

TABLE 7-1 Activity coefficients for aqueous solutions at 25°C

Ion	Ion size (α, pm)	Ionic strength (μ, M)				
		0.001	0.005	0.01	0.05	0.1
Charge = ±1		Activity coefficient (γ)				
H ⁺	900	0.967	0.933	0.914	0.86	0.83
(C ₆ H ₅) ₂ CHCO ₂ [−] , (C ₃ H ₇) ₄ N ⁺	800	0.966	0.931	0.912	0.85	0.82
(O ₂ N) ₃ C ₆ H ₂ O [−] , (C ₃ H ₇) ₃ NH ⁺ , CH ₃ OC ₆ H ₄ CO ₂ [−]	700	0.965	0.930	0.909	0.845	0.81
Li ⁺ , C ₆ H ₅ CO ₂ [−] , HOC ₆ H ₄ CO ₂ [−] , ClC ₆ H ₄ CO ₂ [−] , C ₆ H ₅ CH ₂ CO ₂ [−] , CH ₂ =CHCH ₂ CO ₂ [−] , (CH ₃) ₂ CHCH ₂ CO ₂ [−] , (CH ₃ CH ₂) ₄ N ⁺ , (C ₃ H ₇) ₂ NH ₂ ⁺	600	0.965	0.929	0.907	0.835	0.80
Cl ₂ CHCO ₂ [−] , Cl ₃ CCO ₂ [−] , (CH ₃ CH ₂) ₃ NH ⁺ , (C ₃ H ₇)NH ₃ ⁺	500	0.964	0.928	0.904	0.83	0.79
Na ⁺ , CdCl ⁺ , ClO ₂ [−] , IO ₃ [−] , HCO ₃ [−] , H ₂ PO ₄ [−] , HSO ₃ [−] , H ₂ AsO ₄ [−] , Co(NH ₃) ₄ (NO ₂) ₂ ⁺ , CH ₃ CO ₂ [−] , ClCH ₂ CO ₂ [−] , (CH ₃) ₄ N ⁺ , (CH ₃ CH ₂) ₂ NH ₂ ⁺ , H ₂ NCH ₂ CO ₂ [−]	450	0.964	0.928	0.902	0.82	0.775
⁺ H ₃ NCH ₂ CO ₂ H, (CH ₃) ₃ NH ⁺ , CH ₃ CH ₂ NH ₃ ⁺	400	0.964	0.927	0.901	0.815	0.77
OH [−] , F [−] , SCN [−] , OCN [−] , HS [−] , ClO ₃ [−] , ClO ₄ [−] , BrO ₃ [−] , IO ₄ [−] , MnO ₄ [−] , HCO ₂ [−] , H ₂ citrate [−] , CH ₃ NH ₃ ⁺ , (CH ₃) ₂ NH ₂ ⁺	350	0.964	0.926	0.900	0.81	0.76
K ⁺ , Cl [−] , Br [−] , I [−] , CN [−] , NO ₂ [−] , NO ₃ [−]	300	0.964	0.925	0.899	0.805	0.755
Rb ⁺ , Cs ⁺ , NH ₄ ⁺ , Tl ⁺ , Ag ⁺	250	0.964	0.924	0.898	0.80	0.75
Charge = ±2		Activity coefficient (γ)				
Mg ²⁺ , Be ²⁺	800	0.872	0.755	0.69	0.52	0.45
CH ₂ (CH ₂ CH ₂ CO ₂ [−]) ₂ , (CH ₂ CH ₂ CH ₂ CO ₂ [−]) ₂	700	0.872	0.755	0.685	0.50	0.425
Ca ²⁺ , Cu ²⁺ , Zn ²⁺ , Sn ²⁺ , Mn ²⁺ , Fe ²⁺ , Ni ²⁺ , Co ²⁺ , C ₆ H ₄ (CO ₂ [−]) ₂ , H ₂ C(CH ₂ CO ₂ [−]) ₂ , (CH ₂ CH ₂ CO ₂ [−]) ₂	600	0.870	0.749	0.675	0.485	0.405
Sr ²⁺ , Ba ²⁺ , Cd ²⁺ , Hg ²⁺ , S ^{2−} , S ₂ O ₄ ^{2−} , WO ₄ ^{2−} , H ₂ C(CO ₂ [−]) ₂ , (CH ₂ CO ₂ [−]) ₂ , (CHOHCO ₂ [−]) ₂	500	0.868	0.744	0.67	0.465	0.38
Pb ²⁺ , CO ₃ ^{2−} , SO ₃ ^{2−} , MoO ₄ ^{2−} , Co(NH ₃) ₅ Cl ²⁺ , Fe(CN) ₅ NO ^{2−} , C ₂ O ₄ ^{2−} , Hcitrate ^{2−}	450	0.867	0.742	0.665	0.455	0.37
Hg ₂ ²⁺ , SO ₄ ^{2−} , S ₂ O ₃ ^{2−} , S ₂ O ₆ ^{2−} , S ₂ O ₈ ^{2−} , SeO ₄ ^{2−} , CrO ₄ ^{2−} , HPO ₄ ^{2−}	400	0.867	0.740	0.660	0.445	0.355
Charge = ±3		Activity coefficient (γ)				
Al ³⁺ , Fe ³⁺ , Cr ³⁺ , Sc ³⁺ , Y ³⁺ , In ³⁺ , lanthanides ^a	900	0.738	0.54	0.445	0.245	0.18
citrate ^{3−}	500	0.728	0.51	0.405	0.18	0.115
PO ₄ ^{3−} , Fe(CN) ₆ ^{3−} , Cr(NH ₃) ₆ ³⁺ , Co(NH ₃) ₆ ³⁺ , Co(NH ₃) ₅ H ₂ O ³⁺	400	0.725	0.505	0.395	0.16	0.095
Charge = ±4		Activity coefficient (γ)				
Th ⁴⁺ , Zr ⁴⁺ , Ce ⁴⁺ , Sn ⁴⁺	1 100	0.588	0.35	0.255	0.10	0.065
Fe(CN) ₆ ^{4−}	500	0.57	0.31	0.20	0.048	0.021

a. Lanthanides are elements 57–71 in the periodic table.
SOURCE: J. Kielland, J. Am. Chem. Soc. **1937**, 59, 1675.