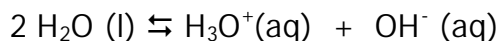
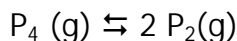


1999 Exam #2 – Chem 36 Exam Questions

1. The autoionization constant of water (K_w) is 1.139×10^{-15} at $0.00\text{ }^\circ\text{C}$ and 9.614×10^{-14} at $60.00\text{ }^\circ\text{C}$.



- Calculate the enthalpy change (ΔH) for the autoionization of water.
 - $K_w = 1.0 \times 10^{-14}$ at $25.^\circ\text{C}$. Calculate the standard molar free energy change (ΔG°) for the autoionization of water at $25.^\circ\text{C}$.
 - What is the pH of pure water at $0\text{ }^\circ\text{C}$ and at $60\text{ }^\circ\text{C}$?
2. At $T=1200\text{ }^\circ\text{C}$, the reaction



has an equilibrium constant $K = 0.612$.

- Suppose the initial partial pressures of P_4 and P_2 are both 2.00 atm . Will the reaction proceed to the right or to the left as equilibrium is approached? (Note: you must show your work to receive full credit!)
 - Calculate the partial pressure of P_2 at equilibrium.
 - If the volume of the system is then increased, will the partial pressure of P_2 increase or decrease? Explain, briefly.
3. The strongest acid that can exist in a solvent is the conjugate acid formed from the autoionization of that solvent. So, for example, the strongest acid that can exist in water is the hydronium ion (H_3O^+).
- Write the acid dissociation equilibrium reaction for H_3O^+ , the equilibrium constant (K_a) expression, and calculate the numerical value of K_a .
 - The approximate K_a values for HCl and HNO_3 are given on the table attached to this exam. In water, which of these acids is stronger? Explain.
 - What is the strongest acid that can exist in a solution of *liquid ammonia*?
 - What fraction of Acetic Acid will be undissociated in a *liquid ammonia* solution? (DO NOT do a calculation for this!)

4. As you all recall from lab, Aspirin is a weak acid (acetylsalicylic acid). When a 0.150 M solution of this acid is prepared, it has a pH of 4.69.
- Calculate the K_a for acetylsalicylic acid.
 - Calculate K_b for the acetylsalicylate ion.
 - Calculate the pH of a 0.150 M solution of sodium acetylsalicylate.
5. Predict the direction favored in each of the following acid-base reactions. That is, for each reaction, indicate the direction (forward or reverse) that the reaction will tend towards. You may wish to make use of the K_a and K_b values tabulated for you on the formula page handed out with this exam.
- $\text{NH}_4^+ + \text{OH}^- \rightleftharpoons \text{H}_2\text{O} + \text{NH}_3$
 - $\text{HSO}_4^- + \text{NO}_3^- \rightleftharpoons \text{HNO}_3 + \text{SO}_4^{2-}$
 - $\text{H}_2\text{CO}_3 + \text{CO}_3^{2-} \rightleftharpoons \text{HCO}_3^- + \text{HCO}_3^-$
6. Circle the member of each of the following pairs that is the stronger acid and briefly explain your choice (based on molecular structure/bonding considerations).
- HF or HCl
 - HClO_2 or HClO_4
 - $\text{ClCH}_2\text{CH}_2\text{COOH}$ or $\text{CH}_3\text{CHClCOOH}$
 - H_3PO_4 or H_2PO_4^-

Extra Credit!!!

At 40 °C and 1.00 atm pressure, a gaseous monoprotic acid has a density of 1.05 g/L. After 1.85 g of this gas is dissolved in water and diluted to 450.0 mL, the pH is measured to be 5.01. Determine the K_a of this acid and use the provided table of K_a -values to identify it.