therefore incorrect to call two gases with different densities "non-separable by any known process."

Electrical and magnetic forces are also agents which can be applied to distinguish between molecules having different masses. Such forces should be considered before any sweeping assertions are made.

It is possible that Mr. Soddy wishes his statement to be limited to the ordinary chemical processes, and as he is trying to prove a negative, it is perhaps unfair to be too critical, but one cannot help remembering the time when neodym and praesodym were "non-separable," and reflecting how many substances might not be separated at the present moment if their optical properties had not given us a clue. No doubt radio-active tests are severe, and the chemical properties of the bodies in question are probably more nearly equal than those of the older chemistry, but there is a vast interval between "very similar" and "identical."

Incidentally, we may reflect that these bodies which are believed to be "non-separable" actually separate themselves of their own free accord in the natural course of their subsequent history, but this may only prove the perversity of nature.

According to Mr. Soddy's theory, the non-separable bodies have identical spectra. This is the vital issue, which, if made good by experiment, will help us to overlook many weaknesses in the argument. The evidence here rests entirely on one experimental fact. It was shown by Russell and Rossi, and also by Exner and Haschek, that a mixture of ionium and thorium does not show in the electric arc lines which can be assigned to ionium, the spectrum of the mixture being identical with that of pure thorium. Assuming that ionium is the only intermediate product between thorium-II. and radium, the life of ionium is 100,000 years, and the ionium-thorium preparation of Russell and Rossi must have contained about 16 per cent. of ionium. But these authors also point out that if the length of life is reduced to 12,000 years, the preparation would only contain 2 per cent., and the absence of ionium lines would be accounted for. At present the radio-active evidence seems in favour of the longer period, and the absence of ionium lines wants explaining; nevertheless, it seems to me to be going ahead too quickly to make a sweeping assertion that not only is the spectrum of ionium identical with that of thorium, but that the same holds in all similar cases, for the accumulated evidence of the spectra of known bodies has all been in the direction of indicating that optical properties of absorption and radiation discriminate in the most decisive manner between bodies which are otherwise similar in chemical properties.

Granting now for the sake of argument that the bodies in question have spectra which cannot be distinguished from each other, it remains to examine the alternative that the bodies are actually identical. It is said that they have different molecular weights, because one has been formed from the other by an expulsion of one α and two β particles. This argument is not necessarily conclusive, as a mass equal to that expelled may have been picked up again in the process. It may be urged that the subsequent history of these bodies shows that they are essentially different. Though a strong argument, this is not quite the last word, because, granting for a moment the temporary identity of two systems, the particular instability which determines their future may depend on their past.

Taking all arguments into consideration, we are left with an interesting theory consistent with our present knowledge but supported by very little real evidence. It may be presumptuous for one who can only claim to be an amateur in modern physics to express an opinion, but having in a previous generation taken part in establishing the fact that the same element can have different spectra according to its molecular constitution, one cannot, without good cause, accept the belief that different elements can have the same spectrum. Mr. Soddy's case would be much strengthened if he could adduce positive instead of merely negative evidence, and this might be supplied if the bodies grouped together with thallium lines could be shown to give the thallium spectrum, assuming thallium not to be present in the raw material.

ARTHUR SCHUSTER.

Manchester, March 7.

Atmospheric Electrification during South African Dust Storms.

THIS short note on the variation in the atmospheric electrical charge due to the presence of dust is not intended to be exhaustive, but merely to direct attention to a factor which has a very great influence in modifying the positive potential gradient existing in the atmosphere during fine weather. Very few observations as to the causes of the variations have been recorded, but Prof. Michie Smith seems to have observed (*Phil. Mag.*, vol. xx., p. 456) something of the same kind during dust storms in India. He notes that "the negative electrification was strongest during gusts of dust-laden air," and, further, "the potential would often run up so rapidly that it was impossible to measure it accurately, whilst during lulls it would often fall almost to zero."

I was, however, unaware of any work having been done in this direction until the present year, though I have been making a study of the variations in the potential gradient over the high veld in South Africa, and have published several short papers on the subject.[1] The general result has been to show that very extraordinary variations are caused by the presence of dust in the atmosphere, whether due to the natural dust-storms or to any artificial means, such as the clouds of dust raised from the mine refuse heaps formed during the working of the cyanide process. At all the places where observations have been taken the dust is either sand or is of siliceous character, and invariably has the effect of lowering the positive potential gradient, and if present in sufficient quantity, to reverse it and give a very high negative gradient.

During the past six months systematic observations have been taken at Bloemfontein with a Bendorf recording electrometer, furnished with a radium-coated plate to act as collector. (The apparatus was obtained by aid of a grant from the Royal Society of South Africa.) The normal potential gradient in South Africa is, of course, positive, but varies considerably with the elevation. The diurnal range is also considerable under fine weather conditions, and during stormy weather very great deviations are shown if rain is falling or dust is blowing. It may be noted here that during the past eighteen months, when very little rain has fallen, the charge brought down by the rain has been invariably negative. A study of the records made by the electrometer shows that three types have to be considered, viz. :—(1) The ordinary fine weather record; (2) record taken on a day when some dust is blowing; (3) record taken on a very dusty day.

In the first case, the positive gradient rises to a maximum at about 7 to 8 a.m., falls to a minimum at midday, remains fairly uniform over a period of several hours, and then rises to another maximum. The slope of the curve is steeper for this second maximum than for the first one. Fig. 1 shows such a curve which was taken in July, from midnight to midnight. The horizontal line shows zero potential,

[1] *South African Journal of Science*; Proc. Roy. Soc. South Africa.

and distances measured above give positive values, and those below negative. The extreme range of the scale is equivalent to a gradient of 380 volts per metre.

Fig. 2 gives the record for a dust-storm which lasted the greater part of the day. In this figure it may be seen that the positive value never goes beyond 70 volts per metre, and on one occasion even becomes slightly negative.

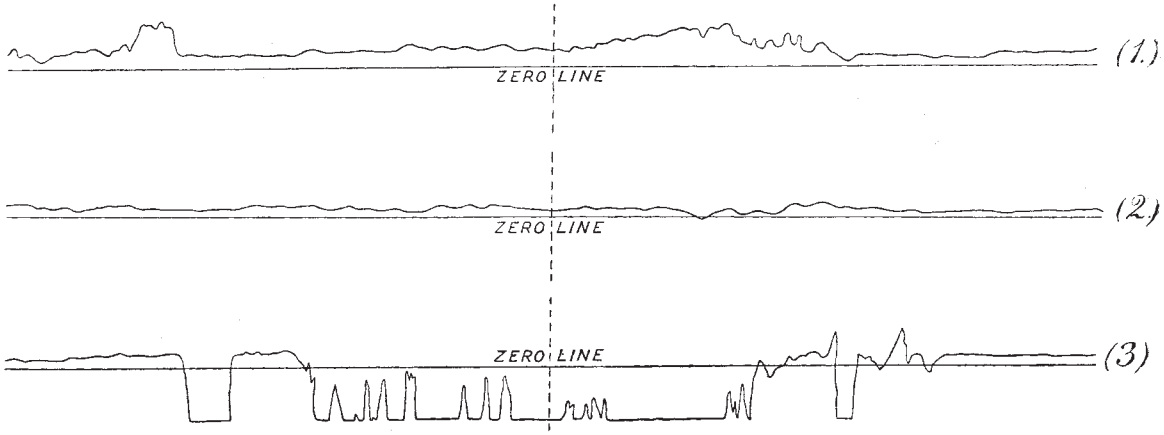
Fig. 3 records a severe dust-storm which lasted from 4 a.m. until 8 p.m. The maximum value of the negative gradient cannot be inferred from the curve because the electrometer needle was deflected as far as it could go, and the horizontal portions of the curve indicate that the potential gradient was higher than the maximum which could be recorded. It will be shown presently that the gradient may reach the value of 5000 to 10,000 volts per metre when the dust is blowing thickly.

The writer has shown (*Phil. Mag.*, May, 1912) that during a dust-storm the charge upon the dust (if siliceous) is positive, while that upon the air at the same time is negative, and he was led from this to devise an electrical machine by means of which charges of both positive and negative electricity might be obtained during a dust-storm. The essential parts are:—(1) A small insulated disc coated with radium attached to a wooden rod about two metres in height; (2) a large hollow vessel with a fine wire gauze bottom; and (3) a pair of insulated spheres to serve as dischargers. The hollow vessel generally used was a five-gallon petrol tin supported upon an insulated rod at a distance of about 20 cm. above the ground, and directed with the open end towards the onrushing dust. Much of this dust is carried through, but a considerable portion is retained, and any charge it may possess is given up to the vessel. *This charge was invariably positive.*

The radium-coated conductor, however, took the negative potential of the current of air blowing past it, so that the two balls acquired opposite charges, and a torrent of sparks as continuous as that furnished by an induction coil passed between them. On some occasions the sparks reached a length of 1·5 cm., showing that the potential difference between the conductors must have been at least 40,000 volts when the apparatus was set up on the open veld.

An ordinary vacuum tube having a radium-tipped wire attached to an electrode, the other electrode being earthed, will light up brilliantly during the passage of a dust-storm. A brush discharge is seen to proceed from the electrode and the shape of the brush makes it quite clear that positive electricity is escaping from the earth into the atmosphere.

W. A. DOUGLAS RUDGE.



(1) Normal fine weather record (2) a mild dust-storm; (3) a severe dust-storm.

Induced Cell-reproduction in the Protozoa.

IN the interesting letter by Mr. A. H. Drew, under the above heading, in NATURE, February 20, it is suggested in the last paragraph that certain substances called auxetics which caused the development of spores in the case of new species of Polytoma, may be necessary for cell-reproduction under natural conditions in ponds, &c., where such substances would probably occur owing to the putrefaction of organic matter.

In the course of an investigation which I have recently carried out on the process of excystation in the ciliated infusorian, *Colpoda cucullus*, from its resting cysts, I have found that this organism can emerge from its cysts when the latter are incubated in 1 per cent. hay infusion (alkaline or acid in reaction) and in pure distilled water—media quite free from auxetics. The real agent which is instrumental in causing excystation is an enzyme which digests the endocyst, and thus allows the organism to swim out into the surrounding medium. As is well known, *Colpoda cucullus* is an organism of wide distribution and of common occurrence in ponds and in infusions of hay, &c. It can frequently be found among rotting grass and decaying vegetation; situations in which the products of organic decomposition and bacterial putrefaction would be plentiful, yet the cysts of this organism can be caused to rupture and yield their contents in active condition when incubated in pure water.

I would therefore suggest that it is unsafe to infer that because auxetics may serve to induce cell-reproduction in certain cases, they may be necessary in all.

The winter spores of Polytoma and the resting (dauer) cysts of Colpoda are not perhaps quite comparable, but I may point out that Colpoda most frequently encysts in the condition of the resting cyst, and that therefore if auxetics are necessary at all they ought to be required for excystation from this condition.

An account of my investigations on this subject will shortly be published. T. GOODEY.

Rothamsted Experimental Station, Harpenden, Herts, March 4.

The Spectra of Neon, Hydrogen, and Helium.

IN a letter published in NATURE of March 6, Prof. Fowler pointed out that a series of "parallelisms" that we gave of lines in the spectra of neon and hydrogen were probably coincidences, and could not be taken as evidence of identity. We are sorry that we did not make our meaning plainer, in our letter in NATURE for February 27, for we did not mean that the lines we compared in the two spectra were