6. pH OF WEAK BASE SOLUTIONS

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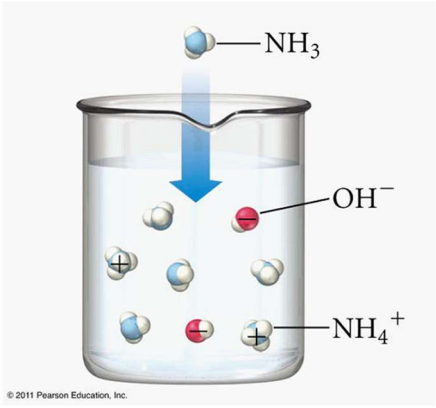
1

WEAK BASES

- Are reactant favored equilibriums
- Have K_b values to represent equilibrium position
- Require ICE tables to determine [OH^-] and pOH/pH



$$B + H_2O \leftrightarrows BH^+ + OH^-$$

$$K_b = \frac{[BH^+][OH^-]}{[B]} = ???$$

2

BE CAREFUL WITH WEAK BASES!

- Weak bases are the conjugate bases of weak acids!
- They are created by dissolving a soluble salt containing the weak base in water.

For example:

Weak Acid	Conj. Base (Weak Base)	Soluble Salt Containing Weak Base
HCN	CN-	NaCN
HF	F-	NaF
CH_3COOH	CH_3COO-	$NaCH_3COO$

TWO COMMON WEAK BASES TO RECOGNIZE:

1. Ammonia (NH_3)
2. Methyamine (CH_3NH_2)

$NaCN(s) \leftrightarrow Na^+(aq) + CN^-(aq) \rightarrow CN^- + H_2O \leftrightarrow OH^- + HCN$

3

K_b's OF WEAK BASES

The K_b of a weak base is related to the K_a of the conjugate acid of that base.

$(Ka)(Kb) = K_w$

$(Ka)(Kb) = 1.0 \times 10^{-14}$

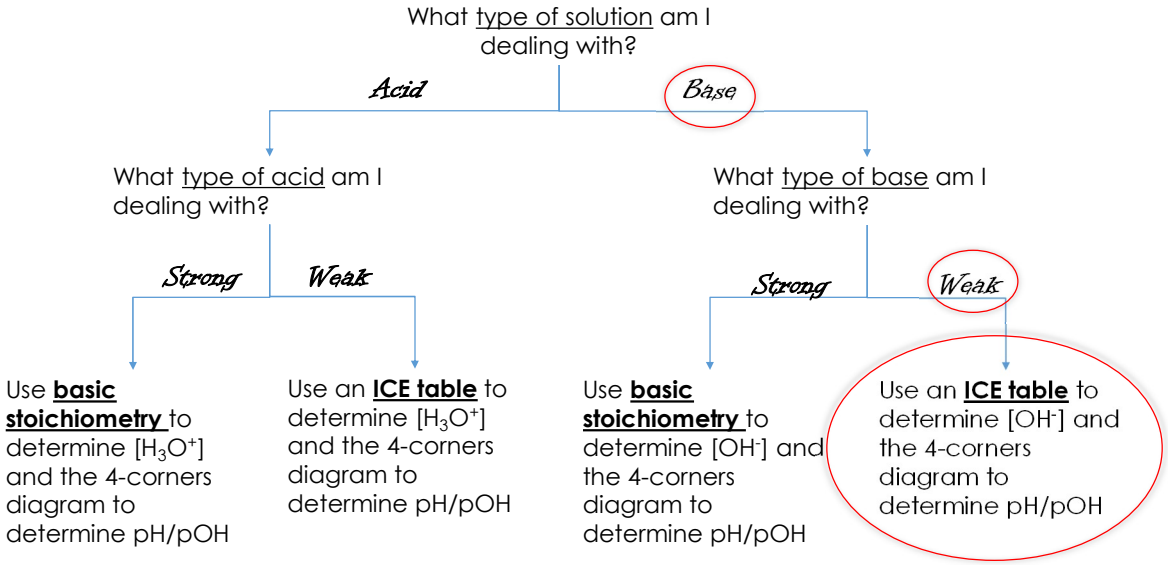
K_b NH_3 =

Ionization Constants for Some Acids and Their Conjugate Bases at 25°C

Acid Name	Formula	Ka	Formula	Kb	Base name
Perchloric acid	$HClO_4$	large	ClO_4^-	very small	Perchlorate ion
Sulfuric acid	H_2SO_4	large	HSO_4^-	very small	Hydrogen sulfate ion
Hydrochloric acid	HCl	large	Cl^-	very small	Chloride ion
Nitric acid	HNO_3	large	NO_3^-	very small	Nitrate ion
Hydronium ion	H_3O^+	1.0	H_2O	1.0×10^{-14}	Water
Sulfurous acid	H_2SO_3	1.2×10^{-2}	HSO_3^-	8.3×10^{-13}	Hydrogen sulfite ion
Hydrogen sulfate ion	HSO_4^-	1.2×10^{-2}	SO_4^{2-}	8.3×10^{-13}	Sulfate ion
Phosphoric acid	H_3PO_4	7.5×10^{-3}	$H_2PO_4^-$	1.3×10^{-12}	Dihydrogen phosphate ion
Hexaaquairon(III) ion	$[Fe(H_2O)_6]^{3+}$	6.3×10^{-3}	$[Fe(H_2O)_5OH]^{2+}$	1.6×10^{-12}	Pentaaquahydroxoiron(III) ion
Hydrofluoric acid	HF	7.2×10^{-4}	F^-	1.4×10^{-11}	Fluoride ion
Nitrous acid	HNO_2	4.5×10^{-4}	NO_2^-	2.2×10^{-11}	Nitrite ion
Formic acid	HCO_2H	1.8×10^{-4}	HCO_2^-	5.6×10^{-11}	Formate ion
Benzoic acid	$C_6H_5CO_2H$	6.3×10^{-5}	$C_6H_5CO_2^-$	1.6×10^{-10}	Benzoate ion
Acetic acid	CH_3CO_2H	1.8×10^{-5}	$CH_3CO_2^-$	5.6×10^{-10}	Acetate ion
Propanoic acid	$CH_3CH_2CO_2H$	1.3×10^{-5}	$CH_3CH_2CO_2^-$	7.7×10^{-10}	Propanoate ion
Hexaaquaaluminium ion	$[Al(H_2O)_6]^{3+}$	7.9×10^{-6}	$[Al(H_2O)_5OH]^{2+}$	1.3×10^{-9}	Pentaaquahydroxoaluminum ion
Carbonic acid	H_2CO_3	4.2×10^{-7}	HCO_3^-	2.4×10^{-8}	Hydrogen carbonate ion
Hexaaquacopper(II) ion	$[Cu(H_2O)_6]^{2+}$	1.6×10^{-7}	$[Cu(H_2O)_5OH]^+$	6.3×10^{-8}	Pentaaquahydroxocopper(II) ion
Hydrogen sulfide	H_2S	1.0×10^{-7}	HS^-	1.0×10^{-7}	Hydrogen sulfide ion
Dihydrogen phosphate ion	$H_2PO_4^-$	6.2×10^{-8}	HPO_4^{2-}	1.6×10^{-7}	Hydrogen phosphate ion
Hydrogen sulfite ion	HSO_3^-	6.2×10^{-8}	SO_3^{2-}	1.6×10^{-7}	Sulfite ion
Hypochlorous acid	HClO	3.5×10^{-8}	ClO^-	2.9×10^{-7}	Hypochlorite ion
Hexaaqualead(II) ion	$[Pb(H_2O)_6]^{2+}$	1.5×10^{-8}	$[Pb(H_2O)_5OH]^+$	6.7×10^{-7}	Pentaaquahydroxolead(II) ion
Hexaaquacobalt(II) ion	$[Co(H_2O)_6]^{2+}$	1.3×10^{-9}	$[Co(H_2O)_5OH]^+$	7.7×10^{-6}	Pentaaquahydroxocobalt(II) ion
Boric acid	$B(OH)_3(H_2O)$	7.3×10^{-10}	$B(OH)_4^-$	1.4×10^{-5}	Tetrahydroxoborate ion
Ammonium ion	NH_4^+	5.6×10^{-10}	NH_3	1.8×10^{-5}	Ammonia
Hydrocyanic acid	HCN	4.0×10^{-10}	CN^-	2.5×10^{-5}	Cyanide ion
Hexaaquairon(II) ion	$[Fe(H_2O)_6]^{2+}$	3.2×10^{-10}	$[Fe(H_2O)_5OH]^+$	3.1×10^{-5}	Pentaaquahydroxoiron(II) ion
Hydrogen carbonate ion	HCO_3^-	4.8×10^{-11}	CO_3^{2-}	2.1×10^{-4}	Carbonate ion
Hexaaquanickel(II) ion	$[Ni(H_2O)_6]^{2+}$	2.5×10^{-11}	$[Ni(H_2O)_5OH]^+$	4.0×10^{-4}	Pentaaquahydroxonickel(II) ion
Hydrogen phosphate ion	HPO_4^{2-}	3.6×10^{-13}	PO_4^{3-}	2.8×10^{-2}	Phosphate ion
Water	H_2O	1.0×10^{-14}	OH^-	1.0	Hydroxide ion
Hydrogen sulfide ion	HS^-	1.0×10^{-19}	S^{2-}	1.0×10^{6}	Sulfide ion
Ethanol	C_2H_5OH	very small	$C_2H_5O^-$	large	Ethoxide ion
Ammonia	NH_3	very small	NH_2^-	large	Amide ion
Hydrogen	H_2	very small	H^-	large	Hydride ion

4

HAVE A PLAN OF ACTION!



5

FOR EXAMPLE

Ammonia acts as a weak base in solution. It is commonly found in household cleaning solutions such as Windex and toilet bowl cleaners. What is the pH of a 0.050 M solution of ammonia?

6

WORKING BACKWARDS

Calculate the K_b of 0.20 M weak base that has a pH of 11.30. What is the identity of this substance?

7