

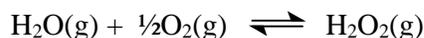
Work through the ChemCAL module “*Chemical Equilibrium*”

1. Ammonium carbamate ($\text{NH}_2\text{CO}_2\text{NH}_4$) is a salt of carbamic acid that is found in the blood and urine of mammals. At $250\text{ }^\circ\text{C}$, based on a standard state of 1 M , $K_c = 1.58 \times 10^{-8}$ for the following equilibrium:

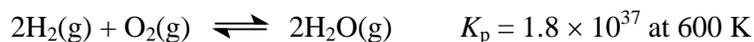
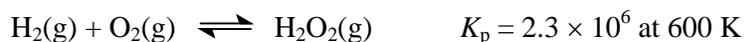


If 7.80 g of $\text{NH}_2\text{CO}_2\text{NH}_4$ is introduced into a 0.500 L evacuated container, what is the total pressure inside the container at equilibrium at $250\text{ }^\circ\text{C}$?

2. Water is oxidized to give hydrogen peroxide according to the reaction below.



- (a) Using the data below, calculate ΔG° at 600 K for this reaction.



Both values of K_p are based on a standard state of $1 \times 10^5\text{ Pa}$.

- (b) Calculate the equilibrium constant K_c for the reaction.
- (c) At 600 K , the entropy change, ΔS° , for the reaction is $+60\text{ J K}^{-1}\text{ mol}^{-1}$. Using this value and the value for ΔG° from (a), calculate the enthalpy change, ΔH° , at 600 K .
- (d) What is the effect on $[\text{H}_2\text{O}_2]$ if the system is subjected to the following changes:
- The volume of the container is decreased
 - The temperature is increased
 - A solid catalyst is added at constant temperature and volume.
3. The equilibrium constant, K_p , for the reaction below is 11.5 at 600 K based on a standard state of $1 \times 10^5\text{ Pa}$.



2.450 g of PCl_5 is placed in an evacuated 500 mL bulb, which is heated to 600 K .

- What would be the initial pressure of $\text{PCl}_5(\text{g})$ before it dissociates?
- What is the partial pressure of $\text{PCl}_5(\text{g})$ at equilibrium?
- What is the total pressure in the bulb at equilibrium?
- What is the degree of dissociation of $\text{PCl}_5(\text{g})$ at equilibrium?

Hint for part (b) As K_p is not very small, you *cannot* assume that the amount of product formed is small compared to the amount of starting material. You will need to solve the quadratic formula.