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THERMOCHEMICAL DATA OF SOLUTES

Standard thermochemical data for some solutes, either pure at 298 K and 100 kPa, or in infinitely dilute aqueous solution at 298 K, 100 kPa and extrapolated to 1 mol/L, including in the latter case the standard electrochemical data for the reduction reaction.

Solute (state)	Reaction of formation	h_f^\oplus kJ/mol	g_f^\oplus kJ/mol	s^\oplus J/(mol·K)	ϵ^\oplus V	$d\epsilon^\oplus/dT$ mV/K
Al ³⁺ (aq)	Al(s)=Al ³⁺ (aq)+3e ⁻	-531	-485	-322	-1.676	
C(s,gra.)	C(s,graphite)=C(s,graphite)	0	0	5.74		
C ₁₂ H ₂₂ O ₁₁ (aq)	C ₁₂ H ₂₂ O ₁₁ (s)=C ₁₂ H ₂₂ O ₁₁ (aq)		-13.5			
C ₁₂ H ₂₂ O ₁₁ (s)	12C(s)+11H ₂ (g)+ $\frac{11}{2}$ O ₂ (g)=C ₁₂ H ₂₂ O ₁₁ (s)	-2222	-1545	360		
Ca(OH) ₂ (s)	Ca(s)+O ₂ (g)+H ₂ (g)=Ca(OH) ₂ (s)	-986	-899	83		
Ca ²⁺ (aq)	Ca(s)=Ca ²⁺ (aq)+2e ⁻	-543	-553	-56	-2.866	-0.175
CaC ₂ (s)	Ca(s)+2C(s)=CaC ₂ (s)	-63	-68	70		
CaCl ₂ (s)	Ca(s)+Cl ₂ (g)=CaCl ₂ (s)	-796	-748	105		
CaCO ₃ (s)	Ca(s)+C(s)+(3/2)O ₂ (g)=CaCO ₃ (s)	-1207	-1129	93		
CaO(s)	Ca(s)+(1/2)O ₂ (g)=CaO(s)	-635	-604	40		
Cl ⁻ (aq)	(1/2)Cl ₂ (g)+e ⁻ =Cl ⁻ (aq)	-167	-131	56	1.360	-1.250
CO ₂ (aq)	C(s)+O ₂ (g)=CO ₂ (aq)	-414	-386	118		
CO ₂ (g)	C(s)+O ₂ (g)=CO ₂ (g)	-394	-394	214		
Cu ²⁺ (aq)	Cu(s)=Cu ²⁺ (aq)+2e ⁻	64.8	65.5	-99.6	0.337	
F ⁻ (aq)	(1/2)F ₂ (g)+e ⁻ =F ⁻ (aq)	-333	-279	-13.8	2.89	
Fe ²⁺ (aq)	Fe(s)=Fe ²⁺ (aq)+2e ⁻	-89	-79	-138	-0.440	
H ⁺ (aq)	(1/2)H ₂ (g)=H ⁺ (aq)+e ⁻	0	0	0	0	0
H ⁺ (g)	(1/2)H ₂ (g)=H ⁺ (g)+e ⁻	1536	1517	109		
H ₂ (aq)	H ₂ (g)=H ₂ (aq)	-4.2	17.6	58		
H ₂ (g)	H ₂ (g)=H ₂ (g)	0	0	131		
H ₂ O(l)	H ₂ (g)+(1/2)O ₂ (g)=H ₂ O(l)	-286	-237	70		
H ₂ O ₂ (aq)	H ₂ (g)+O ₂ (g)=H ₂ O ₂ (aq)	-191	-134	144		
H ₂ O ₂ (l)	H ₂ (g)+O ₂ (g)=H ₂ O ₂ (l)	-188	-120	110		
HCl(g)	(1/2)H ₂ (g)+(1/2)Cl ₂ (g)=HCl(g)	-92	-95	187		
K ⁺ (aq)	K(s)=K ⁺ (aq)+e ⁻	-252	-283	101	-2.925	-1.080
Li ⁺ (aq)	Li(s)=Li ⁺ (aq)+e ⁻	-278	-293	13.4	-3.045	
Mg ²⁺ (aq)	Mg(s)=Mg ²⁺ (aq)+2e ⁻	-467	-455	-138	-2.363	
N ₂ (aq)	N ₂ (g)=N ₂ (aq)					
N ₂ (g)	N ₂ (g)=N ₂ (g)	0	0	191.5		
Na(s)	Na(s)=Na(s)	0	0	51		
Na ⁺ (aq)	Na(s)=Na ⁺ (aq)+e ⁻	-240	-262	58	-2.714	-0.772
NaCl(s)	Na(s)+(1/2)Cl ₂ (g)=NaCl(s)	-411	-384	72		
NH ₃ (aq)	(1/2)N ₂ (g)+(3/2)H ₂ (g)=NH ₃ (aq)	-80.3	-26.5	111		
NH ₃ (g)	(1/2)N ₂ (g)+(3/2)H ₂ (g)=NH ₃ (g)	-46	-17	192		
NH ₄ ⁺ (aq)	(1/2)N ₂ (g)+2H ₂ (g)=NH ₄ ⁺ (aq)+e ⁻	-133	-79	113		
NH ₄ Cl(s)	(1/2)N ₂ (g)+2H ₂ (g)+(1/2)Cl ₂ (g)=NH ₄ Cl(s)	-314	-203	95		
NH ₄ NO ₃ (s)	N ₂ (g)+2H ₂ (g)+(3/2)O ₂ (g)=NH ₄ NO ₃ (s)	-366	-184	151		
O ₂ (aq)	O ₂ (g)=O ₂ (aq)	-11.7	16.4	111		
O ₂ (g)	O ₂ (g)=O ₂ (g)	0	0	205		
O ₃ (aq)	(3/2)O ₂ (g)=O ₃ (aq)	-12.1	16.3	111		
O ₃ (g)	(3/2)O ₂ (g)=O ₃ (g)	142.4	162.9	230.8	2.07	
OH ⁻ (aq)	(1/2)O ₂ (g)+(1/2)H ₂ (g)+e ⁻ =OH ⁻ (aq)	-230	-157	-10.8	2.8	

$\text{Pb}^{2+}(\text{aq})$	$\text{Pb}(\text{s})=\text{Pb}^{2+}(\text{aq})+2\text{e}^{-}$	-1.7	-24.4	10.5	-0.130
$\text{Zn}^{2+}(\text{aq})$	$\text{Zn}(\text{s})=\text{Zn}^{2+}(\text{aq})+2\text{e}^{-}$	-154	-147	-112	-0.763

Many other properties can be found in [Solution properties](#) for some special solutions: salt-water, sugar-water, alcohol-water, hydrogen peroxide-water, ammonia-water and carbon dioxide-water.

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