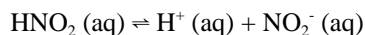


Topics to be covered on the April 27, 2010 test:

equilibrium	common ion effect	equilibrium calculations
buffers	buffer calculations	Henderson-Hasselbalch equation
strong acid and base	weak acid and base	titrations
titration curves	equivalence point	pH
K_a and K_b	acid-base indicators	colors of phenolphthalein
solubility	solubility product constant (K_{sp})	precipitation
complex ion	ligands	coordination compounds
counterions	coordination number	coordinate covalent bond
naming coordination compounds	millimole	use of Q

Practice problems (choose at least 10 to answer/work out for full credit):

- 1) What is meant by the presence of a common ion? How does the presence of a common ion affect an equilibrium such as



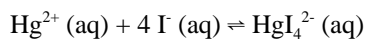
What is an acid-base solution called that contains a common ion?

- 2) Define a buffer solution. What makes up a buffer solution? How do buffers absorb added H^+ and OH^- with little pH change? What is the pH of a buffer when the weak acid and conjugate base concentrations are equal?
- 3) To what reaction does a K_{sp} refer? How is Q different from K_{sp} ? What can K_{sp} be used to calculate? What can Q be used to calculate?
- 4) A certain buffer was made by dissolving NaHCO_3 and Na_2CO_3 in some water. Write equations to show how this buffer neutralizes added H^+ and OH^- .
- 5) Calculate the pH of each of the following solutions:
- 0.100 M propanoic acid ($\text{HC}_3\text{H}_5\text{O}_2$, $K_a = 1.3 \times 10^{-5}$) [2.96]
 - pure water [7.00]
 - 0.100 M sodium propanoate ($\text{NaC}_3\text{H}_5\text{O}_2$) [8.94]
 - a mixture containing 0.100 M $\text{HC}_3\text{H}_5\text{O}_2$ and 0.100 M $\text{NaC}_3\text{H}_5\text{O}_2$ [4.89]
- 6) Calculate the pH of a solution that is 1.00 M HNO_2 and 1.00 M NaNO_2 . [3.40]
- 7) Calculate the pH of a buffer solution prepared by dissolving 21.46 g of benzoic acid ($\text{HC}_7\text{H}_5\text{O}_2$) and 37.68 g of sodium benzoate ($\text{NaC}_7\text{H}_5\text{O}_2$) in 200.0 mL of solution. [4.36]
- 8) Consider the titration of 40.0 mL of 0.200 M HClO_4 by 0.100 M KOH. Calculate the pH of the resulting solution after the following volumes of KOH have been added:
- 0.0 mL [0.699]
 - 10.0 mL
 - 40.0 mL [1.301]
 - 80.0 mL
 - 100.0 mL [12.15]
- 9) Consider the titration of 100.0 mL of 0.200 M acetic acid ($K_a = 1.8 \times 10^{-5}$) by 0.100 M KOH. Calculate the pH of the resulting solution after the following volumes of KOH have been added:
- 0.0 mL
 - 50.0 mL
 - 100.0 mL [4.74]
 - 150.0 mL
 - 200.0 mL [8.79]
 - 250.0 mL

- 10) You have 75.0 mL of 0.10 M HA (an unknown weak acid). After adding 30.0 mL of 0.10 M NaOH, the pH is 5.50. What is the K_a of HA? [2.1×10^{-6}]
- 11) Use the following data to calculate the K_{sp} value for each solid.
 a) The solubility of CaC_2O_4 is 6.1×10^{-3} g/L [2.3×10^{-9}]
 b) The solubility of BiI_3 is 1.32×10^{-5} mol/L [8.20×10^{-19}]
- 12) Calculate the solubility of each of the following compounds in moles per liter. Ignore any acid-base properties.
 a) Ag_3PO_4 , K_{sp} of 1.8×10^{-18} [1.6×10^{-5} M]
 b) CaCO_3 , K_{sp} of 8.7×10^{-9}
 c) Hg_2Cl_2 , K_{sp} of 1.1×10^{-18} (note that Hg_2^{2+} is a polyatomic cation in this solution)
- 13) The concentration of Pb^{2+} in a solution saturated with PbBr_2 (s) is 2.14×10^{-2} M. Calculate the K_{sp} for PbBr_2 . [3.92×10^{-5}]
- 14) Calculate the solubility of solid $\text{Ca}_3(\text{PO}_4)_2$ (K_{sp} of 1.3×10^{-32}) in a 0.20 M Na_3PO_4 solution. [2.3×10^{-11} M]
- 15) The solubility of $\text{Ce}(\text{IO}_3)_3$ in a 0.20 M KIO_3 solution is 4.4×10^{-8} M. Calculate the K_{sp} of $\text{Ce}(\text{IO}_3)_3$.
- 16) What mass of ZnS ($K_{sp} = 2.5 \times 10^{-22}$) will dissolve in 300.0 mL of 0.050 M zinc nitrate? [Ignore the base properties of S^{2-} .] [1.5×10^{-19} g]
- 17) The concentration of magnesium ions in sea water is 0.052 M. At what pH will 99% of the magnesium ions be precipitated as magnesium hydroxide? (K_{sp} for magnesium hydroxide is 8.9×10^{-12})
- 18) Which of the substances in question 12 show increased solubility as the pH of the solution becomes more acidic? Write equations for the reactions that occur to increase the solubility.
- 19) For which salt in each of the following groups will the solubility depend on the pH?
 a) AgF , AgCl , AgBr
 b) $\text{Pb}(\text{OH})_2$, PbCl_2
 c) $\text{Sr}(\text{NO}_3)_2$, $\text{Sr}(\text{NO}_2)_2$
 d) $\text{Ni}(\text{NO}_3)_2$, $\text{Ni}(\text{CN})_2$
- 20) Will a precipitate form when 75.0 mL of 0.020 M barium chloride solution and 125 mL of 0.040 M sodium sulfate solution are mixed together? [Confirm your prediction with a calculation.]
- 21) Will a precipitate form when 100.0 mL of 4.0×10^{-4} M magnesium nitrate solution is added to 100.0 mL of 2.0×10^{-4} M sodium hydroxide solution? [Confirm your prediction with a calculation.]
- 22) Calculate the final concentrations of $\text{K}^+(\text{aq})$, $\text{C}_2\text{O}_4^{2-}(\text{aq})$, $\text{Ba}^{2+}(\text{aq})$, and $\text{Br}^-(\text{aq})$ in a solution prepared by mixing 0.100 L of 0.200 M potassium oxalate solution and 0.150 L of 0.250 M barium bromide solution? (K_{sp} for barium oxalate is 2.3×10^{-8}) [$\text{K}^+ = 0.160$ M, $\text{Ba}^{2+} = 0.0700$ M]
- 23) Calculate the solubility in molarity of $\text{Fe}(\text{OH})_3$ (with a K_{sp} of 4×10^{-38}) in each of the following:
 a) pure water [4×10^{-17} M]
 b) a solution buffered at pH = 5.0 [4×10^{-11} M]
 c) a solution buffered at pH = 11.0
- 24) The K_{sp} for silver sulfate is 1.2×10^{-5} . Calculate the solubility of silver sulfate in each of the following:
 a) pure water
 b) 0.10 M silver nitrate solution
 c) 0.20 M potassium sulfate solution
- 25) The overall formation constant for HgI_4^{2-} is 1.0×10^{30} . That is,

$$1.0 \times 10^{30} = \frac{[\text{HgI}_4^{2-}]}{[\text{Hg}^{2+}][\text{I}^-]^4}$$

What is the concentration of Hg^{2+} in 500.0 mL of a solution that was originally 0.010 M Hg^{2+} and 0.78 M I⁻?
 The reaction is



[3.3 x 10⁻³² M]

- 26) Name the following complex ions:
- $\text{Ru}(\text{NH}_3)_5\text{Cl}^{2+}$ [pentaamminechlororuthenium(III)]
 - $\text{Fe}(\text{CN})_6^{4-}$
 - $\text{Mn}(\text{NH}_2\text{CH}_2\text{CH}_2\text{NH}_2)_3^{2+}$
 - $\text{Co}(\text{NH}_3)_5\text{NO}_2^{2+}$
- 27) Name the following complex ions:
- $\text{Ni}(\text{CN})_4^{2-}$
 - $\text{Cr}(\text{NH}_3)_4\text{Cl}_2^+$
 - $\text{Fe}(\text{C}_2\text{O}_4)_3^{3-}$
 - $\text{Co}(\text{SCN})_2(\text{H}_2\text{O})_4^+$
- 28) Name the following coordination compounds:
- $[\text{Co}(\text{NH}_3)_6]\text{Cl}_2$ [hexaamminecobalt(II) chloride]
 - $[\text{Co}(\text{H}_2\text{O})_6]\text{I}_3$
 - $\text{K}_2[\text{PtCl}_4]$
 - $\text{K}_4[\text{PtCl}_6]$
 - $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$
 - $[\text{Co}(\text{NH}_3)_3(\text{NO}_2)_3]$
- 29) Name the following coordination compounds:
- $[\text{Cr}(\text{H}_2\text{O})_5\text{Br}]\text{Br}_2$
 - $\text{Na}_3[\text{Co}(\text{CN})_6]$
 - $[\text{Fe}(\text{NH}_2\text{CH}_2\text{CH}_2\text{NH}_2)_2(\text{NO}_2)_2]\text{Cl}$
 - $[\text{Pt}(\text{NH}_3)_4\text{I}_2][\text{PtI}_4]$
- 30) Write the formulas for the following:
- potassium tetrachlorocobaltate(II) ($\text{K}_2[\text{CoCl}_4]$)
 - aquatricarbonylplatinum(II) bromide
 - sodium dicyanobis(oxalato)ferrate(III)
 - triamminechloroethylenediaminechromium(III) iodide
- 31) Write the formulas for the following:
- tetrachloroferrate(III) ion
 - pentaammineaquaruthenium(III) ion
 - tetracarbonyldihydroxochromium(III) ion
 - amminetrichloroplatinate(II) ion