

## Copper(I) Oxide

<b>COMPONENTS:</b> (1) Copper(I) oxide; Cu <sub>2</sub> O; [1317-39-1] (2) Sea Water		<b>ORIGINAL MEASUREMENTS:</b> Ferry, J. D.; Carritt, D. E. <i>Ind. Eng. Chem.</i> <u>1946</u> , <u>38</u> , 612-7.	
<b>VARIABLES:</b> pH of the sea water at 25°C.		<b>PREPARED BY:</b> T. P. Dirkse	
<b>EXPERIMENTAL VALUES:</b> Solubility of Cu <sub>2</sub> O in oxygen-free sea water at 25°C.			
pH	$10^4 C_{Cu} / \text{mol dm}^{-3}$	pH	$10^4 C_{Cu} / \text{mol dm}^{-3}$
7.11	8.35 <sup>e</sup>	8.51	0.26 <sup>d</sup>
7.40	3.26 <sup>b</sup>	8.56	0.29 <sup>d</sup>
7.70	2.34 <sup>b</sup>	8.60	0.22 <sup>a</sup>
7.80	1.73 <sup>c</sup>	8.73	0.14 <sup>a</sup>
8.12	0.74 <sup>c</sup>	8.88	0.11 <sup>a</sup>
8.12	1.57 <sup>a</sup>	8.92	0.19 <sup>a</sup>
8.46	0.49 <sup>d</sup>	8.96	0.14 <sup>a</sup>
<sup>a</sup> CO <sub>2</sub> was removed from the sea water by flushing with nitrogen.			
<sup>b</sup> HCl was added to the sea water and the pH was adjusted by adding NaOH.			
<sup>c</sup> gaseous CO <sub>2</sub> was added to the sea water after it was deaerated.			
<sup>d</sup> Same as in c except that the nitrogen was treated to remove all traces of oxygen.			
<sup>e</sup> Same as in d, except the Cu <sub>2</sub> O was painted on to a solid surface.			
The following equation fits the data in the Table:			
$\log C_{Cu} = 4.03 - \text{pH}$ .			
<b>AUXILIARY INFORMATION</b>			
<b>METHOD/APPARATUS/PROCEDURE:</b> Cu <sub>2</sub> O was placed in a vessel that had been evacuated and then filled with N <sub>2</sub> . Air-free sea water was forced into the vessel under nitrogen pressure. The mixtures were agitated at 25°C. After equilibration the mixtures were filtered and the pH of the filtrate was quickly measured with a glass electrode. After the cuprous copper had been air oxidized its concentration was determined colorimetrically with sodium diethyldithiocarbamate (1).	<b>SOURCE AND PURITY OF MATERIALS:</b> The Cu <sub>2</sub> O was an electrolytic preparation. Nothing is said about the composition or source of the sea water.		
		<b>ESTIMATED ERROR:</b> No details are given.	
	<b>REFERENCES:</b> 1. Ketchum, B. H.; Ferry, J. D.; Redfield, A. C.; Burns, A. E. <i>Ind. Eng. Chem.</i> <u>1945</u> , <u>37</u> , 456.		

### The Solid Phase

The definition of solubility permits the occurrence of a single solid phase which may be a pure anhydrous compound, a salt hydrate, a non-stoichiometric compound, or a solid mixture (or solid solution, or "mixed crystals"), and may be stable or metastable. As well, any number of solid phases consistent with the requirements of the phase rule may be present. Metastable solid phases are of widespread occurrence, and may appear as polymorphic (or allotropic) forms or crystal solvates whose rate of transition to more stable forms is very slow. Surface heterogeneity may also give rise to metastability, either when one solid precipitates on the surface of another, or if the size of the solid particles is sufficiently small that surface effects become important. In either case, the solid is not in stable equilibrium with the solution. The stability of a solid may also be affected by the atmosphere in which the system is equilibrated.

Many of these phenomena require very careful, and often prolonged, equilibration for their investigation and elimination. A very general analytical method, the "wet residues" method of Schreinemakers (12) (see a text on physical chemistry) is usually used to investigate the composition of solid phases in equilibrium with salt solutions. In principle, the same method can be used with systems of other types. Many other techniques for examination of solids, in particular X-ray, optical, and thermal analysis methods, are used in conjunction with chemical analyses (including the wet residues method).

### COMPILATIONS AND EVALUATIONS

The formats for the compilations and critical evaluations have been standardized for all volumes. A brief description of the data sheets has been given in the FOREWORD; additional explanation is given below.

#### Guide to the Compilations

The format used for the compilations is, for the most part, self-explanatory. The details presented below are those which are not found in the FOREWORD or which are not self-evident.

**Components.** Each component is listed according to IUPAC name, formula, and Chemical Abstracts (CA) Registry Number. The formula is given either in terms of the IUPAC or Hill (13) system and the choice of formula is governed by what is usual for most current users: i.e. IUPAC for inorganic compounds, and Hill system for organic compounds. Components are ordered according to:

- (a) saturating components;
- (b) non-saturating components in alphanumerical order;
- (c) solvents in alphanumerical order.

The saturating components are arranged in order according to a 18-column, 2-row periodic table:

Columns 1,2: H, groups IA, IIIA;  
 3,12: transition elements (groups IIIB to VIIB, group VIII,  
 groups IB, IIB);  
 13-18: groups IIIA-VIIA, noble gases.

Row 1: Ce to Lu;

Row 2: Th to the end of the known elements, in order of atomic number. Salt hydrates are generally not considered to be saturating components since most solubilities are expressed in terms of the anhydrous salt. The existence of hydrates or solvates is carefully noted in the texts, and CA Registry Numbers are given where available, usually in the critical evaluation. Mineralogical names are also quoted, along with their CA Registry Numbers, again usually in the critical evaluation.

**Original Measurements.** References are abbreviated in the forms given by Chemical Abstracts Service Source Index (CASSI). Names originally in other than Roman alphabets are given as transliterated by Chemical Abstracts.

**Experimental Values.** Data are reported in the units used in the original publication, with the exception that modern names for units and quantities are used; e.g., mass per cent for weight per cent; mol dm<sup>-3</sup> for molar; etc. Both mass and molar values are given. Usually, only one type of value (e.g., mass per cent) is found in the original paper, and the compiler has added the other type of value (e.g., mole per cent) from computer calculations based on 1976 atomic weights (14). Errors in calculations and fitting equations in original papers have been noted and corrected, by computer calculations where necessary.

**Method. Source and Purity of Materials.** Abbreviations used in Chemical Abstracts are often used here to save space.

**Estimated Error.** If these data were omitted by the original authors, and if relevant information is available, the compilers have attempted to

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Copper(I) oxide; Cu <sub>2</sub> O; [1317-39-1] (2) Baltic Sea water.	Ragg, M. Farbe u. Lack <u>1950</u> , 56, 435-41.
VARIABLES:	PREPARED BY:
None.	T. P. Dirkse

## EXPERIMENTAL VALUES:

The solubility of Cu<sub>2</sub>O in Baltic Sea water is given as 0.6 mg dm<sup>-3</sup>. This appears to be the weight of Cu and not of Cu<sub>2</sub>O in the solution, but this is not stated specifically. This amounts to 9.4 × 10<sup>-6</sup> mol dm<sup>-3</sup><sup>a</sup>.

No temperature is stated. The author deals with the solubility of different heavy-metal compounds that are used in marine anti-fouling paints. Some of these solubility values are given at 18°C and others at 15°C, so the solubility value for Cu<sub>2</sub>O is probably one or the other of these temperatures.

The pH of the Baltic Sea water was given as 8.1 for other solubility values. It appears that the Baltic Sea water used for the Cu<sub>2</sub>O solubility determination was at the same pH.

<sup>a</sup> Calculated by the compiler.

## AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:	SOURCE AND PURITY OF MATERIALS:
Cu <sub>2</sub> O was added to the filtered Baltic Sea water and the mixture was shaken for several hours--until saturation. The liquid phase was filtered from the solid phase. The analytical method to determine copper is not described, but later in the article a rather complete description is given of a colorimetric method using dithizone.	No information is given.
	ESTIMATED ERROR:
	No details are given.
	REFERENCES:

estimate errors from the internal consistency of data and type of apparatus used. Methods used by the compilers for estimating and reporting errors are based on the papers by Ku and Eisenhart (15).

*Comments and/or Additional Data.* Many compilations include this section which provides short comments relevant to the general nature of the work or additional experimental and thermodynamic data which are judged by the compiler to be of value to the reader.

*References.* See the above description for Original Measurements.

#### Guide to the Evaluations

The evaluator's task is to check whether the compiled data are correct, to assess the reliability and quality of the data, to estimate errors where necessary, and to recommend "best" values. The evaluation takes the form of a summary in which all the data supplied by the compiler have been critically reviewed. A brief description of the evaluation sheets is given below.

*Components.* See the description for the Compilations.

*Evaluator.* Name and date up to which the literature was checked.  
*Critical Evaluation*

(a) Critical text. The evaluator produces text evaluating all the published data for each given system. Thus, in this section the evaluator review the merits or shortcomings of the various data. Only published data are considered; even published data can be considered only if the experimental data permit an assessment of reliability.

(b) Fitting equations. If the use of a smoothing equation is justifiable, the evaluator may provide an equation representing the solubility as a function of the variables reported on all the compilation sheets.

(c) Graphical summary. In addition to (b) above, graphical summaries are often given.

(d) Recommended values. Data are recommended if the results of at least two independent groups are available and they are in good agreement, and if the evaluator has no doubt as to the adequacy and reliability of the applied experimental and computational procedures. Data are reported as tentative if only one set of measurements is available, or if the evaluator considers some aspect of the computational or experimental method as mildly undesirable but estimates that it should cause only minor errors. Data are considered as doubtful if the evaluator considers some aspect of the computational or experimental method as undesirable but still considers the data to have some value in those instances where the order of magnitude of the solubility is needed. Data determined by an inadequate method or under ill-defined conditions are rejected. However references to these data are included in the evaluation together with a comment by the evaluator as to the reason for their rejection.

(e) References. All pertinent references are given here. References to those data which, by virtue of their poor precision, have been rejected and not compiled are also listed in this section.

(f) Units. While the original data may be reported in the units used by the investigators, the final recommended values are reported in S.I. units (1,16) when the data can be accurately converted.

#### References

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13. Hill, E.A. J. Am. Chem. Soc. 1900, 22, 478.
14. IUPAC Commission on Atomic Weights. Pure Appl. Chem., 1976, 47, 75.

## Copper(I) Oxide

<b>COMPONENTS:</b> (1) Copper(I) oxide; Cu <sub>2</sub> O; [1317-39-1] (2) Water; H <sub>2</sub> O; [7732-18-5]		<b>ORIGINAL MEASUREMENTS:</b> Pocock, F. J.; Stewart, J. F. <i>J. Eng. Power</i> <u>1963</u> , 85, 33-45.	
<b>VARIABLES:</b> Temperature and pressure of the steam.		<b>PREPARED BY:</b> T. P. Dirkse	
<b>EXPERIMENTAL VALUES:</b>			
Solubility of Cu <sub>2</sub> O in supercritical steam.			
pH	temp/oF <sup>a</sup>	Pressure/psig	C <sub>Cu</sub> /ppb
7.5	1148	4500	9.1
7.7	1147	4500	7.7
7.6	1152	4500	9.9
9.6	1155	4500	11.5
9.6	1149	4500	11.5
9.6	1144	4500	7.7
9.6	1149	2700	0.3
9.6	1147	3900	4.7
9.6	1118	3300	2.8
<sup>a</sup> Average temperature during the course of the experiment.			
During these experiments some of the Cu <sub>2</sub> O was reduced to Cu.			
<b>AUXILIARY INFORMATION</b>			
<b>METHOD/APPARATUS/PROCEDURE:</b> Five grams of Cu <sub>2</sub> O was placed on each of six trays in an autoclave. Supercritical steam was passed through the autoclave at a rate sufficient to insure saturation equilibrium. Sampling was continued for about 3 hours. Blanks were run to measure the amount of copper extracted from the stainless steel of the autoclave. The analytical method used to determine copper content is not mentioned or described.	<b>SOURCE AND PURITY OF MATERIALS:</b> Cu <sub>2</sub> O was reagent-grade quality. It was pelletized and sintered at 1850°F under a helium atmosphere, then crushed, screened and washed to remove fines. The feedwater was demineralized and deaerated. NH <sub>4</sub> OH was introduced to raise the pH.		
		<b>ESTIMATED ERROR:</b> No details are given.	
	<b>REFERENCES:</b>		

15. Ku, H.H., p. 73; Eisenhart, C., p. 69; in Ku, H.H., ed. *Precision Measurement and Calibration*. NBS Special Publication 300. Vol. 1. Washington. 1969.
16. *The International System of Units*. Engl. transl. approved by the BIPM of *Le Système International d'Unités*. H.M.S.O. London. 1970.

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<b>COMPONENTS:</b> (1) Copper(II) oxide; CuO; [1317-38-0] (2) Water; H <sub>2</sub> O; [7732-18-5]	<b>ORIGINAL MEASUREMENTS:</b> Remy, H.; Kuhlmann, A. Z. Anal. Chem. <u>1924</u> , 65, 161-81.	
<b>VARIABLES:</b> Method of measuring solubility of CuO in water.	<b>PREPARED BY:</b> T. P. Dirkse	
<b>EXPERIMENTAL VALUES:</b>		
	Solubility of CuO in water.	
Method	$c_{\text{CuO}}/\text{mg dm}^{-3}$	$c_{\text{CuO}}/\text{mol dm}^{-3}$
conductimetric titration	5.46	$6.86 \times 10^{-5}$
specific conductance	5.39	$6.77 \times 10^{-5}$
<p>One of the purposes of this work was to devise a method to correct the measured specific conductance for the presence of CO<sub>2</sub>. A Table was constructed to give these corrections for various conditions. The specific conductance was measured at 19.2°C, but was corrected to 18°C to calculate the solubility of CuO. Because of these corrections, the solubility determined from specific conductance measurements must be considered the less accurate of these two values.</p> <p>The solubility value determined from a conductimetric titration has the disadvantage that small volumes and dilute solutions were used. There is at least a 1% uncertainty in these values.</p>		
AUXILIARY INFORMATION		
<b>METHOD/APPARATUS/PROCEDURE:</b> Hot CuO was added to conductivity water. The mixture was shaken, and after shaking for about 3 hours the electrical conductivity became constant. The specific conductance was measured, corrected for the presence of CO <sub>2</sub> , and the solubility of CuO was calculated from this value and the accepted literature values for individual ionic conductances. The above saturated solution was filtered and subjected to a conductimetric titration. The solution was first titrated with dilute H <sub>2</sub> SO <sub>4</sub> and then back titrated with dilute KOH. From these values, the OH <sup>-</sup> ion content and the solubility of CuO were calculated.	<b>SOURCE AND PURITY OF MATERIALS:</b> Conductivity water was used. The CuO was prepared by dissolving recrystallized pure Cu(NO <sub>3</sub> ) <sub>2</sub> in conductivity water, adding NH <sub>4</sub> OH, carefully washing the precipitate, and then heating the precipitate.  <b>ESTIMATED ERROR:</b> No details are given. The temperature varied from 19.0 to 21.3°C during the measurements.  <b>REFERENCES:</b>	

## Copper(II) Oxide and Hydroxide

<b>COMPONENTS:</b> (1) Copper(II) oxide; CuO; [1317-38-0] (2) Baltic Sea water.	<b>ORIGINAL MEASUREMENTS:</b> Ragg, M. Farbe u. Lack <u>1950</u> , 56, 435-41.
<b>VARIABLES:</b> None.	<b>PREPARED BY:</b> T. P. Dirkse
<b>EXPERIMENTAL VALUES:</b>	
<p>The solubility of CuO in Baltic Sea water is <math>0.08 \text{ mg dm}^{-3}</math>, i.e., <math>1.3 \times 10^{-6} \text{ mol dm}^{-3}</math><sup>a</sup>. The weight is that of copper and not of the oxide.</p> <p>The article also gives solubility values for other compounds that are used in marine anti-fouling paints. The solubilities of these compounds is expressed as the weight of the metal <math>\text{dm}^{-3}</math>. For some of these other determinations the pH of the Baltic Sea water was 8.1, for some the temperature was 15°C, for others it was 18°C. Nothing specific is said about the temperature and the pH of the Baltic Sea water in which the solubility of CuO was measured.</p>	
<p><sup>a</sup> Calculated by the compiler.</p>	
<b>AUXILIARY INFORMATION</b>	
<b>METHOD/APPARATUS/PROCEDURE:</b>  One-half gram of CuO was added to filtered Baltic Sea water and the mixture was shaken for several hours until equilibrium was attained. After filtration, the copper content of the filtrate was determined, but the analytical method is not described. The temperature was probably either 15 or 18°C.	<b>SOURCE AND PURITY OF MATERIALS:</b>  No indication is given.
	<b>ESTIMATED ERROR:</b>  No details are given.
	<b>REFERENCES:</b>  

<b>COMPONENTS:</b> (1) Copper(II) oxide; CuO; [1317-38-0] (2) Water; H <sub>2</sub> O; [7732-18-5]	<b>ORIGINAL MEASUREMENTS:</b> Pocock, F. J.; Stewart, J. F. <i>J. Eng. Power</i> <u>1963</u> , 85, 33-45.
<b>VARIABLES:</b> Temperature and pressure of the steam.	<b>PREPARED BY:</b> T. P. Dirkse
<b>EXPERIMENTAL VALUES:</b> Solubility of CuO in supercritical steam, pH = 7.5	

Pressure/psig	temp/°F <sup>a</sup>	C <sub>Cu</sub> /ppb
4500	1090	2.4
4500	994	5.8
1850	907	0.5
1850	931	-0.4 <sup>b</sup>
2700	1006	2.9
3200	1053	2.9
4500	1153	18.4
4500	1143	15.2
1850	911	0.9
4500	1035	6.2
4500	1068	6.3
4500	1005	8.2
4500	976	11.5
4500	1152	12.3
3900	1136	11.3
4500	963	11.8
4500	1150	15.6
2700	1134	3.3

<sup>a</sup> Average temperature during the entire procedure.

<sup>b</sup> The authors suspect the blank correction was too large.

#### AUXILIARY INFORMATION

<b>METHOD/APPARATUS/PROCEDURE:</b> Samples of CuO were placed in a stainless steel autoclave and the superheated steam was passed through the autoclave at the desired pressure. Sampling was continued until 3 liters of condensate had passed through the sample. This required 2.5 to 3 hours. Blank runs were made to measure the amount of copper extracted from the metal in the apparatus under the test conditions. The method used to determine copper content is not mentioned. Additional runs were made to ensure that equilibrium conditions had been attained.	<b>SOURCE AND PURITY OF MATERIALS:</b> CuO was a reagent grade material that was washed with deionized water to free it of fines. The feedwater was demineralized and deaerated. Some NH <sub>4</sub> OH was added to raise the pH.
	<b>ESTIMATED ERROR:</b> No details are given
	<b>REFERENCES:</b>

## Copper(II) Oxide and Hydroxide

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Copper(II) oxide; CuO, [1317-38-0] (2) Water; H <sub>2</sub> O; [7732-18-5]	Pocock, F. J.; Stewart, J. F. <i>J. Eng. Power</i> <u>1963</u> , 85, 33-45.

## EXPERIMENTAL VALUES:

Solubility of CuO in supercritical steam, pH ~ 9.5.

Pressure/psig	temp/oF <sup>a</sup>	C <sub>Cu</sub> /ppb
1750	904	-1.5 <sup>b</sup>
2700	1015	1.1
3200	1033	4.0
2700	1135	4.2
3300	1161	12.9
4500	1164	17.1
4500	1144	15.1
4500	1159	17.0
4500	1007	23.0
4500	1053	21.1
4500	927	14.9
4500	1012	15.9
2700	1158	5.4
4500	1126	17.6
4500	898	18.4
4500	1063	13.0
4500	1089	20.2

<sup>a</sup> Average temperature during the procedure.<sup>b</sup> This is considered to be due to too large a blank correction.

After the experiments had been concluded, an X-ray diffraction pattern was taken of the solid phase. This indicated that Cu<sub>2</sub>O was present, possibly due to reduction of CuO by H<sub>2</sub> formed as a result of corrosion of the stainless steel.

<b>COMPONENTS:</b> (1) Copper(II) hydroxide; Cu(OH) <sub>2</sub> ; [20427-59-2] (2) Water; H <sub>2</sub> O; [7732-18-5]		<b>ORIGINAL MEASUREMENTS:</b> Jenkins, S. H.; Keight, D. G.; Humphreys, R. E. <i>Air Water Pollution</i> 1964, 8, 537-56.																																																																																	
<b>VARIABLES:</b> Source of the water.		<b>PREPARED BY:</b> T. P. Dirkse																																																																																	
<b>EXPERIMENTAL VALUES:</b> Table I. Solubility of Cu(OH) <sub>2</sub> in distilled water. <sup>a</sup>																																																																																			
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Table II. Solubility of Cu(OH) <sub>2</sub> in CO <sub>2</sub> -free distilled water. <sup>a</sup>																																																																																			
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<sup>a</sup> These results are for the eighth, and final, extraction.																																																																																			
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<table> <thead> <tr> <th>Number of extractions</th> <th>pH of water</th> <th>t/°C</th> <th>Sample 1 pH</th> <th>C<sub>Cu</sub>/ppm</th> <th>Sample 2 pH</th> <th>C<sub>Cu</sub>/ppm</th> <th>Sample 3 pH</th> <th>C<sub>Cu</sub>/ppm</th> </tr> </thead> <tbody> <tr> <td>10</td> <td>7.25</td> <td>22.0</td> <td>7.88</td> <td>0.31</td> <td>7.95</td> <td>0.27</td> <td>7.90</td> <td>0.22</td> </tr> <tr> <td>11</td> <td>7.60</td> <td>20.0</td> <td>7.58</td> <td>0.12</td> <td>7.68</td> <td>0.12</td> <td>7.41</td> <td>0.25</td> </tr> <tr> <td>12</td> <td>7.41</td> <td>20.0</td> <td>8.03</td> <td>0.25</td> <td>7.92</td> <td>0.31</td> <td>7.82</td> <td>0.27</td> </tr> <tr> <td>13</td> <td>7.72</td> <td>17.0</td> <td>7.53</td> <td>0.06</td> <td>7.59</td> <td>0.04</td> <td>7.50</td> <td>0.06</td> </tr> <tr> <td>14</td> <td>7.60</td> <td>16.5</td> <td>7.56</td> <td>0.12</td> <td>7.62</td> <td>0.15</td> <td>7.59</td> <td>0.15</td> </tr> <tr> <td>15</td> <td>7.20</td> <td>17.5</td> <td>7.25</td> <td>0.19</td> <td>7.50</td> <td>0.23</td> <td>7.18</td> <td>0.26</td> </tr> <tr> <td>16</td> <td>7.00</td> <td>19.0</td> <td>7.25</td> <td>0.19</td> <td>7.30</td> <td>0.15</td> <td>7.30</td> <td>0.17</td> </tr> <tr> <td>17</td> <td>7.52</td> <td>19.5</td> <td>7.58</td> <td>0.19</td> <td>7.51</td> <td>0.23</td> <td>7.50</td> <td>0.19</td> </tr> </tbody> </table>			Number of extractions	pH of water	t/°C	Sample 1 pH	C <sub>Cu</sub> /ppm	Sample 2 pH	C <sub>Cu</sub> /ppm	Sample 3 pH	C <sub>Cu</sub> /ppm	10	7.25	22.0	7.88	0.31	7.95	0.27	7.90	0.22	11	7.60	20.0	7.58	0.12	7.68	0.12	7.41	0.25	12	7.41	20.0	8.03	0.25	7.92	0.31	7.82	0.27	13	7.72	17.0	7.53	0.06	7.59	0.04	7.50	0.06	14	7.60	16.5	7.56	0.12	7.62	0.15	7.59	0.15	15	7.20	17.5	7.25	0.19	7.50	0.23	7.18	0.26	16	7.00	19.0	7.25	0.19	7.30	0.15	7.30	0.17	17	7.52	19.5	7.58	0.19	7.51	0.23	7.50	0.19
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<b>AUXILIARY INFORMATION</b>																																																																																			
<b>METHOD/APPARATUS/PROCEDURE:</b> The Cu(OH) <sub>2</sub> was washed several times, then added to the water. The mixtures were shaken mechanically, but there is no indication as to how long they were shaken. After some time was allowed for settling, the mixtures were filtered through a Millipore HA filter. Further extractions were made by adding more water and repeating the process for each such extraction. The copper content of the filtrate was determined colorimetrically using the bis-cyclohexanone oxalyldihydrazone (1).		<b>SOURCE AND PURITY OF MATERIALS:</b> The Cu(OH) <sub>2</sub> was of reagent grade quality. Distilled water and Birmingham (England) tap water were used as solvents.																																																																																	
		<b>ESTIMATED ERROR:</b> No details are given but from the results given in the paper it appears that the average deviation from the mean value was about 15%.																																																																																	
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		1. Williams, T. R.; Morgan, R. R. T. <i>Chem. &amp; Ind. (Rev.)</i> 1954, 16, 461.																																																																																	

## Copper(II) Oxide and Hydroxide

<b>COMPONENTS:</b>		<b>ORIGINAL MEASUREMENTS:</b>	
(1) Copper(II) oxide; CuO; [1317-38-0]		Hearn, B.; Hunt, M. R.; Hayward, A. J. Chem. Eng. Data <u>1969</u> , 14, 442-7.	
(2) Water; H <sub>2</sub> O; [7732-18-5]			
<b>VARIABLES:</b>		<b>PREPARED BY:</b>	
Temperature and pressure of the water.		T. P. Dirkse	
<b>EXPERIMENTAL VALUES:</b>			
Solubility of CuO in superheated steam.			
<b>t/°C</b>	<b>p/psig</b>	<b>C<sub>Cu</sub>/10<sup>-6</sup> g kg<sup>-1</sup></b>	
57 ± 1	1730 ± 25	12.4 ± 0.3	
69 ± 2	1200 ± 100	16 ± 2	
81 ± 2	1100 ± 100	23 ± 2	
87 ± 2	3830 ± 25	23.5 ± 1	
88 ± 1	3850 ± 15	21.5 ± 1	
89 ± 1	3950 ± 75	17 ± 1	
110 ± 2	3300 ± 80	23.5 ± 1	
117 ± 2	3700 ± 45	29 ± 1	
121 ± 2	3520 ± 40	38 ± 1	
122 ± 3	3450 ± 65	23 ± 1	
133 ± 2	1200 ± 100	26 ± 1	
154 ± 2	1200 ± 100	52 ± 2	
181 ± 2	2640 ± 35	198 ± 5	
187 ± 1	2005 ± 20	143 ± 3	
207 ± 3	1900 ± 100	212 ± 2	
232 ± 1	3025 ± 30	281 ± 5	
234 ± 2	3870 ± 45	289 ± 6	
249 ± 2	2900 ± 100	360 ± 4	
252 ± 1	3020 ± 35	391 ± 5	
260 ± 1	3780 ± 55	393 ± 7	
260 ± 1	3900 ± 115	378 ± 8	
260 ± 2	4135 ± 30	395 ± 5	
273 ± 2	3200 ± 50	444 ± 10	
<b>AUXILIARY INFORMATION</b>			
<b>METHOD/APPARATUS/PROCEDURE:</b>  About 500 g of CuO was placed in the equilibrator, which was then flushed with cold water to remove fine particles of CuO. Steam at the prescribed temperature and pressure was passed through the equilibrator. After it had passed through the equilibrator the steam was condensed and about 450 ml was taken for analysis, which was done colorimetrically, using CCl <sub>4</sub> and dibenzylidithiocarbamate (1).	<b>SOURCE AND PURITY OF MATERIALS:</b>  The water was deionized, distilled and deaerated. No information is given about the CuO.		
		<b>ESTIMATED ERROR:</b>  The copper analysis had a standard deviation of 0.15 to 0.7 µg of Cu kg <sup>-1</sup> .	
<b>REFERENCES:</b>			
1. Wilson, A. L. <i>Analyst</i> <u>1962</u> , 87, 884.			

COMPONENTS:		ORIGINAL MEASUREMENTS:
(1)	Copper(II) oxide; CuO; [1317-38-0]	Hearn, B.; Hunt, M. R.; Hayward, A. J. Chem. Eng. Data <u>1969</u> , 14, 442-7.
(2)	Water; H <sub>2</sub> O; [7732-18-5]	
EXPERIMENTAL VALUES, contd.		
t/°C	p/psig	c <sub>Cu</sub> /10 <sup>-6</sup> g kg <sup>-1</sup>
291 ± 1	4055 ± 20	503 ± 5
298 ± 2	3225 ± 50	516 ± 6
307 ± 2	4200 ± 100	547 ± 10
322 ± 3	3270 ± 40	610 ± 32
331 ± 2	4200 ± 35	600 ± 6
350 ± 1	4000 ± 65	462 ± 10
350 ± 1	6000 ± 65	570 ± 10
374 ± 4	3500 ± 65	234 ± 10
379 ± 2	3950 ± 100	137 ± 6
376 ± 2	4000 ± 100	194 ± 6
389 ± 1	4055 ± 15	233 ± 8
389 ± 1	3995 ± 20	227 ± 8
381 ± 2	4000 ± 65	331 ± 10
378 ± 2	4500 ± 65	337 ± 10
381 ± 2	5000 ± 65	320 ± 10
381 ± 2	5500 ± 65	350 ± 10
382 ± 2	6000 ± 65	486 ± 10
386 ± 2	4050 ± 100	89 ± 6
388 ± 2	4600 ± 100	151 ± 6
401 ± 1	4305 ± 20	117 ± 1
408 ± 2	4925 ± 40	129 ± 1
401 ± 3	5100 ± 100	170 ± 1
401 ± 2	5000 ± 65	182 ± 1
405 ± 1	5375 ± 30	214 ± 1
405 ± 1	6070 ± 25	406 ± 6
420 ± 2	3840 ± 60	46 ± 1
422 ± 1	4035 ± 50	90 ± 1
421 ± 2	4435 ± 50	64 ± 1
440 ± 2	4970 ± 65	92 ± 1
430 ± 1	5060 ± 45	100 ± 1
431 ± 2	5500 ± 65	153 ± 2
434 ± 2	6000 ± 130	315 ± 5
440 ± 1	3455 ± 30	77 ± 1
448 ± 2	5990 ± 105	299 ± 2
460 ± 2	3500 ± 80	56 ± 1
460 ± 1	3500 ± 65	81 ± 1
455 ± 2	4010 ± 75	101 ± 1
469 ± 2	4520 ± 65	80 ± 1
468 ± 2	5060 ± 45	108 ± 2
463 ± 2	5490 ± 75	139 ± 4
462 ± 2	6000 ± 115	126 ± 4
461 ± 2	6050 ± 70	184 ± 6
497 ± 1	3465 ± 50	113 ± 1
497 ± 1	4065 ± 25	121 ± 1
502 ± 1	4465 ± 40	145 ± 1
501 ± 2	5045 ± 30	148 ± 1
500 ± 2	5425 ± 40	138 ± 2
503 ± 2	5980 ± 95	178 ± 2
550 ± 1	3530 ± 45	115 ± 1
550 ± 1	4050 ± 35	100 ± 1
551 ± 2	4575 ± 35	133 ± 1
551 ± 1	5050 ± 40	165 ± 1
550 ± 1	5510 ± 35	172 ± 2
550 ± 1	5980 ± 40	159 ± 2

<b>COMPONENTS:</b> (1) Silver(I) oxide; Ag <sub>2</sub> O; [20667-12-3] (2) Water; H <sub>2</sub> O; [7732-18-5]	<b>ORIGINAL MEASUREMENTS:</b> Noyes, A. A.; Kohr, D. A. J. Am. Chem. Soc. <u>1902</u> , 24, 1141-8.
<b>VARIABLES:</b> The solubility in water was measured at 25°C	<b>PREPARED BY:</b> T. P. Dirkse

**EXPERIMENTAL VALUES:**Solubility of Ag<sub>2</sub>O in water at 25°C.

Conc. of Ag expressed as g AgI/250 ml

undersaturation	supersaturation
0.0125	0.0127
0.0130	0.0120
0.0125 a	0.0133 a
0.0102 a	0.0112 a

<sup>a</sup> These values were omitted by the authors in calculating the mean.The mean value chosen by the authors is 0.0127 g AgI/250 ml which corresponds to  $2.16 \times 10^{-4}$  mol dm<sup>-3</sup> as AgOH.Compiler's note: This same article appears in Z. Physik. Chem.  
1903, 42, 36-42.**AUXILIARY INFORMATION**

<b>METHOD/APPARATUS/PROCEDURE:</b> The Ag <sub>2</sub> O-H <sub>2</sub> O mixtures were rotated in a thermostat at 25°C for 4 or 5 hours, and then were allowed to settle for a short while. After this, the liquid phase was sucked out and passed through a filter. The silver content was determined gravimetrically as AgI. Equilibrium was approached from both undersaturation and supersaturation.	<b>SOURCE AND PURITY OF MATERIALS:</b> The Ag <sub>2</sub> O was prepared by adding a clear solution of Ba(OH) <sub>2</sub> to an aqueous solution of AgNO <sub>3</sub> . The precipitate was washed with 4 liters of freshly boiled water. During the process the precipitate was kept out of contact with CO <sub>2</sub> .
	<b>ESTIMATED ERROR:</b> About 5%.
	<b>REFERENCES:</b>

<b>COMPONENTS:</b> (1) Silver(I) oxide; Ag <sub>2</sub> O; [20667-12-3] (2) Water; H <sub>2</sub> O; [7732-18-5]	<b>ORIGINAL MEASUREMENTS:</b> Bottger, W. Z. Physik, Chem. 1903, 46, 521-619.
<b>VARIABLES:</b> Temperature.	<b>PREPARED BY:</b> T. P. Dirkse

**EXPERIMENTAL VALUES:**Saturated solutions of Ag<sub>2</sub>O in water.

t/°C	10 <sup>6</sup> sp.cond. <sup>a</sup>	( <sup>1</sup> <sub>Ag+</sub> + <sup>1</sup> <sub>OH-</sub> ) <sup>b</sup>	C <sub>AgOH</sub> /mol dm <sup>-3</sup>	K <sub>s</sub> <sup>o</sup>
19.94	29.27 <sup>c</sup>	237.2	1.23 x 10 <sup>-4</sup>	1.52 x 10 <sup>-8</sup>
24.94	35.98	259.1	1.39 x 10 <sup>-4</sup>	1.93 x 10 <sup>-8</sup>

<sup>a</sup> No unit is given for this value but it appears to be Ω<sup>-1</sup> cm<sup>-1</sup>.<sup>b</sup> No unit is given for this value but it appears to be Ω<sup>-1</sup> cm<sup>2</sup> mol<sup>-1</sup>.<sup>c</sup> This value is the average of two measurements.**AUXILIARY INFORMATION**

<b>METHOD/APPARATUS/PROCEDURE:</b> Saturated solutions of Ag <sub>2</sub> O in water were prepared by mixing the two components in a rotating conductance cell in a thermostat. The conductance of the solutions was measured after several days.	<b>SOURCE AND PURITY OF MATERIALS:</b> All materials were of analytical reagent grade quality and were recrystallized several times before being used. The Ag <sub>2</sub> O was prepared by adding a solution of Ba(OH) <sub>2</sub> to aqueous AgNO <sub>3</sub> . The precipitate was washed several times with water. Conductivity water was used throughout.
	<b>ESTIMATED ERROR:</b> The uncertainty in the individual measurements was less than 1%. The calculated results have an uncertainty of about 5%.
	<b>REFERENCES:</b>

<b>COMPONENTS:</b> (1) Silver(I) oxide; Ag <sub>2</sub> O; [20667-12-3] (2) Water; H <sub>2</sub> O; [7732-18-5]		<b>ORIGINAL MEASUREMENTS:</b> Rebiere, G. Bull. Soc. Chim. <u>1915</u> , 17, 309-12.
<b>VARIABLES:</b> Method of preparing the Ag <sub>2</sub> O and its solubility in water at 25° and 50°C.		<b>PREPARED BY:</b> T. P. Dirkse
<b>EXPERIMENTAL VALUES:</b>		
Solubility of Ag <sub>2</sub> O in water.		
<b>Oxide<sup>a</sup></b>	<b>25°C</b>	<b>50°C</b>
	<b>C<sub>Ag<sub>2</sub>O</sub>/mg dm<sup>-3</sup></b>	<b>C<sub>Ag<sub>2</sub>O</sub>/mol dm<sup>-3</sup></b>
I	50.00	2.16 x 10 <sup>-4</sup>
II	51.9	2.23 x 10 <sup>-4</sup>
III	53.8	2.32 x 10 <sup>-4</sup>
IV	68.6	2.96 x 10 <sup>-4</sup>
		<b>C<sub>Ag<sub>2</sub>O</sub>/mg dm<sup>-3</sup></b>
		<b>C<sub>Ag<sub>2</sub>O</sub>/mol dm<sup>-3</sup></b>
<p><sup>a</sup> The numbers refer to the method of preparation described below under "SOURCE AND PURITY OF MATERIALS".</p> <p><sup>b</sup> All these numbers have been recalculated by the compiler.</p>		
<b>AUXILIARY INFORMATION</b>		
<b>METHOD/APPARATUS/PROCEDURE:</b>  One gram of Ag <sub>2</sub> O was added to 500 ml of water and the mixture was mechanically agitated for 2 hours in a constant temperature bath. The mixture was then filtered and the silver content was determined by adding ammoniacal KCN to the solution, then adding KI and titrating with dilute AgNO <sub>3</sub> to a bluish opalescence (1).	<b>SOURCE AND PURITY OF MATERIALS:</b>  Conductivity water was used as solvent. Ag <sub>2</sub> O was prepared as follows, using pure materials: (I) adding NaOH to aqueous AgNO <sub>3</sub> ; (II) adding Ba(OH) <sub>2</sub> to aqueous AgNO <sub>3</sub> ; (III) action of concentrated NaOH on freshly precipitated AgCl; (IV) action of concentrated NaOH on freshly precipitated Ag <sub>2</sub> CO <sub>3</sub> . The Ag <sub>2</sub> O formed was collected on a filter, washed, dried between papers, and dried in a vacuum over H <sub>2</sub> SO <sub>4</sub> .	
<b>ESTIMATED ERROR:</b>  No details are given.		
<b>REFERENCES:</b> 1. Rebiere, G. Bull. Soc. Chim. <u>1915</u> , 17, 306.		

<b>COMPONENTS:</b> (1) Silver(I) oxide; $\text{Ag}_2\text{O}$ ; [20667-12-3] (2) Water; $\text{H}_2\text{O}$ ; [7732-18-5]		<b>ORIGINAL MEASUREMENTS:</b> Remy, H.; Kuhlmann, A. Z. Anal. Chem. 1924, 65, 161-81.
<b>VARIABLES:</b> Method of measuring the solubility of $\text{Ag}_2\text{O}$ in water.		<b>PREPARED BY:</b> T. P. Dirkse
<b>EXPERIMENTAL VALUES:</b>		
Solubility of $\text{Ag}_2\text{O}$ in water.		
Method	$c_{\text{Ag}_2\text{O}}/\text{mg dm}^{-3}$	$c_{\text{Ag}_2\text{O}}/\text{mol dm}^{-3}$
Conductimetric titration	25.29	$1.09 \times 10^{-4}$
Specific conductance	24.80	$1.07 \times 10^{-4}$
<p>The solubility determined by conductimetric titration probably has about a 10% uncertainty because of the uncertainty in determining the inflection points in the titration curves.</p> <p>The solubility value determined from the specific conductance measurement has an unknown uncertainty from two sources: (a) the measurement was made at about <math>19.5^\circ\text{C}</math> and then corrected to <math>18^\circ\text{C}</math> before the solubility calculation was made; and (b) the authors introduce a correction for the presence of <math>\text{CO}_2</math> in the conductivity water. The latter correction is subject to some dispute.</p>		
<b>AUXILIARY INFORMATION</b>		
<b>METHOD/APPARATUS/PROCEDURE:</b>  Warm $\text{Ag}_2\text{O}$ was added to conductivity water and the mixture was shaken until equilibrium was established. This was determined as the time when the specific conductance of the solution became constant--after 1.5 hours. The mixture was then filtered and the filtrate was titrated conductimetrically with excess dilute $\text{H}_2\text{SO}_4$ and then back-titrated conductimetrically with dilute KOH. The solubility of $\text{Ag}_2\text{O}$ was calculated as equivalent to the $\text{H}_2\text{SO}_4$ used in this titration. The solubility was also calculated from the specific conductance of the saturated solution, using literature values for the specific ionic conductances.	<b>SOURCE AND PURITY OF MATERIALS:</b>  $\text{Ag}_2\text{O}$ was prepared by dissolving recrystallized $\text{AgNO}_3$ in conductivity water, adding freshly distilled $\text{NH}_4\text{OH}$ , washing the precipitate, redissolving it in $\text{HNO}_3$ , precipitating once again with $\text{NH}_4\text{OH}$ , carefully washing the precipitate and heating it gently in a platinum crucible. Conductivity water was used throughout.	<b>ESTIMATED ERROR:</b>  No details are given. The temperature varied from 19 to $21^\circ\text{C}$ during the measurements.
		<b>REFERENCES:</b>

COMPONENTS: (1) Silver(I) oxide; $\text{Ag}_2\text{O}$ ; [20667-12-3] (2) Water; $\text{H}_2\text{O}$ ; [7732-18-5]	ORIGINAL MEASUREMENTS: Mathur, R. P. P.; Dhar, N. R. Z. <i>Anorg. Allg. Chem.</i> <u>1931</u> , 199, 387-91.																					
VARIABLES: Method of measuring the solubility, and temperature.	PREPARED BY: T. P. Dirkse																					
EXPERIMENTAL VALUES:	Table I. Solubility of $\text{Ag}_2\text{O}$ in water from analysis.																					
<table> <thead> <tr> <th><math>\tau/\text{^{\circ}C}</math></th> <th><math>10^4 C_{\text{Ag}}/\text{mol dm}^{-3}</math><sup>a</sup></th> <th><math>10^4 C_{\text{Ag}}/\text{mol dm}^{-3}</math><sup>b</sup></th> </tr> </thead> <tbody> <tr><td>30</td><td>2.22</td><td>2.1</td></tr> <tr><td>40</td><td>3.14</td><td>3.18</td></tr> <tr><td>50</td><td>3.75</td><td>3.67</td></tr> <tr><td>60</td><td>4.16</td><td>4.19</td></tr> <tr><td>70</td><td>4.51</td><td>4.5</td></tr> <tr><td>80</td><td>4.82</td><td>4.83</td></tr> </tbody> </table>		$\tau/\text{^{\circ}C}$	$10^4 C_{\text{Ag}}/\text{mol dm}^{-3}$ <sup>a</sup>	$10^4 C_{\text{Ag}}/\text{mol dm}^{-3}$ <sup>b</sup>	30	2.22	2.1	40	3.14	3.18	50	3.75	3.67	60	4.16	4.19	70	4.51	4.5	80	4.82	4.83
$\tau/\text{^{\circ}C}$	$10^4 C_{\text{Ag}}/\text{mol dm}^{-3}$ <sup>a</sup>	$10^4 C_{\text{Ag}}/\text{mol dm}^{-3}$ <sup>b</sup>																				
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<p><sup>a</sup> Determined by weighing the residue after the solution had been evaporated to dryness.  <sup>b</sup> Determined gravimetrically by precipitating the Ag as <math>\text{AgCl}</math>.</p>																						
Table II. Solubility of $\text{Ag}_2\text{O}$ in water from e.m.f. measurements.																						
<table> <thead> <tr> <th><math>\tau/\text{^{\circ}C}</math></th> <th>e.m.f./V</th> <th><math>10^4 C_{\text{Ag}}/\text{mol dm}^{-3}</math></th> </tr> </thead> <tbody> <tr><td>30</td><td>0.1552</td><td>1.981</td></tr> <tr><td>40</td><td>0.1440</td><td>3.04</td></tr> <tr><td>50</td><td>0.1462</td><td>3.61</td></tr> <tr><td>60</td><td>0.163</td><td>4.09</td></tr> <tr><td>70</td><td>0.165</td><td>4.48</td></tr> <tr><td>80</td><td>0.165</td><td>4.79</td></tr> </tbody> </table>		$\tau/\text{^{\circ}C}$	e.m.f./V	$10^4 C_{\text{Ag}}/\text{mol dm}^{-3}$	30	0.1552	1.981	40	0.1440	3.04	50	0.1462	3.61	60	0.163	4.09	70	0.165	4.48	80	0.165	4.79
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AUXILIARY INFORMATION																						
METHOD/APPARATUS/PROCEDURE:	SOURCE AND PURITY OF MATERIALS:  Conductivity water was used throughout. The $\text{Ag}_2\text{O}$ was prepared by mixing dilute aqueous $\text{AgNO}_3$ with aqueous $\text{NaOH}$ . The precipitate was washed free of alkali with conductivity water.																					
<p>Three methods were used. (1) <math>\text{Ag}_2\text{O}</math> and conductivity water were shaken vigorously and then allowed to settle for 20 hours. A sample of the solution was evaporated to dryness and weighed, or the <math>\text{Ag}^+</math> in solution was precipitated as <math>\text{AgCl}</math> and then weighed.  (2) The e.m.f. of the cell <math>\text{Ag}, 0.1 \text{ M } \text{AgNO}_3   \text{M } \text{KNO}_3   (\text{Ag}_2\text{O} + \text{H}_2\text{O})</math>, <math>\text{Ag}</math> was measured and <math>C_{\text{Ag}}</math> was calculated using the Nernst equation.  (3) The specific conductance of the saturated solution was measured and the solubility was calculated from this value and the available values for the individual ionic conductances.</p>	ESTIMATED ERROR:  No details are given.																					
	REFERENCES:																					

## COMPONENTS:

- (1) Silver(I) oxide;  $\text{Ag}_2\text{O}$ , [20667-12-3]  
 (2) Water,  $\text{H}_2\text{O}$ , [7732-18-5]

## ORIGINAL MEASUREMENTS:

Mathur, R. P. P.; Dhar, N. R. Z. *Anorg. Allg. Chem.* 1931, 199, 387-91.

EXPERIMENTAL VALUES: con't

Table III. Solubility of  $\text{Ag}_2\text{O}$  in water from conductance.

$\tau/\text{^oC}$	of solution	$10^6 \text{sp. cond.}/\Omega^{-1}$ correction <sup>a</sup>	corrected	$10^4 C_{\text{Ag}}/\text{mol dm}^{-3}$
20	28.16	0.58	27.58	1.2
25	36.13	0.43	35.70	1.5
30	48.87	0.43	48.40	1.8

<sup>a</sup>  
Correction for the solvent conductance.

## Silver(I) Oxide

COMPONENTS:		ORIGINAL MEASUREMENTS:				
(1) Silver(I) oxide; Ag <sub>2</sub> O; [20667-12-3] (2) Water; H <sub>2</sub> O; [7732-18-5]		Britton, H. T. S.; Robinson, R. A. <i>Trans. Faraday Soc.</i> <u>1932</u> , 28, 531-45.				
VARIABLES:		PREPARED BY:				
Ionic strength of solution at 16°C.		T. P. Dirkse				
EXPERIMENTAL VALUES: Solubility product of AgOH at 16°C.						
equiv. of NaOH added	pH <sup>a</sup>	10 <sup>8</sup> K <sub>s</sub> <sup>o</sup> <sup>c</sup>	pH <sup>b</sup>			
0.1	7.48	1.62	7.97			
0.2	7.54	1.58	8.04			
0.3	7.61	1.55	8.11			
0.4	7.69	1.55	8.17			
0.5	7.81	1.62	8.25			
0.6	7.92	1.62	8.34			
0.7	8.03	1.51	8.49			
0.8	8.21	1.45	8.70			
0.9	8.56	1.58	9.04			
	average = 1.56		average = 1.37			
<sup>a</sup> Original concentration of AgNO <sub>3</sub> solution was 0.1 mol dm <sup>-3</sup> .						
<sup>b</sup> Original concentration of AgNO <sub>3</sub> solution was 0.025 mol dm <sup>-3</sup> .						
<sup>c</sup> K <sub>s</sub> <sup>o</sup> = (C <sub>Ag</sub> <sup>+</sup> ) · (a <sub>OH</sub> <sup>-</sup> )						
Using silver ion activity coefficients of 0.732 in 0.1 mol dm <sup>-3</sup> solution and 0.840 in 0.025 mol dm <sup>-3</sup> solution (1), the thermodynamic solubility product constant for AgOH is calculated to be 1.15 × 10 <sup>-8</sup> .						
AUXILIARY INFORMATION						
METHOD/APPARATUS/PROCEDURE:	SOURCE AND PURITY OF MATERIALS:					
100 ml of AgNO <sub>3</sub> solution was titrated with NaOH solution having a concentration of 0.2 mol dm <sup>-3</sup> . The pH of the solution was measured with a glass electrode. The silver ion concentration was calculated from the original concentration of the AgNO <sub>3</sub> and the amount of NaOH that had been added. No other experimental details are given. The purpose of the work was to illustrate the use of the glass electrode.	No details are given.					
ESTIMATED ERROR:						
No details are given.						
REFERENCES:						
1. Lewis, G. N.; Randall, M. <i>Thermodynamics</i> , McGraw-Hill, New York, <u>1923</u> , p. 362.						

<b>COMPONENTS:</b>		<b>ORIGINAL MEASUREMENTS:</b>																				
(1) Silver(I) oxide; $\text{Ag}_2\text{O}$ ; [20667-12-3] (2) Water; $\text{H}_2\text{O}$ ; [7732-18-5]		Johnston, H. L.; Cuta, F.; Garrett, A. B. <i>J. Am. Chem. Soc.</i> 1933, 55, 2311-25.																				
<b>VARIABLES:</b> The temperature was 25°C.		<b>PREPARED BY:</b> T. P. Dirkse																				
<b>EXPERIMENTAL VALUES:</b>																						
<p>Solubility of <math>\text{Ag}_2\text{O}</math> in pure water at 25°C.</p> $10^4 \text{C}_{\text{Ag}} \text{ +/mol kg}^{-1}$ <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center; width: 40%;">from undersaturation</th> <th style="text-align: center; width: 40%;">from supersaturation</th> </tr> </thead> <tbody> <tr><td style="text-align: center;">2.21</td><td style="text-align: center;">2.18</td></tr> <tr><td style="text-align: center;">2.23</td><td style="text-align: center;">2.32</td></tr> <tr><td style="text-align: center;">2.19</td><td style="text-align: center;">2.16</td></tr> <tr><td style="text-align: center;">2.18</td><td style="text-align: center;">2.31</td></tr> <tr><td style="text-align: center;">2.15</td><td style="text-align: center;">2.28</td></tr> <tr><td style="text-align: center;">2.23</td><td></td></tr> <tr><td style="text-align: center;">—</td><td style="text-align: center;">—</td></tr> <tr> <td style="text-align: center;">average</td><td style="text-align: center;"><math>= 2.20</math></td></tr> <tr> <td></td><td style="text-align: center;"><math>= 2.25</math></td></tr> </tbody> </table> <p>The average of all determinations is <math>2.22 \times 10^{-4}</math> mol/kg <math>\text{H}_2\text{O}</math>.</p>			from undersaturation	from supersaturation	2.21	2.18	2.23	2.32	2.19	2.16	2.18	2.31	2.15	2.28	2.23		—	—	average	$= 2.20$		$= 2.25$
from undersaturation	from supersaturation																					
2.21	2.18																					
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2.15	2.28																					
2.23																						
—	—																					
average	$= 2.20$																					
	$= 2.25$																					
<b>AUXILIARY INFORMATION</b>																						
<b>METHOD/APPARATUS/PROCEDURE:</b>  Mixtures of $\text{Ag}_2\text{O}$ and conductivity water were agitated for 10 to 18 days in a thermostat and then allowed to sediment 5 to 7 days in another thermostat at 25°C. The clear solution was siphoned off under $\text{N}_2$ pressure and forced through a silver filter. The silver content was determined by a potentiometric titration with a dilute solution of KI. Equilibrium was approached from both undersaturation and supersaturation.	<b>SOURCE AND PURITY OF MATERIALS:</b>  Conductivity water was prepared and stored in contact with $\text{CO}_2$ -free air. The $\text{Ag}_2\text{O}$ was prepared by adding, dropwise and simultaneously, dilute solutions of $\text{AgNO}_3$ and $\text{Ba}(\text{OH})_2$ , into hot conductivity water. The precipitate was washed 15 times with conductivity water. The entire process was carried out in a $\text{N}_2$ atmosphere.	<b>ESTIMATED ERROR:</b>  In most determinations it was well below 1% and did not exceed 2%.																				
<b>REFERENCES:</b>																						

## Silver(I) Oxide

<b>COMPONENTS:</b> (1) Silver(I) hydroxide; AgOH; [12258-15-0] (2) Water; H <sub>2</sub> O; [7732-18-5]	<b>ORIGINAL MEASUREMENTS:</b> Nasanen, R.; <i>Suomen Kemistilehti</i> <u>1943</u> , 16B, 1-3.
<b>VARIABLES:</b> Ionic strength of the solution at 25°C.	<b>PREPARED BY:</b> T. P. Dirkse

**EXPERIMENTAL VALUES:**

No titration data are given in the article, but only the following calculated results.

## Solubility Product of silver(I) hydroxide at 25°C.

$\sqrt{\mu}$ <sup>a</sup>	$10^3 P$ <sup>b</sup>	$pK_s^o$ <sup>c</sup>
0.0354	0.756	7.569
0.0659	0.808	7.511
0.0659	0.800	7.520
0.302	0.972	7.351
0.505	1.075	7.253 <sup>d</sup>
1.000	1.32	7.083
1.370	1.29	7.106

<sup>a</sup>  $\mu$  is the ionic strength of the solution as mol dm<sup>-3</sup>.

<sup>b</sup> P is the reciprocal of the maximum slope of the titration curve.

<sup>c</sup>  $pK_s^o$  is calculated from the relationship:  $P = 4.606 (K_s^o)^{1/2}$ .

<sup>d</sup> Compiler's note: this should be 7.263.

From the above results and the use of the Debye-Hückel equation for activity coefficients, the author calculates the thermodynamic solubility product of AgOH to be  $2.57 \times 10^{-8}$ .

**AUXILIARY INFORMATION****METHOD/APPARATUS/PROCEDURE:**

Dilute aqueous AgNO<sub>3</sub> was titrated potentiometrically with aqueous KOH under a N<sub>2</sub> atmosphere in a thermostat at 25°C. The solution was stirred and varying amounts of KNO<sub>3</sub> were added to control the ionic strength of the solution. A Ag<sub>2</sub>O/Ag electrode served as the indicator electrode. By means of equations developed earlier (1, 2), the maximum slope of the titration curve was calculated and related to the solubility product.

**SOURCE AND PURITY OF MATERIALS:**

No information is given.

**ESTIMATED ERROR:**

No details are given.

**REFERENCES:**

- Nasanen, R. Z. *Physik. Chem.* 1941, 188A, 272.
- Nasanen, R. Z. *Physik. Chem.* 1942, 190A, 183.

COMPONENTS:		ORIGINAL MEASUREMENTS:		
(1) Silver (I) oxide; $\text{Ag}_2\text{O}$ ; [20667-12-3] (2) Water; $\text{H}_2\text{O}$ ; [7732-18-5]		Gavrish, M. L. : Galinker, I. S. <i>Zh. Neorg. Khim.</i> 1970, 15, 1979-81; <i>Russ. J. Inorg. Chem. (Engl. transl.)</i> 1970, 15, 1017-9.		
VARIABLES:		PREPARED BY:		
Temperature from 25 to 260°C.		T. P. Dirkse		
EXPERIMENTAL VALUES:				
Solubility of $\text{Ag}_2\text{O}$ in water at elevated temperatures.				
$t/^\circ\text{C}$	$c_{\text{Ag}_2\text{O}}/\text{g kg}^{-1}$	$10^4 c_{\text{Ag}_2\text{O}}/\text{mol kg}^{-1}$		
25	0.022	0.95		
130	0.52	22.4		
150	0.64	27.6		
180	0.64	27.6		
200	0.63	27.2		
210	0.55	23.7		
220	0.48	20.7		
230	0.46	19.9		
245	0.22	9.5		
250	0.23	9.9		
260	0.22	9.5		
<sup>a</sup> The mol/kg $\text{H}_2\text{O}$ values were calculated by the compiler.				
AUXILIARY INFORMATION				
METHOD/APPARATUS/PROCEDURE:	SOURCE AND PURITY OF MATERIALS:			
Very little information is given. The $\text{Ag}_2\text{O}$ and water were placed in an autoclave which is described rather completely. No indication is given as to how long the mixtures were in the autoclave or the method that was used to determine the silver content of the solutions.	No details are given.			
ESTIMATED ERROR:				
No details are given.				
REFERENCES:				

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Zinc oxide; ZnO; [1314-13-2] (2) Water; H <sub>2</sub> O; [7732-18-5]	Remy, H.; Kuhlmann, A. Z. Anal. Chem. <u>1924</u> , 65, 161-81.
VARIABLES:	PREPARED BY:  T. P. Dirkse

## EXPERIMENTAL VALUES:

Solubility of ZnO in water at 20°C.

method	mol ZnO dm <sup>-3</sup>	mg ZnO dm <sup>-3</sup>
conductimetric titration	$3.58 \times 10^{-5}$	2.92
specific conductance	$3.76 \times 10^{-5}$	3.06

The solubility values calculated from specific conductance measurements assumed that the dissolved ZnO was present in solution as a completely dissociated hydroxide.

## AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:	SOURCE AND PURITY OF MATERIALS:
Hot ZnO was added to water and the mixture was shaken. Solubility was calculated from 2 types of measurements: (a) the specific conductance was measured and used with literature values for individual ionic conductances; (b) the solution was titrated conductimetrically with H <sub>2</sub> SO <sub>4</sub> . The main concern in this work was to note and correct for the contribution of dissolved CO <sub>2</sub> .	ZnO was produced by heating the precipitate that was formed when freshly distilled NH <sub>4</sub> OH was added to an aqueous solution of pure Zn(NO <sub>3</sub> ) <sub>2</sub> . Conductivity water was used.
	ESTIMATED ERROR:  The temperature was not controlled but varied from 19 to 21°C. In the titrations, the results had a reproducibility within 1% of the average value.
	REFERENCES:

## Zinc Oxide and Hydroxide

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Zinc oxide; ZnO; [1314-13-2] (2) Water; H <sub>2</sub> O; [7732-18-5]	Busch, W. Z. Anorg. Allgem. Chem. 1927, 161, 161-79.
VARIABLES:	PREPARED BY: T. P. Dirkse

## EXPERIMENTAL VALUES:

Solubility of ZnO in water at 29.0°C.

ml of solution used	130
ml H <sub>2</sub> SO <sub>4</sub> added	20
factor of H <sub>2</sub> SO <sub>4</sub>	1.019 × 10 <sup>-3</sup> <sup>a</sup>
factor of KOH	1.151 × 10 <sup>-3</sup> <sup>a</sup>
ml of KOH needed for back titration	13.36
dissolved ZnO	1.92 × 10 <sup>-5</sup> mol dm <sup>-3</sup>

<sup>a</sup> These obviously are concentration values but no units are given.

The purpose of this work was to determine the suitability of the potentiometric titration method for determining the solubility of slightly soluble materials. According to the author, the results are affected by the previous treatment of the solute (therefore the ZnO was heated to 850°C before being used), and by the presence of small amounts of colloidal material (therefore ultrafiltration was used before electrometric measurements were made). The solubility of ZnO was calculated from the amount of H<sub>2</sub>SO<sub>4</sub> required to dissolve the ZnO.

## AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:	SOURCE AND PURITY OF MATERIALS:
ZnO, after being heated to 850°C, was placed in conductivity water and shaken for 6-7 hours in a thermostat at 29.0°C. The mixture was then filtered, using an ultra-filter. A sample of the filtrate was added to excess H <sub>2</sub> SO <sub>4</sub> and the excess acid was determined by a potentiometric titration with KOH. Care was taken to exclude CO <sub>2</sub> .	Freshly distilled NH <sub>4</sub> OH was added to an aqueous solution of pure Zn(NO <sub>3</sub> ) <sub>2</sub> to precipitate Zn(OH) <sub>2</sub> . The Zn(OH) <sub>2</sub> was washed thoroughly and then heated at 850°C to produce ZnO. Conductivity water was used.
ESTIMATED ERROR:	The final solubility values have an uncertainty of 1 × 10 <sup>-6</sup> mol dm <sup>-3</sup> . The author attributes this to the titration procedure.
REFERENCES:	

<b>COMPONENTS:</b> (1) Zinc hydroxide; Zn(OH) <sub>2</sub> ; [20427-58-1] (2) Water; H <sub>2</sub> O; [7732-18-5]		<b>ORIGINAL MEASUREMENTS:</b> Hagisawa, H. <i>Bull. Inst. Phys. Chem. Research (Tokyo)</i> 1939, 18, 368-81.																																											
<b>VARIABLES:</b> Composition of the solvent.		<b>PREPARED BY:</b> H. Akaiwa																																											
<b>EXPERIMENTAL VALUES:</b>																																													
	Solubility product of Zn(OH) <sub>2</sub> at 298 K <sup>a</sup>																																												
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left; padding-bottom: 2px;">cm<sup>3</sup> of NaOH added</th> <th style="text-align: left; padding-bottom: 2px;">pH</th> <th style="text-align: left; padding-bottom: 2px;"><math>10^4 \text{ mol Zn(II) dm}^{-3}</math></th> <th style="text-align: left; padding-bottom: 2px;"><math>K_s o \times 10^{16}</math></th> </tr> </thead> <tbody> <tr><td style="text-align: left;">1</td><td style="text-align: left;">7.890</td><td style="text-align: left;">4.68</td><td style="text-align: left;">2.8</td></tr> <tr><td style="text-align: left;">2</td><td style="text-align: left;">7.926</td><td style="text-align: left;">4.42</td><td style="text-align: left;">3.1</td></tr> <tr><td style="text-align: left;">3</td><td style="text-align: left;">7.942</td><td style="text-align: left;">4.15</td><td style="text-align: left;">3.2</td></tr> <tr><td style="text-align: left;">4</td><td style="text-align: left;">7.965</td><td style="text-align: left;">3.89</td><td style="text-align: left;">3.3</td></tr> <tr><td style="text-align: left;">5</td><td style="text-align: left;">7.992</td><td style="text-align: left;">3.62</td><td style="text-align: left;">3.5</td></tr> <tr><td style="text-align: left;">6</td><td style="text-align: left;">8.009</td><td style="text-align: left;">3.67</td><td style="text-align: left;">3.5</td></tr> <tr><td style="text-align: left;">7</td><td style="text-align: left;">8.031</td><td style="text-align: left;">3.11</td><td style="text-align: left;">3.6</td></tr> <tr><td style="text-align: left;">8</td><td style="text-align: left;">8.053</td><td style="text-align: left;">2.86</td><td style="text-align: left;">3.7</td></tr> <tr><td style="text-align: left;">9</td><td style="text-align: left;">8.077</td><td style="text-align: left;">2.61</td><td style="text-align: left;">3.7</td></tr> <tr><td style="text-align: left;">10</td><td style="text-align: left;">8.098</td><td style="text-align: left;">2.36</td><td style="text-align: left;">3.7</td></tr> </tbody> </table>		cm <sup>3</sup> of NaOH added	pH	$10^4 \text{ mol Zn(II) dm}^{-3}$	$K_s o \times 10^{16}$	1	7.890	4.68	2.8	2	7.926	4.42	3.1	3	7.942	4.15	3.2	4	7.965	3.89	3.3	5	7.992	3.62	3.5	6	8.009	3.67	3.5	7	8.031	3.11	3.6	8	8.053	2.86	3.7	9	8.077	2.61	3.7	10	8.098	2.36	3.7
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10	8.098	2.36	3.7																																										
$\text{average } K_s o = [\text{Zn}^{2+}] a_{\text{OH}^-}^2 = (3.4 + 0.29) \times 10^{-16}$ <sup>b</sup>																																													
<sup>a</sup> 200 cm <sup>3</sup> of 0.0004955 mol dm <sup>-3</sup> ZnSO <sub>4</sub> solution was titrated with 0.00991 mol dm <sup>-3</sup> NaOH solution.																																													
<sup>b</sup> the standard deviation was calculated by the compiler.																																													
<b>AUXILIARY INFORMATION</b>																																													
<b>METHOD/APPARATUS/PROCEDURE:</b>  An aqueous ZnSO <sub>4</sub> solution was titrated with a dilute NaOH solution. The pH of the solution was measured in a cell using a glass electrode and a saturated calomel electrode. The zinc content apparently was determined by calculating the difference between the original zinc content and the amount used up by precipitation.	<b>SOURCE AND PURITY OF MATERIALS:</b>  ZnSO <sub>4</sub> was dissolved in water at 343 K and recrystallized by cooling and adding alcohol. During the recrystallization process CO <sub>2</sub> was bubbled through the solution to avoid hydration of Zn(II). The CO <sub>2</sub> was removed from the solid by drying.																																												
<b>ESTIMATED ERROR:</b>																																													
The final results have a standard deviation of 0.29.																																													
<b>REFERENCES:</b>																																													

## Zinc Oxide and Hydroxide

<b>COMPONENTS:</b>		<b>ORIGINAL MEASUREMENTS:</b>	
(1) Zinc oxide; ZnO; [1314-13-2]		Ragg, M. <i>Farbe u. Lack</i> <u>1950</u> , <u>56</u> , 435-41	
(2) Baltic Sea water			
(3) Water; H <sub>2</sub> O; [7732-18-5]			
<b>VARIABLES:</b> Composition of solvent.		<b>PREPARED BY:</b> T. P. Dirkse	
<b>EXPERIMENTAL VALUES:</b>			
Solubility of ZnO at pH = 8.0			
in distilled water		in Baltic Sea water	
<u>mg dm<sup>-3</sup></u>	<u>mol dm<sup>-3</sup><sup>a</sup></u>	<u>mg dm<sup>-3</sup></u>	<u>mol dm<sup>-3</sup><sup>a</sup></u>
6.3	$7.7 \times 10^{-5}$	2.5	$3.1 \times 10^{-5}$
<sup>a</sup> calculated by compiler			
During the first 3 hours of agitation the pH of the distilled water changed from 6.1 to 8.0. This was considered to be due to the transformation of ZnO to Zn(OH) <sub>2</sub> . During this same time interval the pH of the Baltic Sea water changed from 8.1 to 8.0. This was considered to be caused by the removal of Ca(HCO <sub>3</sub> ) <sub>2</sub> as CaCO <sub>3</sub> .			
The temperature is not specified but from the context in the article it appears to be either 15 or 18°C.			
<b>AUXILIARY INFORMATION</b>			
<b>METHOD/APPARATUS/PROCEDURE:</b> 0.5 g of ZnO were added to 100 ml of solvent. The mixture was agitated until the pH = 8. The mixture was then filtered and the filtrate was analyzed for zinc content. The analytical method is not described, but indications are that the zinc content was determined by a colorimetric method using dithizone.	<b>SOURCE AND PURITY OF MATERIALS:</b> Distilled water and filtered Baltic Sea Water were used as solvents. The ZnO was of a purified grade.		
		<b>ESTIMATED ERROR:</b> No data are given as to the reproducibility of the procedures or the results.	
		<b>REFERENCES:</b>	

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Zinc hydroxide; $\text{Zn(OH)}_2$ ; [20427-58-1] (2) Water; $\text{H}_2\text{O}$ ; [7732-18-5]	Collat, J. W. <i>Anal. Chem.</i> <u>1958</u> , <u>30</u> , 1726-9.
VARIABLES:	PREPARED BY:
Method of measuring pH.	T. P. Dirkse

## EXPERIMENTAL VALUES:

Solubility products of  $\text{Zn(OH)}_2$ 

From current-voltage experiments.

$c_{\text{Zn}^{2+}}/\text{mmol dm}^{-3}$	t/°C.	$c_{\text{KNO}_3}/\text{mol dm}^{-3}$	Solid phase <sup>a</sup>	pOH	$pK_s^o$
10.5	22	0.27	A	6.55	15.08
10.0	24	0.27	B	6.60	15.20

From zero-current potential measurements.

$c_{\text{Zn}^{2+}}/\text{mol dm}^{-3}$	t/°C.	$c_{\text{KNO}_3}/\text{mol dm}^{-3}$	Solid phase <sup>a</sup>	pH	$K_s^o$
0.00085	24	0.195	A	7.83	$3.9 \times 10^{-16}$
0.0100	24	0.168	A	7.26	$3.3 \times 10^{-16}$
0.0666	24	0	A	6.72	$1.8 \times 10^{-16}$
0.0100	24	0.170	C	7.19	$2.4 \times 10^{-16}$
0.0235	25	0.0294	C	6.98	$2.2 \times 10^{-16}$
0.0118	25	0.0648	C	7.08	$1.7 \times 10^{-16}$
0.0094	24	0.0718	D	6.71	$2.5 \times 10^{-17}$
0.0235	24	0.0295	D	6.60	$3.8 \times 10^{-17}$

<sup>a</sup> A = amorphous  $\text{Zn(OH)}_2$ ; B = aged ( $\beta_1$ )  $\text{Zn(OH)}_2$ ; C =  $\epsilon$ - $\text{Zn(OH)}_2$ ; D =  $\text{ZnO}$ .

## AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:	SOURCE AND PURITY OF MATERIALS:
The dropping mercury electrode was used to measure the pH in a solution of a quinone. The solution was buffered by the presence of $\text{Zn}^{2+}$ ions. The buffer reaction consisted of the formation of the insoluble hydroxide. An amount of $\text{HNO}_3$ calculated to give the desired concentration of $\text{Zn}^{2+}$ ions was added to $\text{Zn(OH)}_2$ or $\text{ZnO}$ . The pH of the buffered solution was measured by making the usual current-voltage measurements, and also by measuring the potential at zero current.	The quinhydrone was purified by recrystallization from hot water. Other materials used were of the purest grade available. Amorphous $\text{Zn(OH)}_2$ was prepared by adding $\text{NaOH}$ to a solution of a zinc salt. $\epsilon$ - $\text{Zn(OH)}_2$ was prepared as described by others (1).
	ESTIMATED ERROR: No details are given.
	REFERENCES: 1. Dietrich, H. G.; Johnston, J. J. <i>Am. Chem. Soc.</i> <u>1927</u> , <u>49</u> , 1419.

## Zinc Oxide and Hydroxide

<b>COMPONENTS:</b> (1) Zinc oxide; ZnO; [1314-13-2] (2) Water; H <sub>2</sub> O; [7732-18-5]								<b>ORIGINAL MEASUREMENTS:</b> Jenkins, S. H.; Keight, D. G.; Humphreys, R. E. <i>Air Water Pollution</i> 1964, 8, 537-56
<b>VARIABLES:</b> Different samples of CO <sub>2</sub> -free distilled water at room temperature.								<b>PREPARED BY:</b> T. P. Dirkse
<b>EXPERIMENTAL VALUES:</b>								
Solubility of ZnO in distilled water								
pH of H <sub>2</sub> O	temp, °C	pH of soln	C <sub>Zn</sub> , ppm	pH of soln	C <sub>Zn</sub> , ppm	pH of soln	C <sub>Zn</sub> , ppm	
8.58	20.0	7.78	0.48	7.66	0.56	7.60	0.56	
8.75	18.2	7.92	0.40	7.95	0.64	7.10	0.64	
8.90	17.0	7.56	0.33	7.80	0.22	8.24	0.24	
9.20	18.4			8.80	0.29	8.92	0.30	
8.20	22.0			8.12	0.28	8.46	0.22	
8.40	20.0			7.75	0.36	8.04	0.31	
8.31	20.0			7.68	0.68	7.98	0.39	
8.05	17.0			6.70	0.41	7.20	0.34	
7.00	16.5			7.02	0.60	7.50	0.49	
8.30	17.5			7.00	0.67	7.28	0.53	
5.80	19.0			6.71	0.46	6.90	0.32	
5.85	19.5			7.22	0.48	7.40	0.28	
<b>AUXILIARY INFORMATION</b>								
<b>METHOD/APPARATUS/PROCEDURE:</b>					<b>SOURCE AND PURITY OF MATERIALS:</b>			
ZnO was washed several times with distilled water to remove soluble impurities. The washed oxide was placed in different bottles filled with distilled water. The bottles were shaken intermittently for 3 days and then allowed to stand for 3 days to allow the suspended material to settle. Samples were removed, filtered through HA millipore filters and analyzed for zinc content colorimetrically using the dithizone method. After the first extraction the procedure was repeated many times.					The distilled water was CO <sub>2</sub> -free. The ZnO was a commercially available grade.			
					<b>ESTIMATED ERROR:</b>			
					No information is given.			
					<b>REFERENCES:</b>			

<b>COMPONENTS:</b> (1) Zinc hydroxide; $Zn(OH)_2$ ; [20427-58-1] (2) Water; $H_2O$ ; [7732-18-5]		<b>ORIGINAL MEASUREMENTS:</b> Schindler, P.; Althaus, H.; Feitknecht, W. <i>Helv. Chim. Acta</i> <u>1964</u> , 47, 982-91.				
<b>VARIABLES:</b> Type of zinc hydroxide.		<b>PREPARED BY:</b> T. P. Dirkse				
<b>EXPERIMENTAL VALUES:</b> Solubility products of zinc hydroxide at 25.0°C.						
Solid phase	$\log *K_s^o$ <sup>a</sup>	$\log K_s^o$ <sup>a</sup>	$\log *K_s^o$ <sup>b</sup>	$\log K_s^o$ <sup>b</sup>		
amorph. $Zn(OH)_2$	$12.70 \pm 0.02$	$-14.70 \pm 0.03$	$12.48 \pm 0.03$	$-15.52 \pm 0.03$		
$\beta_1-Zn(OH)_2$	11.98	-15.42	11.76	-16.24		
$\beta_2-Zn(OH)_2$	12.02	-15.38	11.80	-16.20		
$\gamma-Zn(OH)_2$	11.96	-15.44	11.74	-16.26		
$\delta-Zn(OH)_2$	12.07	-15.33	11.85	-16.15		
$\epsilon-Zn(OH)_2$	11.75	-15.65	11.53	-16.47		
active $ZnO^c$	11.56	-15.84	11.34	-16.66		
inactive $ZnO^d$	11.39	-16.01	11.17	-16.83		
<sup>a</sup> These values were determined experimentally in solutions containing 0.2 mol $KNO_3$ $dm^{-3}$ or 0.2 mol $NaClO_4$ $dm^{-3}$ .						
<sup>b</sup> These values were calculated for infinite dilution from the free energy of formation and $E^\circ$ for the zinc electrode.						
<sup>c</sup> Active $ZnO$ was formed by adding an equivalent amount of $NaOH$ to a solution of $Zn(ClO_4)_2$ and allowing the precipitate to stand for several days at room temperature.						
<sup>d</sup> Inactive $ZnO$ was formed by heating the $ZnO$ at 900°C.						
Note: $K_s^o = C_{Zn}^{2+} (a_{OH^-})^2$ .						
<b>AUXILIARY INFORMATION</b>						
<b>METHOD/APPARATUS/PROCEDURE:</b> Solutions were equilibrated at 25°C with the selected solid phase. The solid phases were: amorphous $Zn(OH)_2$ ; $\beta_1-Zn(OH)_2$ ; $\beta_2-Zn(OH)_2$ ; $\gamma-Zn(OH)_2$ ; $\delta-Zn(OH)_2$ ; $\epsilon-Zn(OH)_2$ ; active and inactive $ZnO$ . The hydrogen ion concentration in these solutions was measured by an e.m.f. measurement. The zinc content was determined by a compleximetric titration. From these results the value of $*K_s^o = [Zn^{2+}]/[H^+]^2$ was determined. The relationship $\log K_s^o = \log *K_s^o + 2\log K_w$ allows the solubility products to be calculated. $\log K_s^o = -13.70 \pm 0.2$ at 25°C. in 0.2 mol $KNO_3$ $dm^{-3}$ .	<b>SOURCE AND PURITY OF MATERIALS:</b> All materials were of reagent grade quality.					
<b>ESTIMATED ERROR:</b> The authors state that the uncertainty in the results was generally less than 0.1%.						
<b>REFERENCES:</b>						

COMPONENTS: (1) Cadmium oxide; CdO; [1306-19-0] (2) Water; H <sub>2</sub> O; [7732-18-5]	ORIGINAL MEASUREMENTS: Remy, H; Kuhlman, A. Z. anal. Chem. <u>1924</u> , <u>66</u> , 161-81.	
VARIABLES: Method of measuring the solubility of CdO in water at 20°C.	PREPARED BY: T. P. Dirkse	
EXPERIMENTAL VALUES:		
Solubility of CdO in water at 20°C.		
Method	$\text{mol CdO dm}^{-3}$	$\text{mg CdO dm}^{-3}$
specific conductance	$3.90 \times 10^{-5}$	5.00
conductimetric titration	$3.74 \times 10^{-5}$	4.80
AUXILIARY INFORMATION		
METHOD/APPARATUS/PROCEDURE: Hot CdO is added to water and the mixture shaken. Two methods are used to calculate the solubility; (1) from the measured specific conductance and literature values for ionic conductances; (2) a conductimetric titration with H <sub>2</sub> SO <sub>4</sub> . The point of the work is to note the contribution of dissolved CO <sub>2</sub> to the conductance and how to correct for this.	SOURCE AND PURITY OF MATERIALS: Reagent grade CdO and conductivity water were used.	
ESTIMATED ERROR: The temperature was not controlled but varied between 19 and 21°C. In the titration results, the uncertainty was 1% of the value reported.		
REFERENCES:		

## Cadmium Oxide and Hydroxide

<b>COMPONENTS:</b> (1) Cadmium hydroxide; Cd(OH) <sub>2</sub> ; [21041-95-2] (2) Water; H <sub>2</sub> O; [7732-18-5]		<b>ORIGINAL MEASUREMENTS:</b> Moeller, T.; Rhymer, P. W.; <i>J. Phys. Chem.</i> <u>1942</u> , 46, 477-85.
<b>VARIABLES:</b> Composition of solvent at 25°C		<b>PREPARED BY:</b> T. P. Dirkse
<b>EXPERIMENTAL VALUES:</b>		
Solubility product <sup>a</sup> of cadmium hydroxide at 25°C		
$\frac{c_{\text{OH}^-}}{c_{\text{Cd}^{2+}}}$	pH	$10^{14} K_s^o$
0.2	8.13	3.1
0.4	8.18	3.4
0.6	8.21	3.3
0.8	8.23	3.0
1.0	8.26	2.8
1.2	8.32	2.8
1.4	8.40	3.0
1.6	8.52	3.3
$^a K_s^o = c_{\text{Cd}^{2+}} \cdot (a_{\text{OH}^-})^2$		
Salts other than Cd(NO <sub>3</sub> ) <sub>2</sub> were also used but Cd(NO <sub>3</sub> ) <sub>2</sub> gave the purest form of precipitated Cd(OH) <sub>2</sub> .		
In calculating K <sub>s</sub> <sup>o</sup> the ionic product constant of water at 25°C was taken as $1 \times 10^{-14}$ .		
Using the expression $S = \sqrt[3]{K_s^o/4}$ the solubility of Cd(OH) <sub>2</sub> in water at 25°C is calculated to be $2 \times 10^{-5}$ mol dm <sup>-3</sup> .		
<b>AUXILIARY INFORMATION</b>		
<b>METHOD/APPARATUS/PROCEDURE:</b> 10 mol of 0.0996 mol dm <sup>-3</sup> Cd(NO <sub>3</sub> ) <sub>2</sub> was diluted to 50 ml with water, thermostated at 25 ± 0.5°C, stirred vigorously, and titrated with 0.1 mol dm <sup>-3</sup> carbonate-free NaOH or KOH. The pH of the solution was measured with a glass electrode. The values chosen were in the region where Cd(OH) <sub>2</sub> had precipitated from the solution.	<b>SOURCE AND PURITY OF MATERIALS:</b> All materials were of reagent grade quality. The water was CO <sub>2</sub> -free.	
		<b>ESTIMATED ERROR:</b> No details are given about the reproducibility of any of the measurements.
	<b>REFERENCES:</b>	



COMPONENTS:	ORIGINAL MEASUREMENTS:					
(1) Mercury(II) oxide; HgO; [21908-53-2]	Ragg, M. <i>Farbe u. Lack</i> <u>1950</u> , 56, 435-41					
(2) Baltic Sea water						
(3) Water; H <sub>2</sub> O; [7732-18-5]						
VARIABLES:	PREPARED BY:					
Solvent composition at 18°C and pH = 8.3-8.5	T. P. Dirkse					
EXPERIMENTAL VALUES:						
Solubility of HgO at 18°C <sup>b</sup>						
distilled water		Baltic Sea water				
g HgO dm <sup>-3</sup>	mol HgO dm <sup>-3</sup> <sup>a</sup>	g HgO dm <sup>-3</sup>	mol HgO dm <sup>-3</sup> <sup>a</sup>			
yellow HgO	0.0500	2.3 x 10 <sup>-4</sup>	0.2188			
red HgO	0.0515	2.4 x 10 <sup>-4</sup>	0.1881			
<sup>a</sup> calculated by compiler						
<sup>b</sup> There is a question about the reliability of the values in this Table because later in this article, Table 1 gives a summary of all the experimental results and there the following values are given.						
Compound		solubility in mg dm <sup>-3</sup>				
distilled water		Baltic Sea water				
red HgO	51.5	219				
yellow HgO	52.0	288				
Nowhere in the article is this discrepancy discussed.						
AUXILIARY INFORMATION						
METHOD/APPARATUS/PROCEDURE:	SOURCE AND PURITY OF MATERIALS:					
Both yellow and red HgO were used. 0.5 g of the HgO was added to 1 liter of solvent and the mixture was shaken for 48 hours at 18°C. The mixture was then filtered and the filtrate was analyzed for mercury content by adding H <sub>2</sub> S and weighing the HgS that was formed.	Distilled water and filtered Baltic Sea water were used as solvents.					
ESTIMATED ERROR: No information is given about reproducibility of temperature control or any of the procedures. Furthermore, the data given in the body of the report do not agree with those given in a summarizing Table.						
REFERENCES:						