Chemistry 2, HW 20, 2026

Acids can provide H^+ (proton) for reactions with other compounds.

An acid is composed from atoms of hydrogen and a conjugate base. The conjugate base reacts as an independent particle. (HSO_4^{1-}, Cl^-, NO_3^- are conjugate bases of sulfuric ($H2SO4$), hydrochloric (HCl), and nitric acids ($HNO3$) respectively, notice these are, except Cl^-, polyatomic ions).

Bases can provide OH^- for reactions with other compounds (more general definition, bases accept proton in reactions).

Salts are compound where we have different combinations of metals and conjugate bases ($NaCl$, $MgSO_4$, $HCOONa$).

A strong acid and a strong base ionize completely in water solution.

A weak acid or weak base ionize partially in aqueous solution.

strong acid:

$$HCl + H_2O \longrightarrow H^+ + Cl^-$$

weak acid:

$$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H^+$$

strong base:

$$NaOH + H_2O \longrightarrow Na^+ + OH^-$$

weak base:

$$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$$

What is Ka (Acid Dissociation Constant)?

Ka measures how strongly an acid dissociates in water.

For a general acid:

$$HA \rightleftharpoons H^+ + A^-$$

$$Ka = [H^+][A^-] / [HA]$$

Where:

[H$^+$] = concentration of hydrogen ions (protons)
[A$^-$] = concentration of conjugate base
[HA] = concentration of undissociated acid

Interpretation:
• Large Ka → strong acid (dissociates more)
• Small Ka → weak acid (dissociates less)

What is pKa?

pKa is a logarithmic way to express Ka.

pKa = −log(Ka)

Interpretation:
• Low pKa → strong acid
• High pKa → weak acid

Example:
If Ka = 1.0 × 10^{-5}
Then pKa = 5

A buffer is a solution that resists changes in pH when small amount of acid or base are added. Buffer usually consists of a weak acid (HA) and its conjugate base (A$^-$) or a weak base (B) and its conjugate acid (BH$^+$).
Example: acetic buffer solution, mixture of acetic acid CH3COOH and its salt CH3COONa. When we write the chemical reaction, we do not write Na in the salt, we represent salt as negative ion of the salt (conjugate base) – **CH3COO$^-$**, remember, when a salt dissolves in water, it breaks up completely into ions. The major species in the solution are CH3COOH, Na$^+$, CH3COO$^-$, H2O.
CH3COOH + H2O → CH3COO$^-$ + H3O$^+$
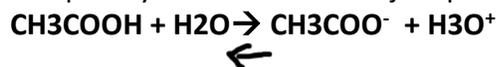
If acid (H$^+$) is added, the acetate ion (CH3COO$^-$) binds it to form CH3COOH, equilibrium is shifted to the left. If base (OH$^-$) is added, equilibrium is shifted to the right, acetic acid donates protons to neutralize OH$^-$, acetic acid decreases, acetate ion increases, pH increases slightly but not drustically.

Questions:

1. Identify the following substances as strong acid, weak acid, strong base, weak base or salt: HCOOH, HCl, H$_2$SO$_4$, NH$_4$NO$_3$, KOH, NH$_3$, HNO$_3$, Na$_2$SO$_4$, H$_2$CO$_3$, Mg(OH)$_2$, KNO$_3$, CH$_3$NH$_2$.

2. If acid A has Ka = 1.0 × 10⁻³ and acid B has Ka = 1.0 × 10⁻⁶, which acid is stronger? If an acid has pKa = 2 and another has pKa = 5, which is stronger?
3. Proton Concentration and pH

   $pH = -log[H^+]$
   $[H^+] = 10^{\wedge}(-pH)$

   Calculate the pH if $[H^+] = 1.0 \times 10^{-3}$ M.

   Calculate the pH if $[H^+] = 1.0 \times 10^{-5}$ M.

   Calculate the proton concentration if pH = 4.

   Calculate the proton concentration if pH = 7
4. Can we measure Ka for HCl?