

Reading Assignments

Mon Nov 15: Ch 10 sects 1-3

Wed Nov 17: Ch 10 sects 4-5

Fri Nov 19: Ch 10 sects 6-8

Acids chemical compounds

sharp taste Säure, acide

corrosive action on metals

effervescence results when applied to chalk

turn certain blue vegetable dyes red

Bases Chemical compounds

soapy to the touch

turn red vegetable dyes blue

neutralize acids to form **salts**

characterized mainly by their ability
to neutralize acids and form salts

Salts substances

salty taste

formed by reaction of acid & base

none of the characteristic properties
of either acids or bases

Lavoisier

all acids must contain oxygen

HCl--oops!

Humphry Davy (1815)

key element in acids is hydrogen.

Justus von Liebig (1838)

acid is a compound containing hydrogen in a form in which it can be replaced by a metal.

Wilhelm Ostwald

Svante August Arrhenius

Electrolytic dissociation theory

electrolytes

compounds which **dissociate in solution to give ions.**

Electrolytes and Non-electrolytes

Arrhenius Definitions

Acids: H-containing substance giving H^+ ions in water

HBr hydrobromic acid

HNO_3 nitric acid

$HClO_4$ perchloric acid

H_2CO_3 carbonic acid

Arrhenius Definitions

Bases: OH containing substance producing OH^- ions

cmpds of metals with OH

LiOH , NaOH , etc. *alkalis*

$\text{Mg}(\text{OH})_2$; $\text{Ca}(\text{OH})_2$ *alkaline earths*

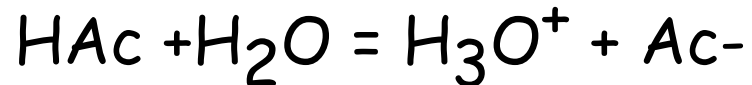
Neutralization of acids by bases



Brønsted-Lowry

Acid donates a proton

Base accepts a proton



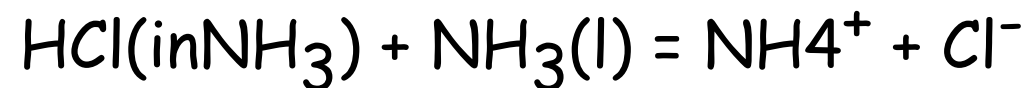
H_2O acts like a base because it accepts the proton.

HAc/Ac⁻ Conjugate acid-base pairs.

Ac⁻ is the base conjugate to HAc

HAc is the acid conjugate to Ac⁻

B-L thy not limited to aqueous solutions.

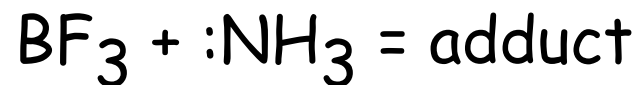


Here NH_3 acts as the base

Lewis Definition:

Acid is electron acceptor;

base is electron donor



Acid anhydrides: strip off the H₂O

HClO₄: dimer is H₂Cl₂O₈

strip off H₂O--Cl₂O₇

Increasing acidity →

	I	II	III	IV	V	VI	VII	
↑ Increasing basicity ↓	Li ₂ O	BeO	B ₂ O ₃	CO ₂	N ₂ O ₅	(O ₂)	OF ₂	↑ Increasing acidity
	Na ₂ O	MgO	Al ₂ O ₃	SiO ₂	P ₄ O ₁₀	SO ₃	Cl ₂ O ₇	
	K ₂ O	CaO	Ga ₂ O ₃	GeO ₂	As ₂ O ₅	SeO ₃	Br ₂ O ₇	
	Rb ₂ O	SrO	In ₂ O ₃	SnO ₂	Sb ₂ O ₅	TeO ₃	I ₂ O ₇	
	Cs ₂ O	BaO	Tl ₂ O ₃	PbO ₂	Bi ₂ O ₅	PoO ₃	At ₂ O ₇	

← Increasing basicity

Acid & Base Strength

Strong Acids

Readily dissolve metals depends on
concentration

strong electrolytes

conduct electricity

colligative properties

Strong acids (bases) ionize completely

Strong and Weak Electrolytes

How measure concentration? pH.

Electrical measurements

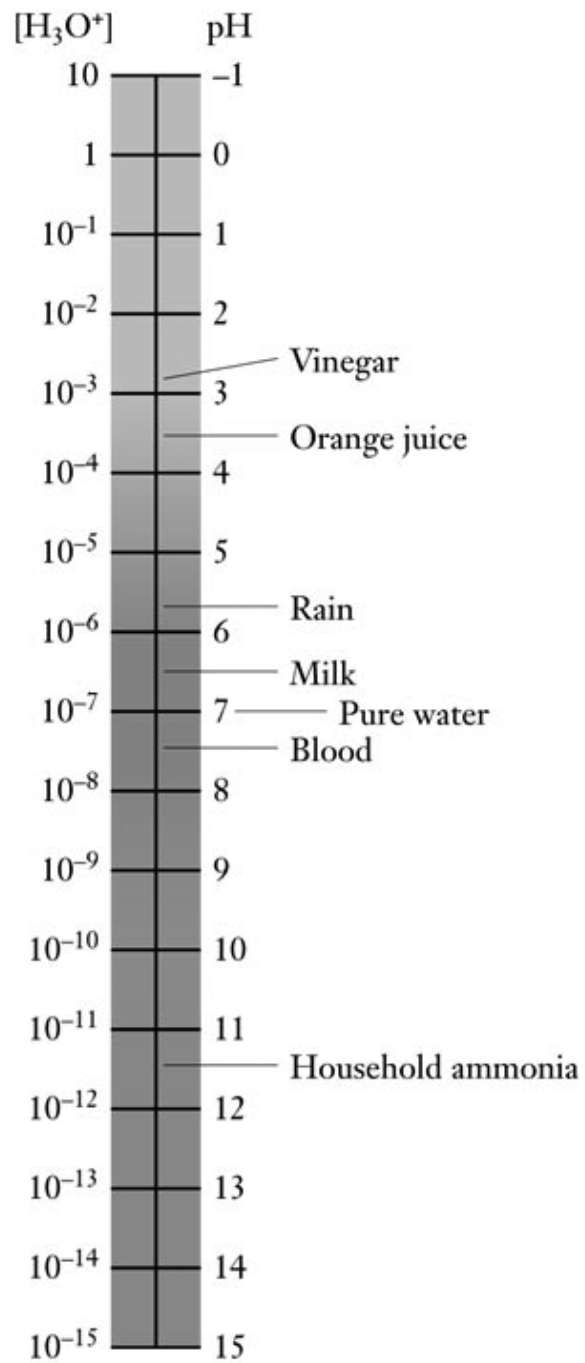


$$\text{pH} = -\log(\text{H}^+)$$

Acid soln: $\text{pH} < 7$

Neutral $\text{pH} = 7$

Basic soln $\text{pH} > 7$



Ex 1; what is $[H^+]$ if $pH=0$ or 6.5 ?

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

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

$$[H^+] = 10^{-0} = 1$$

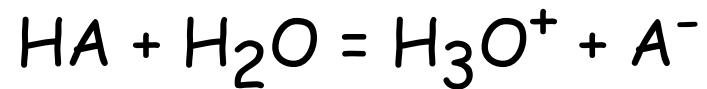
$$[H^+] = 10^{-6.5} = 3.16 \times 10^{-7}$$

Ex 2; what is pH if $H = 3.7 \times 10^{-8}$

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

$$pH = -\log[3.7 \times 10^{-8}] = 7.43$$

Acid and Base Strength - weak acids



$$K_a = \frac{[\text{H}_3\text{O}^+][\text{A}^-]}{[\text{HA}]} = 1.76 \times 10^{-5}$$

$$\text{p}K_a = -\log_{10}(K_a) = 4.75$$

$$K_a = \frac{[H_3O^+][A^-]}{[HA]} = 1.76 \times 10^{-5}$$

what is pH of 0.1 M Acetic Acid? $HA + H_2O = H_3O^+ + A^-$

$$[H_3O^+] = [A^-] \quad [HA] = 0.1 - [H_3O^+]$$

$$K_a = \frac{[H_3O^+][H_3O^+]}{0.1 - [H_3O^+]} \approx \frac{[H_3O^+]^2}{0.1}$$

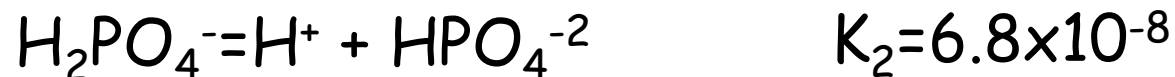
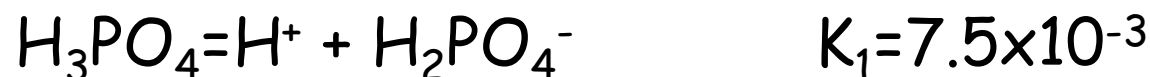
$$[H_3O^+] = 1.32 \times 10^{-3} \quad \text{pH} = 2.87$$

Strengths of Acids

HX: strong except for HF

Oxygen Acids

1. Successive dissociation constants decrease by 10^5



2. $\text{XO}_m(\text{OH})_n$

$m=0$; very weak $K < 10^{-7}$ HOCl H_3BO_3

$m=1$; weak $K \approx 10^{-2}$ HClO₂

$m=2$; strong $K \approx 10^3$ HClO₃

$m=3$; very strong HClO₄

TABLE 10.3
ACID IONIZATION CONSTANTS FOR OXOACIDS OF THE NONMETALS

$X(OH)_m$ Very Weak	K_a	$XO(OH)_m$ Weak	K_a	$XO_2(OH)_m$ Strong	K_a	$XO_3(OH)_m$ Very Strong	K_a
Cl(OH)	3×10^{-8}	H ₂ PO(OH)	8×10^{-2}	SeO ₂ (OH) ₂	10^3	ClO ₃ (OH)	2×10^7
Te(OH) ₆	2×10^{-8}	IO(OH) ₅	2×10^{-2}	ClO ₂ (OH)	5×10^2		
Br(OH)	2×10^{-9}	SO(OH) ₂	2×10^{-2}	SO ₂ (OH) ₂	1×10^2		
As(OH) ₃	6×10^{-10}	ClO(OH)	1×10^{-2}	NO ₂ (OH)	2×10^1		
B(OH) ₃	6×10^{-10}	HPO(OH) ₂	1×10^{-2}	IO ₂ (OH)	1.6×10^1		
Ge(OH) ₄	4×10^{-10}	PO(OH) ₃	8×10^{-3}				
Si(OH) ₄	2×10^{-10}	AsO(OH) ₃	5×10^{-3}				
I(OH)	4×10^{-11}	SeO(OH) ₂	3×10^{-3}				
		TeO(OH) ₂	3×10^{-3}				
		NO(OH)	5×10^{-4}				

