COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Zinc oxide; ZnO; [1314-13-2] (2) Water; H_2O; [7732-18-5]	Remy, H.; Kuhlmann, A. *Z. Anal. Chem.* 1924, *65*, 161-81.
VARIABLES:	**PREPARED BY:**
Method of measuring the solubility of ZnO in water.	T. P. Dirkse

EXPERIMENTAL VALUES:

Solubility of ZnO in water at 20°C.

method	mol ZnO dm^{-3}	mg ZnO dm^{-3}
conductimetric titration	3.58×10^{-5}	2.92
specific conductance	3.76×10^{-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:

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_2SO_4. The main concern in this work was to note and correct for the contribution of dissolved CO_2.

SOURCE AND PURITY OF MATERIALS:

ZnO was produced by heating the precipitate that was formed when freshly distilled NH_4OH was added to an aqueous solution of pure $Zn(NO_3)_2$. 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:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Zinc oxide; ZnO; [1314-13-2] (2) Water; H_2O; [7732-18-5]	Busch, W. *Z. Anorg. Allgem. Chem.* 1927, *161*, 161-79.
VARIABLES:	**PREPARED BY:**
All work was done at 29.0°C.	T. P. Dirkse

EXPERIMENTAL VALUES:

Solubility of ZnO in water at 29.0°C.

ml of solution used	130
ml H_2SO_4 added	20
factor of H_2SO_4	1.019×10^{-3} [a]
factor of KOH	1.151×10^{-3} [a]
ml of KOH needed for back titration	13.36
dissolved ZnO	1.92×10^{-5} mol dm^{-3}

[a] 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_2SO_4 required to dissolve the ZnO.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

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 ultrafilter. A sample of the filtrate was added to excess H_2SO_4 and the excess acid was determined by a potentiometric titration with KOH. Care was taken to exclude CO_2.

SOURCE AND PURITY OF MATERIALS:

Freshly distilled NH_4OH was added to an aqueous solution of pure $Zn(NO_3)_2$ to precipitate $Zn(OH)_2$. The $Zn(OH)_2$ 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^{-6} mol dm^{-3}. The author attributes this to the titration procedure.

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Zinc hydroxide; $Zn(OH)_2$; [20427-58-1] (2) Water; H_2O; [7732-18-5]	Hagisawa, H. *Bull. Inst. Phys. Chem. Research (Tokyo)* 1939, *18*, 368-81.
VARIABLES: Composition of the solvent.	**PREPARED BY:** H. Akaiwa

EXPERIMENTAL VALUES:

Solubility product of $Zn(OH)_2$ at 298 K[a]

cm^3 of NaOH added	pH	10^4 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

average $K_s o = [Zn^{2+}]\ a^2_{OH-} = (3.4 \pm 0.29) \times 10^{-16}$ [b]

[a] 200 cm^3 of 0.0004955 mol dm^{-3} $ZnSO_4$ solution was titrated with 0.00991 mol dm^{-3} NaOH solution.

[b] the standard deviation was calculated by the compiler.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

An aqueous $ZnSO_4$ 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.

SOURCE AND PURITY OF MATERIALS:

$ZnSO_4$ was dissolved in water at 343 K and recrystallized by cooling and adding alcohol. During the recrystallization process CO_2 was bubbled through the solution to avoid hydration of Zn(II). The CO_2 was removed from the solid by drying.

ESTIMATED ERROR:

The final results have a standard deviation of 0.29.

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Zinc oxide; ZnO; [1314-13-2] (2) Baltic Sea water (3) Water; H_2O; [7732-18-5]	Ragg, M. *Farbe u. Lack* 1950, *56*, 435-41
VARIABLES: Composition of solvent.	**PREPARED BY:** T. P. Dirkse

EXPERIMENTAL VALUES:

Solubility of ZnO at pH = 8.0

in distilled water		in Baltic Sea water	
mg dm^{-3}	mol dm^{-3} [a]	mg dm^{-3}	mol dm^{-3} [a]
6.3	7.7×10^{-5}	2.5	3.1×10^{-5}

[a] 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 $Zn(OH)_2$. 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 $Ca(HCO_3)_2$ as $CaCO_3$.

The temperature is not specified but from the context in the article it appears to be either 15 or 18°C.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

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.

SOURCE AND PURITY OF MATERIALS:

Distilled water and filtered Baltic Sea Water were used as solvents. The ZnO was of a purified grade.

ESTIMATED ERROR:

No data are given as to the reproducibility of the procedures or the results.

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Zinc hydroxide; $Zn(OH)_2$; [20427-58-1] (2) Water; H_2O; [7732-18-5]	Collat, J. W. *Anal. Chem.* 1958, *30*, 1726-9.
VARIABLES:	**PREPARED BY:**
Method of measuring pH.	T. P. Dirkse

EXPERIMENTAL VALUES:

Solubility products of $Zn(OH)_2$

From current-voltage experiments.

$C_{Zn^{2+}}$/mmol dm^{-3}	t/°C.	C_{KNO_3}/mol dm^{-3}	Solid phase[a]	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.

$C_{Zn^{2+}}$/mol dm^{-3}	t/°C.	C_{KNO_3}/mol dm^{-3}	Solid phase[a]	pH	K_s^o
0.00085	24	0.195	A	7.83	3.9×10^{-16}
0.0100	24	0.168	A	7.26	3.3×10^{-16}
0.0666	24	0	A	6.72	1.8×10^{-16}
0.0100	24	0.170	C	7.19	2.4×10^{-16}
0.0235	25	0.0294	C	6.98	2.2×10^{-16}
0.0118	25	0.0648	C	7.08	1.7×10^{-16}
0.0094	24	0.0718	D	6.71	2.5×10^{-17}
0.0235	24	0.0295	D	6.60	3.8×10^{-17}

[a] A = amorphous $Zn(OH)_2$; B = aged (β_1) $Zn(OH)_2$; C = ε-$Zn(OH)_2$; D = ZnO.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The dropping mercury electrode was used to measure the pH in a solution of a quinone. The solution was buffered by the presence of Zn^{2+} ions. The buffer reaction consisted of the formation of the insoluble hydroxide. An amount of HNO_3 calculated to give the desired concentration of Zn^{2+} ions was added to $Zn(OH)_2$ or 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.

SOURCE AND PURITY OF MATERIALS:

The quinhydrone was purified by recrystallization from hot water. Other materials used were of the purest grade available. Amorphous $Zn(OH)_2$ was prepared by adding NaOH to a solution of a zinc salt. ε-$Zn(OH)_2$ was prepared as described by others (1).

ESTIMATED ERROR:

No details are given.

REFERENCES:

1. Dietrich, H. G.; Johnston, J. *J. Am. Chem. Soc.* 1927, *49*, 1419.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Zinc oxide; ZnO; [1314-13-2] (2) Water; H_2O; [7732-18-5]	Jenkins, S. H.; Keight, D. G.; Humphreys, R. E. *Air Water Pollution* 1964, *8*, 537-56
VARIABLES: Different samples of CO_2-free distilled water at room temperature.	**PREPARED BY:** T. P. Dirkse

EXPERIMENTAL VALUES:

Solubility of ZnO in distilled water

		Bottle 1		Bottle 2		Bottle 3	
pH of H_2O	temp, °C	pH of soln	C_{Zn}, ppm	pH of soln	C_{Zn}, ppm	pH of soln	C_{Zn}, 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

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:	SOURCE AND PURITY OF MATERIALS:
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_2-free. The ZnO was a commercially available grade.
	ESTIMATED ERROR: No information is given.
	REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Zinc hydroxide; $Zn(OH)_2$; [20427-58-1] (2) Water; H_2O; [7732-18-5]	Schindler, P.; Althaus, H.; Feitknecht, W. *Helv. Chim. Acta* 1964, 47, 982-91.
VARIABLES:	PREPARED BY:
Type of zinc hydroxide.	T. P. Dirkse

EXPERIMENTAL VALUES:

Solubility products of zinc hydroxide at 25.0°C.

Solid phase	log $*K_s o$[a]	log $K_s o$[a]	log $*K_s o$[b]	log $K_s o$[b]
amorph. $Zn(OH)_2$	12.70 ± 0.02	-14.70 ± 0.03	12.48 ± 0.03	-15.52 ± 0.03
β_1-$Zn(OH)_2$	11.98	-15.42	11.76	-16.24
β_2-$Zn(OH)_2$	12.02	-15.38	11.80	-16.20
γ-$Zn(OH)_2$	11.96	-15.44	11.74	-16.26
δ-$Zn(OH)_2$	12.07	-15.33	11.85	-16.15
ε-$Zn(OH)_2$	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

[a] These values were determined experimentally in solutions containing 0.2 mol KNO_3 dm^{-3} or 0.2 mol $NaClO_4$ dm^{-3}.

[b] These values were calculated for infinite dilution from the free energy of formation and E° for the zinc electrode.

[c] 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.

[d] Inactive ZnO was formed by heating the ZnO at 900°C.

Note: $K_s o = C_{Zn^{2+}} (a_{OH^-})^2$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:	SOURCE AND PURITY OF MATERIALS:
Solutions were equilibrated at 25°C with the selected solid phase. The solid phases were: amorphous $Zn(OH)_2$; β_1-$Zn(OH)_2$; β_2-$Zn(OH)_2$; γ-$Zn(OH)_2$; δ-$Zn(OH)_2$; ε-$Zn(OH)_2$; 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 complexiметric 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. $\log K_w = -13.70 \pm 0.2$ at 25°C. in 0.2 mol KNO_3 dm^{-3}.	All materials were of reagent grade quality.
	ESTIMATED ERROR:
	The authors state that the uncertainty in the results was generally less than 0.1%.
	REFERENCES: