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Chromium(II)

The divalent state is unstable in water, producing hydrogen whilst being oxidised to a higher valency state (Baes and Mesmer, 1976). The reliability of the data is in doubt.

Reaction	NIST46	Ball and Nordstrom, 1988
$Cr^{2+} + H_2O = CrOH^+ + H^+$	–5.5	
$Cr(OH)_2(s) = Cr^{2+} + 2\ OH^-$		-17 ± 0.02

J.W. Ball and D.K. Nordstrom, Critical evaluation and selection of standard state thermodynamic properties for chromium metal and its aqueous ions, hydrolysis species, oxides and hydroxides. J. Chem. Eng. Data, 43, 895–918 (1998).

NIST46, NIST Critically Selected Stability Constants of Metal Complexes: Version 8.0. Available at: www.nist.gov/srd/nist46

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Chromium(III)

Reaction	Baes and Mesmer, 1976	Rai et al., 1987	Ball and Nordstrom, 1988	Brown and Ekberg, 2016
$Cr^{3+} + H_2O = CrOH^{2+} + H^+$	–4.0	-3.57 ± 0.08		-3.60 ± 0.07
$Cr^{3+} + 2\ H_2O = Cr(OH)_2^+ + 2\ H^+$	–9.7	–9.84		-9.65 ± 0.20
$Cr^{3+} + 3\ H_2O = Cr(OH)_3 + 3\ H^+$	–18	–16.19		-16.25 ± 0.19
$Cr^{3+} + 4\ H_2O = Cr(OH)_4^- + 4\ H^+$	–27.4	-27.65 ± 0.12		-27.56 ± 0.21
$2\ Cr^{3+} + 2\ H_2O = Cr_2(OH)_2^{4+} + 2\ H^+$	–5.06	–5.0		-5.29 ± 0.16
$3\ Cr^{3+} + 4\ H_2O = Cr_3(OH)_4^{5+} + 4\ H^+$	–8.15	-10.75 ± 0.15		-9.10 ± 0.14

$Cr(OH)_3(s) + 3\,H^+ = Cr^{3+} + 3\,H_2O$	12		9.35	9.41 ± 0.17
$Cr_2O_3(s) + 6\,H^+ = 2\,Cr^{3+} + 3\,H_2O$			8.52	
$CrO_{1.5}(s) + 3\,H^+ = Cr^{3+} + 1.5\,H_2O$				7.83 ± 0.10

C.F. Baes and R.E. Mesmer, The Hydrolysis of Cations. Wiley, New York, 1976.

J.W. Ball and D.K. Nordstrom, Critical evaluation and selection of standard state thermodynamic properties for chromium metal and its aqueous ions, hydrolysis species, oxides and hydroxides. J. Chem. Eng. Data, 43, 895–918 (1998).

P.L. Brown and C. Ekberg, Hydrolysis of Metal Ions. Wiley, 2016, pp. 541–555.

D.Rai, B.M. Sass and D.A Moore, Chromium(III) hydrolysis constants and solubility of chromium(III) hydroxide. Inorg. Chem. 26, 345-349 (1987); accepted in the critical compilation by J.W. Ball and D.K. Nordstrom, Critical evaluation and selection of standard state thermodynamic properties for chromium metal and its aqueous ions, hydrolysis species, oxides and hydroxides. J. Chem. Eng. Data, 43, 895–918 (1998).

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Chromium(VI)

Reaction	Baes and Mesmer, 1976	Ball and Nordstrom, 1998
$CrO_4^{2-} + H^+ = HCrO_4^-$	6.51	6.55 ± 0.04
$HCrO_4^- + H^+ = H_2CrO_4$	–0.20	
$CrO_4^{2-} + 2\ H^+ = H_2CrO_4$		6.31
$2\ HCrO_4^- = CrO_7^{2-} + H_2O$	1.52	
$2\ CrO_4^{2-} + 2\ H^+ = CrO_7^{2-} + H_2O$		14.7 ± 0.1

C.F. Baes and R.E. Mesmer, The Hydrolysis of Cations. Wiley, New York, 1976.

J.W. Ball and D.K. Nordstrom, Critical evaluation and selection of standard state thermodynamic properties for chromium metal and its aqueous ions, hydrolysis species, oxides and hydroxides. J. Chem. Eng. Data, 43, 895–918 (1998).