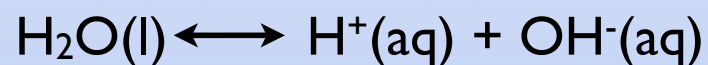
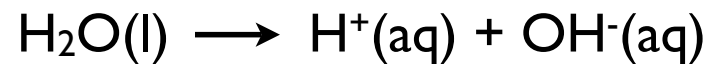


Acid Base Equilibria

Critical for most aqueous chemistry
(if you've missed it biochemistry is mostly aqueous chemistry)

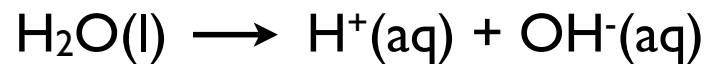


For this reaction which has a higher entropy?



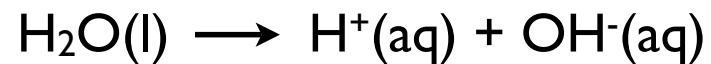
- A. the products
- B. the reactants
- C. they are the same

For this reaction which has a lower enthalpy?



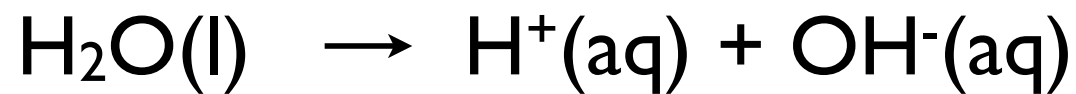
- A. the products
- B. the reactants
- C. they are the same

For this reaction which has a lower free energy?



- A. the products
- B. the reactants
- C. they are the same

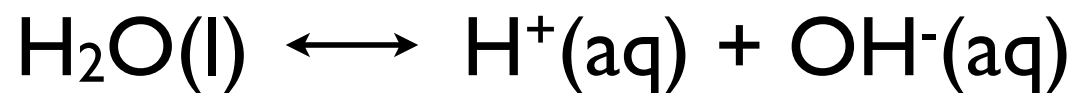
Liquid Water
will spontaneously dissociate to a small extent



$$K = \text{—————}$$

$$K_w =$$

In pure water what is the concentration of $[H^+]$
at 25 °C when $K_w = 10^{-14}$?



$$K_w = [H^+][OH^-] = 10^{-14}$$

Pure Water

H⁺

OH⁻

I

C

E

$$K_w = 10^{-14} =$$

x =

Acid/Base we are dealing with the balance of
 H^+ and OH^-

Definition of “Neutral”

Definition of “Acidic”

Definition of “Basic”

pH

Log scale.

Useful when dealing with very small
or very large number (big ranges of numbers)
every "pH" unit is 10x larger or smaller $[H^+]$

$$pH = -\log[H^+]$$

$$[H^+] = 10^{-13}$$

$$[H^+] = 10^{-7}$$

$$[H^+] = 10^{-2}$$

pH 3-14

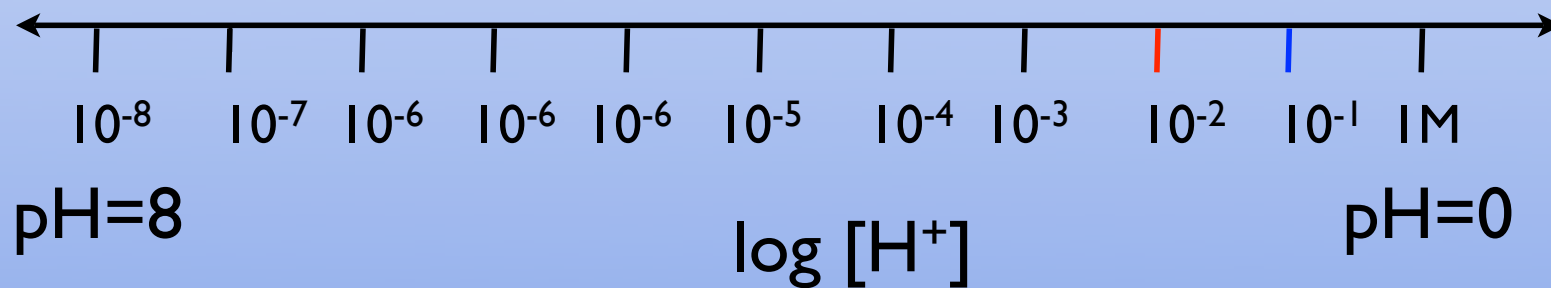
10^{-2} M pH = 2

0 M

10^{-1} M pH = 1

linear $[\text{H}^+]$

1 M

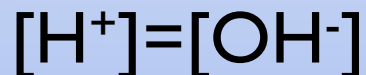


pH of pure water at 25°C

$$x = 10^{-7} \quad [H^+] = [OH^-] = 10^{-7}$$

$$pH =$$

Neutral



at 25°C

$$pH =$$
$$pOH =$$

Acidic



at 25°C

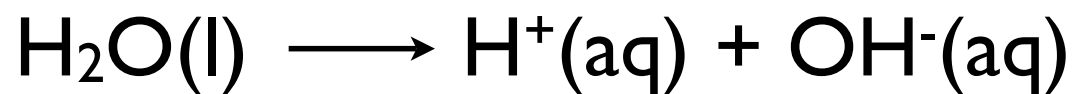
$$pH$$
$$pOH$$

Basic



at 25°C

$$pH$$
$$pOH$$



This reaction is endothermic.
Given that information what do you think
the pH is for pure water at 60°C?

- A. 6.5
- B. 7
- C. 7.5

If pure water has a $\text{pH} = 6.5$ at 60°C is it Acidic?

A. Yes

B. No

Acids and Bases

Brønsted-Lowry Definition

Acid is a proton (H^+) donor

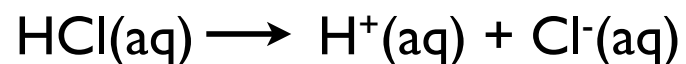
Base is a proton (H^+) acceptor

Strong Acids and Bases

"Strong" means one thing

The substance dissociates 100% in water

Strong Acid



$$K_{\text{a}} = \text{—————}$$

Strong Electrolyte



$$K_{\text{sp}} =$$

Strong Acids

Hydrochloric

Hydrobromic

Hydroiodic

Perchloric

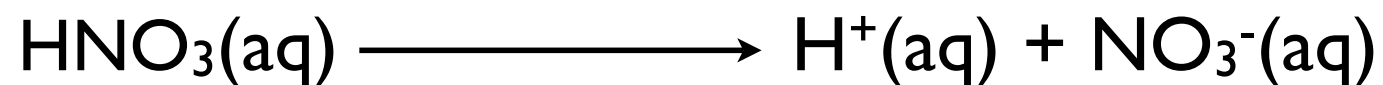
Chloric

Sulfuric

Nitric

All Dissociate 100%

What is the pH of a 0.1 M solution of Nitric Acid



0.1 M acid makes a solution with $[\text{H}^+] =$

What is the pH of a 0.5M solution of HBr?

A. -0.2

B. 1

C. 0.3

D. 0

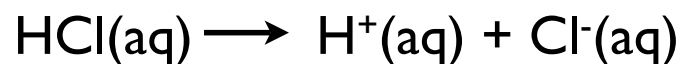
E. 12

Generally Scheme for Acids



$$K_{\text{a}} = \text{_____}$$

We can ignore the conjugate base of a strong acid



$$K_{\text{a}} = \frac{[\text{H}^{\text{+}}][\text{Cl}^{-}]}{[\text{HCl}]} \approx \infty$$

equilibrium constant is so large,
even if we add Cl^{-} the shift back to
HCl will be negligible

TABLE 7.1 Various Ways to Describe Acid Strength

Property	Strong Acid	Weak Acid
K_a value	K_a is large	K_a is small
Position of the dissociation equilibrium	Far to the right	Far to the left
Equilibrium concentration of H^+ compared with original concentration of HA	$[H^+] \approx [HA]_0$	$[H^+] \ll [HA]_0$
Strength of conjugate base compared with that of water	A^- much weaker base than H_2O	A^- much stronger base than H_2O

Weak Acid



I

C

E

assuming $x \ll C$

$$K_a = \frac{\text{---}}{\text{---}} = \frac{\text{---}}{\text{---}} =$$

Weak Base



$$K_b = \text{—————}$$

identical result as before (same assumptions)

$$[OH^-] =$$

What is an Acid? What is a Base?

Generic Naming HA

Generic Naming B

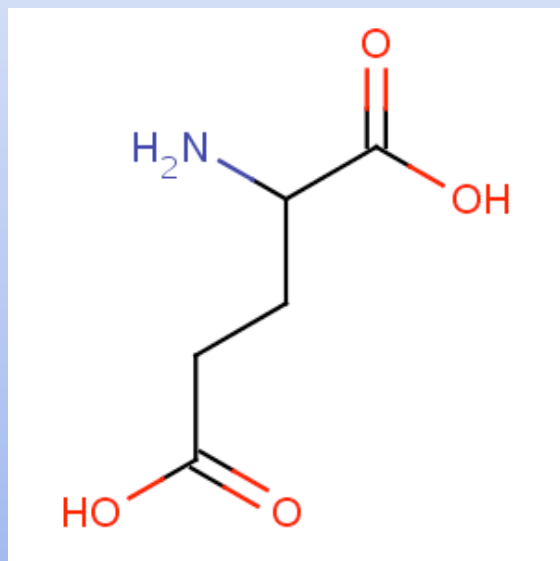
What is the approximate pH of a 1M solution of Glutamic Acid?

$$K_a = 5 \times 10^{-5}$$

- A. 2
- B. -2
- C. 7
- D. 5
- E. 12

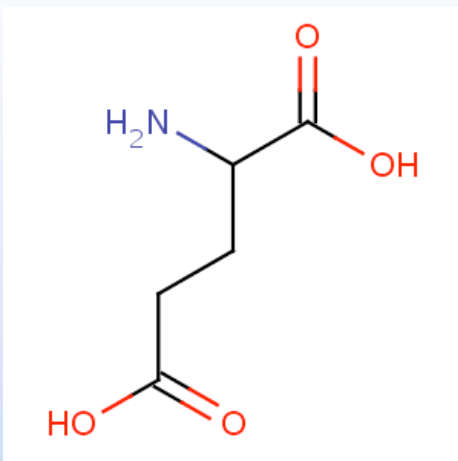
Think about $\text{pH} = 4$
why would we care?

H^+



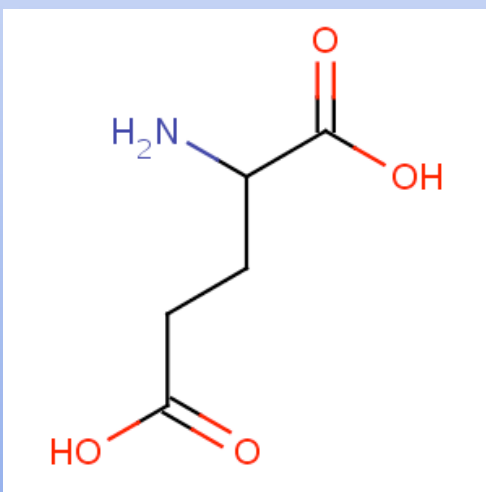
Glutamic Acid
 $K_a = 5 \times 10^{-5}$
 $\text{p}K_a = 4.3$

What concentration
of $[\text{H}^+]$ is
 $[\text{HA}] = [\text{A}^-]$

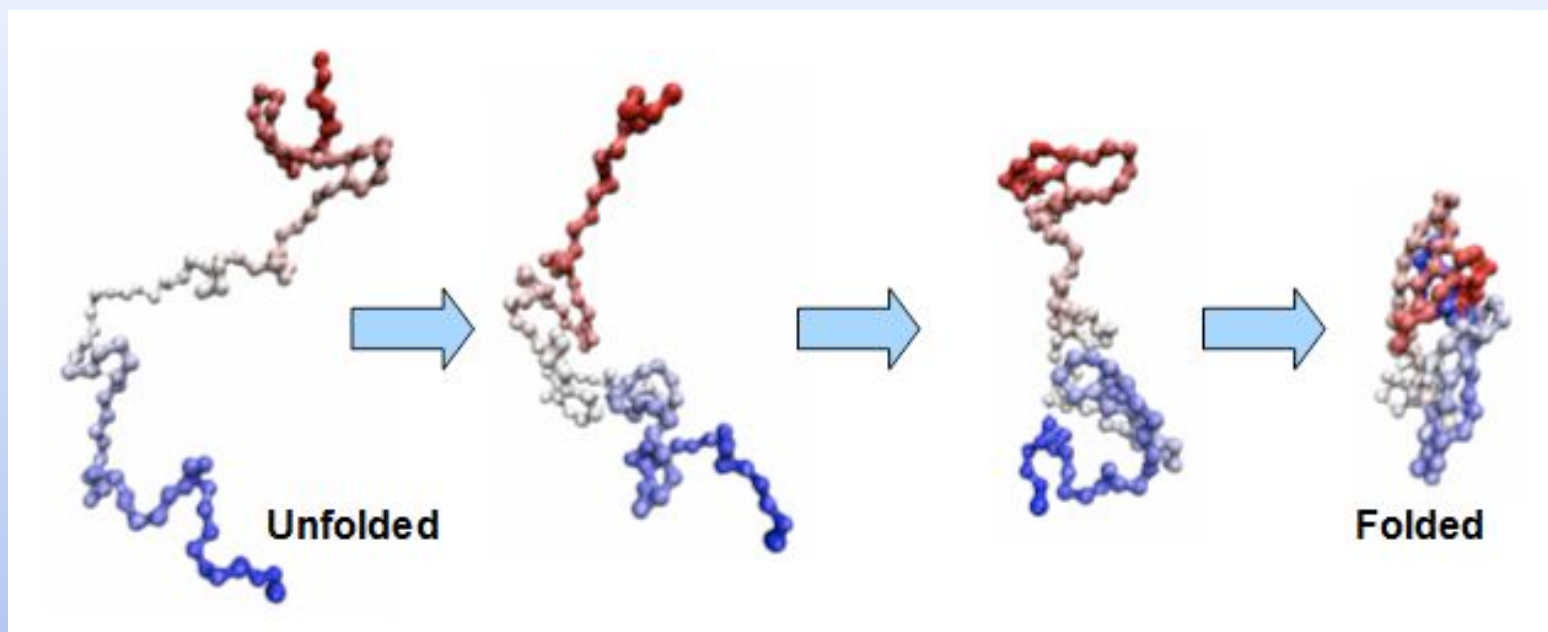


So if the pH is < 4.3

if the pH is > 4.3



Protein Function is derived from its structure



Structure results from interactions of the amino acids that make up the protein

Change the charge and you dramatically alter the structure