THE SOLUBILITY OF THE CHLORIDE, THE BROMIDE, AND THE IODIDE OF LEAD, IN WATER, AT TEMPERATURES FROM 0° UPWARD.

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THE solubility of lead chloride at 25°, as given by von Ende,[1] is 38.8 milligram-molecules or 10.678 grams per liter of solution, and therefore somewhat higher in 1000 grams of water. Ditte[2] gives the solubility in 1000 grams of water as 8 grams at 0°, 11.8 at 20°, 17 at 40°, 21 at 55°, and 31 at 80°. The solubility was found to be higher at 20° than von Ende found it at 25°. According to Bell,[3] the solubility at 16.5° is 9.503 grams[4] in 1000 of water, while the solubility at the same temperature based on Ditte's results is about 11 grams in 1000 of water. The data on the solubility of the bromide and the iodide being even less satisfactory, the writer undertook to determine the solubility of these three salts at different temperatures from 0° upward. The purity of the salts used is attested by the results of analysis given later. Very pure water, such as is used in electric conductivity work, was employed.

The saturated solutions were prepared by making approximately saturated solutions at a higher temperature (generally by 10°) than the one at which the solubility was to be determined, and then placing these solutions in a bath at the desired temperature for about six hours. The considerable quantity of larger crystals which always formed over the smaller crystals left undissolved in the bottom of the flask, served to show that the solutions had really been supersaturated with respect to the temperature of measurement. The flasks used for making the solutions had a capacity of 250 cc. and were immersed to the lip in the bath and stoppered. From these, calibrated glass-stoppered flasks (capacity 100 cc.) which were brought to the working temperature by weighing and immersing in the bath, were filled to a point slightly above the mark by means of a siphon and rubber bulb. After a few minutes,

[1] *Ztschr. anorg. Chem.*, **26**, 134 (1901).

[2] *Compt. Rend.*, **92**, 718.

[3] *Chem. News*, **16**, 69.

[4] A saturated solution of lead chloride contains 0.9414 per cent. of the salt at 16.5°, is the substance of Bell's statement.

the solutions were carefully brought to the mark by means of a pipette. The flasks and their contents were then rapidly brought to the temperature of the room, dried and weighed, after which the solutions were transferred to weighed platinum dishes, evaporated and then dried at 180° for several hours. The evaporation proved very tedious, owing to the fact that on the surface of the solutions there collected a very thin film of crystals through which burst gas bubbles rising from the bottom of the dishes, thus causing a small amount of the salt to be thrown out, which could be prevented only by very frequent stirring until the solutions were from one-half to three-fourths evaporated.

The measuring flasks were calibrated either at 20° or 25°, and at all other temperatures corrections were made for either expansion or contraction. Each weight of solution was reduced to weight *in vacuo,* while the weight of the salt was not, the correction amounting at most to only 0.2 milligram. The data were reduced to solubility in grams and milligram-molecules per liter of solution and to grams and milligram-molecules per 100 grams of water. The densities compared with water at 4° C. were also calculated.

The flasks chosen for measuring the solutions had necks of such diameter that a length of 10 mm. had a capacity of about 0.6 gram of water at 25° or 6 milligrams per 0.1 mm., so that the meniscus could be adjusted to ± 10 milligrams or 1 part in 10,000 for water, and to a but slightly larger quantity for the solutions, whose densities did not differ much from the density of water.

Below 45° the temperatures were maintained within less than 0.1°, for 45° and 55° to about 0.1°, for 65° and 80° within 0.2°, and for 95° within 0.3°, the correct temperature being determined by means of a standardized instrument, whose 0° and 100° points had not measurably altered since the standardizing.

ANALYSIS OF SALTS.

	Gram.
Lead chloride taken	0.3848
Silver chloride obtained	0.3970
Silver chloride calculated	0.3971
Lead bromide taken	0.4468
Silver bromide obtained	0.4572
Silver bromide calculated	0.4576
Lead iodide taken	0.2462
Silver iodide obtained	0.2507
Silver iodide calculated	0.2510

TABLE I.—SOLUBILITY OF LEAD CHLORIDE IN MILLIGRAM-MOLECULES.

Temperature.	Milligram-molecule per 100 cc. solution.		Milligram-molecule per 100 grams water.		Density referred to water at 0°.	
0°	2.428	....	2.428	....	1.00666	....
0°	2.415	2.421	2.415	2.421	1.00665	1.00665
15°	3.266	....	3.273	....	1.00695	....
15°	3.264	3.265	3.271	3.272	1.00691	1.00693
25°	3.878	....	3.905	....	1.00726	....
25°	3.887	3.882[1]	3.901	3.903	1.00724	1.00725
35°	4.734	....	4.768	....	1.00602	....
35°	4.732	4.733	4.766	4.767	1.00598	1.00600
45°	5.580	....	5.646	....	1.00417	....
45°	5.578	5.579	5.642	5.644	1.00429	1.00423
55°	6.484	....	6.553	....	1.00206	....
55°	6.488	6.486	6.594	6.573	1.00195	1.00200
65°	7.498	....	7.655	....	0.99938	....
65°	7.482	7.490	7.647	7.651	0.99928	0.99933
80°	9.149	....	9.439	....	0.99465	....
80°	9.152	9.150	9.440	9.439	0.99484	0.99474
95°	10.931	....	11.395	....	0.98962	....
95°	10.922	10.926	11.393	11.394	0.98921	0.98941
100°[2]	....	11.52	....	12.01	....	....

TABLE II.—SOLUBILITY OF LEAD BROMIDE IN MILLIGRAM-MOLECULES.

Temperature.	Milligram-molecule per 100 cc. of solution.		Milligram-molecule per 100 grams of water.		Density referred to water at 0°.	
0°	1.242	....	1.242	....	1.00435	....
0°	1.241	1.241	1.241	1.241	1.00431	1.00433
15°	1.990	....	1.991	....	1.00525	....
15°	1.985	1.987	1.988	1.989	1.00536	1.00530
25°	2.648	....	2.658	....	1.00617	....
25°	2.644	2.646[3]	2.652	2.655	1.00599	1.00608
35°	3.589	....	3.615	....	1.00587	....
35°	3.566	3.577	3.592	3.603	1.00609	1.00598
45°	4.704	....	4.758	....	1.00601	....
45°	4.706	4.705	4.763	4.760	1.00586	1.00593
55°	5.743	....	5.840	....	1.00449	....
55°	5.719	5.731	5.814	5.827	1.00461	1.00455
65°	6.870	....	7.027	....	1.00284	....
65°	6.849	6.859	7.006	7.016	1.00281	1.00282
80°	8.812	....	9.107	....	1.00000	....
80°	8.826	8.819	9.120	9.113	1.00007	1.00003
95°	11.387	....	11.890	....	0.99948	....
95°	11.386	11.386	11.890	11.890	0.99945	0.99946
100°[4]	....	12.40	....	12.94	....	....

[1] Von Ende, 38.8 per liter.
[2] By extrapolation, see Fig. 1.
[3] Von Ende, 26.28 per liter.
[4] By extrapolation, see Fig. 1.

TABLE III.—SOLUBILITY OF LEAD IODIDE IN MILLIGRAM-MOLECULES.

Temperature.	Milligram-molecule per 100 cc. of solution.		Milligram-molecule per 100 grams of water.		Density referred to water at 0°.	
0°	0.096	....	0.096	....	1.00057	....
0°	0.096	0.096	0.096	0.096	1.00055	1.00056
15°	0.132	....	0.132	....	0.99982	....
15°	0.134	0.133	0.134	0.133	0.99984	0.99983
25°	0.166	....	0.166	....	0.99801	....
25°	0.165	0.165[1]	0.165	0.166	0.99795	0.99798
35°	0.224	....	0.225	....	0.99498	....
35°	0.225	0.224	0.227	0.226	0.99518	0.99508
45°	0.313	....	0.316	....	0.99158	....
45°	0.312	0.312	0.315	0.315	0.99149	0.99153
55°	0.374	....	0.380	....	0.98729	....
55°	0.374	0.374	0.382	0.381	0.98717	0.98723
65°	0.465	....	0.474	....	0.98264	....
65°	0.464	0.464	0.473	0.473	0.98272	0.98268
80°	0.636	....	0.655	....	0.97450	....
80°	0.639	0.637	0.657	0.656	0.97454	0.97452
95°	0.829	....	0.860	....	0.96689	....
95°	0.827	0.828	0.858	0.859	0.96730	0.96709
100°[2]	....	0.895	....	0.927	....	....

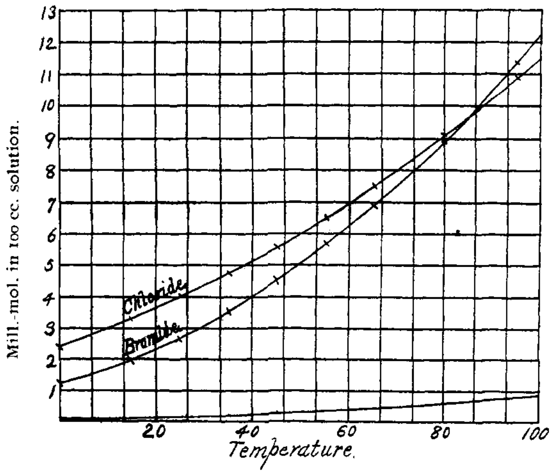

Fig. 1.

A comparison of the data in the three foregoing tables will at once show that the solubility curves based on milligram-molecules in 100 cc. of solution and those based on milligram-molecules in 100 grams of water will be similar, the latter turning a little far-

[1] Von Ende, 1.59 per liter.

[2] By extrapolation, see Fig. 1.

ther away from the temperature axis than the former; it was consequently deemed sufficient to draw the curves for the former. Either the data or the curves show that at the lower temperatures the molecular solubility of the bromide is less than that of the chloride, but that the solubility of the former increases more rapidly with the temperature than does that of the latter, and that the solubilities are the same between 80° and 95°. The curves show that the temperature of common solubility is 88.5° and the solubility 10.15 milligram-molecules. The solubility of the iodide is decidedly less than that of either of the other salts, not reaching, even at 100°, the same value as that of the bromide at 0°.

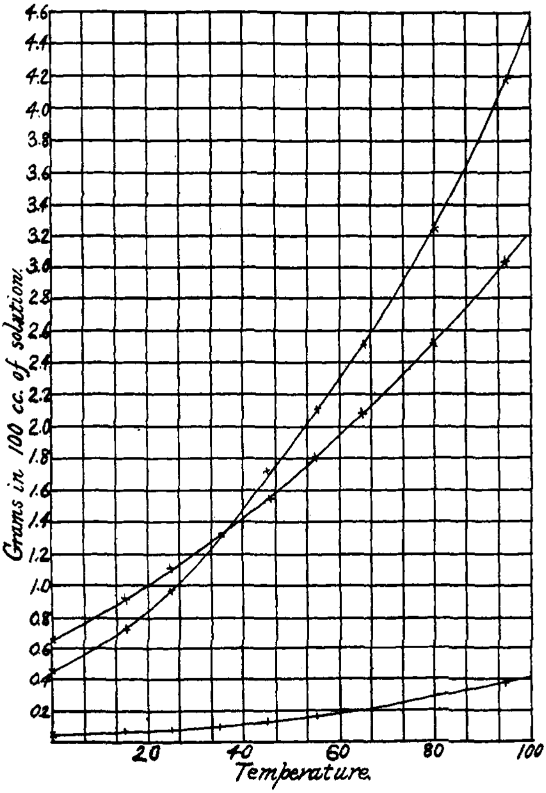

Fig. 2.

TABLE IV.—SOLUBILITY BY WEIGHT.

Temperature.	Chloride. Grams in 100 cc. solution.	Chloride. Grams in 100 grams water	Bromide. Grams in 100 cc. solution.	Bromide. Grams in 100 grams water.	Iodide. Grams in 100 cc. solution.	Iodide. Grams in 100 grams water.
0°	0.6728	0.6728	0.4554	0.4554	0.0442	0.0442
15°	0.9070	0.9090	0.7285	0.7305	0.0613	0.0613
25°	1.0786	1.0842	0.9701	0.9744	0.0762	0.0764
35°	1.315	1.3244	1.3124	1.3220	0.1035	0.1042
45°	1.5498	1.5673	1.7259	1.7457	0.1440	0.1453
55°	1.8019	1.8263	2.1024	2.1376	0.1726	0.1755
65°	2.0810	2.1265	2.5161	2.5736	0.2140	0.2183
80°	2.5420	2.6224	3.2350	3.3430	0.2937	0.3023
95°	3.0358	3.1654	4.1767	4.3613	0.3814	0.3960
100°[1]	3.208	3.342	4.550	4.751	0.420	0.436

At 0° the solubility of the chloride by weight is about one and one-half times that of the bromide; at 35°, their solubilities are practically equal and at 95° that of the chloride is about three-fourths of that of the bromide.

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THE CARBOHYDRATE GROUP IN THE PROTEIN MOLECULE.[2]

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IT HAS been known for some time that certain complex substances found in animal organisms, when decomposed with acids, yielded protein and carbohydrate bodies, together with other products. These substances, known as mucins, mucoids, chondroproteids, nucleins, hyalogen substances, etc., are generally regarded as compounds in which the protein is united with some other complex organic group of which this carbohydrate is a part. Although several investigators long ago suggested the possible presence of a carbohydrate group in the protein molecule proper, no evidence of weight supported this view until Pavy,[3] by hydrolyzing coagulated ovalbumin, obtained a solution from which he prepared an osazone with a melting-point near that of glucosazone. In consequence of this discovery, Pavy concluded that his investigations brought "the extensive group of proteids of both the animal and vegetable kingdoms of nature into the class of glucosides."

This announcement of Pavy's led to numerous investigations

1 By extrapolation, see Fig. 2.

2 From the laboratory of the Connecticut Agricultural Experiment Station.

3 "Physiology of the Carbohydrates."