



ACID–BASE EQUILIBRIUM

Part I – Strong Acid: HClO_4

A perchloric acid solution, HClO_4 , has an initial concentration of

$$C = 1.0 \times 10^{-2} \text{ mol L}^{-1}$$

Its measured pH is 2.00.

1. Calculate the degree of dissociation, α , of HClO_4 .
2. Calculate the theoretical pH, assuming complete dissociation. Compare your result with the measured pH.
3. Can we determine whether an acid is strong simply by measuring its pH? Explain your answer.
4. Using the following equilibrium concentrations, calculate K_a and then pK_a :

$$[\text{H}_3\text{O}^+] = 1.0 \times 10^{-2} \text{ mol L}^{-1},$$

$$[\text{ClO}_4^-] = 1.0 \times 10^{-2} \text{ mol L}^{-1},$$

$$[\text{HClO}_4] = 1.0 \times 10^{-8} \text{ mol L}^{-1}.$$

Part II – Weak Base and Mixture

Question 1: Weak Base

An aqueous ammonia solution, NH_3 , has a concentration of

$$C_b = 0.10 \text{ mol L}^{-1}.$$

The pK_a of its conjugate acid, NH_4^+ , is 9.25 at 25°C .

- a) Calculate the value of

$$pK_a - \log C_b.$$

- b) Calculate the pH of the weak-base solution.

Question 2: Strong Acid + Weak Base

Mix 50.0 mL of HClO_4 at 0.10 mol L^{-1} with 100.0 mL of NH_3 at 0.10 mol L^{-1} . Assume that the total volume is the sum of the two initial volumes.

- a) Write the reaction equation and indicate the direction in which the reaction proceeds.
- b) Calculate the pH of the final mixture.



Part III – Ampholytes and Polyacids

1. Define an ampholyte and give one example.
2. Using the hydrogen carbonate ion, HCO_3^- , write one reaction showing its acidic behaviour and another showing its basic behaviour in water.
3. What is a polyprotic acid? Distinguish between a diprotic acid and a triprotic acid, giving one example of each.
4. Why does a polyprotic acid have more than one acid-dissociation constant? Explain the meanings of K_{a1} and K_{a2} .
5. For a diprotic acid, H_2A , write the two successive dissociation equations and identify the conjugate acid–base pairs.

Useful data: At 25°C , $pK_e = 14.00$. All concentrations are expressed in mol L^{-1} .

No formulas are provided. Choose the appropriate relations and justify your calculations.