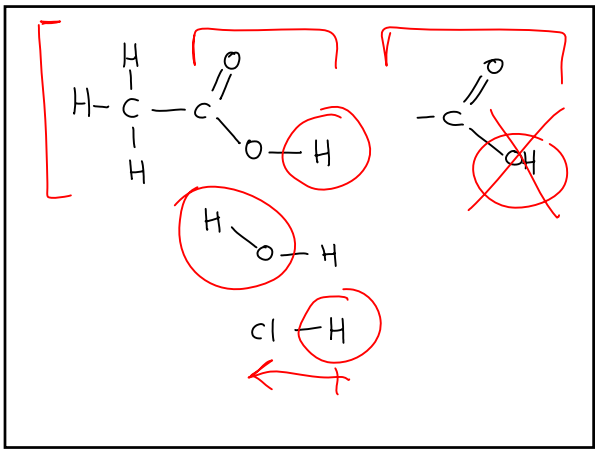
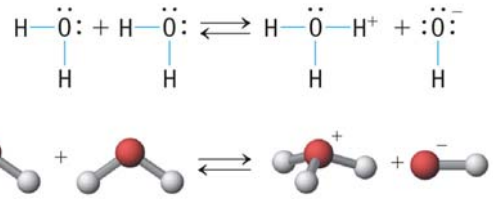
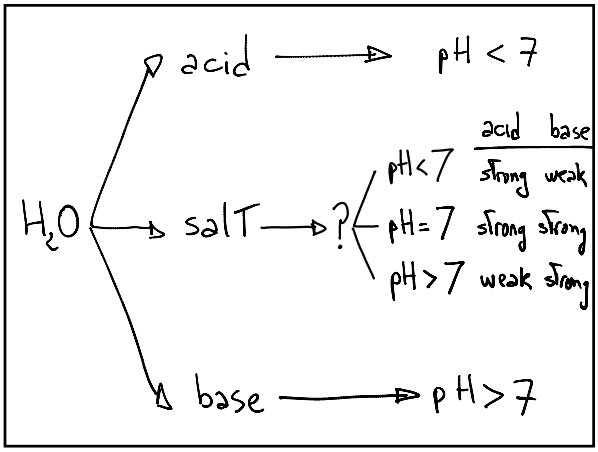


Auto Ionization of Water

$$2\ H_2O(\ell) \rightleftharpoons H_3O^+(aq) + OH^-(aq)$$

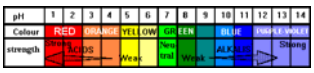




Demo pH

- CH_3CO_2H weak acid pH < 7
- NH_4Cl salt pH < 7
- NaCl salt pH = 7
- $NaCH_3CO_2$ salt pH > 7
- NH_3 weak base > 7

Universal indicator



Acids: can donate a proton

K_a		in water
Large	Strong acid	$[H_3O^+]$ = [acid]
<1	Weak acid	$[H_3O^+]$ < [acid]

Bases: can accept a proton

K_b		in water
Large	Strong base	$[HO^-]$ = [base]
<1	Weak base	$[HO^-]$ < [base]

Bronsted Concept of Acids and Bases

Table 17.2 Conjugate Acid–Base Pairs*

Name	Acid 1		Base 2		Base 1		Acid 2
Hydrochloric acid	HCl	+	H_2O	$\longrightarrow$	Cl^-	+	H_3O^+
Nitric acid	HNO_3	+	H_2O	$\longrightarrow$	NO_3^-	+	H_3O^+
Hydrogen carbonate	HCO_3^-	+	H_2O	$\rightleftharpoons$	CO_3^{2-}	+	H_3O^+
Acetic acid	CH_3CO_2H	+	H_2O	$\rightleftharpoons$	$CH_3CO_2^-$	+	H_3O^+
Hydrocyanic acid	HCN	+	H_2O	$\rightleftharpoons$	CN^-	+	H_3O^+
Hydrogen sulfide	H_2S	+	H_2O	$\rightleftharpoons$	HS^-	+	H_3O^+
Ammonia	H_2O	+	NH_3	$\rightleftharpoons$	OH^-	+	NH_4^+
Carbonate ion	H_2O	+	CO_3^{2-}	$\rightleftharpoons$	OH^-	+	HCO_3^-
Water	H_2O	+	H_2O	$\rightleftharpoons$	OH^-	+	H_3O^+

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NH_4^+ and NH_3 - a conjugate acid-base pair

$$NH_3(aq) + H_2O(\ell) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$$

Base

Weak base

$K_B = 1.8 \times 10^{-5}$

$$NH_4^+(aq) + H_2O(\ell) \rightleftharpoons NH_3(aq) + H_3O^+(aq)$$

Acid

Weak acid

$K_A = 5.6 \times 10^{-10}$

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For any conjugate acid/base pair

(such as NH_3/NH_4^+):

$K_W = K_A K_B = \boxed{5{,}6 \cdot 10^{-10} \cdot 1{,}8 \cdot 10^{-5} = 1{,}0\ 10^{-14}}$

Therefore: $K_A = K_W/K_B$ and $K_B = K_W/K_A$

$\log K_W = \log K_A + \log K_B \rightarrow pK_W = pK_A + pK_B$

$\boxed{9{,}25 + 4{,}75 = 14}$

PRS