From last class- Amphoteric

(behaves as an acid or base.

e.g. H_2O

base

$CH_3COOH + H_2O \rightleftharpoons H_3O^+ + CH_3COO^-$

H^+ donor receiver

acid base

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

acid

Questions p. 557

3. (a) $HCl + H_2O \rightarrow Cl^- + H_3O^+$

acid — conjugate

2. $CH_3COO^- + H_2O \rightleftarrows CH_3COOH + OH^-$

base — acid — conj acid — conj. base

Acid-base pairs

3(d) $N_2H_5^+ \xrightarrow{H^+} N_2H_4$

acid — base

Strong/Weak Acids and Bases Demonstration

Substances	Conductivity (electr.)
H_2O (pure)	no
HCl	yes - good
CH_3COOH	weak
NaOH	good
$Ca(OH)_2$	good
NH_4OH	weak
NaCl	good
$NaOH_{(s)}$	no

Read text p. 560-563

See animations (web site)

Conclusion -

Strong → 100% ionization

Weak → < 100% (equilibrium)

Using equations

1. strong acid - $HCl + H_2O \rightarrow H_3O^+ + Cl^-$

2. strong base - $NaOH_{(s)} \rightarrow Na^+_{(aq)} + OH^-_{(aq)}$

3. weak acid - $CH_3COOH + H_2O \rightleftharpoons H_3O^+_{(aq)} + CH_3COO^-_{(aq)}$

See list p. 563

Ionization Constants Ka and Kb

Text- p. 587 Derive ionization constant

e.g. $CH_3COOH_{(l)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + CH_3COO^-_{(aq)}$

$$K_{eq} = \frac{[H_3O^+][CH_3COO^-]}{[CH_3COOH][H_2O]}$$

Constant

Constant

$$K_{eq} \cdot [H_2O] = \frac{[H_3O^+][CH_3COO^-]}{[CH_3COOH]}$$

new constant

$$K_a = \frac{[H_3O^+][CH_3COO^-]}{[CH_3COOH]}$$

1.8×10^{-5}

For bases-

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

$$K_b = \frac{[NH_4^+][OH^-]}{[NH_3]}$$

Calculations with Ka and Kb

given → K_a
given → [acid] ⟶ calculate $[H_3O^+]$

example- Find $[H_3O^+]$ in a 0.010 mol/L solution of CH_3COOH.

$CH_3COOH + H_2O \rightleftharpoons H_3O^+ + CH_3COO^-$

	CH_3COOH	H_2O	H_3O^+	CH_3COO^-
I	0.010	?	0	0
C	$-x$		$+x$	$+x$
E	$0.010-x$		x	x

$$K_a = \frac{[H_3O^+][CH_3COO^-]}{[CH_3COOH]}$$

$$1.8\times10^{-5} = \frac{x \cdot x}{0.010-x}$$ ← assume x is small

$$1.8\times10^{-5} = \frac{x^2}{0.010}$$

$$1.8\times10^{-7} = x^2$$

$$\sqrt{1.8\times10^{-7}} = \sqrt{x^2}$$

$$[H_3O^+] = 4.2\times10^{-4} = x$$