1. Na_2O (s) ⇌ 2Na (l) + 1/2O_2 (g)  \[ K_1 = 2 \times 10^{-25} \]
   NaO (g) ⇌ Na (l) + 1/2O_2 (g)  \[ K_2 = 2 \times 10^{-5} \]
   Na_2O_2 (s) ⇌ 2Na (l) + O_2 (g)  \[ K_3 = 5 \times 10^{-29} \]
   NaO_2 (s) ⇌ Na (l) + O_2 (g)  \[ K_4 = 3 \times 10^{-14} \]

   Determine the equilibrium constant for the following reactions using the data above. You may not need some equations. (2+2)

   a. NaO (g) + Na_2O (s) ⇌ Na_2O_2 (s) + Na (l)

   b) 2NaO(g) ⇌ Na_2O_2(s)

2. Oxalic acid, H_2C_2O_4, reacts with the chromate ion in an acidic solution as follows:

   H_2C_2O_4 (aq) + CrO_4^{2-} (aq) \rightarrow CO_2 (g) + Cr^{3+} (aq)

   a. Balance the equation. (2 points)

   b. Determine the molarity of the oxalic acid solution if 10.0mL of this solution consumes 50.0 mL of 0.0350 M CrO_4^{2-}. (2 points)

3. Indicate the direction in which the equilibrium shifts for the following reactions if the reactions were in equilibrium when the change was affected. (0.5 pts each)

   PCl_3 + Cl_2 \rightleftharpoons PCl_5 with heat

   a. increase Cl_2 concentration b. decrease pressure

   N_2O_4 with heat \rightleftharpoons 2 NO_2

   c. decrease pressure d. remove N_2O_4
1. NO and Br\(_2\) react by the following reaction:

\[
2\text{NO}(g) + \text{Br}_2(g) \rightleftharpoons 2\text{NOBr}(g)
\]

A container contains NO with partial pressure of 98.4 atm and Br\(_2\) with partial pressure of 41.3 atm. At equilibrium the total pressure of the gasses is 110.5 atm. Calculate the value of \(K_p\). (4)

2. You have the following reaction in equilibrium:

\[
\text{A}_4\text{B}_2 \leftrightarrow \text{A}_2\text{B}_2 + \text{A}_2
\]

You know that initially you have \(\text{A}_4\text{B}_2\) in an evacuated flask at the pressure of 1.500 atm. After it goes to equilibrium you remove all the \(\text{A}_2\) from the reaction flask. You measure that you had the partial pressure of \(\text{A}_2\) equal to 0.21 atm. After letting the reaction to equilibrium again, what is the concentration of \(\text{A}_2\text{B}_2\) and \(\text{A}_2\)? (Hint: Calculate the \(K_p\) and then proceed) (4 pts)

For \(ax^2 + bx + c = 0\), the value of \(x\) is given by:

3. Indicate the direction in which the equilibrium shifts for the following reactions if the reactions were in equilibrium when the change was affected. (2 pts)

\(\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3 + \text{heat}\)

a. remove \(\text{NH}_3\) gas  b. decrease pressure
   c. add \(\text{N}_2\) gas  d. increase temperature
1. You are running the following reaction at STP:

\[ \text{Cr}_2\text{O}_7^{2-}(aq) + \text{Cl}^{-}(aq) \rightarrow \text{Cr}^{3+}(aq) + \text{Cl}_2(g) \]

The equation is unbalanced.

a) Balance the equation. (2 points)

b) You run this reaction and collect the gas formed. If you obtain 1 L of gas, and had an excess of Cl\(^-\), what was the starting concentration of Cr\(_2\text{O}_7^{2-}\)(aq)?

Hint: Use the following ideal gas equation to calculate the number of moles (n)

\[ n = \frac{PV}{RT} \]

Where P = Pressure (in atm); V=Volume (in Liters); R=Gas constant =0.08206. T=Temp (in Kelvins)

If you are wondering what the values are for P and T, remember that the reaction is done at STP conditions. (2 points)

2. For the gas phase reaction

\[ \text{H}_2(g) + \text{I}_2(g) \rightleftharpoons 2 \text{HI}(g) \]

\[ K_c = 50.3 \text{ at } 731 \text{ K.} \] Equal amounts (0.100 M each) is introduced to a container, and then the temperature is raised to 731 K.

Calculate the concentration of each when the system is at equilibrium at 731 K. (4)

For \( ax^2 + bx + c = 0 \), the value of \( x \) is given by:

3. Indicate the direction in which the equilibrium shifts for the following reactions if the reactions were in equilibrium when the change was affected. (0.5 pts each)

a. increase \( \text{H}_2 \) concentration

b. Increase pressure

c. decrease \( \text{O}_2 \) concentration

d. Add catalyst