6.12: Acid-Base Ionization Constant

Acid-Base Ionization Constant

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Ionization Constants for Select Acids (a table for bases is below)

K_a determined at 25 °C.

Acid	Formula and Ionization Equation	K_a	pK_a
Acetic	$CH_3COOH + H_2O \rightleftharpoons H_3O^+ + CH_3COO^-$	1.8×10^{-5}	4.74
Arsenic	$H_3AsO_4 + H_2O \rightleftharpoons H_3O^+ + H_2AsO_4^-$	$K_1 = 6.17 \times 10^{-3}$	2.210
	$H_2AsO_4^- + H_2O \rightleftharpoons H_3O^+ + HAsO_4^{2-}$	$K_2 = 1.17 \times 10^{-7}$	6.932
	$HAsO_4^{2-} + H_2O \rightleftharpoons H_3O^+ + AsO_4^{3-}$	$K_3 = 3.09 \times 10^{-12}$	11.523
Benzoic	$C_6H_5COOH + H_2O \rightleftharpoons H_3O^+ + C_6H_5COO^-$	1.2×10^{-4}	3.92
Boric	$B(OH)_3(H_2O) + H_2O \rightleftharpoons H_3O^+ + B(OH)_4^-$	5.8×10^{-10}	9.24
Butyric	$CH_3CH_2CH_2COOH + H_2O \rightleftharpoons H_3O^+ + CH_3CH_2CH_2COO^-$	1.5×10^{-5}	4.82
Carbonic	$H_2CO_3 + H_2O \rightleftharpoons H_3O^+ + HCO_3^-$	$K_1 = 4.3 \times 10^{-7}$	6.37
	$HCO_3^- + H_2O \rightleftharpoons H_3O^+ + CO_3^{2-}$	$K_2 = 4.7 \times 10^{-11}$	10.33
Citric	$H_3C_6H_5O_7 + H_2O \rightleftharpoons H_3O^+ + H_2C_6H_5O_7^-$	$K_1 = 1.4 \times 10^{-3}$	2.85
	$H_2C_6H_5O_7^- + H_2O \rightleftharpoons H_3O^+ + HC_6H_5O_7^{2-}$	$K_2 = 4.5 \times 10^{-5}$	4.35
	$HC_6H_5O_7^{2-} + H_2O \rightleftharpoons H_3O^+ + C_6H_5O_7^{3-}$	$K_3 = 1.5 \times 10^{-6}$	5.82
Chloroacetic	$CH_2ClCOOH + H_2O \rightleftharpoons H_3O^+ + CH_2ClCOO^-$	1.4×10^{-3}	2.85
4-chlorobutyric	$CH_2ClCH_2CH_2COOH + H_2O \rightleftharpoons H_3O^+ + CH_2ClCH_2CH_2COO^-$	3.0×10^{-5}	4.53
3-chlorobutyric acid	$CH_3CHClCH_2COOH + H_2O \rightleftharpoons H_3O^+ + CH_3CHClCH_2COO^-$	8.9×10^{-5}	4.05
2-chlorobutyric acid	$CH_3CH_2CHClCOOH + H_2O \rightleftharpoons H_3O^+ + CH_3CH_2CHClCOO^-$	1.3×10^{-3}	2.89
Chlorous	$HClO_2 + H_2O \rightleftharpoons H_3O^+ + ClO_2^-$	1.1×10^{-2}	1.96
Dichloroacetic	$CHCl_2COOH + H_2O \rightleftharpoons H_3O^+ + CHCl_2COO^-$	4.5×10^{-2}	1.35
Formic	$HCOOH + H_2O \rightleftharpoons H_3O^+ + HCOO^-$	1.8×10^{-4}	3.75
Hydrazoic	$HN_3 + H_2O \rightleftharpoons H_3O^+ + N_3^-$	1.0×10^{-5}	5.00
Hydrochloric	$HCl + H_2O \rightleftharpoons H_3O^+ + Cl^-$	1.2×10^{6}	-6.1
Hydrocyanic	$HCN + H_2O \rightleftharpoons H_3O^+ + CN^-$	3.3×10^{-10}	9.48
Hydrofluoric	$HF + H_2O \rightleftharpoons H_3O^+ + F^-$	6.8×10^{-4}	3.17
Hydrogen peroxide	$H_2O_2 + H_2O \rightleftharpoons H_3O^+ + HO_2^-$	2.1×10^{-12}	11.68
Hydrosulfuric†	$H_2S + H_2O \rightleftharpoons H_3O^+ + HS^-$	$K_1 = 1 \times 10^{-7}$	7.0
	$HS^- + H_2O \rightleftharpoons H_3O^+ + S^{2-}$	$K_2 = 1 \times 10^{-19}$	19.0
Hypobromous	$HOBr + H_2O \rightleftharpoons H_3O^+ + OBr^-$	3×10^{-9}	8.5
Hypochlorous	$HOCl + H_2O \rightleftharpoons H_3O^+ + OCl^-$	6.8×10^{-8}	7.17
Hypoiodous	$HOI + H_2O \rightleftharpoons H_3O^+ + OI^-$	3×10^{-11}	10.5
Nitric	$HNO_3 + H_2O \rightleftharpoons H_3O^+ + NO_3^-$	27	-1.43
Nitrous	$HNO_2 + H_2O \rightleftharpoons H_3O^+ + NO_2^-$	7.41×10^{-4}	3.130
Oxalic	$H_2C_2O_4 + H_2O \rightleftharpoons H_3O^+ + HC_2O_4^-$	$K_1 = 5.5 \times 10^{-2}$	1.26
	$HC_2O_4^- + H_2O \rightleftharpoons H_3O^+ + C_2O_4^{2-}$	$K_2 = 1.4 \times 10^{-4}$	3.85
Phenol	$HC_6H_5O + H_2O \rightleftharpoons H_3O^+ + C_6H_5O^-$	1.7×10^{-10}	9.77
Phosphoric	$H_3PO_4 + H_2O \rightleftharpoons H_3O^+ + H_2PO_4^-$	$K_1 = 7.2 \times 10^{-3}$	2.14

Acid	Formula and Ionization Equation	K_a	pK_a
	$H_2PO_4^- + H_2O \rightleftharpoons H_3O^+ + HPO_4^{2-}$	$K_2 = 6.3 \times 10^{-8}$	7.20
	$HPO_4^{2-} + H_2O \rightleftharpoons H_3O^+ + PO_4^{3-}$	$K_3 = 4.6 \times 10^{-13}$	12.34
Phosphorous	$H_3PO_3 + H_2O \rightleftharpoons H_3O^+ + H_2PO_3^-$	$K_1 = 2.4 \times 10^{-2}$	1.62
	$H_2PO_3^- + H_2O \rightleftharpoons H_3O^+ + HPO_3^{2-}$	$K_2 = 2.9 \times 10^{-7}$	6.54
Propanoic	$CH_3CH_2COOH + H_2O \rightleftharpoons H_3O^+ + CH_3CH_2COO^-$	1.33×10^{-5}	4.85
Selenic	$H_2SeO_4 + H_2O \rightleftharpoons H_3O^+ + HSeO_4^-$	K_1 = very large	---
	$HSeO_4^- + H_2O \rightleftharpoons H_3O^+ + SeO_4^{2-}$	$K_2 = 2.2 \times 10^{-2}$	1.66
Selenous	$H_2SeO_3 + H_2O \rightleftharpoons H_3O^+ + HSeO_3^-$	$K_1 = 2.5 \times 10^{-3}$	2.60
	$HSeO_3^- + H_2O \rightleftharpoons H_3O^+ + SeO_3^{2-}$	$K_2 = 1.6 \times 10^{-9}$	8.80
Sulfuric	$H_2SO_4 + H_2O \rightleftharpoons H_3O^+ + HSO_4^-$	$K_1 = 4.0 \times 10^{3}$	-3.6
	$HSO_4^- + H_2O \rightleftharpoons H_3O^+ + SO_4^{2-}$	$K_2 = 1.1 \times 10^{-2}$	1.96
Sulfurous	$H_2SO_3 + H_2O \rightleftharpoons H_3O^+ + HSO_3^-$	$K_1 = 1.7 \times 10^{-2}$	1.77
	$HSO_3^- + H_2O \rightleftharpoons H_3O^+ + SO_3^{2-}$	$K_2 = 6.3 \times 10^{-8}$	7.2
Tellurous	$H_2TeO_3 + H_2O \rightleftharpoons H_3O^+ + HTeO_3^-$	$K_1 = 7.1 \times 10^{-7}$	6.15
	$HTeO_3^- + H_2O \rightleftharpoons H_3O^+ + TeO_3^{2-}$	$K_2 = 4.0 \times 10^{-9}$	8.40
Trichloroacetic	$CCl_3COOH + H_2O \rightleftharpoons H_3O^+ + CCl_3COO^-$	0.17	0.77
Trifluoroacetic	$CF_3COOH + H_2O \rightleftharpoons H_3O^+ + CF_3COO^-$	0.30	0.52

Taken from Hogfeldt, E. and Perrin, D. D., Stability Constants of Metal-Ion complexes, 1st ed. Oxford: New York: Pergamon, 1979-1982. International Union of Pure and Applied Chemistry Commission on Equilibrium Data.
Also from Serjeant, E. P. and Dempsey, B. (eds.), "Ionization Constants of Organic Acids in Aqueous Solution," IUPAC Chemical Data Series No. 23, Pergamon Press, Oxford, 1979.
†From Myers, R., Journal of Chemical Education, Vol. 63, 1986, pp. 687-690.

Ionization Constants for Select Bases

K_b determined at 25 °C.

Base	Formula and Ionization Equation	K_b	pK_b
Acetylide	$C_2H^- + H_2O \rightleftharpoons OH^- + C_2H_2$	1×10^{11}	-11
Amide	$NH_2^- + H_2O \rightleftharpoons OH^- + NH_3$	1×10^{20}	-20
Ammonia‡	$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH-$	1.77×10^{-5}	4.752
Aniline§	$C_6H_5NH_2 + H_2O \rightleftharpoons C_6H_5NH_3^+ + OH-$	3.9×10^{-10}	9.41
Dimethylamine§	$(CH_3)_2NH + H_2O \rightleftharpoons (CH_3)_2NH_2^+ + OH-$	5.8×10^{-4}	3.24
Ethoxide	$CH_3CH_2O^- + H_2O \rightleftharpoons OH^- + CH_3CH_2OH$	1×10^{2}	-2
Ethylenediamine	$(CH_2)_2(NH_2)_2 + H_2O \rightleftharpoons (CH_2)_2(NH_2)_2H^+ + OH-$	$K_1 = 7.8 \times 10^{-5}$	4.11
	$(CH_2)_2(NH_2)_2H^+ + H_2O \rightleftharpoons (CH_2)_2(NH_2)_2H_2^{2+} + OH-$	$K_2 = 2.1 \times 10^{-8}$	7.68
Hydrazine	$N_2H_4 + H_2O \rightleftharpoons N_2H_5^+ + OH-$	$K_1 = 1.2 \times 10^{-6}$	5.92
	$N_2H_5^+ + H_2O \rightleftharpoons N_2H_6^{2+} + OH-$	$K_2 = 1.3 \times 10^{-15}$	14.89
Hydride	$H^- + H_2O \rightleftharpoons OH^- + H_2$	1×10^{21}	-21
Hydroxylamine	$NH_2OH + H_2O \rightleftharpoons NH_3OH^+ + OH-$	9.3×10^{-9}	8.03
Methylamine	$CH_3NH_2 + H_2O \rightleftharpoons CH_3NH_3^+ + OH-$	5.0×10^{-4}	3.30
Pyridine	$C_5H_5N + H_2O \rightleftharpoons C_5H_5NH^+ + OH-$	1.6×10^{-9}	8.80
Trimethylamine§	$(CH_3)_3N + H_2O \rightleftharpoons (CH_3)_3NH^+ + OH-$	6.2×10^{-5}	4.21

Taken from Hogfeldt, E. and Perrin, D. D., Stability Constants of Metal-Ion complexes, 1st ed. Oxford: New York: Pergamon, 1979-1982. International Union of Pure and Applied Chemistry Commission on Equilibrium Data.

Also from Serjeant, E. P. and Dempsey, B. (eds.), "Ionization Constants of Organic Acids in Aqueous Solution," IUPAC Chemical Data Series No. 23, Pergamon Press, Oxford, 1979.

‡From Read, A. J., Journal of Solution Chemistry, Vol. 11, No. 9, 1982, pp. 649-664.

§From Meites, L., Ed. Handbook of Analytical Chemistry, 1st ed. New York: McGraw-Hill, 1963.