peratures, but agree well with his at the higher temperatures. The values for anhydrite at rounded temperatures presented in Table VII were obtained by passing a smooth curve through our points and the 218° point of Melcher (Fig. 4). The values for soluble anhydrite were obtained from a smooth curve the position of which was determined by the data of Boyer-Guillon, Melcher and the writers.

TABLE VII

SOLUBILITY OF ANHYDRITE AND SOLUBLE ANHYDRITE AT ROUNDED TEMPERATURES (PARTS PER MILLION)

Temp., °C.	100	120	140	160	180	200	220
Anhydrite	850	587	372	226	130	75	56
Sol. anhydrite	1630	1015	640	410	265	165	...

Summary

Direct determinations have been made of the solubility of anhydrite and soluble anhydrite at temperatures characteristic of boiler waters. The values for soluble anhydrite agree with those of Boyer-Guillon and Melcher; those for anhydrite agree well with Melcher's values at higher temperatures, but not so well with those at lower temperatures.

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[CONTRIBUTION FROM THE KENT CHEMICAL LABORATORY OF THE UNIVERSITY OF CHICAGO]

THE ISOTOPIC COMPOSITION AND ATOMIC WEIGHT OF CHLORINE FROM METEORITES AND FROM MINERALS OF NON-MARINE ORIGIN

(Papers on Atomic Stability)

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1. Introduction. Constancy of the Isotopic Composition of the Element

According to the Whole Number rule of Harkins and Wilson[1] the atomic weights of individual atomic species are whole numbers, with a precision of about 0.1%. On this basis the present atomic weight of ordinary chlorine, 35.457, indicates a composition of 77.15% of chlorine of isotopic number 1, and 22.85% of isotopic number 3.

The investigation described here was undertaken in order to determine to what extent the constancy of composition previously observed in chlorine of marine origin, which might be explained as due to mixing, is exhibited in the chlorine of the meteorites, which has probably never been thoroughly mixed with the terrestrial element.

As a secondary feature of the work the atomic weight of the element

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[1] Harkins and Wilson, THIS JOURNAL, **37**, 1367 (1915).

as found in three minerals of non-marine origin, apatite, wernerite and sodalite, was also determined. Similar determinations, but with methods which involved considerably larger errors, have been made by Gleditsch and Samdahl,[2] Gleditsch,[3] I. Curie[4] and M. Dorenfeldt.[5] The work of Gleditsch indicates a probability that in apatite the atomic weight of the chlorine is within 0.02 unit of that of the ordinary element.

2. Meteoric Chlorine

The chlorine used for the determination of the atomic weight was obtained from a meteorite secured from the National Museum through the courtesy of Dr. George P. Merrill, Curator of Geology, a noted authority on the chemical composition of meteorites. Both Dr. Merrill and Dr. O. C. Farrington, another well-known worker on the same subject, consider that the chlorine was certainly of meteoric origin.

3. Treatment of the Meteorite and the Minerals

Hydrochloric acid was obtained from the finely ground material of the meteorite and of the minerals by heating it for several days with 10% solution of sulfuric acid. The hydrogen chloride was finally expelled as a gas, and was collected in pure water. The chlorine was precipitated as silver chloride, and this was dissolved in ammonia, and again precipitated by the addition of nitric acid. This process was repeated, with the appropriate filtrations of the solutions and washing of the precipitates, until no visible impurities remained. The dried precipitate was heated with sulfuric acid in a Pyrex flask and the hydrogen chloride collected in conductivity water. The hydrochloric acid was then freed from any iodine and bromine which might have been present, by a fractional distillation from potassium permanganate in the usual way. The acid finally obtained was found to be free from bromine and iodine.

4. Method for the Determination of the Atomic Weight

Since the amount of chlorine present in the meteorite, and in the other minerals, with the exception of the chlorapatite, was quite small, it was necessary to use a method capable of yielding the accuracy desired, without the use of large amounts of chlorine. This was especially necessary in the case of the meteoric chlorine, where the total available chlorine was less than 6 g.

The method chosen consisted in a determination of the amount of silver chloride formed from a known amount of silver. A silver button of approximately 2g. weight, was placed in a quartz flask of 100 cc. capacity. The flask had a round bottom, and a neck 12 cm. long and about 1 cm. in diameter.

The silver was then covered with 10 cc. of nitric acid of the concentration obtained by distillation and allowed to stand overnight on a hot-plate

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[2] Gleditsch and Samdahl, *Compt. rend.*, **174**, 746 (1922).

[3] Gleditsch, *J. chim. phys.*, **21**, 456 (1924).

[4] Curie, *Compt. rend.*, **172**, 1025 (1921).

[5] Dorenfeldt, THIS JOURNAL, **45**, 1577 (1923).

heated to 70°. Although solution took place so slowly that no spray was emitted, the neck of the flask was always kept covered. The cover was later removed and washed into the flask. Water was then added to make the silver nitrate as dilute as possible, after which a 25 to 50% excess of hydrochloric acid was added.

The flask was then allowed to stand on the hot-plate for eight hours. The excess of liquid was evaporated by passing a slow current of clean dry air through the heated flask. The air used was first passed through columns of soda lime, sulfuric acid, a potassium hydroxide solution, glass wool, and a very long tube of absorbent cotton, and then through an electrically heated Pyrex tube. It was entirely free from dust. The current of air was passed for many hours into a moist flask. When this flask was dried it exhibited no increase in weight.

The solution of the silver and all processes involving the silver chloride were carried out in a large carefully darkened box, which excluded the light in a very efficient manner. The silver chloride dried in this manner was always obtained as a completely white precipitate, although an occasional unused sample showed slight traces of darkening when it had been in contact with the flask.

The dried silver chloride was not entirely free from occluded water and lost from 0.01 to 0.04% of weight on fusion in air. This corresponds to the experience of Richards and Wells[6] who found that silver chloride dried at 150° occluded at times as much as 0.01% of water.

The dried silver chloride was then fused in air and weighed. It was next fused in a mixture of hydrogen chloride and chlorine and reweighed. The weight of the silver chloride[7] was divided by the weight of silver used, to obtain the ratio of silver chloride to silver. In the chlorination of the fused silver chloride, both the chlorine and hydrogen chloride were obtained from pure sodium chloride of marine origin. Since the average increase in weight due to this treatment was only 0.007 mg. per g. of silver chloride, it is obvious that the use of normal chlorine could not introduce any error. The magnitude of the error thus introduced can be readily calculated. If the chlorine which was being analyzed had an atomic weight of 35.50 and it gained 0.007 mg. per g. of silver chloride after fusion in an atmosphere of normal chlorine and hydrogen chloride, then after fusion in an atmosphere of isotopic chlorine and hydrogen chloride, the increase in weight would have been 0.00701 mg. per g. of silver chloride. Even in this extreme case the difference would have been negligible.

Since this method avoids any transfer of material it makes possible a high degree of accuracy with the use of only small amounts of material.

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[6] Richards and Wells, *Carnegie Inst. Pub.*, **28**, 38 (1905).

[7] The further treatment of the fused silver chloride is described in Section 10, "Treatment of the Fused Silver Chloride."

A similar method had previously been employed by Stas, using glass vessels. As a check on their other methods, all of which involved a transfer of material, Richards and Wells[8] used a modification of the method of Stas. Hydrogen chloride gas was brought in contact with a silver nitrate solution which was in a quartz crucible, and the silver chloride formed was weighed in the same crucible. The average of three determinations for the ratio of silver chloride to silver was 1.328673. The average of their determinations involving transference of the precipitate was 1.328668. The probable error according to the method of least squares was 0.000005, so the two methods may be considered to yield identical results.

5. Preparation of Pure Silver

The methods and the materials used for the preparation of pure silver were so nearly those used by Richards and Wells that a description of this work is not necessary. The silver was prepared by S. B. Stone in the Chemical Laboratory of the University of Michigan by means of apparatus that had been used by Professors Willard and McAlpine in their work on atomic weights.

6. Balance and Weighing

The balance used in this work was made especially for the purpose by Ainsworth and Company. It was supported by a concrete pier, and was surrounded by a large metal case, *outside* of which the temperature was kept constant to 0.2° for the day. The deflection of the beam was determined by the use of a ray of light from a mirror mounted adjacent to the central knife edge, and this made it possible to read the zero point to within a deflection which corresponded to a weight of 0.003 mg.

The weights were standardized by the method of Richards, both before and during the progress of the work. Vacuum corrections were applied whenever platinum weights were balanced against brass.

On account of the necessity of using only small amounts of material, the accuracy of the weighing is a more significant source of error than in ordinary atomic-weight determinations and it will therefore be discussed in detail.

The major portion of the weighed flask was balanced by a tare, consisting of a quartz flask of the same size and shape. Both flask and tare were carefully heated before being weighed to expel any adsorbed moisture. The heating of the tare was found to be a necessary precaution, since under unfavorable conditions of humidity it was observed to increase in weight by as much as 0.10 mg. in the course of three days. This increase was due to moisture adsorbed on the inner walls. That a dry quartz flask adsorbs moisture only very slowly after the elapse of 40 minutes after heating is shown by the data in Table I.

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[8] Ref. 6, p. 65.

TABLE I

ADSORPTION OF MOISTURE BY A QUARTZ FLASK

Date	Weight of tare	Remarks
May 5	38.69893	Rainy day, tare not heated
6	38.69894	Rainy day, tare not heated
6	38.69890	Rainy day, tare heated at 2 P.M. weighed 2:40
6	38.69891	Rainy day, 3:00 P.M.
6	38.69893	3:45 P.M.
6	38.69893	4:10 P.M.
7	38.69891	Clear day, tare not heated

The method of weighing was as follows. The flask was carefully wiped with soft, lintless cloth, from which all the sizing had been removed by washing several times. After being heated it was then balanced to within 0.05 mg. and after 45 minutes the zero point was observed. Readings of the zero point were then taken at 10-minute intervals until a value constant to 0.003 mg. (the error involved in reading) was obtained. By this method it was possible to weigh the same flask on different days even when not balanced by a tare, and obtain weights concordant to 0.02 mg. For the reduction of weights in air to weights in a vacuum, the tables used by Richards and Wells[6] in their determination of the ratio of silver chloride to silver were employed.

7. Materials Used

Conductivity water prepared by distilling ordinary distilled water over potassium permanganate was used for all the determinations. The nitric acid used was distilled thrice from an apparatus made entirely of Pyrex glass. The first and last third fractions were rejected from each distillate. The hydrochloric acid used for comparison was distilled after the addition of a few crystals of potassium permanganate, and then doubly distilled as before. The distillations were conducted in a room free from all laboratory fumes, and care was taken to exclude dust at all stages of the distillation. All liquids were then stored in resistance glass containers, which had previously been soaked for a month or more with the same liquids.

8. Residues in the Liquids

The weight of silver chloride obtained was always corrected for the residues present in the water and acids employed in the analysis. The residue correction was obtained by taking the average of several blank determinations, under the same conditions as in an actual analysis. The correction thus determined was either 0.03 or 0.05 mg. and remained constant for several weeks. By mistake, three of the determinations made on sodalite, and also two of those on comparison hydrochloric acid were made with liquids whose residue corrections were 0.26 and 0.52 mg., respectively. In spite of the large corrections these determinations agree extremely well with those whose corrections were very small.

9. Adsorption by Silver Chloride

The silver chloride first precipitated was formed in the presence of silver nitrate of about 0.2 *N* concentration, and to aid in reducing occlusion of the nitrate in the chloride, the solution of hydrogen chloride was added rapidly, and *an excess of 25 to 50% of the chloride was used.* The solution was allowed to stand on a hot-plate at 80° for eight hours in the dark, and was then evaporated as previously described.

The silver chloride which was formed showed *no trace* of darkening either before or after fusing, and this indicates that the amount of silver nitrate occluded is very small indeed. Even when the hydrogen chloride was added while undissolved solid silver nitrate was present, the ratio of silver chloride to silver was obtained as 1.32868, provided the final dilution was as great as in the ordinary determinations, if the excess of hydrogen chloride was as great as usual. This same ratio was obtained in both of the two experiments conducted in this way. When, however, the silver chloride was precipitated in a solution initially 0.6 N with respect to silver nitrate and only a *slight* excess of hydrogen chloride was added, then the fused silver chloride was darkened, and in one experiment the above ratio was found to be as high as 1.32879.

10. Treatment of the Fused Silver Chloride

The fused silver chloride was refused in a mixture of chlorine and hydrogen chloride gas, according to the practice of Richards and Wells. A summary of the mean changes in weight for each substance used is given in Table II.

TABLE II

MEAN GAIN IN WEIGHT PER GRAM OF SILVER CHLORIDE CAUSED BY FUSION IN A MIXTURE OF CHLORINE AND HYDROGEN CHLORIDE

	Apatite	Sodalite	Wernerite	Ordinary HCl	Meteorite	Average
Mg.	0.01	0.00_8	0.00_3	0.00_4	0.01	0.007

The average increase obtained by Richards and Wells is given as 0.01_1 mg.

If the gain of weight in such a fusion is specially large, a part of the increase may disappear if the chloride is fused once more, as is illustrated in Table III.

TABLE III

CHANGE OF WEIGHT OF FUSED SILVER CHLORIDE IN ADDITIONAL FUSIONS

Increase in weight of fused silver chloride on fusion in chlorine and hydrogen chloride, mg.	Decrease in weight on standing overnight and additional fusion, mg.	Decrease per gram of silver chloride, mg.
0.01	0.00	0.00
.04	.00	.00
.07	.01	$.00_3$
.07	.01	$.00_3$
.09	.01	$.00_3$

Table IV exhibits the results obtained by three fusions of an eight gram sample of silver chloride in air.

TABLE IV

LOSS OF WEIGHT OF SILVER CHLORIDE ON FUSION IN AIR

	Wt. of AgCl, g. chloride	Decrease, mg.	Decrease, mg. per g. of AgCl
After fusion in chlorine and hydrogen chloride	8.47430	..	...
After first fusion in air	8.47430	0.00	0.00
After second fusion in air	8.47425	.05	$.00_6$
After third fusion in air	8.47424	.01	$.00_1$

In order to avoid an increase in weight of the silver chloride used in the atomic-weight determinations due to a solution of chlorine or hydrogen chloride, the silver salt was fused in air subsequent to the fusion in these gases. It was then allowed to stand overnight, and was again fused in air. The weight thus obtained was found to be constant upon a repetition of the process provided, of course, that the temperature was not unduly high.

In additional experiments the silver chloride was fused and the fused salt heated to a temperature at which it volatilized rapidly so that the condensed salt could be seen in the lower end of the neck of the flask. Even this severe treatment in no case produced a loss of more than 0.02 mg. per g. of silver chloride. Such a loss would correspond to a difference of 0.002 unit of atomic weight of chlorine. A summary of the results is given in Table V.

TABLE V

LOSS OF WEIGHT ON HEATING SILVER CHLORIDE TO TEMPERATURE OF MODERATELY RAPID VOLATILIZATION

Fused in	Wt. of AgCl, g.	Change in wt., mg.	Change in wt. per g. of AgCl
Chlorine	4.36690	....	.....
Air	4.36685	−0.05	-0.01_1
Air	4.36682	− .03	$-.00_7$
Air	4.36680	− .02	$-.00_4$
Air	4.36671	− .09	$-.02_1$
Air	4.36664	− .07	$-.01_6$
Chlorine	2.99619	....	.....
Air	2.99619	.00	.00
Chlorine	1.55099	....	.....
Air	1.55100	+ .01	$+.00_6$

The constancy of weight on repeated fusions, together with the fact that only slight losses in weight occurred during a much stronger heating than was actually used in the determinations, demonstrates that no correction need be applied for the volatilization of silver chloride. This agrees with the conclusions of Richards and Wells[9] and also with the results of Biltz and Victor Meyer[10] who found that silver chloride was only slightly volatile at temperatures much higher than the melting point.

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[9] Ref. 6, p. 60.

[10] Biltz and Victor Meyer, *Ber.*, **22**, 727 (1889).

11. The Final Determinations

After we had become satisfied concerning the reliability of this method, the preliminary determinations were rejected, and only the new values used. As a check on the accuracy of the results, the silver chloride remaining from the analyses of the meteorite, and of each mineral, was treated with sulfuric acid. The hydrochloric acid thus recovered was then distilled several times, in a small distilling apparatus made entirely of Pyrex glass. This hydrochloric acid was used for further determinations. A summary of all the results is given in Tables VIII to XII. In Table VI, the average values for the determinations are given.

The average of all the results for the ratio of silver chloride to silver is 1.32867_7, which is identical within the probable error (0.00000_2) with the present accepted value of $1.32867 \pm 0.00000_5$. By using the same method, and the same comparison hydrochloric acid, with specimens of the same silver, Dr. F. Jenkins obtained as an average the value 1.32867. In these determinations the silver chloride was not fused in hydrogen chloride and chlorine, so if we add to Dr. Jenkins' value the average gain in weight produced by this treatment, the corrected value 1.32867_9 is almost identical with our average value.

Since our determinations with sodalite were carried out under slightly less perfect conditions than those on wernerite, apatite and hydrochloric acid obtained from sodium chloride, the best result for the atomic weight of *terrestrial chlorine* as obtained by us is 35.457_4, the mean value obtained in work on these three substances.

TABLE VI

THE ATOMIC WEIGHT OF CHLORINE

Source	Ratio AgCl:Ag	At. wt. of Cl	Probable error Each detn.	Probable error Av. value
Meteorite	1.32868_0	35.458_0	0.00001_2	0.00000_5
Apatite	1.32867_4	35.457_4	$.00000_9$	$.00000_3$
Sodalite	1.32868_0	35.458_0	$.00001_9$	$.00000_7$
Wernerite	1.32867_4	35.457_4	$.00001_2$	$.00000_4$
Salt	1.32867_4	35.457_4	$.00001_2$	$.00000_4$

In obtaining the average values it was necessary to reject one determination on the chlorine obtained from apatite, which gave a value for the ratio of silver chloride to silver of 1.32890. That this is permissible was shown by applying Chauvenet's criterion[11] to our data. According to this test any of our values for the ratio of silver chloride to silver above 1.32872 or below 1.32863 would not be regarded as reliable.

As a further check on the accuracy of the data, the following method was used. According to the theory of errors,[12] $\pi|\bar{\delta}|^2$ should be approximately

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[11] Mellor, "Higher Mathematics," 1st ed., **1902,** p. 476.

[12] Wilson, "Advanced Calculus," 1st ed., **1911,** p. 390.

equal to $2\,\bar{\delta}^1$. Here $|\tilde{\delta}|$ is the average deviation from the mean, and $\bar{\delta}^2$ is the average square of the deviations. Only an approximate equality can be expected in the case of the different substances, where only seven or eight determinations were made. However, for the average of all our 36 results a very high degree of concordance was found (Table VII).

Table VII

Test of Reliability of Data on the Ratio of Silver Chloride to Silver

Source	Meteorite	Sodalite	Wernerite	Apatite	NaCl	Av.
$\pi\|\tilde{\delta}\| \times 10^{12}$	64	125	43	35	72	72
$2\,\bar{\delta}^2 \times 10^{12}$	57	125	51	28	51	70

12. Discussion of Results

The atomic weight of the chlorine present in the meteorite is identical to within 0.000_5 of a unit of atomic weight with that of terrestrial chlorine. Presumably the material of meteorites has not been mixed with that on earth during the last few billion years. Therefore, if during this period there has been any disintegration or formation of chlorine atoms it has either not affected at all the relative ratio of the two isotopes, or the relative amounts have been altered in the same manner in both places. The possibility that the coincidence is accidental seems to be ruled out by the similar results of Baxter[13] who found that the atomic weight of meteoric nickel is within 0.02 unit of that found on earth.

While the observed constancy of the atomic weight of terrestrial chlorine has been explained by Aston[14] as due to an original mixing of the materials in the sea it does not appear plausible that such an hypothesis could account for the similar results obtained with meteoric elements. An alternative explanation can be based upon the hydrogen-helium theory of atomic structure. According to Harkins[15] the atoms of the lighter isotope of chlorine are the more stable, and the constancy in the ratio of the two isotopes of chlorine depends largely on the stability of its two isotopic elements. According to this theory the greater part if not all of the exhibited constancy of isotopic element is due to the net effects of the different types of atomic stability.

The same explanation can also be used to account for the fact that the chlorine present in sodalite, wernerite and apatite was found to be identical with that of marine origin. Presumably such chlorine of igneous origin has not been mixed with that in the sea within known geologic time. Therefore any theory of the observed constancy of its isotopic composition, which is based on an original thorough mixing, would necessarily assume that the mixing occurred either during the very hypothetical and, on the basis of recent theories, improbable, molten state of the earth or at an

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[13] Baxter, This Journal, **34,** 1657 (1912).

[14] Aston, *Nature*, **107,** 334 (1921).

[15] Harkins, This Journal, **39,** 856 (1917); *Phil. Mag.*, **42,** 332 (1921).

even earlier time. Since a very intimate mixing on such a cosmic scale does not seem particularly plausible, it appears better to interpret the constancy of isotopic composition as due largely to the relative stability of the isotopes, and to the abundance and stability of the atomic species from which they are formed.

TABLE VIII

THE ATOMIC WEIGHT OF CHLORINE

Wt. of Ag, g.	Wt. of AgCl (corr.), g.	Increase in wt. on fusion in Cl_2, mg.	Residue corr., mg.	Ratio, AgCl: Ag	At. wt. of Cl
A. IN A METEORITE					
2.78435	3.69954	+0.09	0.05	1.32869	35.459
1.15347	1.53260	+ .01	.05	1.32869	35.459
				1.321[a]	
1.95226	2.59394	.00	.05	1.32868	35.458
1.22393	1.62617	+ .01	.05	1.32865	35.455
1.30383	1.73235	+ .01	.05	1.32866	35.456
				Mean at. wt. =	35.457_4
DATA FOR HYDROCHLORIC ACID OBTAINED FROM THE SILVER CHLORIDE FORMED IN THE EXPERIMENTS GIVEN ABOVE					
2.25496	2.99614	.00	.05	1.32869	35.459
2.12146	2.81879	+ .02	.05	1.32870	35.460
Mean atomic weight (all determinations) = 35.458_0. Mean ratio, silver chloride to silver = 1.32868_0.					
B. FROM HYDROCHLORIC ACID					
2.48501	3.30198	−0.02	0.05	1.32868	35.458
2.77226	3.68347	+ .04	.05	1.32869	35.459
3.21541	4.27224	− .03	.05	1.32865	35.455
3.28631	4.36638	+ .08	.52	1.32866	35.456
2.45646	3.26385	.00	.52	1.32869	35.459
				Mean at. wt. =	35.457_4
HYDROCHLORIC ACID RECOVERED FROM SILVER CHLORIDE OBTAINED					
2.01345	2.67519	.00	.03	1.32866	35.456
1.86794	2.48191	.02	.03	1.32869	35.459
Mean atomic weight (all determinations) = 35.457_4. Mean ratio, silver chloride to silver = 1.32867_4.					
C. IN A SODALITE					
2.41629	3.21048	+0.00	0.26	1.32868	35.458
3.02359	4.01740	+ .09	.26	1.32868	35.458
2.09238	2.78001	+ .08	.26	1.32864	35.454
1.94695	2.58687	+ .04	.03	1.32868	35.458
2.56432	3.40716	.00	.03	1.32869	35.459
1.66464	2.21171	+ .02	.03	1.32864	35.454
				Mean at. wt. =	35.456_8
DATA FOR HYDROCHLORIC ACID OBTAINED FROM THE SILVER CHLORIDE FORMED ABOVE					
2.08619	2.77195	− .03	.03	1.32872	35.462
1.66564	2.21316	.00	.03	1.32871	35.461
Mean atomic weight (all determinations) = 35.458_0. Mean ratio, silver chloride to silver = 1.32868_0.					

[a] Heated silver chloride before it was dry.

TABLE VIII (*Concluded*)

Wt. of Ag, g.	Wt. of AgCl (corr.), g.	Increase in wt. on fusion in Cl_2, mg.	Residue corr., mg.	Ratio, AgCl: Ag	At. wt. of Cl
		D. IN WERNERITE			
2.00984	2.67042	0.00	0.05	1.32867	35.457
2.16411	2.87547	.00	.05	1.32871	35.461
				1.329	Washed sweat from hand into flask
1.16727	1.55094	.01	.05	1.32868	35.458
1.52094	2.02083	.00	.05	1.32867	35.457
1.98439	2.63657	− .02	.05	1.32866	35.456
				Mean at. wt. =	35.457_8
DATA FOR HYDROCHLORIC ACID RECOVERED FROM SILVER CHLORIDE FORMED					
1.55638	2.06791	+ .05	.03	1.32867	35.457
1.85157	2.46011	.00	.03	1.32866	35.456
Mean atomic weight (all determinations) = 35.457_4. Mean ratio, silver chloride to silver 1.32867_4.					
		E. IN APATITES			
2.38976	3.17526	0.00	0.05	1.32869	35.459
2.04659	2.71923	.07	.05	1.32867	35.457
2.79021	3.70791	.07	.05	1.32890[a]	35.490[a]
2.31017	3.06944	.04	.05	1.32866	35.456
2.83454	3.76616	.01	.05	1.32867	35.457
2.25500	2.99617	.00	.05	1.32868	35.458
				Mean at. wt. =	35.457_4
DATA FOR HYDROCHLORIC ACID RECOVERED FROM SILVER CHLORIDE FORMED					
2.10302	2.79426	0.03	0.03	1.32869	35.459
1.92004	2.55108	.02	.03	1.32866	35.456
Mean atomic weight (all determinations) = 35.457_4. Mean ratio, silver chloride to silver = 1.32867_4.					

[a] Rejected in obtaining average.

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Summary

1. The atomic weight of chlorine from a meteorite is found to be the same as that of terrestrial chlorine within the limit of error of the extremely accurate method used in its determination.

2. The mean value obtained for the atomic weight of chlorine from common salt, apatite, wernerite and sodalite is $35.457_{55} \pm 0.000_2$, while

that of meteoric chlorine is $35.458_0 \pm 0.000_5$. The mean of the best results on terrestrial chlorine is 35.457_4, which is identical with the mean of the first five determinations with meteoric chlorine, that is, those made upon the original highly purified hydrogen chloride obtained from the chlorine of the meteorite.

3. Terrestrial chlorine of non-marine origin is found to have the same atomic weight as that obtained from the sea.

4. Silver may be converted into silver chloride in quartz flasks with long necks without the loss of any material essential to the exact determination of the ratio of the weights of the two substances, and in such a way that aside from air, nothing but pure silver chloride is left in the flask. The mean of all of the ratios of silver chloride to silver is found to be $1.32867_7 \pm 0.00000_2$. The average values from each set of seven determinations varied from the others only in the seventh significant figure.

5. The identity of the atomic weights of meteoric chlorine, and of chlorine of non-marine and marine origin is further evidence in favor of the theory of Harkins that the relative abundance of isotopes is most largely conditioned by the relative stability of the isotopes, that is their stability with regard to the different types of both disintegration and formation and also by the abundance of the atomic species from which they are formed.

CHICAGO, ILLINOIS

[CONTRIBUTION FROM THE CHEMICAL LABORATORY OF THE COLLEGE OF LIBERAL ARTS, NORTHWESTERN UNIVERSITY]

A STUDY OF 3,4-DIAMINO-PHENYLARSONIC ACID AND SOME OF ITS DERIVATIVES

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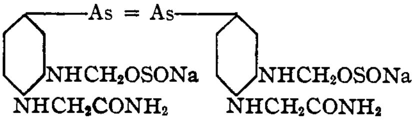
The present study was undertaken with a view to the synthesis of a new arsenical which would combine structural features of the important drugs Neoarsphenamine, "Ehrlich 914," and Tryparsamide, namely, the sodium formaldehyde sulfoxylate derivative of 3,3′-diamino-4,4′-di-N-glycylamide-arseno-benzene.



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