Chemical Affinity and Solution.

In continuation of my inquiry into the relation between chemical affinity and solution (NATURE, vol. xxxiii. p. 615, and and vol. xxxiv. p. 263) I would direct attention to some remarkable facts in connexion with the heats of formation of the sulphates. Take H_2SO_4Aq, and assume that SO_3 acts on the O of water with the average energy with which the S acts on O_3, and we have the following :—

$$\begin{array}{lll} [H_2,O] = 68360 & & [H_2S,O_4Aq] = 210770 \\ [S,O_3] = 103240 & & \\ [S,H_2] = 4740 & & \\ [SO_3,O] = 34413 & & \\ \hline 210753 & = & 210770 \end{array}$$

Now consider $BaSO_4$. We have $[Ba,S,O_4] = 338070$ and—

$$\begin{array}{lll} [Ba,O] = 124240 & & \\ [S,O_3] = 103240 & & \\ \text{Difference} = 110590 & & \\ \hline 338070 & = & 338070 \end{array}$$

The difference 110590 is almost exactly equal to $[Ba,S] = 109600$, so that the heat of combination of BaO with SO_3 is practically equal to [Ba,S], and the whole of the affinity of S is used up so that it has no power to act on the O of water, and hence the salt is insoluble.

Take again in the same manner $SrSO_4$, and the result is even more striking—

$$\begin{array}{lll} [Sr,O] = 128440 & & [Sr,S,O_4] = 330900 \\ [S,O_3] = 103240 & & \\ \text{Difference} = 99220 & & \\ \hline 330900 & = & 330900 \end{array}$$

Difference $99220 = [Sr,S] = 99200$, and again we have an insoluble salt. This seems to me pretty strong evidence that the cause of these combinations is the affinity of S for the metal, and that the S cannot act on the water to cause solution, because of its intense affinity for the metal. Further, the heat of neutralization is the difference between the heat of solution of the oxide and SO_3 on the one hand, and the heat of [MS] on the other, thus :—

$$\begin{array}{lllll} [SrO,Aq] = 29340 & & & & \\ [SO_3,Aq] = 39153 & & & & \\ \text{Neutralization} = 30710 & & & & \\ 99203 & = & [Sr,S] & = & 99200 \end{array}$$

and so on in other cases.

Now examine $CaSO_4$, which is a sparingly soluble salt, and note the difference, we have—

$$\begin{array}{lll} [Ca,O] = 130930 & & [Ca,S,O_4] = 318370 \\ [S,O_3] = 103240 & & \\ \text{Difference} = 84200 & & \\ \hline 318370 & & 318370 \end{array}$$

This difference, 84200, is not equal to [Ca,S], which is $=92000$, or 7800 units more, and accordingly we find this salt slightly soluble with a heat of 4440 units, because the S is somewhat free to act on water. Further, we have the remarkable fact that $CaSO_4$ combines with $2H_2O$, and evolves in so doing 4740 units of heat, which is exactly equal to $[S,H_2]$. Evidently the whole of the affinity of S for Ca not being used up in CaO,SO_3 the S can act with its full energy on the H of the water. $MgSO_4$, which is a still more soluble salt, shows entirely analogous results, the freedom of the S to act on water being much greater than with $CaSO_4$.

Take now an example of a somewhat different nature ; consider the following :—

$$\begin{array}{lll} [Na_2,O] = 99760 & & [Na_2,S,O_4,10H_2O] = 347810 \\ [S,O_3] = 103240 & & \\ \text{Difference} = 144810 & & \\ \hline 347810 & = & 347810 \end{array}$$

The heat of $[Na_2,S]$ is only 88200 units, but the heat of solution of Na_2O is 55500, and these two make up very nearly the difference of 144810 units. Thus we have the affinity of the S entirely used up, but the affinity of the Na_2 for the oxygen of the H_2O is so great that it can combine as a crystal with ten molecules, in addition to combining with the SO_3.

If space permitted, these facts might be extended and gone into more minutely, and their complete agreement in every particular with my theory of solution pointed out.

I may add further that the amount of salt dissolved in saturated solutions which I have examined is in complete harmony with that theory, as the following example will show :—

Heat of Combination.	Amount of Salt in Saturated Solution.
$[M,Cl_2] - [M,O,Aq]$	MCl_2
Ca = 20560	63 grains
Sr = 26770	46 ,,
Ba = 35980	35 ,,

It is evident at once that the amount of salt in solution is almost exactly inversely as the difference of heat of $[M,Cl_2]$ and [M,O,Aq].

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Early Perseids.

FROM my observations in preceding years I found the great shower of Perseids commenced on about July 25, and that the last visible traces of it were seen on August 22, after a duration of 29 days.

This year a series of very clear nights occurred on July 16, 18, 19, 20, 21, 22, 23, 27, 28, and 29, and I watched the sky attentively throughout each one, with the idea of tracing, if possible, the earlier stages of this famous shower. On the 16th there were certainly no Perseids visible, but on the 18th, at 11h. 1m., I saw a brilliant streak-leaving meteor in Andromeda, which must have belonged to this stream. On the 19th I recorded 4 Perseids (2 of which were brilliant), and the radiant-point was sharply defined at 19° + 51°. On the 20th and 21st I noticed several other Perseids, but they were too distant from their radiant, and the paths too few to indicate a good centre. On the 22nd, however, I saw 5 Perseids (one of which was as bright as Jupiter), and the radiant now appeared at 25° + 52°. On the 23rd I registered 4 Perseids, apparently from the same point of the heavens.

The few ensuing nights were cloudy, but on the 27th the sky became partly clear, and in 3 hours I counted 38 meteors, of which 5 were Perseids from a radiant at 29° + 54°. On the 28th in 3¾ hours I saw 47 meteors, though clouds were very prevalent all night. On this occasion 10 Perseids were seen from a centre at 30° + 55°, and there were 15 Aquariads from 337° − 12°. On the 29th the sky was almost uninterruptedly clear, and in 3¾ hours I recorded 52 meteors, including 10 Perseids from 31° + 54½. On the 30th, clouds prevailed.

Between July 16 and 29 I observed 287 meteors, of which 43 were Perseids. These observations prove that the display really begins a week earlier than that (July 25) given in my paper in the *Monthly Notices* of the Royal Astronomical Society, vol. xlv. p. 97. The displacement of the apparent radiant-point as there described is well confirmed by my new observations. During the interval from July 18 to August 22 this point advances from 19° + 51° to 77° + 57°.

I subjoin the observed paths of a few bright meteors seen during my recent observations :—

1887.	h. m.	mag.	Path.				Radiant.
July 19	11 43	1	358½° + 38°	to	351° + 30°	streak	19° + 51°
	11 43	1	298 + 56	,,	14 + 65¼	slow	271 + 21
	12 25	1	350 + 62	,,	330½ + 64	streak	19 + 51
	12 52	1	9 + 20	,,	17 + 20¼	swift	333 + 12
,, 22	10 59	♃	16 + 41	,,	16½ + 51	streak	16 + 31
	12 21	♃	356 + 45	,,	332 + 29	streak	25 + 52
	12 25	♃	344 + 33	,,	320 + 29	streak	16 + 31
	13 15	♃	323 + 37	,,	355½ + 10½	slowish	271 + 48
	13 35	1	111 + 50 seemed stationary.				
,, 27	10 40½	♃	325 + 6	,,	330 + 8	slow	322 + 4
	13 21	♃	319½ + 16½	,,	308 + 32	slowish	337 − 12
,, 29	11 28	♃	66 + 72½	,,	114 + 70	swift, streak	21 + 57

Many others were seen of 1st mag. A perfectly stationary meteor of the 2nd mag., and sparkling like a star, was visible on July 29 at 14h. 17m. at 337° − 12°, so that it was an Aquariad travelling directly in the line of sight.

On the 22nd I registered some brilliant meteors, of precisely the same visible type as the Perseids, from a radiant at 16° + 31° or 3° south of β Andromedæ. Many meteors have also been falling from the points 269° + 49°, 310° + 9°, 333° + 12°,