

## Concepts of pH, pOH, pKa, pKb, and Henderson Equation

### pH and pOH

- **pH** is defined as the negative logarithm of the hydrogen ion concentration:

$$pH = -\log_{10}[H_3O^+]$$

This measures the acidity of a solution.

- **pOH** is similarly defined as:

$$pOH = -\log_{10}[OH^-]$$

This measures the alkalinity of a solution.

- The relationship between **pH and pOH** is:

$$pH + pOH = 14 \quad (\text{at } 25^\circ\text{C})$$

This is derived from the ion product of water,  $K_w = 1.0 \times 10^{-14}$ .

### pKa and pKb

- **pKa** is the negative logarithm of the acid dissociation constant:

$$pKa = -\log_{10} K_a$$

- **pKb** is the negative logarithm of the base dissociation constant:

$$pKb = -\log_{10} K_b$$

- The relationship between **pKa and pKb** is:

$$pKa + pKb = 14$$

This relationship holds for conjugate acid-base pairs.

### Henderson-Hasselbalch Equation

This equation is used to calculate the pH of buffer solutions:

- **For acidic buffers:**

$$pH = pKa + \log \frac{[\text{Salt}]}{[\text{Acid}]}$$

- **For basic buffers:**

$$pOH = pKb + \log \frac{[\text{Salt}]}{[\text{Base}]}$$

The equation is derived from the equilibrium expression for a weak acid and its conjugate base. It allows for easy calculation of pH changes in buffer solutions when small amounts of acid or base are added.