Chapter Ten Acids, Bases, and Salts

Acidity of the water matters

→ CO 10.1
Fish are very sensitive to the acidity of the water present in an aquarium.

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In water acids and bases dissociate

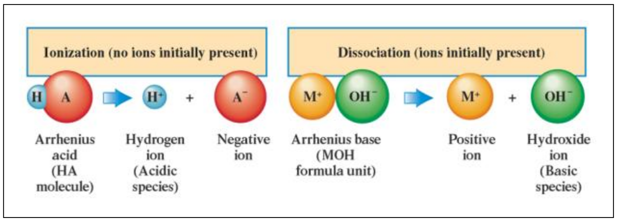

Fig. 10.1
The difference between the aqueous solution processes of ionization and dissociation.

Litmus changed color in acids and bases

→ **Fig. 10.2**
Litmus is a vegetable dye obtained from certain lichens found principally in the Netherlands.

Some acids and bases reactions does not require water

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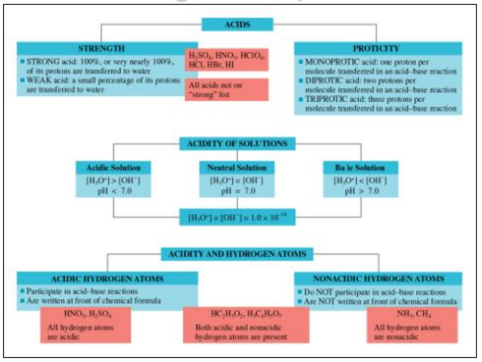
← **Fig. 10.3**
A white cloud of finely divided solid NH_4Cl is produced by the acid-base reaction that results when the colorless gases HCl and NH_3 mix.

Acid and base strengths and pH

→ *Table 10.1*



Acids tastes sour

→ **Fig. 10.4**
The sour taste of limes and other citrus fruit is due to the citric acid present in the fruit juice.

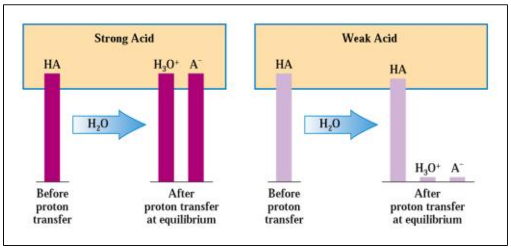
K_a for some acids and ions

Table 10.2

Name	Formula	K_a	Percent Ionization
phosphoric acid	H_3PO_4	7.5×10^{-3}	8.3
hydrofluoric acid	HF	6.8×10^{-4}	2.6
nitrous acid	HNO_2	4.5×10^{-4}	2.1
acetic acid	$HC_2H_3O_2$	1.8×10^{-5}	0.42
carbonic acid	H_2CO_3	4.3×10^{-7}	0.065
dihydrogen phosphate ion	$H_2PO_4^-$	6.2×10^{-8}	0.025
hydrocyanic acid	HCN	4.9×10^{-10}	0.0022
hydrogen carbonate ion	HCO_3^-	5.6×10^{-11}	0.00075
hydrogen phosphate ion	HPO_4^{2-}	4.2×10^{-13}	0.000065

Weak acids have fewer ions

Fig. 10.5
A comparison of the number of acidic species present in strong acid and weak acid solutions of the same concentration.



Hydroxy bases of group IA and IIA

Group IA Hydroxides	Group IIA Hydroxides
LiOH	—
NaOH	—
KOH	$Ca(OH)_2$
RbOH	$Sr(OH)_2$
CsOH	$Ba(OH)_2$

← **Table 10.3**

K_a and percent ionization

Table 10.4

Name	Formula	K_a	Percent Ionization
phosphoric acid	H_3PO_4	7.5×10^{-3}	8.3
hydrofluoric acid	HF	6.8×10^{-4}	2.6
nitrous acid	HNO_2	4.5×10^{-4}	2.1
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Acid and base reactions produce salts

→ **Fig. 10.6**
The acid-base reaction between sulfuric acid and barium hydroxide produces the insoluble salt barium sulfate.

Neutralization is water formation

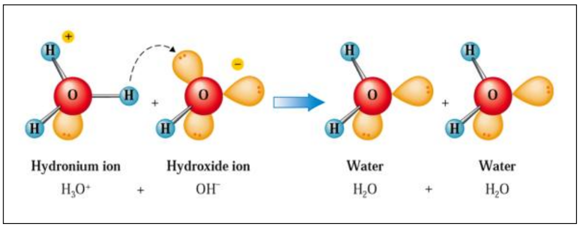


Fig. 10.7
Formation of water by the transfer of protons from H_3O+ ion to OH- ions.

Common anti-acids

- CC 10.1

Brand name	Neutralizing agent(s)
Alka-Seltzer	$NaHCO_3$
BiSoDol	$NaHCO_3$
DiGel	$Mg(OH)_2$, $Al(OH)_3$
Gaviscon	$Al(OH)_3$, $NaHCO_3$
Gelusil	$Mg(OH)_2$, $Al(OH)_3$
Maalox	$Mg(OH)_2$, $Al(OH)_3$
Milk of Magnesia	$Mg(OH)_2$
Mylanta	$Mg(OH)_2$, $Al(OH)_3$
Riopan	$AlMg(OH)_5$
Rolaids	$NaAl(OH)_2CO_3$
Tums	$CaCO_3$

H_3O^+ and OH^- ion concentrations flip-flop

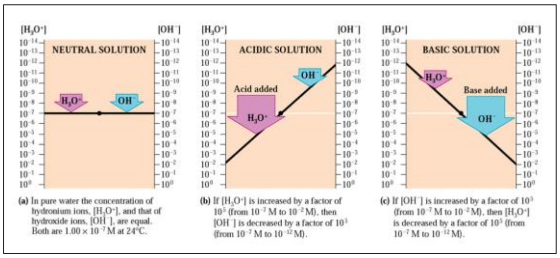


Fig. 10.9
The relationship between H_3O+ and OH- in aqueous solution is an inverse proportion.

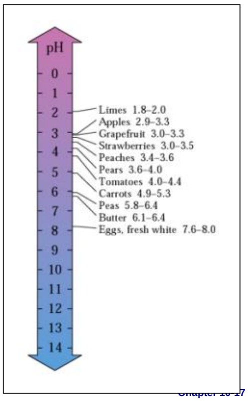
$[H_3O^+]$ and $[OH^-]$ ion product is constant

neutral solution	$[H_3O^+] = [OH^-] = 1.00 \times 10^{-7}$
acidic solution $[H_3O^+] > [OH^-]$	$[H_3O^+]$ is greater than 1.00×10^{-7} $[OH^-]$ is less than 1.00×10^{-7}
basic solution $[OH^-] > [H_3O^+]$	$[H_3O^+]$ is less than 1.00×10^{-7} $[OH^-]$ is greater than 1.00×10^{-7}

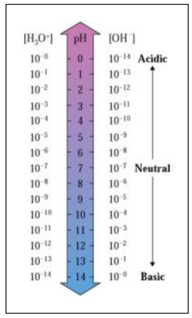
Table 10.5

pH of aqueous solutions

→ **Fig. 10.10**
Most fruits and vegetable are acidic.



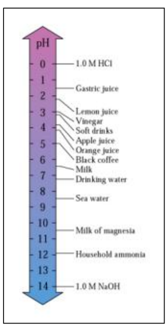
$[H_3O^+]$ and $[OH^-]$ ion concentrations



← **Fig. 10.11**
Relationship among pH values, H_3O+ and OH- at 24 degrees Celsius .

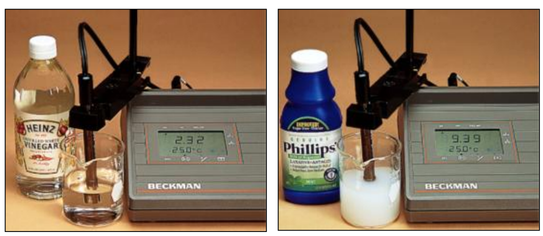
pH of different solutions

→ **Fig. 10.12**
pH values of selected common liquids.



pH meter is helpful

Fig. 10.13
A pH meter gives an accurate measurement of pH values.



pH of body fluids

Type of Fluid	pH Value
bile	6.8–7.0
blood plasma	7.3–7.5
gastric juices	1.0–3.0
milk	6.6–7.6
saliva	6.5–7.5
spinal fluid	7.3–7.5
urine	4.8–8.4

← Table 10.6

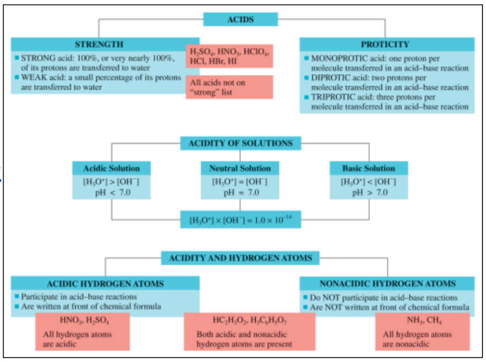
Acidity/basicity of salt solutions

Table 10.7

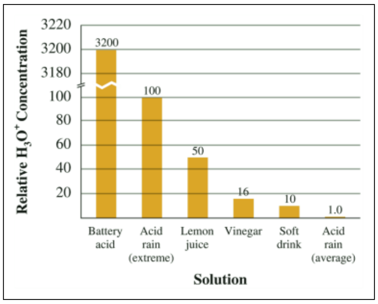
Type of Salt	Nature of Aqueous Solution	Examples
strong acid–strong base	neutral	NaCl, KBr
strong acid–weak base	acidic	NH_4Cl, NH_4NO_3
weak acid–strong base	basic	$NaC_2H_3O_2$, K_2CO_3
weak acid–weak base	depends on the salt	$NH_4C_2H_3O_2$, NH_4NO_2

Summary of acids

→ *CAG 10.1*



Acidity of various solutions



← CC 10.2 Acid Rain

Predicting pH of salts solutions

Table 10.8

Name of Salt	Formula of Salt	pH	Category of Salt
ammonium nitrate	NH_4NO_3	5.1	strong acid–weak base
ammonium nitrite	NH_4NO_2	6.3	weak acid–weak base
ammonium acetate	$NH_4C_2H_3O_2$	7.0	weak acid–weak base
sodium chloride	NaCl	7.0	strong acid–strong base
sodium fluoride	NaF	8.1	weak acid–strong base
sodium acetate	$NaC_2H_3O_2$	8.9	weak acid–strong base
ammonium cyanide	NH_4CN	9.3	weak acid–weak base
sodium cyanide	NaCN	11.1	weak acid–strong base

Buffers solutions compared to unbuffered

Table 10.9

Unbuffered Solution	
1 liter water	pH = 7.0
1 liter water + 0.01 mole strong base (NaOH)	pH = 12.0
1 liter water + 0.01 mole strong acid (NaOH)	pH = 2.0
Buffered Solution	
1 liter buffer[a]	pH = 7.2
1 liter buffer[a] + 0.01 mole strong base (NaOH)	pH = 7.3
1 liter buffer[a] + 0.01 mole strong acid (HCl)	pH = 7.1

[a]Buffer = equal amounts of 0.1 M HPO_4^{2-} and 0.1 M $H_2PO_4^-$

Buffers solutions compared to unbuffere

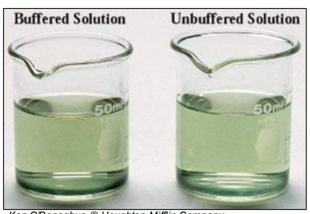


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Fig. 10.14 (a) **The buffered and unbuffered solutions have the same pH level.**

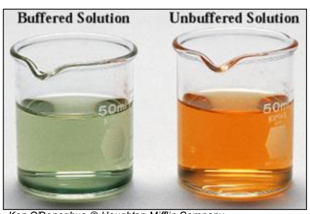

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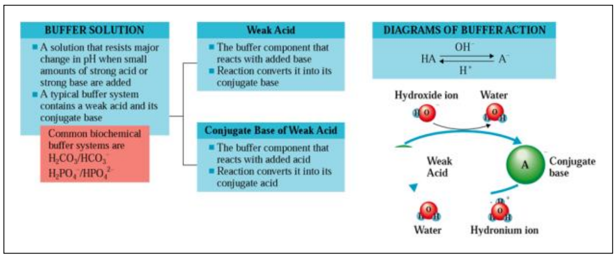
Fig. 10.14 (b) After adding 1mL of a 0.01 M HCl solution, the pH of the buffered solution has not perceptibly changed, but the unbuffered solution has become acidic.

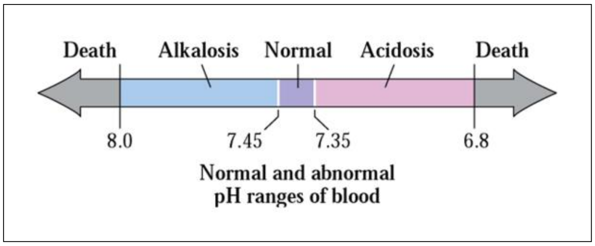
How buffers are made?

CAG 10.2



pH of blood. Does it matters?

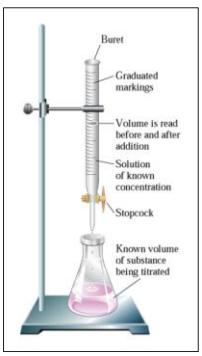
CC 10.4



How you tell something is an electrolytes, weak electrolytes, or nonelectrolyte?

Fig. 10.15
This simple device can be used to distinguish among strong electrolytes, weak electrolytes, and nonelectrolytes.

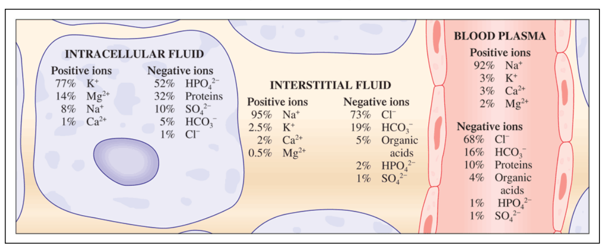
Acids/base titrations: How you do it?



← **Fig. 10.16**
Diagram showing setup for titration procedures.

Electrolytes in Body Fluids

CC 10.5
Electrolyte and Body Fluids



How does indicator show the end point?

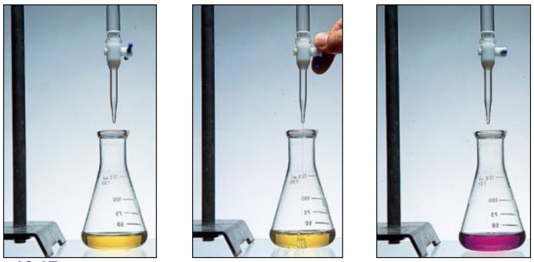


Fig. 10.17

An acid-base titration using an indicator that is yellow in acidic solution and red in basic solution.