1. A buffer is prepared by adding 20.0 g of acetic acid (HC₂H₃O₂) and 20.0 g of sodium acetate (NaC₂H₃O₂) in enough water to prepare 2.00 L of solution. Calculate the pH of this buffer? (\(K_a = 1.8 \times 10^{-5}\))

2. What is the ratio of HCO₃⁻ to H₂CO₃ in blood of pH 7.4? (\(K_a\) for H₂CO₃ = 4.3x10⁻⁷)

3. How many grams of NaBrO should be added to 1.00 L of 0.200 M HBrO to form a buffer with a pH of 8.80? (\(K_a\) for HBrO = 2.5x10⁻⁹)
4. Acetylsalicylic acid (aspirin, H\textsubscript{C}\textsubscript{9}H\textsubscript{7}O\textsubscript{4}) is a weak acid with Ka = 2.75x10\textsuperscript{-5} at 25°C. 3.00 g of sodium acetylsalicylate (NaC\textsubscript{9}H\textsubscript{7}O\textsubscript{4}) is added to 200.0 mL of 0.100 M solution of this acid. Calculate the pH of the resulting solution at 25°C.

5. The equations and dissociation constants for three different acids are given below:

\begin{align*}
\text{HCO}_3^- & \rightleftharpoons \text{H}^+ + \text{CO}_3^{2-} \quad K_a = 4.2x10^{-7} \\
\text{H}_2\text{PO}_4^- & \rightleftharpoons \text{H}^+ + \text{HPO}_4^{2-} \quad K_a = 6.2x10^{-8} \\
\text{HSO}_4^- & \rightleftharpoons \text{H}^+ + \text{SO}_4^{2-} \quad K_a = 1.3x10^{-2}
\end{align*}

Identify the conjugate pair that is best for preparing a buffer with a pH of 7.2. Clearly explain your choice.
6. A sample of 25.0 mL of 0.100 M solution of HBr is titrated with 0.200 M NaOH. Calculate the pH of solution after 10.0 mL of the base is added.

7. A buffer solution is prepared by adding 0.10 L of 2.0 M acetic acid solution to 0.10 L of 1.0 M NaOH solution.
   a) Calculate the pH of this buffer solution.
   b) 0.10 L of 0.20 M HCl is added to 0.40 L of the buffer solution above. What is the pH of the resulting solution?
8. A 10.0 mL solution of 0.100 M NH₃ (Kₐ = 1.8x10⁻⁵) is titrated with a 0.100 M HCl solution. Calculate the pH of this solution at equivalence point.

9. A 10.0-mL solution of 0.300 M NH₃ is titrated with a 0.100 M HCl solution. Calculate the pH after the following additions of the HCl solution: (a) 0.0 mL, (b) 10.0 mL, (c) 30.0 mL
10. A 45.0-mL sample of 0.200 M acetic acid is titrated with 0.180 M NaOH. Calculate the pH of the solution (a) before addition of NaOH, (b) after addition of 20.0 mL of NaOH and (c) at the equivalence point.

11. Calculate the molar solubility of AgBr (Ksp= 5.0x10^{-13}) in 0.50 M NaBr solution.
12. A solution is made by mixing 10.0 mL of 0.10 M Pb(NO$_3$)$_2$ and 10.0 mL of 0.0010 M Na$_2$SO$_4$. Will a precipitate form? (Ksp for PbSO$_4$ = 1.06x10$^{-8}$)

13. The solubility of iron (II) hydroxide, Fe(OH)$_2$, is 1.43x10$^{-3}$ g/L.
   a) Calculate the Ksp for iron (II) hydroxide.
   b) Calculate pH of a saturated solution of iron (II) hydroxide.
   c) A 50.0 mL sample of 3.00x10$^{-3}$ M FeSO$_4$ solution is added to 50.0 mL of 4.00x10$^{-6}$ M NaOH solution. Does a precipitate form?
14. Lead iodate, Pb(IO\textsubscript{3})\textsubscript{2}, is a slightly soluble salt with a Ksp of 2.6x10\textsuperscript{-13} at 25°C. To 35.0 mL of 0.150 Pb(NO\textsubscript{3})\textsubscript{2} solution is added 15.0 mL of 0.800 M KIO\textsubscript{3}. A precipitate of Pb(IO\textsubscript{3})\textsubscript{2} results. What are the [Pb\textsuperscript{2+}] and [IO\textsubscript{3}\textsuperscript{-}] in the final solution?

15. Consider a solution that is 0.010 M in Ba\textsuperscript{2+} and 0.020 M in Ca\textsuperscript{2+}. If sodium sulfate is added to this solution to selectively precipitate one of the cations, which will precipitate first? What is the minimum concentration of Na\textsubscript{2}SO\textsubscript{4} that would trigger the precipitation of this cation?
16. What is the Cr\(^{3+}\) concentration when 0.010 mol of Cr(NO\(_3\)_3 is dissolved in a liter of solution buffered at pH of 10.0. Cr\(^{3+}\) forms a complex ion with hydroxide shown below:

\[
\text{Cr}^{3+} (aq) + 4 \text{OH}^- (aq) \rightleftharpoons \text{Cr(OH)}_4^- (aq) \quad K_f = 8 \times 10^{29}
\]

17. A 0.10-mol sample of AgNO\(_3\) is dissolved in 1.00 L of 1.00 M NH\(_3\). If 0.010 mol of NaCl is added to this solution, will AgCl (K\(_{sp}\) = 1.8 \times 10^{-10}) precipitate? (Ag\(^+\) and NH\(_3\) form the complex ion [Ag(NH\(_3\)_2]\(^+\) with K\(_f\) = 1.6 \times 10^7)
18. AgNO$_3$ is added to a solution that is 0.10 M in NaCl and 0.010 M K$_2$CrO$_4$. Assume no dilution caused by the addition of AgNO$_3$. Given the Ksp values below:

- $K_{sp}$ for AgCl = $1.6 \times 10^{-10}$
- $K_{sp}$ for Ag$_2$CrO$_4$ = $9.0 \times 10^{-12}$

a) Which precipitates first, AgCl or Ag$_2$CrO$_4$? Calculate the [Ag$^+$] when precipitation first begins.

b) What is the [Cl$^-$] when Ag$_2$CrO$_4$ first begins to precipitate?
19. Blood is buffered by $\text{H}_2\text{CO}_3/\text{HCO}_3^-$ system. Normal blood plasma is 0.024 M $\text{HCO}_3^-$ and 0.0012 M $\text{H}_2\text{CO}_3$. $\text{pK}_a$ for $\text{H}_2\text{CO}_3$ at body temperature is 6.1.

a) What is pH of blood plasma?

b) If the volume of blood in a normal adult is 5.0 L, what mass of HCl can be neutralized by the buffering system in blood before the pH falls below 7.0 (which would result in death)?

c) For the same adult in (b), what mass of NaOH can be neutralized before the pH rises above 7.8?

20. An important buffer used in biochemical analysis is made by dissolving TRIS $[(\text{HOCH}_2)_3\text{CNH}_2]$ in dilute HCl. A biochemist prepares a buffer by dissolving an unknown amount of TRIS in 1L of 0.095 M HCl solution. The pH of the resulting buffer solution was measured to be 8.53. How many grams of TRIS was used in this buffer? Assume volume of solution did not change after addition of TRIS.
(Molar mass of TRIS = 121.14 g/mol; $\text{pK}_b$ of TRIS = 5.91)