and platinum. We consider it more probable, in view of the still larger capacities which we have found with parallel conductance, and in view of the fact that Scott found the capacity for gold (10.3 Mf. sq. cm.) almost the same as that for aluminium (10.6 Mf. sq. cm.), where there certainly is such a film, that gold and platinum, likewise, are covered with an oxide film, which is at least the main factor in determining their capacity. From the very irregular values of capacities found for platinum, except after it has been heated in the flame, it appears as if such heating produces a very regular film, which slowly changes when left standing in air or in solution.

The capacity of platinized platinum is many times larger, but it is not at all improbable that here, too, the size of the capacity is largely determined by such a film. By this assumption a number of facts can be explained, which are hard to reconcile with the heretofore accepted theory that the capacity is due to changes in concentration of gas occluded in the electrode. A few of these facts we shall merely mention, as a discussion of this point would carry us far beyond the intent of this paper. Scott found no change in the capacity of platinized platinum with change in pressure, although he used pressures as high as 800 atmospheres. It has recently been shown by several different methods that platinized platinum, saturated with oxygen, does not give the correct potential value for an oxygen electrode.[1] Gordon,[2] as well as Wien,[3] found an apparent increase in the resistance of an electrolytic cell subjected to alternating current polarization, even when this polarization was balanced by capacity or inductance.

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

THE ABSORPTION COEFFICIENTS OF URANIUM COMPOUNDS.

BY HENRY M. GOETTSCH.

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IT WAS first stated by Mme. Curie[4] that the radioactivity of

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[1] Lewis: This Journal, **28**, 158 (1906).

[2] Gordon: Loc. cit.

[3] Wien: Wied. Ann. **58**, 37 (1896).

[4] Thèse, Paris, 1903: Chem. News, **88**, 98 (1903).

uranium compounds was an atomic and not a molecular property; the activities found, however, were only very roughly proportional to the percentages of uranium. In her experiments, Mme. Curie took no account of the absorption of the α-ray activity by the active compound itself. It was shown by McCoy,[1] that it was possible to determine the amount of this absorption, and that by taking it into account, the activity was indeed strictly proportional to the percentage of uranium, and therefore an atomic property. Only three compounds of uranium were investigated by McCoy. It therefore seemed desirable to examine thoroughly in a similar manner a larger number of pure uranium compounds. My results on five other uranium compounds confirm those previously announced by McCoy. The absorption coefficients of a large additional number of uranium compounds were then obtained, indirectly, in an endeavor to find relationships between the absorption and other physical or chemical properties.

The theory of the absorption of the activity within the radioactive film has been given by McCoy.[2] He has shown that

$$k_2 = 2.303\ s/w \log 1/1\text{-}x,$$

where k_2 is the absorption coefficient for unit weight on unit area; x is the ratio of the observed activity of a thin film to that of a film of the same substance, of equal area, and sufficiently thick to be of maximum activity; w is the weight of the thin film; and s is the area of the films, which in all of these experiments was equal to 39.82 sq. cm. The coefficient, k_2, differs for different uranium compounds, but is constant for any one compound. These values of k_2 may be used to calculate the total activities of unit weight, k_1, of each of the compounds examined. If the activity of a film of uranium oxide of maximum activity be taken as unity, and if A_1 represents the maximum activity of a film of any other body as compared with the standard, the following relation holds:

$$k_1 = 2k_2A_1/s.$$

The value of k_1 may be obtained in another way.[3] For an infinitely thin film there would be no absorption, hence

$$A = {}^1/_2 k_1 w, \text{ and } k_1 = 2A/w \qquad (1)$$

but $x = A/A_1$. Substituting in (1),

$$k_1 = 2A_1x/w.$$

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[1] This Journal, 27, 391 (1905).

[2] Loc. cit.

[3] McCoy: Loc. cit.

If the values of w be plotted along the axis of abscissae, and the ratios of w/x as ordinates, the point of intersection of the curve with the axis of ordinates gives the value of w/x for an infinitely thin film. The values of k_1 obtained by the two methods are shown in Tables VII and VIII.

If the radioactivity of uranium compounds is an atomic property, k_1/P should be a constant, where P is the weight of uranium in 1 gram of the compound. Complete series of measurements, made on six different uranium compounds, show that the value of k_1/P is a good constant, and confirm the results previously announced by McCoy.[1]

The mean value for k_1/P was found to be 19.84. If this value be assumed to hold for all compounds of uranium, it becomes possible to deduce the value of k_2 for any compound by the measurement of the activity of a single film of maximum activity. From the relation $k_1 = 2k_2A_1/s$, where $s = 39.82$, we obtain $k_2 = \frac{395P}{A_1}$. The comparison of the activity of a film of maximum activity with that of the standard oxide gives A_1, P being derived from analysis. The results of these determinations are given in Table IX.

Methods of Preparation and Analysis.—For all the preparations used, Kahlbaum's purest uranium nitrate served as the starting material. Since all uranium ores contain radium,[2] it was necessary to show that the nitrate employed was free from radium in quantities sufficient to affect the activity. A large quantity of the nitrate was finely ground in an agate mortar, thoroughly mixed, and a 10-gram sample taken. This was dissolved in 250 cc. of water, warmed to 70°, and then treated with an amount of ammonium carbonate sufficient to redissolve the precipitate first formed. About 2 grams of barium chloride were then added, and a slight excess of ammonium sulphate. After digesting at 70–80° for about an hour, the precipitated barium sulphate was filtered off and dried. This treatment was carried out three times. The activity of the precipitated sulphates was then determined. No. 1 was much the most active, as will be seen from the appended time of discharge of the electroscope.

[1] Loc. cit.

[2] McCoy: Ber. 37, 2641 (1904); Boltwood: Am. J. Sci. 18, 97 (1904); Phil. Mag. [6] 9, 599 (1906).

Sample.	Time of discharge (seconds).
Standard U_3O_8	15.75
$BaSO_4$, No. 1	89.
$BaSO_4$, No. 2	431.
$BaSO_4$, No. 3	329.

It was evident from the pale yellow color of the precipitates that they had mechanically carried down uranium. To remove this they were then boiled with 200 cc. of water to which had been added 10 cc. of pure concentrated hydrochloric acid. After digesting the hot solution for an hour, it was filtered, and the residue washed till the wash-water failed to give a test for uranium with potassium ferrocyanide. The precipitates were now pure white, and after drying in the oven were returned to the trays which had been washed and dried. The activity had been diminished greatly.

Sample.	Time of discharge.
Standard U_3O_8	15.80
No. 1	369.
No. 2	3740.
No. 3	3991.

The weight of each sulphate precipitate was about 2 grams. The radium is practically removed by the first precipitation. As this amount was obtained from 10 grams of the nitrate, and as the maximum weight of the substances examined rarely exceeded 1.5 grams, it was evident that the amount of radium was too small to affect appreciably the activity of the preparations measured. This conclusion was verified by converting the purified nitrate into the oxide and comparing its activity with that of my standard oxide which had been made by the direct ignition of the commercial nitrate. After making three precipitations as described, I added hydrochloric acid to the filtrate until precipitation began, and then concentrated by boiling down. An orange-yellow, granular precipitate fell out, which was easy to filter and wash. It was probably a mixture of ammonium uranate and ammonium carbonate. After drying, the precipitate was ignited, at first gently, in a porcelain crucible. After most of the moisture and ammonia had been driven off, the residue was transferred to a platinum crucible and the ignition finished in oxygen. About 5.2 grams of pure black oxide, U_3O_8, were obtained. From it a film was prepared, sufficiently thick to be of maximum activity. By comparison with the standard oxide their activities were found to be practically identical.

Sample.	w.	Time of discharge.
Standard	0.5637	15.75
"Purified" sample	0.5671	15.80

The result showed that the nitrate was sufficiently pure to be used directly in the preparation of the compounds to be tested.

A large number of methods for the determination of uranium were tried. In many compounds containing no other fixed substances, simple ignition converts the uranium into urano-uranic oxide, U_3O_8. In using this method it is necessary to finish the ignition in oxygen, since the researches of Zimmermann[1] have shown that when the ignition is done in air, there is a slow loss of oxygen. The color of the residue varies with the degree of heat, from a dark green if ignited at bright redness, to a pure black when the highest temperature of the blast lamp is employed. The composition, according to the same author, does not vary. I have found that thick films, prepared from both the green and the black oxides, have the same activity.

In acid solutions, in the presence of alkalies or alkaline earths, uranium may be precipitated as ammonium uranate, $(NH_4)_2U_2O_7$, which on ignition gives the oxide. The precipitate is always contaminated with considerable amounts of the other metals; however, as Hillebrand[2] has shown, and Kern[3] has confirmed, the uranate may be obtained free from alkalies or alkaline earths by redissolving and reprecipitating twice. The method is somewhat tedious, but gives good results. The separation of uranium from barium, by precipitation of the former as uranyl ammonium phosphate, as recommended by Kern,[4] was found unsatisfactory. A considerable amount of barium was carried down. A better separation from alkaline earths was afforded by electrolytic methods. Kollock and Smith[5] have shown that uranium is deposited on the cathode as a hydrated oxide from acetic acid solutions, molybdenum being the only other metal showing a similar behavior. Kern also has investigated the method, and the directions given by him were followed with good results.

For analysis, material was taken from some of the thicker films, after completing measurements upon their activity. In this

[1] Ann. **232**, 276 (1885).

[2] Am. J. Sci. **10**, 136 (1900).

[3] This Journal, **23**, 708 (1901).

[4] Ibid.

[5] Ibid. **23**, 607 (1901).

way the results of the analysis would more accurately represent the uranium content of the films in the condition of actual use, since small changes of composition, due to gain or loss of moisture, would be accounted for. The films were usually kept in the open air, carefully protected from dust; in some cases, where a tendency to absorb moisture was observed, they were kept in desiccators.

The gravimetric determination of uranium being rather tedious, recourse was often had to the volumetric process. The comments on this process as given in the literature are of a conflicting character. The reduction of uranium solutions with zinc and sulphuric acid and titration with permanganate is due to Belouhoubeck.[1] Guyard[2] states that the results are always inexact, and he ascribes this to the formation of lower suboxides of uranium. Zimmermann,[3] who next took up the process, states that these suboxides do not exist, that uranyl salts are not reduced beyond UO_2, and that they admit of most exact determination by permanganate. He carried out his reductions in a flask provided with a Bunsen valve, and found that half an hour was sufficient for the reduction of rather large quantities. He also found that the oxidation of uranous salts exposed to the air occured but slowly, so that the error from that cause became inappreciable in rapid work. Kern[4] has published the results of numerous experiments with the process. He finds, in agreement with Zimmermann, that the reduction does not proceed beyond the tetravalent stage, even when prolonged for five hours. To prevent a possible reoxidation in the air, he works in an atmosphere of carbon dioxide, by pouring the reduced acid liquid into the titrating flask which contained some sodium carbonate. In opposition to these statements, Pulman[5] finds that the reduction does proceed partly beyond the tetravalent stage. He finds, however, that this may be corrected by dispensing with the atmosphere of carbon dioxide, and allowing the solution to drip from the reductor into the titrating dish, all the time freely exposed to the air. In this way the part reduced beyond the UO_2 stage, is oxidized back without any tendency to oxidize further. The time of reduction was one hour.

[1] Z. anal. Chem. 6, 120 (1867).

[2] Bull. soc. chim. 1, 94.

[3] Ann. 213, 300 (1882).

[4] This Journal, 23, 712 (1901).

[5] Am. J. Sci. [4] 16, 229 (1903).

In agreement with the work of Pulman, I found that the results were not uniform when Kern's directions were followed, but that they often came high, showing that the reduction did proceed too far. This was also indicated by the color of the solution which finally became a dirty brownish green. The method of work finally adopted was one recommended by Prof. McCoy, who had used it in work on uranium ores. In view of the uniformly good results given by the method, and its rapidity of execution, it seems worth while to give the details of the process.

The reductions were carried out in a large beaker of about one liter capacity. One hundred grams of pure stick zinc were introduced in the form of 15 to 20 small pieces; then the uranium compound was added, dissolved in dilute sulphuric acid and in amount equivalent to 0.100–0.150 gram of metallic uranium; finally the volume of the liquid was brought to about 125 cc., of a concentration corresponding to one part of acid, sp. gr. 1.84, to five parts of water, by volume. The beaker was then covered with a watch-glass and the solution heated to boiling. After boiling began, the heat was so regulated as to maintain about 1 cm. of thick foam over the boiling solution.

Under these conditions the reduction proceeds with great rapidity. It was often complete in two minutes, and never took more than five, and could be continued for a quarter of an hour without affecting the result. The color of the solution changes from yellow through various shades of green to a muddy brownish green, which indicates the completion of the reaction. The sides of the beaker were rinsed with water and the hot solution decanted through a filter into a large evaporating dish. The zinc was rapidly rinsed with cold water, and the washings also run through. The color changes almost instantly to a pale olive-green. About five minutes were taken up with the filtration. The final volume of the solution just before titration was about 500 cc. The titration was then carried out, using approximately N/30 permanganate, which had been standardized against metallic iron, and also against pure U_3O_8, the two methods giving practically identical results. The results of the titration were not appreciably different if the solution was allowed to stand fifteen minutes before running in the permanganate. This method was used in the analysis of many of the compounds, and as only bodies of apparently well established composition were used, besides uranium no other constituents were as a rule determined. Twenty-six uranium compounds were prepared and analyzed; the details are given elsewhere.[1] In that which follows, the formulas given for the various compounds are those indicated by the analyses.

In cases where a different method of analysis was followed, this is mentioned in connection with the preparation of the compound.

Determination of Radioactivity.—The method of work used was the one developed by McCoy.[2] The substance under examination was very finely ground with a volatile liquid in an agate mortar. Chloroform and alcohol proved the most generally useful, but ether, ligroin, benzene and carbon bisulphide were also used. After grinding, the mixture was transferred to a small beaker and then, while still in suspension, rapidly poured into a circular shallow, tinned iron tray. These trays, which were 7.12 cm. in diameter, with rims 0.8 cm. high,[3] were intended for covers for jelly glasses, and were easily obtained in quantity. A cover glass was placed over the tray, until the solid matter had settled; the liquid was then allowed to evaporate spontaneously. When alcohol was used, it sometimes happened that on account of the slow evaporation, the metal trays became rusty before the films were dry. This was avoided by placing under a large inverted crystallizing dish, along with the evaporating sample, trays of fused calcium chloride. This very rapidly absorbed both alcohol and water, and proved of great assistance in getting smooth and uniform films. The measurements of the activity were made with an electroscope of the C. T. R. Wilson type,[4] but having in addition a horizontal metal plate 5 cm. in diameter attached to the vertical strip carrying the aluminium leaf. The measurement consisted in noting with a stop-watch the time of discharge of the leaf of the electroscope across ten divisions of the scale of

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[1] Dissertation, Univ. of Chicago, 1906.

[2] Loc. cit.

[3] It might be thought that an error in the determination of the activity would result from the absorption of a portion of the rays by the rims, but as all of the trays had rims of the same height, the same fraction of the activity would be absorbed in the case of every film, including the standard. No error was incurred on this account.

[4] Pr. Roy. Soc. 68, 152 (1901).

the micrometer microscope. The potentials corresponding to the beginning and end of the ten divisions were 200 and 150 volts, respectively. The natural leak of the electroscope remained quite constant. Observations at different times during a period of several months showed the time of discharge of the empty electroscope to be from eight to ten hours. After being in continual use for over a year, the time of leak had diminished to about five hours. It was therefore necessary to make corrections for the natural leak. With an active sample, the minimum time of discharge was found for a distance, between the active sample and the charged plate of the electroscope, of 34 mm. This distance was used in all of the following measurements.

Four determinations of the activity of each film were made and the average taken. These determinations were repeated on different days, and the mean of three or more different measurements taken for the final value. To compensate for any change of sensitiveness of the electroscope, measurements were made on the standard sample immediately before and after the measurements made with each film. The mean of these was used to compare with the activity of the film to deduce the value of x. In this manner, complete measurements were made for a series of films of six different compounds. The results are given in Tables I–VI.

TABLE I.—URANO-URANIC OXIDE, U_3O_8

No.	w.	x.	w/x.	k_2.
1 (Standard)	0.5637	1.000	0.5637	.....
2	0.2936	0.945	0.3108	.....
3	0.2148	0.853	0.2519	355
4	0.2101	0.822	0.2556	327
5	0.1678	0.749	0.2241	328
6	0.0966	0.549	0.1760	328
7	0.0873	0.518	0.1686	333
8	0.0736	0.460	0.1600	334
9	0.0486	0.324	0.1500	321
10	0.0418	0.293	0.1427	331
11	0.0244	0.176	0.1387	316
12	0.0147	0.117	0.1256	338
13	0.0110	0.088	0.1250	334
14	0.0078	0.061	0.1278	321
			Mean,	331

The value found by McCoy was 335. The results are in good agreement and show themselves in no way dependent upon the sample or the instruments used, thus furnishing a further proof of the correctness of the theory.

TABLE II.—URANIC ACID, $H_2U_2O_7$.

No.	w.	x.	w/x.	k_2.
1	0.5160	Maximum	0.516	.....
2	0.2927	0.983	0.2977	.....
3	0.2345	0.884	0.2653	366
4	0.1671	0.772	0.2165	353
5	0.1468	0.740	0.1985	365
6	0.1412	0.730	0.1934	369
7	0.1274	0.691	0.1844	367
8	0.0624	0.432	0.1444	361
9	0.0503	0.372	0.1352	367
			Mean,	364

Benzene was used as the suspending liquid. It was not possible to obtain uniform films thinner than No. 9. Attempts were made with chloroform, ligroin and alcohol, as suspending liquids, but the films presented peculiar mottled and striped effects. This is probably a result of surface tension and was a difficulty repeatedly encountered.

TABLE III.—URANYL IODATE, $UO_2(IO_3)_2.H_2O$.

No.	w.	x.	w/x.	k_2.
1	0.9282	Maximum		
2	0.6916	"	0.6916	.....
3	0.4790	0.986	0.4857	....
4	0.4039	0.971	0.4160	.....
5	0.2617	0.937	0.2793	421
6	0.2160	0.889	0.2430	400
7	0.2048	0.885	0.2314	421
8	0.1555	0.790	0.1968	400
9	0.1463	0.782	0.1879	413
10	0.1048	0.673	0.1557	425
11	0.0660	0.502	0.1314	421
12	0.0450	0.364	0.1236	401
			Mean,	413

Alcohol was used as the suspending liquid in making films of the iodate.

TABLE IV.—URANYL THIOSULPHATE, $UO_2S_2O_3.2H_2O$.

No.	w.	x.	w/x.	k_2.
1	0.5539	Maximum		
2	0.4404	"	0.4404	
3	0.3771	0.977	0.3859	.....
4	0.2334	0.932	0.2504	.....
5	0.2278	0.914	0.2492	428
6	0.2134	0.887	0.2406	407
7	0.1517	0.817	0.1857	446
8	0.1475	0.805	0.1832	441
9	0.1211	0.740	0.1636	443
10	0.1043	0.674	0.1547	428
11	0.0903	0.621	0.1454	428
12	0.0715	0.537	0.1331	429
			Mean,	431

The thiosulphate films were made by the use of chloroform as suspending liquid.

TABLE V.—SODIUM URANATE, $Na_2U_2O_7$.

No.	w.	x.	w/x.	k_2.
1	0.9443	Maximum		
2	0.5315	0.985	0.5396	.....
3	0.2539	0.901	0.2818	363
4	0.1750	0.793	0.2207	358
5	0.1738	0.787	0.2208	355
6	0.1518	0.744	0.2040	358
7	0.1487	0.740	0.2010	361
8	0.1089	0.622	0.1751	356
9	0.0866	0.562	0.1541	380
10	0.0841	0.502	0.1675	338
11	0.0634	0.433	0.1464	356
12	0.0458	0.338	0.1355	358
13	0.0457	0.337	0.1356	358
14	0.0382	0.285	0.1341	350
			Mean,	358

A mixture of chloroform and alcohol was used as the suspending liquid for the films of sodium uranate.

TABLE VI.—URANYL AMMONIUM PHOSPHATE, $UO_2NH_4PO_4.3H_2O$.

No.	w.	x.	w/x.	k_2.
1	0.9813	Maximum		
2	0.9749	"		
3	0.4788	0.974	0.4915	.....
4	0.2088	0.923	0.2262	489
5	0.1984	0.917	0.2164	504
6	0.1939	0.910	0.2131	495
7	0.1660	0.887	0.1872	524
8	0.1494	0.847	0.1764	501
9	0.1229	0.790	0.1555	506
10	0.1078	0.749	0.1440	511
11	0.1040	0.735	0.1415	508
12	0.0791	0.632	0.1251	492
13	0.0773	0.624	0.1239	515
14	0.0483	0.451	0.1071	495
15	0.0347	0.347	0.1000	489
			Mean,	502

A mixture of alcohol and chloroform was used as the suspending liquid.

The values of k_2 given in the preceding tables may now be used to calculate the values of k_1 and k_1/P for the different compounds examined. The values as obtained by the first method are given in Table VII.

TABLE VII.

Substance.	A'.	k_2.	k_1.	100P.	k/P.
Urano-uranic oxide	1.000	331	16.63	84.82	19.60
Uranic acid	0.876	364	16.01	80.73	19.82
Uranyl iodate	0.356	413	7.37	37.15	19.86
Uranyl thiosulphate	0.533	431	11.53	57.32	20.10
Sodium uranate	0.816	358	14.67	74.27	19.74
Uranyl ammon. phosphate	0.431	502	10.86	54.68	19.93
				Mean,	19.94

We may compare with these values those obtained by McCoy.[1]

Urano-uranic oxide	1.000	335	16.69	84.90	19.7
Uranyl oxalate	0.459	507	11.59	57.60	20.1
Ammonium uranate	0.720	417	14.95	74.40	20.1
				Mean,	20.0

The values of McCoy are for S=40.15. In order to compare them with my results we must multiply them by the ratio between

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[1] This Journal, **27**, 391 (1905).

the areas of the trays used. The value then found for k_1/P is $\frac{40.15}{39.82}\times 20.0 = 20.16$.

The value of k_1/P, which represents the total activity of unit weight of metallic uranium, should be constant, if radioactivity is an atomic property. The result is in harmony with the theory.

In Table VIII are given the values of k_1 as obtained by graphic extrapolation. The values of w/x are taken from curves, which were similar to those obtained by McCoy.[1] In the fourth column are given for comparison the values of k_1 as found by the first method. The greatest deviation is about 1 per cent.

TABLE VIII.

Substance.	$(w/x)_0$.	A^1.	k_1.	(k_1).	k_1/P.
Urano-uranic oxide	0.120	1.000	16.66	16.63	19.64
Uranic acid	0.110	0.876	15.92	16.01	19.72
Uranyl iodate	0.095	0.356	7.49	7.37	20.17
Uranyl thiosulphate	0.093	0.533	11.47	11.53	19.99
Sodium uranate	0.112	0.816	14.57	14.67	19.62
Uranyl ammon. phosphate	0.080	0.431	10.77	10.86	19.71
				Mean,	19.81

The mean value of k_1/P is practically identical with that found before (19.84). The value 19.84 will be taken as the most probable value of the constant. If the unit of activity is taken as that due to 1 sq. cm. of a thick film of U_3O_8, instead of that due to the whole standard film, the value of k_1/P becomes $19.84\times s$. Since s, the area of the films, was 39.82 sq. cm., $k_1/P = 790$. Therefore, the total activity of 1 gram of uranium is 790 times that of 1 sq. cm. of a thick film of U_3O_8.

In Table IX are given the absorption coefficients of all the compounds examined. In the case of six of the compounds they were obtained by direct measurements of a series of films; in all other cases they were derived by calculation, by means of the equation $k_2 = 395P/A_1$ from the measured value of the activity, A_1, of a film of maximum activity. In most cases a film of 0.5 gram in weight was sufficient to give the maximum activity, but in every case several films were prepared, ranging in weight from about 0.7 to 1.5 grams. When several thick films of different weight but of equal activity were obtained, the resulting activity was taken as the maximum.

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[1] This Journal, 27, 391 (1905).

TABLE IX.

Substance.	100 P.	A'.	k_1.	k_2.
Uranium (Merck) (impure)	90.00	1.18	17.85	301
Uranium (E. & A.) (impure)	90.20	1.20	17.89	297
Uranium dioxide	88.16	1.126	17.50	310
Urano-uranic oxide	84.82	1.000	16.63	331
Uranic acid	80.73	0.876	16.01	364
Sodium uranate	74.27	0.816	14.67	358
Potassium uranate	70.03	0.765	13.90	362
Calcium uranate	74.00	0.785	14.70	373
Strontium uranate	66.88	0.651	13.27	406
Barium uranate	58.63	0.591	11.63	392
Uranyl sodium acetate	50.81	0.357	10.05	562
Uranyl potassium acetate	49.04	0.339	9.74	573
Uranyl lead acetate	31.24	0.250	6.20	494
Uranyl barium acetate	44.64	0.320	8.87	551
Uranyl nitrate ($2\frac{1}{2}H_2O$)	54.43	0.436	10.80	493
Uranyl nitrate ($3\frac{1}{2}H_2O$)	52.24	0.411	10.36	502
Uranyl potassium nitrate	48.25	0.369	9.57	517
Uranyl sulphate	55.73	0.446	11.02	492
Uranous sulphate	46.10	0.362	9.15	504
Uranyl potassium sulphate	40.60	0.302	8.06	531
Uranyl oxalate	57.60	0.459	11.59	507
Uranyl potassium oxalate	41.20	0.280	8.18	582
Uranyl potassium propionate	45.00	0.297	8.93	599
Uranyl potassium butyrate	41.65	0.260	8.26	633
Uranyl thiosulphate	57.32	0.533	11.53	431
Uranyl ammonium phosphate	54.68	0.431	10.86	502
Uranyl iodate	37.15	0.356	7.37	413
Uranyl potassium chloride	45.10	0.352	8.95	506
Uranyl potassium carbonate	38.64	0.285	7.60	531

The values found above for the absorption coefficient of metallic uranium cannot be taken as more than a rough approximation to the true value.

Summary.—The theory of the absorption of radioactivity of uranium compounds, as developed by McCoy,[1] is shown to hold accurately in the case of the six compounds examined. It is proven that absorption is not dependent on the form of the measuring instrument, and that measurements can be accurately duplicated. The theory that radioactivity is an atomic phenomenon receives additional confirmation in the good constant found for the value of k_1/P. The absorption is not proportional to the molecular weight. This is readily seen in the case of the

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[1] Loc. cit.

black oxide which has a low absorption with a very high molecular weight. It is very probable that absorption, like radioactivity, is an atomic phenomenon. A fuller discussion of this question is given in a later paper by Prof. McCoy and myself.

This work was undertaken at the suggestion of Dr. H. N. McCoy, and carried out under his guidance. It is a pleasant duty, in concluding, to express to him my gratitude for his unfailing interest in the work, and for the many helpful suggestions received.

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

THE ABSORPTION OF THE α-RAYS OF URANIUM.

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IF k_2 is the absorption coefficient (referred to unit weight upon unit area) of the α-rays of any uranium compound, it is found[1] that

$$A = A_1 \left(1 - e^{-\frac{k_2 w}{s}}\right), \qquad (1)$$

where A is the activity of a *uniform, thin* film of the compound, of weight w and area s, and A_1 is the activity of a film of the same compound of equal area and sufficiently thick to be of maximum activity. If $\frac{A}{A_1} = x$, then

$$k_2 = \frac{2.303\, s}{w} \log \frac{1}{1 - x}. \qquad (2)$$

Calling k_1 the *total* activity of unit mass of the active compound,

$$k_1 = \frac{2 k_2 A_1}{s}. \qquad (3)$$

In the paper referred to, results were given for three uranium compounds. The values found for k_2 were constant for each compound, but different for different compounds. The values of k_1 as found from those of k_2 by the above equation, were strictly proportional to the uranium content, P, of the compound. This investigation has now been extended by one of us.[2] Table I gives a summary of both series of measurements.

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[1] McCoy: This Journal, 27, 391 (1905).

[2] Goettsch: Preceding paper.