1. A solution is prepared by mixing 90.0 mL of 5.00 M HCl and 30.0 mL of 0.10 M HNO₃. Water is then added until the final volume is 1.00 L. Calculate \([H^+], [OH^-], \text{pH and pOH for this solution.}\)

2. A solution is prepared by dissolving 12.2 g benzoic acid (\(C_6H_5COOH, K_a = 6.4 \times 10^{-5}\)) in enough water to make 1.00 L of solution. Calculate \([C_6H_5COOH], [C_6H_5COO^-], [H^+], [OH^-]\) and the pH in this solution.

3. A solution with a total volume of 250.0 mL is prepared by diluting 20.0 mL of glacial acetic acid with water. Calculate \([H^+]\) and the pH of this solution. Assume that glacial acetic acid is pure liquid acetic acid with a density of 1.05 g/mL.

4. Monochloroacetic acid, \(\text{ClH}_2\text{C-COOH}\), is a skin irritant that is used in “chemical peels” intended to remove the top layer of dead skin from the face and ultimately improve the complexion. \(K_a\) for monochloroacetic acid is \(1.35 \times 10^{-3}\).

   Calculate the pH of a 0.10 M solution of monochloroacetic acid.

   Calculate the percent dissociation of monochloroacetic acid.

5. Codeine\((C_{18}H_{21}NO_3)\) is a derivative of morphine that is used as an analgesic, narcotic, or antitussive. It was once commonly used in cough syrups but is now available only by prescription because of its addictive properties. If the pH of a \(1.7 \times 10^{-3}\) M solution of codeine is 9.59, calculate \(K_b\).
6. Arrange the following 0.10 M solutions in order of most acidic to most basic: KOH, KCl, KCN, NH₄Cl, HCl
   Write chemical equations to justify your answers.

7. Will the following oxides give acidic, basic, or neutral solutions when dissolved in water? Write chemical reactions to justify your answers.
   a. CaO
   b. SO₂
   c. Cl₂O

8. Aluminum hydroxide is an amphoteric substance. It can act as either a Bronsted-Lowry base or a Lewis acid. Write a reaction showing Al(OH)₃ acting as a base toward H⁺ and as an acid toward OH⁻.

9. Making use of the assumptions we ordinarily make in calculating the pH of a aqueous solution of a weak acid, calculate the pH of a 1.0 x 10⁻⁶ M solution of hypobromous acid (HBrO, Kₐ = 2.0 x 10⁻⁹).
   What is wrong with your answer?
   Why is it wrong?
   Without trying to solve the problem, tell what has to be included to solve the problem correctly.

10. Captain Kirk, of the Starship Enterprise, has been told by his superiors that only a chemist can be trusted with the combination to the safe containing the dilithium crystals the power the ship. The combination is the pH of solution A described below, followed by the pH of solution C. (Example: If the pH of solution A is 3.47 and that of solution C is 8.15, then the combination to the safe is 3-47-8-15.) The chemist must determine the combination using only the information below (all solutions are at 25°C):
    Solution A is 50.0ml of a 0.100 M solution of a weak monoprotic acid HX.
    Solution B is a 0.0500 M solution of the salt NaX. It has a pH of 10.02.
    Solution C is made by adding 15.0ml of 0.250 M KOH to solution A.
    What is the combination to the safe?