

in a very agreeable style; moreover, he does not assume the reader to possess any knowledge of advanced mathematics. For those who wish to study any of the more important topics in detail he gives ample references; for those merely in search of diversion he provides a mine of amusement, in exploring which many pleasant hours may be spent. And there are some unsolved problems mentioned which the amateur with a mathematical turn of mind may attack with nearly as much chance of success as the expert; for instance, to give a strict proof that only four different colours are necessary to colour a map distinctly. Altogether this is an excellent work of its kind, and ought to find a large number of readers; even those who have a former edition will be likely to buy this one, if only for the sake of the very interesting account of the vicissitudes of the mathematical tripos.

LETTERS TO THE EDITOR.

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The Rate of Formation of Radium.

THE production of radium from uranium has now been observed experimentally; the rate of production is not, however, in accordance with the quantitative theory. Mr. Soddy's observations (*Phil. Mag.*, June, 1905) gave a rate of production of only one-thousandth of the theoretical amount. An experiment which I made on a specimen of uranium salt, known to be at least thirty years old, has confirmed Mr. Soddy's conclusion so far as to show that the mean rate of production of radium could not have exceeded a hundredth part of the theoretical amount. It may, of course, have been much less, since the amount of radium initially present is unknown.

The explanation of this discrepancy, which has been suggested by Mr. Soddy and others, is that there may be a transitional product. If this is the case, it is to be expected that the rate of production of radium from uranium initially purified will be found to accelerate as time goes on. In the meantime, I am trying an experiment which promises to give the required information more easily.

The transitional product, if it exists, must be contained in pitchblende. If, therefore, we could remove all the radium, but as little else as possible, from a solution of pitchblende, the increased rate of production of radium might be apparent.

Fifty grams of the best pitchblende were dissolved in nitric acid. The insoluble residue was fused with sodium carbonate and added to the solution. The whole was evaporated to small bulk to render silica insoluble; more dilute acid was added, and the silica filtered off and rejected. The metallic bases were thus got into solution.

The solution was freed from radium so far as possible by adding barium nitrate solution in small portions, alternately with equivalent quantities of potassium sulphate. Four and a half grams of the barium salt were thus added. After this the amount of radium remaining was determined by its emanation; three determinations gave, on an arbitrary scale, 69, 58.5, 61.5, mean 63.0. After an interval of three and a half months the amount was again determined. The values were 73.5, 74.5, 72.0, 75.0, 72.5, mean 73.5. It appears probable that this increase is significant, since each of the second series of numbers is larger than any of the first series.

Assuming that the difference is significant, the rate of production per gram of mineral per year would be, on the same scale, 0.723. The equilibrium quantity of radium, the amount, that is, in the untreated mineral, was found to be, per gram, 10,100. If radium decays to one-half its initial quantity in a thousand years, as theory indicates, then the production in one year from a gram of the

mineral should be $10,100/1.45 \times 1000 = 6.9$, about ten times the observed amount.

The increase is insufficient to inspire complete confidence. It seems most probable, however, that there is an increase much greater than in Mr. Soddy's experiments with pure uranium salts. It would not have been difficult to remove all traces of radium, and then the increase (if real) would have been unmistakable. It was feared, however, that the barium precipitation might remove part of the hypothetical intermediate product. It seems likely that this is the case, since the rate of production is still less than theory requires.

A little longer interval will, it is hoped, give a conclusive result. It is intended to try other methods of separating the radium, in the hope of avoiding all loss of the intermediate product.

R. J. STRUTT.

The Effect of Radium on the Strength of Threads.

IN a note which appeared in NATURE on February 4, 1904, Lord Blythwood announced his observation of the destructive action exerted on cambric by the radiation from radium. Having at our disposal recently twenty milligrams of radium bromide which had, for a time, nothing better to do, we investigated the progressive decrease of strength of threads exposed to its influence. In order to have examples of both animal and vegetable fibres, we used unspun silk and ordinary bleached cotton thread.

Ten pieces of thread were exposed at a time. The threads were folded round a strip of writing paper and held in place by being caught in notches cut in the edges of the strip. The paper was laid on the top of the capsule containing the radium, so that the ten threads were exposed to the bare radium at a distance of about half a centimetre. The whole was enclosed in a lead box. After a certain period of exposure the average breaking strength of the threads was taken and plotted against the time. The points obtained lay closely on a smoothly descending curve.

In the case of the silk fibres the loss of strength went on at a practically uniform rate from the beginning up to the longest duration of exposure given (seven days). The initial strength was 78 gms., and this decreased by about 4 gms. per day. The cotton threads, on the other hand, gave a curve which fell more rapidly in the early than in the later stages. The strength began at 370 gms., and decreased at first by about 60 gms. per day. After ten days the rate of weakening was about half this. The longest exposure given was seventeen days; at the end of this time the strength was reduced to 50 gms. The different behaviour of the two kinds of fibres may be due to the much greater thickness of the cotton threads.

The effect seemed to be due entirely to the α rays. A piece of paper was interposed between the threads and the radium, and three days' exposure was given. In the subsequent test none of the threads broke at the exposed part, and the strength was not decreased.

We tried the effect of moistening the cotton threads, the two ends of each thread being left, during a three days' exposure, dipping into a vessel of water. On opening the lead box, in which the whole arrangement was enclosed, it was found that the radium bromide, being hygroscopic, was wet and partially dissolved. The strength of the threads was found to be higher than when exposed in a dry condition for the same period. The difference was too great to be attributed to the increase of strength imparted to threads by moisture, and was plainly due to the decreased emission of rays accompanying the solution, and the consequent removal of the emanation from the radium. We traced the course of the recovery of activity by the dried radium by making a series of three-day exposures of dry threads. The effectiveness of the radiation as measured by the weakening of the threads came back by regular steps in about a fortnight to a value slightly greater than its original one. This may have been due to a re-arrangement of the upper surface of the powder, which was not, at the beginning, very regularly spread over the bottom of the capsule.

HILDA P. MARTIN.

W. B. MORTON.

Queen's College, Belfast, August 8.