

TABLE II  
INDIVIDUAL ACTIVITY COEFFICIENTS OF IONS IN WATER

Parameter	Total ionic concentration $\Gamma = \sum_{i=1}^s c_i z_i^2$								
	$10^3 a_1$	0.001	0.002	0.005	0.01	0.02	0.05	0.1	0.2
<b>Inorganic ions:</b>									
H <sup>+</sup>	9	0.975	0.967	0.950	0.933	0.914	0.88	0.86	0.83
Li <sup>+</sup>	6	.975	.965	.948	.929	.907	.87	.835	.80
Rb <sup>+</sup> , Cs <sup>+</sup> , NH <sub>4</sub> <sup>+</sup> , Tl <sup>+</sup> , Ag <sup>+</sup>	2.5	.975	.964	.945	.924	.898	.85	.80	.75
K <sup>+</sup> , Cl <sup>-</sup> , Br <sup>-</sup> , I <sup>-</sup> , CN <sup>-</sup> , NO <sub>2</sub> <sup>-</sup> , NO <sub>3</sub> <sup>-</sup>	3	.975	.964	.945	.925	.899	.85	.805	.755
OH <sup>-</sup> , F <sup>-</sup> , NCS <sup>-</sup> , NCO <sup>-</sup> , HS <sup>-</sup> , ClO <sub>3</sub> <sup>-</sup> , ClO <sub>4</sub> <sup>-</sup> , BrO <sub>3</sub> <sup>-</sup> , IO <sub>4</sub> <sup>-</sup> , MnO <sub>4</sub> <sup>-</sup>	3.5	.975	.964	.946	.926	.900	.855	.81	.76
Na <sup>+</sup> , CdCl <sup>+</sup> , ClO <sub>2</sub> <sup>-</sup> , IO <sub>3</sub> <sup>-</sup> , HCO <sub>3</sub> <sup>-</sup> , H <sub>2</sub> PO <sub>4</sub> <sup>-</sup> , HSO <sub>3</sub> <sup>-</sup> , H <sub>2</sub> AsO <sub>4</sub> <sup>-</sup> , [Co(NH <sub>3</sub> ) <sub>4</sub> (NO <sub>2</sub> ) <sub>2</sub> ] <sup>+</sup>	4-4.5	.975	.964	.947	.928	.902	.86	.82	.775
Hg <sub>2</sub> <sup>2+</sup> , SO <sub>4</sub> <sup>2-</sup> , S <sub>2</sub> O <sub>3</sub> <sup>2-</sup> , S <sub>2</sub> O <sub>6</sub> <sup>2-</sup> , S <sub>2</sub> O <sub>8</sub> <sup>2-</sup> , SeO <sub>4</sub> <sup>2-</sup> , CrO <sub>4</sub> <sup>2-</sup> , HPO <sub>4</sub> <sup>2-</sup>	4	.903	.867	.803	.740	.660	.545	.445	.355
Pb <sup>2+</sup> , CO <sub>3</sub> <sup>2-</sup> , SO <sub>3</sub> <sup>2-</sup> , MoO <sub>4</sub> <sup>2-</sup> , [Co(NH <sub>3</sub> ) <sub>5</sub> Cl] <sup>2+</sup> , [Fe(CN) <sub>5</sub> NO] <sup>2-</sup>	4.5	.903	.868	.805	.742	.665	.55	.455	.37
Sr <sup>2+</sup> , Ba <sup>2+</sup> , Ra <sup>2+</sup> , Cd <sup>2+</sup> , Hg <sup>2+</sup> , S <sup>2-</sup> , S <sub>2</sub> O <sub>4</sub> <sup>2-</sup> , WO <sub>4</sub> <sup>2-</sup>	5	.903	.868	.805	.744	.67	.555	.465	.38
Ca <sup>2+</sup> , Cu <sup>2+</sup> , Zn <sup>2+</sup> , Sn <sup>2+</sup> , Mn <sup>2+</sup> , Fe <sup>2+</sup> , Ni <sup>2+</sup> , Co <sup>2+</sup>	6	.905	.870	.809	.749	.675	.57	.485	.405
Mg <sup>2+</sup> , Be <sup>2+</sup>	8	.906	.872	.813	.755	.69	.595	.52	.45
PO <sub>4</sub> <sup>3-</sup> , [Fe(CN) <sub>6</sub> ] <sup>3-</sup> , [Cr(NH <sub>3</sub> ) <sub>6</sub> ] <sup>3+</sup> , [Co- (NH <sub>3</sub> ) <sub>6</sub> ] <sup>3+</sup> , [Co(NH <sub>3</sub> ) <sub>5</sub> H <sub>2</sub> O] <sup>3+</sup>	4	.796	.725	.612	.505	.395	.25	.16	.095
[Co(ethylenediamine) <sub>3</sub> ] <sup>3+</sup>	6	.798	.731	.620	.52	.415	.28	.195	.13
Al <sup>3+</sup> , Fe <sup>3+</sup> , Cr <sup>3+</sup> , Se <sup>3+</sup> , Y <sup>3+</sup> , La <sup>3+</sup> , In <sup>3+</sup> , Ce <sup>3+</sup> , Pr <sup>3+</sup> , Nd <sup>3+</sup> , Sm <sup>3+</sup>	9	.802	.738	.632	.54	.445	.325	.245	.18
[Fe(CN) <sub>6</sub> ] <sup>4-</sup>	5	.668	.57	.425	.31	.20	.10	.048	.021
[Co(S <sub>2</sub> O <sub>3</sub> )(CN) <sub>5</sub> ] <sup>4-</sup>	6	.670	.575	.43	.315	.21	.105	.055	.027
Th <sup>4+</sup> , Zr <sup>4+</sup> , Ce <sup>4+</sup> , Sn <sup>4+</sup>	11	.678	.588	.455	.35	.255	.155	.10	.065
[Co(SO <sub>3</sub> ) <sub>2</sub> (CN) <sub>4</sub> ] <sup>5-</sup>	9	.542	.43	.28	.18	.105	.045	.020	.009
<b>Organic ions:</b>									
HCOO <sup>-</sup> , H <sub>2</sub> citrate <sup>-</sup> , CH <sub>2</sub> NH <sub>3</sub> <sup>+</sup> , (CH <sub>3</sub> ) <sub>2</sub> NH <sub>2</sub> <sup>+</sup>	3.5	.975	.964	.946	.926	.900	.855	.81	.76
NH <sub>3</sub> +CH <sub>2</sub> COOH, (CH <sub>3</sub> ) <sub>3</sub> NH <sup>+</sup> , C <sub>2</sub> H <sub>5</sub> NH <sub>3</sub> <sup>+</sup>	4	.975	.964	.947	.927	.901	.855	.815	.77
CH <sub>3</sub> COO <sup>-</sup> , CH <sub>2</sub> ClCOO <sup>-</sup> , (CH <sub>3</sub> ) <sub>4</sub> N <sup>+</sup> , (C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> - NH <sub>2</sub> <sup>+</sup> , NH <sub>2</sub> CH <sub>2</sub> COO <sup>-</sup>	4.5	.975	.964	.947	.928	.902	.86	.82	.775
CHCl <sub>2</sub> COO <sup>-</sup> , CCl <sub>3</sub> COO <sup>-</sup> , (C <sub>2</sub> H <sub>5</sub> ) <sub>3</sub> NH <sup>+</sup> , (C <sub>3</sub> H <sub>7</sub> )NH <sub>3</sub> <sup>+</sup>	5	.975	.964	.947	.928	.904	.865	.83	.79
C <sub>6</sub> H <sub>5</sub> COO <sup>-</sup> , C <sub>6</sub> H <sub>4</sub> OHCOO <sup>-</sup> , C <sub>6</sub> H <sub>4</sub> ClCOO <sup>-</sup> , C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub> COO <sup>-</sup> , CH <sub>2</sub> =CHCH <sub>2</sub> COO <sup>-</sup> , (CH <sub>3</sub> ) <sub>2</sub> C-CHCOO <sup>-</sup> , (C <sub>2</sub> H <sub>5</sub> ) <sub>4</sub> N <sup>+</sup> , (C <sub>3</sub> H <sub>7</sub> ) <sub>2</sub> - NH <sub>2</sub> <sup>+</sup>	6	.975	.965	.948	.929	.907	.87	.835	.80
[OC <sub>6</sub> H <sub>2</sub> (NO <sub>2</sub> ) <sub>3</sub> ] <sup>-</sup> , (C <sub>3</sub> H <sub>7</sub> ) <sub>3</sub> NH <sup>+</sup> , CH <sub>3</sub> OC <sub>6</sub> H <sub>4</sub> - COO <sup>-</sup>	7	.975	.965	.948	.930	.909	.875	.845	.81
(C <sub>6</sub> H <sub>5</sub> ) <sub>2</sub> CHCOO <sup>-</sup> , (C <sub>3</sub> H <sub>7</sub> ) <sub>4</sub> N <sup>+</sup>	8	.975	.966	.949	.931	.912	.880	.85	.82
(COO) <sub>2</sub> <sup>2-</sup> , H citrate <sup>2-</sup>	4.5	.903	.867	.804	.741	.662	.55	.45	.36
H <sub>2</sub> C(COO) <sub>2</sub> <sup>2-</sup> , (CH <sub>2</sub> COO) <sub>2</sub> <sup>2-</sup> , (CHOHCOO) <sub>2</sub> <sup>2-</sup>	5	.903	.868	.805	.744	.67	.555	.465	.38
C <sub>6</sub> H <sub>4</sub> (COO) <sub>2</sub> <sup>2-</sup> , H <sub>2</sub> C(CH <sub>2</sub> COO) <sub>2</sub> <sup>2-</sup> , (CH <sub>2</sub> CH <sub>2</sub> - COO) <sub>2</sub> <sup>2-</sup>	6	.905	.870	.809	.749	.675	.57	.485	.405
[OOC(CH <sub>2</sub> ) <sub>6</sub> COO] <sup>2-</sup> , [OOC(CH <sub>2</sub> ) <sub>8</sub> COO] <sup>2-</sup> , Congo red anion <sup>2-</sup>	7	.906	.872	.812	.755	.685	.58	.50	.425
Citrate <sup>3-</sup>	5	.796	.728	.616	.51	.405	.27	.18	.115

As another test we have in Table III compared the experimental<sup>16</sup> mean activity coefficients for some strong electrolytes with those calculated from individual coefficients. The last four col-

umns represent: (1) author's Table II (formula 1, with calculated  $a_1$ -values); (2) author's approximate formulas; (3) Guggenheim's formula; and (4) Lewis and Randall's old tables.