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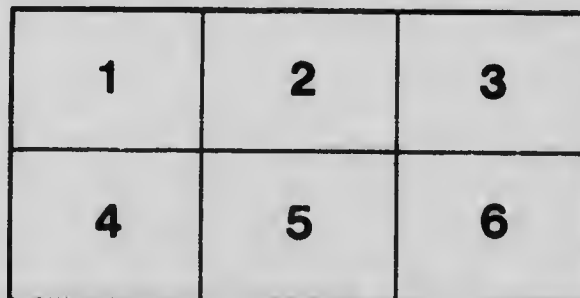
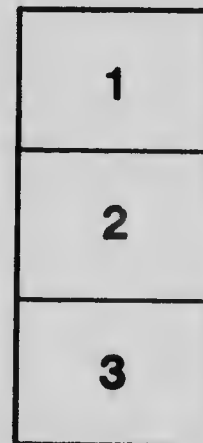
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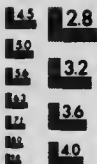
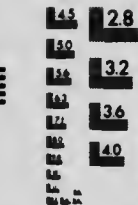
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STUDIES

PAPERS FROM THE PHYSICAL
LABORATORIES

MEMOIR ON THE RADIOACTIVITY OF POTASSIUM AND
OTHER ALKALI METALS, BY J. C. McLENNAN AND W. J. KENNEDY

EXTRACTED FROM THE PHILOSOPHICAL MAGAZINE, SEPTEMBER 1908

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**ON THE RADIOACTIVITY OF POTASSIUM
AND OTHER ALKALI METALS.**

BY

J. C. MCLENNAN,

AND

W. T. KENNEDY.

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On the Radioactivity of Potassium and other Alkali Metals.

By Prof. J. C. McLENNAN and Mr. W. T. KENNEDY.

I. *Introduction.*

IN the course of some experiments made by them on the radioactivity of a series of salts which had hitherto been considered inactive, Messrs. Campbell and Wood (*Proc. Camb. Phil. Soc.* vol. xiv. pt. 1, p. 15, 1907) found that potassium salts exhibited a radioactivity greater than that of any other substance previously examined which did not contain any of the so-called radioactive elements.

In seeking for the source of this activity these experimenters found it impossible to separate out any active impurity from the salts examined, and they were led by the results of their investigation, which included measurements on the activities of a limited number of compounds of potassium, to conclude that the activity originated with the potassium itself and was an atomic property of that metal.

In a later paper (*Proc. Camb. Phil. Soc.* vol. xiv. pt. 2, 1907) Campbell described some additional experiments dealing with the character of the radiation emitted by the potassium salts, and in concluding expressed the opinion that the radiation consisted of β rays possessing an average velocity less than that of the β rays of uranium.

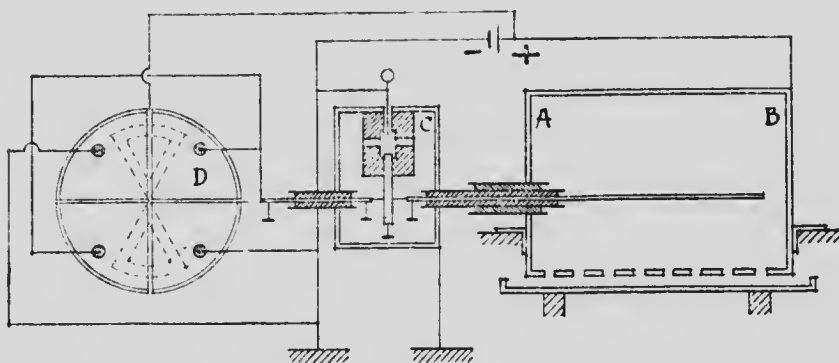
In a recent note by one of us (*'Nature,'* May 14th, and *Phys. Zeit.* Aug. 1st) an account is given of some experiments which involved a minute examination of the radioactivity of a large number of potassium and other salts. In this note it was stated that while the results of this examination confirmed the discovery made by Campbell and Wood, that potassium salts generally possess an exceptionally high activity, and emit a radiation possessing considerable penetrating power, they did not support the conclusion that the activity of these salts was connected with a normal atomic property of potassium and that it was always directly proportional to the amount of that metal present in the salt.

The salts used in this examination were those ordinarily sold as chemically pure, and in drawing the conclusion just referred to it was assumed that the salts were, as they are reported to be, of a high grade of purity. It has been found, however, since the publication of this note that the assumption was by

no means warrantable; and from the results of additional measurements it has been found necessary to modify the conclusions mentioned in the earlier notices.

In measuring and comparing the activities of the different salts, these were each spread out in turn in uniform layers on a shallow tray which was placed on the bottom of the ionizing chamber shown in fig. 1, which was 40 cm. long,

Fig. 1.



26 cm. wide, and 28 cms. deep. The saturation currents through the air in the chamber were measured with a sensitive quadrant electrometer, and were taken as measures of the activities of the different salts.

II. Relation of Activity to Area of Salt exposed.

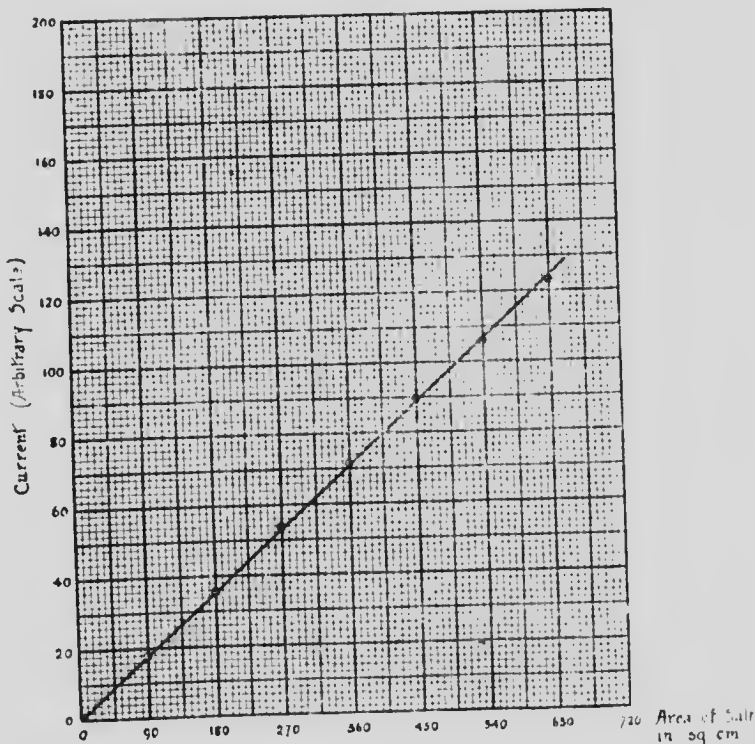
Before proceeding with the examination of the different salts some preliminary measurements were made on the activity of potassium sulphate when different areas of a layer of this salt were exposed to the air in the chamber. A layer of the salt some 6 mm. in thickness was placed in the tray mentioned above, which was 35 cms. long and 18 cms. wide, and then covered with a thick plate of metal divided into sections 18 cms. long, and 5 cms. wide. These sections were, one after another, removed from the tray, so that larger and larger areas of the salt were left exposed to the air in the chamber. The saturation current corresponding to each area was measured, and the values which are given in Table I. and plotted in fig. 2, show that the saturation currents were

directly proportional to the areas of the salt exposed. From this result it was evident that the substance which constituted the source of the radiation was uniformly distributed throughout the mass of the salt.

TABLE I.

Area of salt exposed in sq. cm.	Saturation current. Arbitrary Scale.
5 × 18	17.87
10 × 18	35.5
15 × 18	53.8
20 × 18	71.5
25 × 18	89.75
30 × 18	106
35 × 18	123

Fig. 2.



III. Relation between Thickness of Salt Layer and Activity.

Some additional measurements were made to ascertain the relation of the activity of a number of the salts to the thickness of the layer of salt exposed. In making these measurements the salts were ground to a fine powder and then sifted as uniformly as possible on the bottom of a shallow tray which had a surface area of 228 sq. cms. This tray was then placed in the ionizing chamber, and the saturation currents measured for each layer as before.

The results obtained with potassium sulphate are recorded in Table II., and a curve representing them is shown in fig. 3. From these it will be seen that the saturation currents steadily increased with the thickness of the layer of salt exposed until a thickness of 2.5 cm. was reached, when the current assumed a steady value and remained the same for greater thicknesses.

Additional observations were made with the halogen salts of potassium, and still others with two samples of potassium cyanide, one with a sample of potassium hydroxide, and one with a second specimen of chloride of potassium. The results of these measurements are given in Tables III. and IV., and curves representing them in figs. 4 and 5. From all the results recorded it will be seen that layers of the different salts between 2 and 3 mms. were amply sufficient to give the maximum saturation currents.

TABLE II.

Activity of Potassium Sulphate.

Thickness of salt layer (mm.).	Activity of salt. Saturation current (Arbitrary scale).
0.188	32
0.43	61
0.625	86
1.09	112
1.56	128
2.03	134
2.50	142
3.75	142
5.00	142

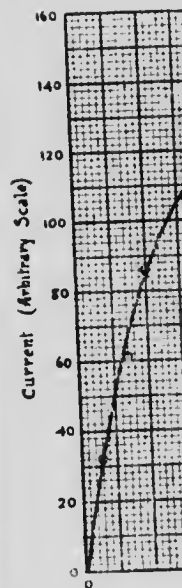


Fig. 3.

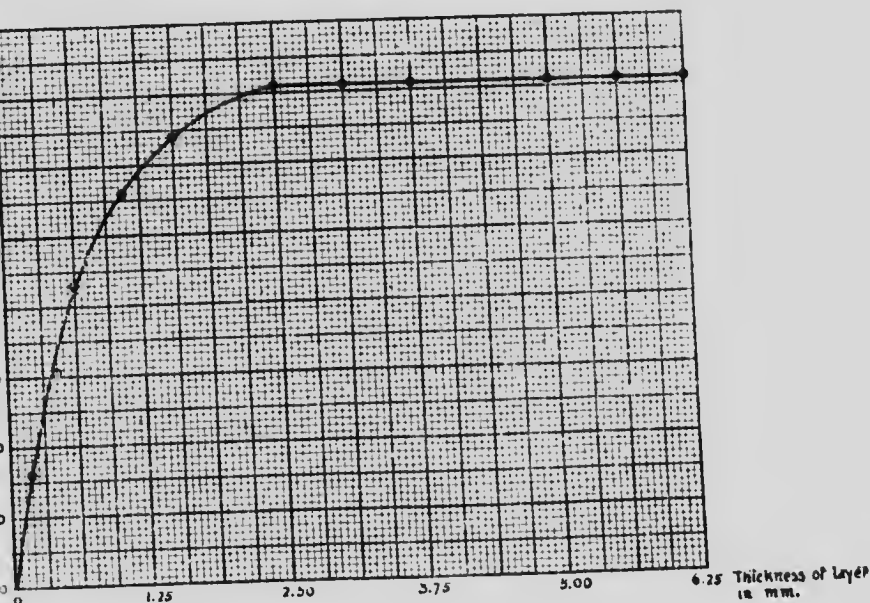


TABLE III.

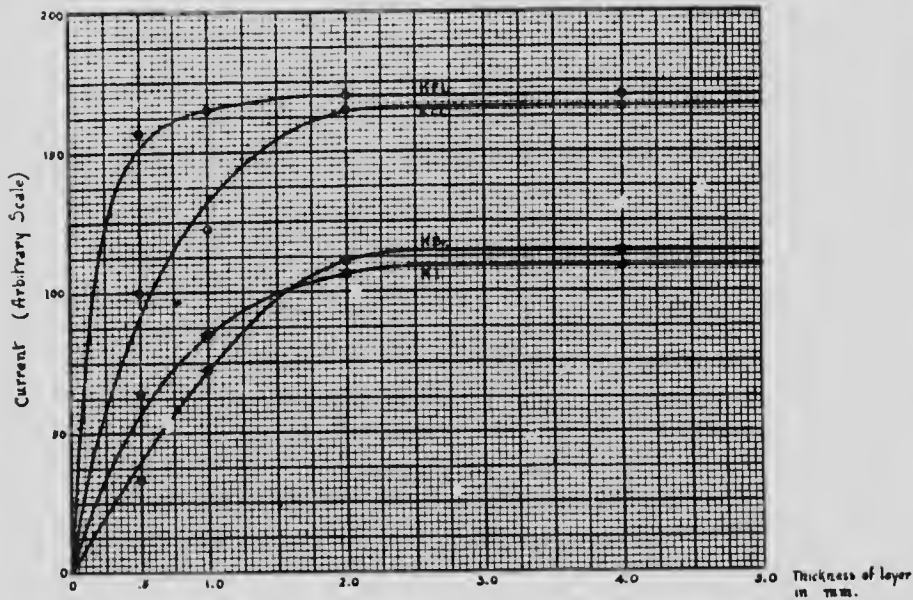
Activity of Potassium Salts of Halogen Group.

Thickness of salt layer (mm.).	Activity of salt. Saturation current (Arbitrary scale).			
	Potassium Fluoride.	Potassium Chloride.	Potassium Bromide.	Potassium Iodide.
.5	157	100	33.5	64
1.0	165	122.5	72.5	85
2.0	170	165	110.5	106
4.0	170	166.2	114.4	109

TABLE IV.

Thickness of salt layer (mm.).	Activity of salt. Saturation current (Arbitrary scale).		
	Potassium Chloride.	Potassium Hydroxide.	Potassium Cyanide (Kahlbaum).
.5	82.5	58	65
1.0	110	96.3	100
2.0	150	132.5	160
4.0	152.5	160	167.5

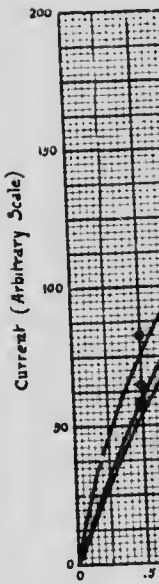
Fig. 4.



IV. Activities of different Potassium and other Salts.

After ascertaining that the activity of a selected salt was directly proportional to the area exposed, and that layers having a thickness of approximately 2.5 to 3 mm. furnished a measure of the maximum activity of the salt, a series of

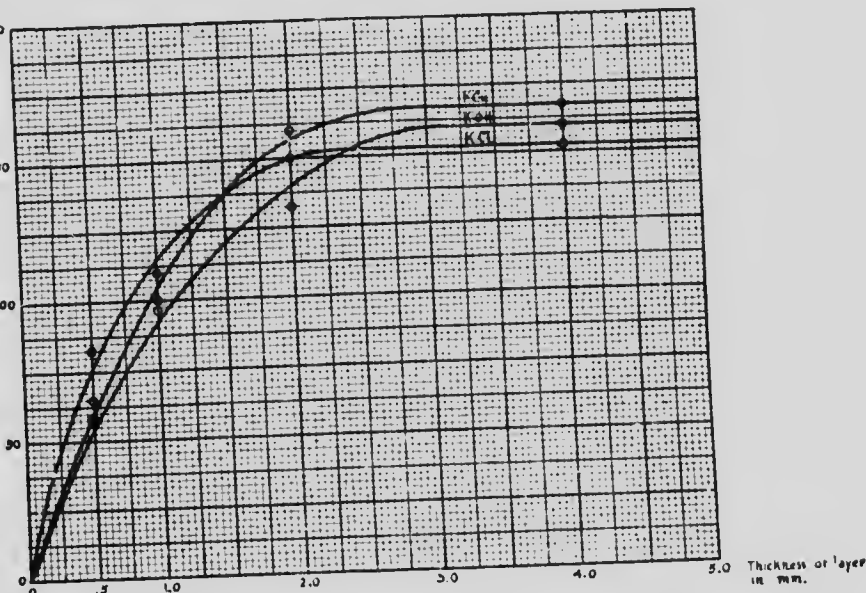
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measurements was made on the activities of a large number of potassium salts as well as on a number of others of the different alkali metals.

Fig. 5.



The results of the examination of these different salts are given in Table V. (p. 384), and in all cases they represent the activities of layers of sufficient thickness to give the maximum saturation currents.

From this table it will be seen:—

First. That samples of a selected salt obtained from different sources exhibited widely differing degrees of activity. Two of the chlorides, as Nos. 3 and 4 show, differed by more than 40 per cent. in their activities, and two of the hydroxides, Nos. 7 and 8, by nearly an equal amount. In the case of the cyanide of potassium the variation in activity was especially marked. As can be seen from Nos. 10 and 12, two samples of this salt exhibited activities which were approximately only 5 per cent. and 20 per cent. respectively of that shown by a number of other specimens of the same composition.

In addition to the results recorded in Table V. it may be stated that on one occasion a sample of potassium cyanide obtained from Valboalum was compared with one of potassium sulphate and one of potassium chloride obtained from Mercks,

TABLE V.
Table of Activities.

No.	Salt.	Source of salt.	Percentage of metal in salt. = K.	Activity of salt Saturation current, (Arbitrary scale = A.	A 10^2 . K	No.
1...	KF(H ₂ O) ₂	Mercks	41.5	207	499	1
2...	KCl	Mercks	52	152	292	2
3...	KCl	Kahlbaum	52	208	400	3
4...	KCl	Commercial	52	150	288	4
5...	KBr	Mallinckrodt	33	105	320	5
6...	KI	Mallinckrodt	24	110	466	6
7...	KOH	Mercks	70	223	319	7
8...	KOH	Kahlbaum	70	160	228	8
9...	KOH	Mercks	70	200	285	9
10...	KCN	Eim. & Am.	60	41	68	10
11...	KCN	Kahlbaum	60	183	305	11
12...	KCN	Mercks	60	8	15	12
13...	KCN	Commercial	60	191	318	13
14...	KCN	Commercial	60	208	346	14
15...	KCN	Commercial	60	185	308	15
16...	KNO ₃	Commercial	38.6	85	218	16
17...	KNO ₂	Mercks	46	125	272	17
18...	KClO ₃	Kahlbaum	32	128	400	18
19...	KMnO ₄	Commercial	25	80	320	19
20...	KMnO ₄	Commercial	25	78	312	20
21...	K ₂ C ₂ O ₄	Commercial	47	126	268	21
22...	K ₂ C ₂ O ₄	Commercial	47	93	198	22
23...	K ₂ SO ₃ (H ₂ O) ₂	Mercks	40.2	20	50	23
24...	K ₂ SO ₄	Kahlbaum	45	141	313	24
25...	K ₂ CO ₃ (H ₂ O) ₂	Kahlbaum	45	141	313	25
26...	K ₂ C ₂ O ₇	Commercial	36.4	128	387	26
27...	K ₃ PO ₄	Mercks	55	166	300	27
28...	K ₃ Fe(CN) ₆ (H ₂ O) ₃	Kahlbaum	37	174	470	28
29...	K ₃ Fe ₂ C ₁₂ N ₁₂	Kahlbaum	36	163	459	29
30...	K (metal)	Mercks	100	195	195	30
31...	Na (metal)	Commercial	100	0	0	31
32...	NaCl (evapor.)	Commercial	39	0	0	32
33...	NaCl (rock) (1)	Commercial	39	66	169	33
	NaCl (rock) (2)	Commercial	39	0	0	
	NaCl (rock) (3)	Commercial	39	0	0	
34...	Na ₂ CO ₃	Commercial	43	0	0	34
35...	LiCl(H ₂ O) ₂	Mercks	9	0	0	35
36...	Li ₂ C ₂ O ₇	Mercks	23.3	0	0	36
37...	Li ₂ CO ₃	Commercial	19	0	0	37
38...	Rb ₂ Al ₂ (SO ₄) ₄ (H ₂ O) ₂₄	Commercial	16.3	4	2.5	38
39...	CsCl	Commercial	80	5	6	39
40...	NH ₄ Cl	Commercial	33	14	40	40
41...	NH ₄ Br	Commercial	18.4	0	0	41
42...	(NH ₄) ₂ CO ₃	Commercial	37.5	0	0	42
43...	NH ₄ NO ₃	Kahlbaum	22	0	0	43

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and all three salts were found to possess to within one per cent. the same activity. On another occasion, a sample of potassium cyanide obtained from Kahlbbaum was compared with a specimen of the same salt manufactured by Mercks, and was found to display an activity more than four times as intense as that of the latter.

In this connexion the extremely low value found for the activity of the sample of potassium sulphite tested also merits emphasis. Potassium metal itself, it will be seen, exhibited a marked activity, but the value assigned to it, however, is not to be taken as comparable with the values recorded for the different salts of this metal, inasmuch as it was not possible to prepare layers of the metal for examination as regular and uniform as those of the salts.

From a consideration of all the results given in Table V. it would appear:—

First. That the values of $\frac{A}{K} \times 10^3$ found for the different potassium salts exhibited extremely wide variations, and that if the purity of the salts was assumed, these were such as to practically preclude the view that the activity of the salts was due to a normal atomic property of potassium.

Second. That while one sample of sodium chloride in the form of rock-salt showed an activity comparable with that exhibited by a number of potassium salts, several other samples of rock-salt were found to be quite inactive. Metallic sodium, too, and also a specimen of sodium carbonate, when examined, did not exhibit the slightest trace of radioactivity, and consequently it would appear that the activity observed in the single instance of sodium chloride mentioned was due to the presence in this salt of a trace of an active impurity. The low values obtained by Elster and Geitel in their measurements on the conductivity of air in a salt mine would also support this view.

Third. That with the exception of ammonium chloride which emitted a feeble activity, none of the lithium and ammonium salts showed the slightest trace of radioactivity, and that a sample of rubidium alum exhibited an activity which was extremely small, and a specimen of cesium chloride one which was only just measurable.

V. Activities of Different Samples of Potassium Cyanide.

From suggestions received by the writers from a number of sources it seemed desirable to make a closer examination of the activities of different specimens of potassium cyanide; and with the object of doing this five different samples were

obtained from one manufacturer, one from a second, and also one from a third manufacturer.

The activities of these salts were examined in the manner indicated above, and the salts themselves have since been analysed by Professor A. B. Macallum, who has very kindly determined the potassium content of each of them for us, using the platinum method.

The results of this examination are recorded in Table VI., the relative activities being given in Column I. of this table. In making the analyses, equal weights of the different salts were taken and the potassium present in each sample of the salt determined as a percentage of the total weight. These percentages are recorded in Column II. of Table VI.

TABLE VI.
Activities of different samples of Potassium Cyanide.

Source of Salt.	COLUMN I.	COLUMN II.
	Relative Activities of Salts.	Percentage by weight of Potassium present in Salts.
Manufacturer "A" Sample No. 1.	8.85	52.15
Manufacturer "B" Sample No. 1.	1.40	9.44
Manufacturer "C" Sample No. 1.	.15	2.84
" " No. 2.	.10	2.76
" " No. 3.	.60	9.57
" " No. 4.	.00 (slight)	2.36
" " No. 5.	1.47	7.64

In arriving at these results the different salts were placed in bottles and sealed immediately after their activities were ascertained. They were also kept sealed until the analyses were made. This precaution was taken in order to prevent the absorption of moisture from the air, as otherwise, since the salts are hygroscopic, values for the percentage contents of potassium in the salts would have been obtained which would not have been applicable in a discussion of their relative activities determined some time previously.

From the results set forth in Table VI. it will be seen that exceedingly wide variations were found in the potassium content of the different specimens. It will be seen, too, that those salts which possessed the greater potassium content also exhibited the higher activities, and that in the case of

the more active the radioactivities were approximately proportional to the potassium contents of the salts. The results obtained with potassium cyanide in this series of measurements, therefore, rather support the view taken by Campbell that the activities of potassium salts are directly proportional to the amount of potassium present in them.

In the light of these results it would appear advisable, too, before drawing definite conclusions from the numbers given in Table V., to make a chemical analysis of each of the salts and to accurately determine its potassium content.

VI. Absorption Experiments.

In order to obtain an estimate of the penetrating power of the radiations emitted by the potassium salt, quantities of the sulphate, the chloride, and the cyanide were spread in turn in uniform layers on a tray and placed beneath and close to the bottom of the ionizing chamber AB, fig. 1. In these measurements the bottom of the chamber consisted of a finely meshed gauze, which permitted the rays to pass into the chamber with as little absorption as possible. The tray containing the salt was then gradually lowered so as to increase the air-column traversed by the rays before they entered the chamber, and the ionization currents were measured with

TABLE VII.
Absorption Experiments.

Distance (cm.).	Potassium.		
	Sulphate (Current arbitrary scale).	Chloride (Current arbitrary scale).	Cyanide (Current arbitrary scale).
2.1	178	235	240
4.7	158	200	205
9.1	118	166	178
16.6	81	94	125
24.4	59	65.4	96
31.9	39	44	64
39.1	28.5		33

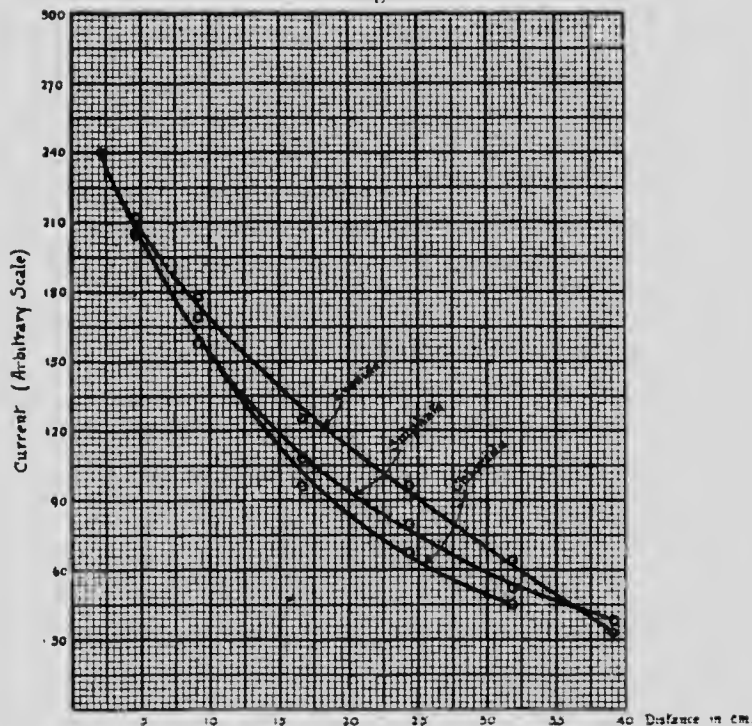
the salt at different distances. The values of the currents obtained with three of the salts mentioned are shown in Table VII. These values have been reduced for purposes of comparison to a common maximum intensity, and the reduced

388 Prof. McLennan and Mr. Kennedy on the readings are given in Table VIII., curves representing them being shown in fig. 6. From these it will be seen, just as

TABLE VIII.
Absorption Experiments (Reduced values).

Distance (cm.).	Potassium.		
	Sulphate.	Chloride.	Cyanide.
2.1	240	240	240
4.7	212	204	205
9.1	158	169	178
16.6	108	96	125
21.4	79.7	67	96
31.9	52	45	64
39.1	38	...	33

Fig. 6.



Campbell and Wood have pointed out, that the rays emitted by potassium salts possess considerable penetrating power.

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The saturation currents were not reduced to half value until the columns of air traversed amounted to between 12 and 15 cms., and even with the salts at a distance of 40 cms. from the chamber the ionizing currents were still approximately 15 per cent. of their highest values.

From the form of the curves it is evident that the radiations from the different potassium salts were not identical in their composition. The absorption curves for the sulphate and the chloride were very similar, but that for the cyanide was markedly different, and indicated by its shape that the rays from this salt, besides being heterogeneous in character, contained a predominating proportion of the more penetrating types.

It is of interest to note, too, that the absorption curves in fig. 6 show no irregularities in their initial portions, such as one would have expected if the radiations had consisted, amongst others, of a type possessing the characteristics of the α radiations from the known radioactive elements.

These results, it will be seen, are in accordance with Campbell and Wood's observations, and confirm the conclusions reached by them that the radioactivity exhibited by the potassium salts possesses the characteristics of either a β or an easily absorbed γ radiation, rather than those of an α type.

In a second series of measurements on the absorption of the potassium rays, the tray was filled with a quantity of potassium sulphate and then placed in the ionizing chamber, resting on the bottom. The salt was covered successively with an increasing number of sheets of tinfoil, and the saturation current measured for each set of the absorbing sheets. The foil used was 0.0089 mm. in thickness. The values of the currents corresponding to the different thicknesses of tinfoil are given in Table IX., and the manner in

TABLE IX.

Thickness of tinfoil. (cm.)	Saturation current (Arbitrary scale).
0.00000	188
0.00089	163
0.00178	149
0.00446	106
0.01157	50
0.01607	31
0.02239	10

which the value of the currents decreased is indicated by the curve in fig. 7. In arriving at the numbers recorded in

Fig. 7.

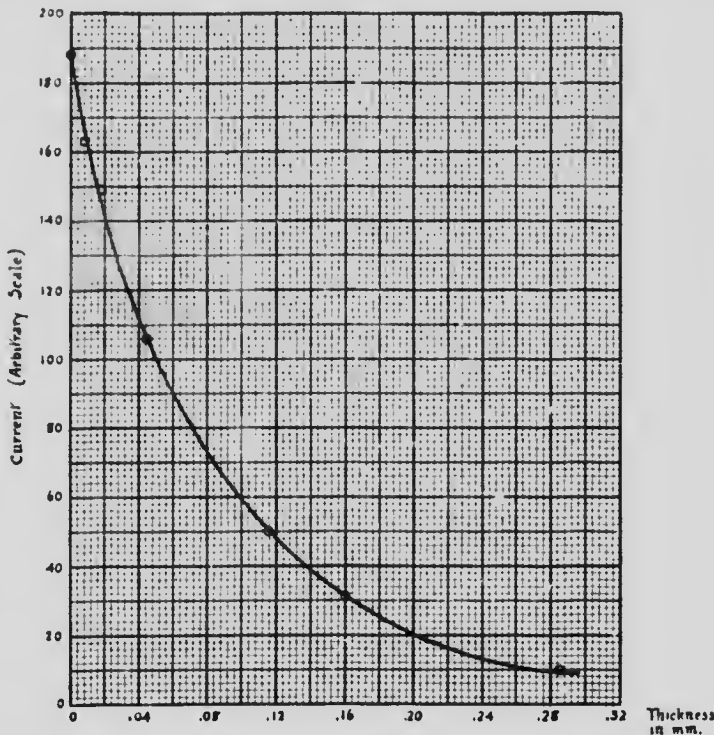


Table IX. corrections were made from a preliminary set of observations for the activity of the tinfoil sheets which were found to emit an extremely feeble though measurable radiation. From the values given in Table IX. it will be seen that it was necessary to cover the salt with foil representing a total thickness of 0.6 mm. before the radiation from the salt was reduced to one-half its original intensity.

The mean values of the absorption constant λ for the different thicknesses were deduced from the formula

$$I = I_0 e^{-\lambda d},$$

where I_0 was the ionization current obtained with the un-screened salt, and I the current when d centimetres was the thickness of the tinfoil traversed. The deduced values of λ are given in Table X., and as will be seen these show a gradual decrease as the number of sheets of tinfoil used for a screen was increased.

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TABLE X.
Absorption by Tinfoil.

Thickness of tinfoil (cm.).	I_0	λ .
0.00089	867	160
0.0178	793	150
0.0446	563	124
0.1157	265	115
0.1607	165	112
0.2839	653	104

The values obtained by Rutherford* for the constant λ when studying the absorption of the β rays from uranium with screens of tinfoil was 96, and later the value found by Crowther† for the same constant under similar circumstances was 69.3. A comparison of these values and those given in Table IX. makes it evident that while the rays emitted by the potassium salts were very heterogeneous in character, they did not contain any types possessing greater penetrating power than the β rays emitted by uranium salts. This result, too, is in keeping with what Campbell and Wood found in their investigations on the absorption of these potassium rays.

VII. Activity of Potassium Salts and Secondary Radiations.

A set of measurements was made with the object of ascertaining whether the radiation emitted by the potassium salts, which from its characteristics evidently consisted of β rays, was due to some property inherent in the salts, or whether it was due to a secondary radiation, of exceptionally high intensity, excited in the salt by the penetrating radiation which is known to exist at the surface of the earth.

A cylinder of lead some 60 cms. high and 25 cms. in diameter was prepared, and the natural conductivity of the air in this cylinder determined. A layer of potassium sulphate was then placed in a tray on the bottom of the cylinder, and when the conductivity of the air was again measured it was found to be approximately twice as high as it was before the salt was introduced.

From this it was evident that the radiation from the salt

* Rutherford, 'Radioactivity,' 2nd edition, p. 137.

† Phil. Mag. Oct. 1906, p. 379.

contributed to the conductivity practically as much as the combined action of the earth's penetrating radiation and that emitted by the walls of the cylinder. If then the activity of the salt consisted solely of a secondary radiation one should expect, with a penetrating radiation gradually increasing in intensity, to obtain proportionately greater effects when the salt was in the cylinder than when it was removed from it.

In order to realize these conditions, a few milligrams of radium bromide sealed in a glass tube were enclosed in a heavy block of lead, and this was placed at a number of different distances from the cylinder and the conductivity of the air in the chamber ascertained, with the radium in each position. The observations were made first with the salt in the cylinder and then repeated for each position of the radium after the salt had been removed.

The results of these measurements are given in Table XI.,

TABLE XI.

Position of radium bromide.	Saturation current. (Arbitrary scale) Salt in cylinder.	Saturation current. (Arbitrary scale) Salt not in cylinder.
First	6053	6272
Second	2568	2641
Third	907	945
Fourth	271	273
Fifth	209	227

and from the numbers given in the table it will be seen that although the ionization currents were increased over thirty-fold, the ionization, and consequently the secondary radiation produced by the gamma rays from the radium, was invariably less when the salt was in the cylinder than before the salt was introduced.

Inasmuch as the ordinary or spontaneous ionization in the cylinder was found to be increased approximately twofold by the introduction of the salt, it is clear, in the light of the numbers given above, that this increase in the conductivity was due to a primary activity possessed by the salt, and not due to a secondary activity imparted to it by the influence of external radiations.

VIII. *Miscellaneous Experiments.*

With a view to ascertaining whether the activity of potassium salts arose from the presence in the salts of traces of any of the active elements, radium, thorium, or actinium, an attempt was made to drive off any emanation which they might contain by raising the salts to moderate temperatures. Although a number of the salts was treated in this way, with none of them, however, was the slightest indication obtained of a loss of activity such as should accompany the expulsion of radioactive gases.

Although these experiments made it probable that the activity was not due to the presence of traces of the elements radium, thorium, and actinium, or of their immediate products, in the salts, it was still possible that the activity might be due to the presence in minute quantities of uranium or of one of the active products of slow decay of radium. With the object of testing this surmise a sample of potassium sulphate which had been found to exhibit a comparatively high activity was heated to a little over 1000° C., and maintained at that temperature for a considerable time.

After the salt had been subjected to this treatment it was again examined, but was found to possess exactly the same activity as before being heated.

Similar attempts were made to reduce the activities of samples of potassium chloride and potassium cyanide, but in none of these tests was any reduction of activity obtained as a result of the heating.

To test still further the possibility of driving off by volatilization any active impurities which might be present, a quantity of active potassium sulphate, contained in a graphite crucible, which on examination showed no sign of activity, was placed in a coke furnace, first melted and then heated as highly as possible for a time. During this heating the sulphate became partially converted into the sulphides of potassium. After cooling, the mixture, which was ground to a fine powder and tested for radioactivity in the manner indicated above, was found to possess the same activity as before the treatment.

As the melting-point of potassium sulphate is approximately 1060° C., and inasmuch as the temperature of the salt during this experiment was raised very much beyond this point, it is clear that a temperature was reached considerably above the points of volatilization of the radium products of slow decay, and it follows therefore, from the absence of any loss of activity from the heating, that none of

these active products were present in the salt, and that the source of its activity must be sought for elsewhere.

The only remaining known active product whose presence in the salt could account for its activity appeared to be uranium X, and although it was not clear how such a product could become mixed with the salts of potassium, attempts were made to separate it out by recrystallization, by precipitation with ammonium carbonate, and also by treating solutions of the salts with ether after the manner of Meyer and Schweidler*. By none of these processes, however, was it found possible to effect to a measurable degree the separation of any active product.

Attempts were also made with some of the salts to separate out by electrolysis active impurities which might be present, but it was again found impossible to bring about any separation of the active constituents in this way.

XI. Summary of Results.

1. It has been shown that the activity of uniform layers of active potassium salts was directly proportional to the area of the salt exposed.
2. With uniform layers of a number of potassium salts the activity was found to increase with the thickness of the layer, and maximum activities were obtained with all the salts examined with layers of the salts from 2 to 3 mm. in thickness.
3. Wide variations were found in the activities of different potassium salts, and of potassium salts of the same composition obtained from different sources, and ordinarily sold as chemically pure. In particular, different samples of potassium cyanide were found to vary widely in their potassium content, but the activities of the different samples were found to be approximately proportional to the amount of potassium present.
4. The rays from the potassium salts, which were found to be heterogeneous and to possess considerable penetrating power, exhibited characteristics similar to those of the β radiation emitted by uranium X. The penetrating power of the latter, however, is somewhat greater than that possessed by the potassium rays.
5. Experiments have been described which go to show that the activity of potassium salts is not due to the excitation of a secondary radiation in the salts by the

* Meyer and Schweidler, *Wien. Ber.* 113, July 1904.

action of penetrating rays coming from external sources.

6. By various tests it was found impossible to trace the activity of potassium salts to the existence in them of minute quantities of any of the known radioactive elements or their active products.
7. Of all the elements in the alkali group, potassium alone has been found to exhibit marked radioactivity. Both sodium and all of its salts were found to be quite inactive, and although a sample of rubidium alum exhibited an activity which was extremely small, and a specimen of caesium chloride one which was only just measurable, sufficient evidence has not been adduced to support exclusively the view that the activities observed were due to a physical property of the metallic constituents of these salts.

In conclusion, we wish to express our very great indebtedness to Prof. Lang and to Prof. Lash Miller, as well as to other members of the staff in the Department of Chemistry, for their kindness in placing at our disposal a number of the specimens of the salts examined.

Physical Laboratory, University of Toronto,
August 5, 1908.

