

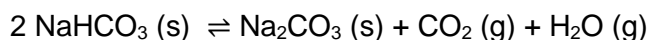


Suppose initially we have pure  $\text{NO}_2(\text{g})$  at 1000 K and 0.500 bar. If the total pressure is 0.732 bar when equilibrium is reached, what is the value of  $K_p$  (make sure to include the correct units)?

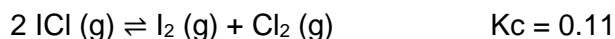
4. (19.17) Given that  $[\text{Ni}(\text{CO})_4] = 0.85 \text{ M}$  at equilibrium for the reaction below, calculate the concentration of  $\text{CO}(\text{g})$  at equilibrium.



5. (19.24) Sodium bicarbonate decomposes according to the equation below. Given that  $K_p = 0.26 \text{ bar}^2$  at 125 °C, calculate the partial pressures of  $\text{CO}_2(\text{g})$  and  $\text{H}_2\text{O}(\text{g})$  at equilibrium when  $\text{NaHCO}_3(\text{s})$  is heated to 125 °C in a closed vessel.



6. (19.25) For the reaction below, calculate the equilibrium concentrations of  $\text{ICl}(\text{g})$ ,  $\text{I}_2(\text{g})$ , and  $\text{Cl}_2(\text{g})$  when 0.65 moles of  $\text{I}_2(\text{g})$  and 0.33 moles of  $\text{Cl}_2(\text{g})$  are mixed in a 1.5 liter reaction vessel.



7. (19.37) Consider the chemical equilibrium described below. Predict the way in which the equilibrium will shift in response to each of the following changes.



- The temperature is decreased
- The volume is decreased
- Decrease in the pressure of  $\text{H}_2$
- Increase in the pressure of  $\text{CH}_4$
- Adding  $\text{C}(\text{s})$  to the flask

8. (19.50) If 0.20 bar  $\text{H}_2$  and 3.0 bar  $\text{CH}_4(\text{g})$  are mixed in the presence of 4 grams of carbon at 500 °C, determine if the reaction is at equilibrium. If it is not, determine if products or reactants will be formed

