XX. *Additional Observations on the Diffusion of Liquids.* (*Third Memoir.*) By Thomas Graham, *Esq., F.R.S., F.C.S. &c.*

THE experiments on diffusion to be presently described are in continuation of those detailed in my last publication on the subject, the same method of observing being followed without change. The diffusion is generally made from solutions in four different proportions, so as to exhibit pretty fully the characters of the property in question for each salt, so far as is possible at a constant temperature. The salts operated upon are of two bases only, potash and soda; but the acids are considerably varied, so as to include hydrates, carbonates, sulphates, sulphites, hyposulphites, sulphovinates, oxalates, acetates and tartrates. Salts of almost every class of acids come thus to be represented, either in the present or former series of experiments on diffusion, while at the same time much information is elicited respecting the diffusive relation of the two important bases named.

Comparison of Salts of Potash and Soda.

Hydrate of Potash.—Time of diffusion 4·041 days. The usual number of eight cells of the 1 and 2 per cent. solutions of this substance were diffused, and four cells of the 4 and 8 per cent. solutions. The whole diffusates of each proportion were then mixed together, and the quantity of hydrate of potash diffused for two cells determined by an alkalimetric experiment, which was always repeated twice.

1. One per cent. of hydrate of potash, density 1·00978, diffused at 63°·4, gave 6·56 grs. of hydrate of potash for two cells.

2. 2·005 per cent. of hydrate of potash, density 1·01878, diffused at 63°·4, gave 12·88 grs. for two cells; calculated for 2 per cent., 12·84 grs. of hydrate of potash in two cells.

3. 4·01 per cent. of hydrate of potash, density 1·0366, diffused at 63°·4, gave 12·56 grs. for one cell; calculated for 4 per cent., 12·52 grs. of hydrate of potash in one cell.

4. 8·02 per cent. of hydrate of potash, density 1·07069, diffused at 63°·4, gave 26·20 grs. for one cell; calculated for 8 per cent., 26·12 grs. of hydrate of potash in one cell.

Diffusion of Hydrate of Potash in 4·04 days at 63°·4 ; two cells.

	Grs.	Ratio.
From 1 per cent. solution . . .	6·56	1·022
From 2 per cent. solution . . .	12·84	2
From 4 per cent. solution . . .	25·04	3·900
From 8 per cent. solution . . .	52·24	8·137

Hydrate of Soda.—Time of diffusion 4·9497 days; the times chosen as hitherto for the corresponding potash and soda salts being always, when squared, in the proportion of 2 to 3. The usual number of eight cells of the 1 and 2 per cent. solutions were diffused, and four cells of the 4 and 8 per cent. solutions. The whole diffusates of each proportion were then mixed together, and the quantity of hydrate of soda diffused for two cells determined by alkalimetric experiments.

1. 1·043 per cent. of hydrate of soda, density 1·01256, diffused at 63°·3, gave 6·06 grs. for two cells; calculated for 1 per cent., 5·81 grs. of hydrate of soda in two cells.

2. 2·087 per cent. of hydrate of soda, density 1·0242, diffused at 63°·3, gave 11·58 grs. for two cells; calculated for 2 per cent., 11·09 grs. of hydrate of soda in two cells.

3. 4·177 per cent. of hydrate of soda, density 1·04666, diffused at 63°·3, gave 10·90 grs. for one cell; calculated for 4 per cent., 10·43 grs. of hydrate of soda in one cell.

4. 8·35 per cent. of hydrate of soda, density 1·08846, diffused at 63°·3, gave 21·10 grs. for one cell; calculated for 8 per cent., 20·22 grs. of hydrate of soda in one cell.

Diffusion of Hydrate of Soda in 4·95 days at 63°·3 ; two cells.

	Grs.	Ratio.
From 1 per cent. solution . . .	5·81	1·048
From 2 per cent. solution . . .	11·09	2
From 4 per cent. solution . . .	20·86	3·765
From 8 per cent. solution . . .	40·44	7·30

The nearest approach to equality of diffusion in the hydrates of potash and soda, is exhibited by the 1 per cent. solutions, which are as 6·56 to 5·81, or as 100 to 88·57, being a difference of so much as 11·43 per cent.

Comparative Diffusion of Hydrate of Potash in 4·041 days at 63°·4, and of Hydrate of Soda in 4·95 days at 63°·3.

	From solutions of			
	1 per cent.	2 per cent.	4 per cent.	8 per cent.
Hydrate of potash	100	100	100	100
Hydrate of soda................	88·57	86·37	83·30	77·41

The marked departure from the usual ratio of diffusion, here exhibited, must not be overlooked in considering the relation between potash and soda salts.

Carbonate of Potash.—Time of diffusion 8·083 days, or double the time of hydrate of potash. The usual number of eight cells of the 1 and 2 per cent. solutions were diffused, with four cells of the 4 and 8 per cent. solutions, and the diffusates of each proportion determined by alkalimetric experiments as with the preceding alkaline hydrates.

1. 1·002 per cent. of carbonate of potash, density 1·00957, diffused at 63°·7, gave 6·15 grs. for two cells; calculated for 1 per cent., 6·13 grs. of carbonate of potash in two cells.

2. 2·005 per cent. of carbonate of potash, density 1·01843, diffused at 63°·7, gave 11·95 grs. for two cells; calculated for 2 per cent., 11·92 grs. of carbonate of potash in two cells.

3. 4·01 per cent. of carbonate of potash, density 1·03577, diffused at 63°·7, gave 11·48 grs. for one cell; calculated for 4 per cent., 11·44 grs. of carbonate of potash in one cell.

4. 8·02 per cent. of carbonate of potash, density 1·06935, diffused at 63°·7, gave 22·79 grs. for one cell; calculated for 8 per cent., 22·72 grs. of carbonate of potash in one cell.

5. 2·005 per cent. of carbonate of potash, density 1·01843, diffused at 68°·2, gave 12·64 grs. for two cells; calculated for 2 per cent., 12·62 grs. of carbonate of potash in two cells.

Diffusion of Carbonate of Potash in 8·08 days at 63°·7; two cells.

	Grs.	Ratio.
From 1 per cent. solution . . .	6·13	1·028
From 2 per cent. solution . . .	11·92	2
From 4 per cent. solution . . .	22·88	3·839
From 8 per cent. solution . . .	45·44	7·624

Comparative Diffusion of Hydrate of Potash in 4·04 days at 63°·4, and Carbonate of Potash in 8·08 days at 63°·7.

	From solutions of			
	1 per cent.	2 per cent.	4 per cent.	8 per cent.
Hydrate of potash	100	100	100	100
Carbonate of potash	93·48	92·81	91·36	86·97

The diffusion of hydrate of potash appears to be excessive when compared with the carbonate of potash, as well as when compared with the hydrate of soda.

Carbonate of Soda.—Time of diffusion 9·8994 days. The usual number of eight cells of the 1 and 2 per cent. solutions of this substance were diffused, and four cells of the 4 and 8 per cent. solutions, and the diffusates determined by alkalimetric experiments.

1. 1·003 per cent. of carbonate of soda, density 1·01120, diffused at 63°·4, gave 6·04 grs. for two cells; calculated for 1 per cent., 6·02 grs. of carbonate of soda in two cells.

2. 2·007 per cent. of carbonate of soda, density 1·0216, diffused at 63°·4, gave 11·74 grs. for two cells; calculated for 2 per cent., 11·70 grs. of carbonate of soda in two cells.

3. 4·015 per cent. of carbonate of soda, density 1·04156, diffused at 63°·4, gave 10·74 grs. for one cell; calculated for 4 per cent., 10·71 grs. of carbonate of soda in one cell.

4. 8·03 per cent. of carbonate of soda, density 1·0800, diffused at 63°·4, gave 19·93 grs. for one cell; calculated for 8 per cent., 19·87 grs. of carbonate of soda in one cell.

In the two following additional experiments the diffusate was treated with hydrochloric acid, and estimated from the weight of chloride of sodium produced.

5. 2·007 per cent. of carbonate of soda, density 1·02166, diffused at 68°·1, gave 12·06 grs. for two cells; calculated for 2 per cent., 12·02 grs. of carbonate of soda in two cells at 68°·1.

6. 2·13 per cent. of carbonate of soda, density 1·02246, diffused at 59°·6 in eight cells, 11·12, 11·34, 11·17, 11·58; mean 11·38 grs. for two cells; calculated for 2 per cent., 10·65 grs. of carbonate of soda in two cells at 59°·6.

Diffusion of Carbonate of Soda in 9·9 days at 63°·4; two cells.

	Grs.	Ratio.
From 1 per cent. solution . . .	6·02	1·028
From 2 per cent. solution . . .	11·70	2
From 4 per cent. solution . . .	21·42	3·661
From 8 per cent. solution . . .	39·74	6·792

The similarity of diffusion between the carbonates of potash and soda is remarkable in the 1 per cent. solution, which are as 6·13 to 6·02, or as 100 to 98·2; also in the 2 per cent. solutions, which were observed at two different temperatures.

Diffusion of 2 per cent. solutions of Carbonate of Potash in 8·083 days, and Carbonate of Soda in 9·9 days.

	Grs.	Ratio.
Carbonate of potash at 63°·7 . . .	11·92	100
Carbonate of soda at 63°·4	11·70	98·15
Carbonate of potash at 68°·2 . . .	12·62	100
Carbonate of soda at 68°·1	12·02	95·24

Comparative Diffusion of Carbonate of Potash in 8·083 days at 63°·7,
and Carbonate of Soda in 9·9 days at 63°·4.

	From solutions of			
	1 per cent.	2 per cent.	4 per cent.	8 per cent.
Carbonate of potash	100	100	100	100
Carbonate of soda	98·20	98·15	93·63	87·44

The carbonate of soda appears to preserve more analogy to the hydrate of soda in its diffusion than the carbonate of potash to the hydrate of potash.

Comparative Diffusion of Hydrate of Soda in 4·937 days at 63°·3,
and Carbonate of Soda in 9·9 days at 63°·4.

	From solutions of			
	1 per cent.	2 per cent.	4 per cent.	8 per cent.
Hydrate of soda	100	100	100	100
Carbonate of soda	103·62	105·50	102·68	98·27

Here we have a nearly equal diffusion with the times as 1 to 2 for the hydrate and carbonate of soda respectively.

Sulphate of Potash.—Time of diffusion 8·083 days. The solution of diffused salt was evaporated to dryness and weighed.

1. 1·005 per cent. of sulphate of potash, density 1·00844, diffused at 60°·3, in eight cells, 6·11, 6·21, 6·12, 6·32; mean 6·19 grs. in two cells; calculated for 1 per cent., 6·16 grs. of sulphate of potash in two cells.

2. 2·01 per cent. of sulphate of potash, density 1·01653, diffused at 60°·3, in eight cells, 11·61, 11·58, 11·50, 11·97; mean 11·66 grs. in two cells; calculated for 2 per cent., 11·60 grs. of sulphate of potash in two cells.

3. 4·02 per cent. of sulphate of potash, density 1·03240, diffused at 60°·3, in four cells, 10·80, 11·33, 11·20, 12·07; mean 11·35 grs. for one cell; calculated for 4 per cent. 11·35 grs. of sulphate of potash in one cell.

4. 8·04 per cent. of sulphate of potash, density 1·06306, diffused at 60°·3, in four cells, 21·91, 21·93, 22·00, 22·47; mean 22·08 grs. for one cell; calculated for 8 per cent., 21·96 grs. of sulphate of potash in one cell.

Diffusion of Sulphate of Potash in 8·083 days at 60°·3 ; two cells.

	Grs.	Ratio.
From 1 per cent. solution . . .	6·16	1·062
From 2 per cent. solution . . .	11·60	2
From 4 per cent. solution . . .	22·70	3·914
From 8 per cent. solution . . .	43·92	75·72

The diffusion of sulphate of potash above, at 60°·3, appears to be similar to that of carbonate of potash at 63°·7, a higher temperature by 3°·4 (p. 413). The numbers for the sulphate of potash and hydrate of potash (p. 412) would probably correspond

closely at the same temperature, the times of diffusion of the two substances being taken as 2 to 1.

Sulphate of Soda.—Time of diffusion 9·9 days. The diffusate was evaporated to dryness and weighed.

1. One per cent. of sulphate of soda, density 1·00940, diffused at 59°·9, in eight cells, 6·31, 6·47, 6·21, 6·32; mean 6·33 grs. for two cells.

2. 1·995 per cent. of sulphate of soda, density 1·01832, diffused at 59°·9, in eight cells, 12·02, 12·10, 11·66, 12·16; mean 11·98 grs. for two cells; calculated for 2 per cent., 12·00 grs. of sulphate of soda in two cells at 59°·9.

3. 3·99 per cent. of sulphate of soda, density 1·03594, diffused at 59°·9, in four cells, 10·00, 10·80, 11·53, 11·53; mean 10·96 grs. for one cell; calculated for 4 per cent., 10·98 grs. of sulphate of soda in one cell at 59°·9.

4. 7·98 per cent. of sulphate of soda, density 1·06960, diffused at 59°·9, in four cells, 20·50, 21·36, 20·01, 20·68; mean 20·64 grs. for one cell; calculated for 8 per cent., 20·69 grs. of sulphate of soda in one cell at 59°·9.

Diffusion of Sulphate of Soda in 9·9 days at 59°·9; two cells.

	Grs.	Ratio.
From 1 per cent. solution . . .	6·33	1·055
From 2 per cent. solution . . .	12·00	2
From 4 per cent. solution . . .	21·96	3·66
From 8 per cent. solution . . .	41·38	6·896

The 2 per cent. solution of sulphate of soda above, at 59°·9, appears to be more diffusive than the corresponding solution of carbonate of soda at 59°·6, as 12·00 to 10·65 grs., or as 100 to 88·75.

The assumed relation in the times of equal diffusion for salts of potash and soda appears to derive support from the sulphates, particularly in the lower proportions of salt.

Comparative Diffusion of Sulphate of Potash in 8·083 days at 60°·3, and Sulphate of Soda in 9·9 days at 59°·9.

	From solutions of			
	1 per cent.	2 per cent.	4 per cent.	8 per cent.
Sulphate of potash............	100	100	100	100
Sulphate of soda	102·74	103·45	96·74	94·21

Another set of experiments made upon these two salts, simultaneously with certain oxalates and acetates which follow, may be placed here to illustrate the same relation. The preceding times of diffusion were observed.

5. 2·013 per cent. of sulphate of potash, diffused at 59°·8, in eight cells, gave 11·90, 11·94, 11·41, 11·71; mean 11·74 grs. for two cells; calculated for 2 per cent., 11·67 grs. of sulphate of potash in two cells.

6. Two per cent. of sulphate of soda, density 1·01846, diffused at 59°·6, in eight cells, gave 11·58, 11·56, 11·94, 11·97; mean 11·76 grs. of sulphate of soda in two cells.

The present results, from 2 per cent. solutions of these salts, are as follows :—

Sulphate of potash in 8·083 days at 59°·8 . . . 11·67   100
Sulphate of soda in 9·9 days at 59°·6 . . . . 11·76   100·94

The diffusion in the selected times appears therefore to be, as nearly as possible, equal at the present temperatures.

Another experiment may be recorded at present, of which the object was to ascertain the influence of free sulphuric acid upon the diffusion of sulphate of soda.

7. Sulphate of soda, 2·02 per cent., to which an equivalent quantity of sulphuric acid was added, had the density 1·02703. This solution, diffused into pure water, in eight cells, at 59°·6, for the same time as the preceding sulphate of soda, gave a diffusate of 9·70, 10·06, 10·17 and 10·29 grs. of sulphate of soda; mean 10·05 grs. in two cells; calculated for 2 per cent., this diffusate becomes 9·95 grs. The presence of one equivalent of sulphuric acid appears therefore to diminish the diffusion of sulphate of soda considerably, namely, from 11·76 to 9·95 grs., or from 100 to 84·61. The free sulphuric acid diffused in the experiment was not determined.

Sulphite of Potash.—It was curious to observe how far this and other salts of the oxygen acids of sulphur correspond with the sulphates. Time of diffusion 8·083 days. The diffusate was treated with sulphuric acid and estimated in the form of neutral sulphate of potash.

1·90 per cent. of sulphite of potash, density 1·01753, diffused at 59°·5, in eight cells, gave 11·36, 10·72, 11·22 and 10·90 grs. in two cells; mean 11·05 grs. in two cells; calculated for 2 per cent., 11·63 grs.

Making the comparison for 2 per cent. solutions we have—

Sulphate of potash at 60°·3 . . . 11·60   100
Sulphite of potash at 59°·5 . . . 11·63   100·26

The two salts appear to have the same diffusibility.

Sulphite of Soda.—Time of diffusion 9·9 days. The diffusate was estimated in the same manner as the preceding salt.

2·26 per cent. of sulphite of soda, density 1·02330, diffused at 59°·6, in eight cells, gave 12·93, 13·35, 13·56 and 13·62 grs. in two cells; mean 13·37 grs. in two cells; calculated for 2 per cent., 11·83 grs.

The comparative diffusion of the sulphites of the two bases is as follows :—

Sulphite of potash in 8·083 days at 59°·5 . . . 11·63   100
Sulphite of soda in 9·9 days at 59°·6 . . . . . 11·83   100·72

The sulphites of potash and soda appear therefore to exhibit the usual relation of these two bases.

Hyposulphite of Potash.—Time of diffusion 8·083 days. The diffusate was evaporated to dryness with sulphuric acid, ignited and estimated from the sulphate produced.

1·925 per cent. of anhydrous hyposulphite of potash, density 1·0150, diffused at 59°·8, in eight cells, gave 11·66, 11·67, 12·01, 12·26 grs.; mean 11·90 grs. for two cells; calculated for 2 per cent., 12·37 grs. of hyposulphite of potash in two cells.

Comparing this salt with the sulphate of the same base, we have—

Sulphate of potash at 60°·3 . . .	11·60	100
Hyposulphite of potash at 59°·8 . .	12·37	106·44

A slight error in excess may possibly have been introduced from the circumstance that the hyposulphite of potash employed was not absolutely free from sulphate.

Hyposulphite of Soda.—Time of diffusion 9·9 days. The diffusate was estimated in the same manner as the preceding salt.

2·136 per cent. of anhydrous hyposulphite of soda, density 1·01778, diffused at 59°·9, in eight cells, gave 13·11, 12·77, 12·92, 11·99 grs.; mean 12·70 grs. for two cells; calculated for 2 per cent., 11·89 grs. of hyposulphite of soda in two cells.

The comparative diffusion of the salts of potash and soda appears thus:—

Hyposulphite of potash in 8·083 days at 59°·8 . . .	12·37	100
Hyposulphite of soda in 9·9 days at 59°·9	11·89	96·21

The relation of the sulphate and hyposulphite of soda appears still closer.

Sulphate of soda at 59°·6	11·76	100
Hyposulphite of soda at 59°·9 . .	11·89	101·10

Sulphovinate of Potash.—Time of diffusion 8·083 days. The diffusate was evaporated to dryness and ignited with sulphuric acid.

1·966 per cent. of sulphovinate of potash, of density 1·00977, diffused at 59°·8, in eight cells, gave 12·57, 12·48, 12·12 and 12·39 grs.; mean 12·39 grs. for two cells; calculated for 2 per cent., 12·60 grs. of sulphovinate of potash in two cells.

The diffusion of this salt appears in excess when compared with sulphate of potash.

Sulphate of potash at 60°·3 . . .	11·60	100
Sulphovinate of potash at 59°·8 . .	12·60	108·62

Sulphovinate of Soda.—Time of diffusion 9·9 days. The diffusate was estimated in the same manner as the preceding salt.

2·063 per cent. of sulphovinate of soda, of density 1·00944, diffused at 59°·6, in eight cells, gave 13·32, 13·50, 13·78 and 13·15 grs.; mean 13·44 grs. for two cells; calculated for 2 per cent., 13·03 grs. of sulphovinate of soda in two cells.

Comparing the two sulphovinates together, we have—

Sulphovinate of potash in 8·083 days at 59°·8 . . .	12·60	100
Sulphovinate of soda in 9·9 days at 59°·6	13·03	103·41

Neither of these sulphovinates appeared to suffer decomposition in the act of diffusion, at least to any considerable extent. But the experiments on both of these salts are less precise than usual, from the difficulty of obtaining them entirely free from sulphates.

Oxalate of Potash.—Time of diffusion 8·083 days. The diffusate was evaporated to dryness, ignited, and then converted into chloride of potassium.

1. 0·981 per cent. of anhydrous oxalate of potash, density 1·00775, diffused at 59°·8, in eight cells, 6·24, 6·22, 5·91, 5·97; mean 6·08 grs. for two cells; calculated for 1 per cent., 6·20 grs. of oxalate of potash in two cells.

2. 1·92 per cent. of oxalate of potash, density 1·01463, diffused at 59°·9, in eight cells, 11·54, 11·63, 11·94, 11·63; mean 11·68 grs. for two cells; calculated for 2 per cent., 12·17 grs. of oxalate of potash, in two cells.

3. 3·84 per cent. of oxalate of potash, density 1·02864, diffused at 59°·9, in four cells, 11·10, 11·16, 11·09, 10·92; mean 11·07 grs. for one cell; calculated for 4 per cent., 11·52 grs. of oxalate of potash in one cell.

4. 7·68 per cent. of oxalate of potash, density 1·05604, diffused at 59°·9, in four cells, 20·45, 20·63, 20·99, 20·15; mean 20·55 grs. for one cell; calculated for 8 per cent., 21·41 grs. of oxalate of potash in one cell.

Diffusion of Oxalate of Potash in 8·083 days at 59°·9; two cells.

	Grs.	Ratio.
From 1 per cent. solution . . .	6·20	1·019
From 2 per cent. solution . . .	12·17	2
From 4 per cent. solution . . .	23·04	3·789
From 8 per cent. solution . . .	42·82	7·042

The oxalate of potash corresponds well with sulphate of potash.

Comparative diffusion in 8·083 days of Sulphate of Potash at 60°·3, and Oxalate of Potash at 59°·9.

	From solutions of			
	1 per cent.	2 per cent.	4 per cent.	8 per cent.
Sulphate of potash............	100	100	100	100
Oxalate of potash	100·65	104·91	101·50	97·47

The sensible excess in the diffusion of the 2 per cent. solution of oxalate of potash is, I believe, to be accounted for by this proportion having been estimated in the form of carbonate of potash instead of chloride of potassium.

Oxalate of Soda.—Time of diffusion 9·9 days. The diffusate was evaporated to dryness, ignited and then converted into chloride, as with the preceding oxalate of potash.

1. 0·925 per cent. of oxalate of soda, density 1·00882, diffused at 59°·9, in eight cells, 5·99, 5·81, 5·69, 5·59; mean 5·77 grs. for 2 cells; calculated for 1 per cent., 6·24 grs. of oxalate of soda in two cells.

It was found impossible to form a 2 per cent. solution of this salt from its sparing solubility, so that the observations respecting it are limited to the lowest proportion of salt.

The comparative diffusion from 1 per cent. solutions of these alkaline oxalates is as follows:—

Oxalate of potash in 8·083 days at 59°·9 . . . . . 6·20   100

Oxalate of soda in 9·9 days at 59°·9 . . . . . . 6·24   100·65

Here again a nearly equal diffusion is observed in times of which the squares are as 2 to 3.

Acetate of Potash.—Time of diffusion 8·083 days. The diffusate was converted into chloride of potassium and weighed in that form.

1. 0·951 per cent. of anhydrous acetate of potash, density 1·00540, diffused at 60°·3, in eight cells, 6·01, 6·18, 6·27, 6·06; mean 6·13 grs. for two cells; calculated for 1 per cent., 6·44 grs. of acetate of potash in two cells.

2. 1·903 per cent. of acetate of potash, density 1·00976, diffused at 60°·3, in eight cells, 11·90, 11·91, 11·65, 12·24; mean 11·92 grs. for two cells; calculated for 2 per cent., 12·52 grs. of acetate of potash in two cells.

3. 3·807 per cent. of acetate of potash, density 1·01928, diffused at 60°·3, in four cells, 10·91, 11·08, 11·48, 11·18; mean 11·16 grs. for one cell; calculated for 4 per cent., 11·72 grs. of acetate of potash in one cell.

4. 7·614 per cent. of acetate of potash, density 1·03743, diffused at 60°·3, in four cells, 22·62, 21·72, 23·23, 22·42; mean 22·50 grs. for one cell; calculated for 8 per cent., 23·63 grs. of acetate of potash in one cell.

Diffusion of Acetate of Potash in 8·08 days at 60°·3; two cells.

	Grs.	Ratio.
From 1 per cent. solution . . .	6·44	1·028
From 2 per cent. solution . . .	12·52	2
From 4 per cent. solution . . .	23·44	3·744
From 8 per cent. solution . . .	47·26	7·549

The acetate will be found to exceed sensibly the sulphate and oxalate of potash in diffusibility at the preceding temperature.

Comparative diffusion of Sulphate and Acetate of Potash in 8·083 days, at 60°·3.

	From solutions of			
	1 per cent.	2 per cent.	4 per cent.	8 per cent.
Sulphate of potash............	100	100	100	100
Acetate of potash	104·55	107·93	103·26	107·58

The acetate of potash appears to possess that increased diffusibility which is observed in bicarbonate of potash. But a parallelism still holds between the acetate and sulphate, and the diffusion of the two salts would probably coincide if that of the acetate were observed at a temperature 3° or 4° lower than the sulphate.

Acetate of Soda.—Time of diffusion 9·9 days. The diffusate was converted into chloride of sodium and weighed in that form.

1. 0·958 per cent. of anhydrous acetate of soda, density 1·00530, diffused at 59°·6, in eight cells, 6·33, 6·56, 6·63, 6·05; mean 6·39 grs. for two cells; calculated for 1 per cent., 6·67 grs. of acetate of soda in two cells.

2. 1·917 per cent. of acetate of soda, density 1·01032, diffused at 59°·6, in eight cells, 11·70, 12·04, 11·90, 12·19; mean 11·96 grs. for two cells; calculated for 2 per cent., 12·46 grs. of acetate of soda in two cells.

3. 3·835 per cent. of acetate of soda, density 1·02039, diffused at 59°·6, in four cells, 12·19, 11·74, 12·15, 11·93; mean 12·00 grs. for one cell; calculated for 4 per cent., 12·52 grs. of acetate of soda in one cell.

4. 7·67 per cent. of acetate of soda, density 1·03968, diffused at 59°·6, in four cells, 23·49, 22·26, 23·87, 22·49; mean 23·03 grs. for one cell; calculated for 8 per cent., 24·02 grs. of acetate of soda in one cell at 59°·9

Diffusion of Acetate of Soda in 9·9 days at 59°·6; two cells.

	Grs.	Ratio.
From 1 per cent. solution . . .	6·67	1·070
From 2 per cent. solution . . .	12·46	2
From 4 per cent. solution . . .	25·04	4·019
From 8 per cent. solution . . .	48·04	7·711

The diffusion of acetate of soda presents a general parallelism to that of acetate of potash for the times chosen, the temperatures of the two series of experiments differing only 0°·7.

Comparative diffusion of Acetate of Potash in 8·083 days at 60°·3, and Acetate of Soda in 9·9 days at 59°·6.

	From solutions of			
	1 per cent.	2 per cent.	4 per cent.	8 per cent.
Acetate of potash	100	100	100	100
Acetate of soda	103·57	99·52	106·82	101·65

Tartrate of Potash.—Time of diffusion 8·08 days. The diffusate was evaporated to dryness, ignited, and then converted into chloride of potassium.

1·82 per cent. of anhydrous tartrate of potash, density 1·01227, diffused at 59°·9, in eight cells, 9·96, 10·02, 10·06, 9·87; mean 9·98 grs. for two cells; calculated for 2 per cent., 10·96 grs. of tartrate of potash in two cells.

Tartrate of Soda.—Time of diffusion 9·9 days. The diffusate was evaporated to dryness, ignited, and then converted into chloride of sodium.

2·03 per cent. of anhydrous tartrate of soda, density 1·01460, diffused at 59°·6, in

eight cells, 10·84, 10·77, 10·81, 10·82; mean 10·81 grs. for two cells; calculated for 2 per cent., 10·65 grs. of tartrate of soda in two cells.

Diffusion of 2 per cent. solutions of Tartrate of Potash in 8·08 days at 59°·9, and Tartrate of Soda in 9·9 days at 59°·6.

Tartrate of potash	10·96	100
Tartrate of soda	10·65	97·18

The tartrate of soda happens to correspond absolutely with the carbonate of soda, the diffusate of the latter salt obtained at the same temperature being also 10·65 grs. (p. 486).

The double *Tartrate of Potash and Soda* afforded an interesting instance of decomposition produced by diffusion. Instead of the usual diffusion cells, a single plain cylindrical jar was employed about 5 inches in diameter and 10 inches in height. A portion of a 4 per cent. solution of Rochelle salt, amounting to 5000 grs. of liquid, was covered over by nine times as much pure water, in this jar, and the salt allowed to diffuse upwards for three weeks at 56°. The upper third of the fluid column, amounting to 17,000 grs. of liquid, was then drawn off, evaporated to dryness, and the salt ignited and converted, by the addition of hydrochloric acid, into chloride, which weighed 3·14 grs. The salt proved to be a mixture of the two chlorides in the proportion of 2·43 grs. of chloride of potassium and 0·71 gr. of chloride of sodium. This gives the following as the composition of the diffusate:

Tartrate of potash	3·68
Tartrate of soda	1·17
	4·85

It hence follows that the proportion of potash, or of tartrate of potash, in the diffusate is nearly three times greater than existed in the original Rochelle salt. It will be recollected that the salt decomposed is, strictly speaking, a bibasic tartrate of potash and soda, and not a double tartrate of potash and soda. The diffusate was observed to be exactly neutral to test-paper. This mode of diffusing upwards in water from the lower part of a deep jar obviously gives the greatest degree of separation attainable in consequence of unequal diffusibility.

I may confine myself at present to the conclusion that of the nine pairs of potash and soda salts, of which the diffusion is compared in this paper, the potash salt uniformly exceeds in diffusibility the corresponding soda salt; that the ratio between the two classes is always sensibly the same, or exhibits only a small range of variation at the temperature of the experiments, which was near 60°; with the peculiar exception of the hydrates of potash and soda.