

ing a meteoric spectacle on perhaps a more extensive scale will probably be revived on the near approach of the Leonid epoch of 1904. Reasons have already been given for supposing that last year's display was connected by the nineteen years' period with a very similar phenomenon observed on November 13, 1865, the interval between the two events representing two complete revolutions of the meteoric cycle. The present epoch, therefore, which is thus associated with the historic meteor shower of November 14, 1866, will be liable to reproduce its brilliant prototype, though only to a limited extent.

The anticipated shower, however, if it takes place, will not occur on the night of November 14, as it might naturally have been expected to do, owing to 1904 being a leap year. The meteor-swarm, according to calculations made by the present writer, has undergone considerable retardation since 1903, and as a result of this perturbation the Leonid meteor shower becomes due in 1904 on the night of November 15. It is on the latter night, therefore, that the maximum will take place, whether it culminate in a shower or not. There will occur, however, on November 14, 15h., an interesting miniature meteor display. The shower on the night of November 15, though not so intense, will be more extensive than that of 1866, as maxima fall due at 9h., 12h. to 15h., and 17h. 30m. G.M.T.

JOHN R. HENRY.

### The Definition of Entropy.

FROM time to time controversies have appeared in various journals regarding that most difficult of all physical conceptions—entropy. I have purposely avoided passing any opinions as to the merits of the views of different writers, as I have considered the question far too large a one to be dealt with satisfactorily by destructive criticism directed towards particular points. I have, however, now found a definition of entropy which certainly appears to meet most of the objections to the conventional treatment. That definition may be stated somewhat as follows:—

Let the available energy of any system at any instant relative to a refrigerator of temperature  $T_0$  be defined by the condition that it is the maximum amount of energy that could be obtained from the system at that instant by reversible thermodynamic engines working between the system and the refrigerator  $T_0$ , the remaining portion of the energy being, of course, called non-available energy. Then in any change of the system the increase of entropy is the quantity obtained by dividing the increase of non-available energy by the temperature  $T_0$  of the refrigerator.

I hope to publish a detailed treatment shortly, but in the meantime I would mention that this definition overcomes all the difficulties inherent in the conventional treatment of at least the more ordinary irreversible phenomena, such as friction, impact, gas rushing into a vacuum.

If we adopt the principle of degradation of energy as the fundamental second law of thermodynamics (as I suggested in the Boltzmann *Festschrift*), Clausius's statement that the entropy of the universe tends to a maximum now follows at once. So, too, do his inequalities. For every irreversible transformation in the interior of a system produces loss of available energy, and therefore (since it does not affect the total energy) increase of non-available energy, and therefore increase of entropy. We may say that entropy can be generated, but never destroyed. It follows that the total increase of entropy in the system is greater than the quantity of entropy entering from without. This is Clausius's inequality for an irreversible non-cyclic process. If the process is cyclic the total gain of entropy is zero, and therefore the entropy generated in the system must be exported during the cycle. This is Clausius's inequality for a cyclic process.

The introduction of the refrigerator presents no real difficulty. If non-available energy, instead of being given to the refrigerator  $T_0$ , is worked down reversibly to a refrigerator at a lower temperature  $T_1$ , its amount will be decreased in the ratio  $T_1 : T_0$ .

G. H. BRYAN.

### The Direction of the Spiral in the Petals of *Selenipedium*.

In *Selenipedium grande*, *S. longifolium*, and *S. conchiferum*, the twisted petals are so arranged that the direction of the spiral is right-handed on each side.

They are not heteronymous, i.e. the right petal with a left twist and the left petal with a right twist, as in all

antelopes' horns, nor are they arranged homonymously, as in most sheep's horns,<sup>1</sup> but the twisted petals have the same direction on each side, and in the cases above mentioned the right-handed spiral is always present. In trying to find a cause for the direction, I expected it to appear that before and during the unfolding of the flower the petals were twisted when lying together, and thus took the bias, which continued during growth. If two strips of paper be laid together and twisted into a pipe-lighter, each, when separated, would exhibit the same spiral twist.

Examination of the still-folded flower proves that this simple explanation is not the true one, and, at least in *S. grande*, the petals are straight when they show at first (two inches or more in length), and become afterwards spirally twisted during growth and elongation.

The necessary bias to determine the direction of the spiral evidently acts after the unfolding of the flower, and is a slight force acting continuously during growth, such as would be made by the circulation if there were a difference in the circulation of the sap in the two edges of each petal.

This difference would act alike in each, and would make each petal twist in the same way; but, of course, this is a mere conjectural suggestion.

GEORGE WHERRY.

Cambridge, October 30.

### Thinking Cats.

THE story of the cat that saved the cook, in your last issue, is certainly remarkable, but surely it is not unusual for cats to find out how to direct attention when they want to get into or out of a house, or for them to conceal their kittens in curious places.

Two instances of the former occur to me among many. A cat in my father's house used to rattle the letter-plate at the front door (it was in a window near the door) whenever it was shut out, and another, in my own house, would come to any lighted window, even on the top storey, and tap at the glass if it was shut out at night. In the same house a cat hid its kittens, after one family had been destroyed, under the boards of a lead flat, so that, as they grew, it could not get them out, and directed our attention to them by running backwards and forwards. They were released by taking up the boards.

From cats to birds seems a natural transition. I have a curious instance, at this moment, of a pair of robins mistaking their own importance. Last spring they built, and reared their family, in a hole in the wall of an old country mansion, which was being rebuilt under my supervision. The wall was inside the house, in the great hall, and the female sat on her nest, looking out at the workmen, amid all the noise and disturbance of building. They disappeared in the summer, but now that the house is finished and occupied, the pair have returned, and flit about the same hall and the adjoining drawing-room, evidently under the impression that the house was built for them.

R. LANGTON COLE.

### Change in the Colour of Moss Agate.

A FRIEND of mine possesses a penholder the handle of which is made of moss agate. Originally the colour of the handle was bluish throughout, but recently the upper part of the handle has become very much lighter in colour and much more transparent.

I thought perhaps some of your readers could tell me whether it is usual for moss agates to undergo changes of this kind after having been cut and polished, and, if it is usual, to what agent or agents the change is ascribed.

W. A. WHITTON.

County School, Bridgend, November 7.

### The Origin of Life.

MR. HOOKHAM ingeniously argues that experiments to evolve living out of non-living matter are inconclusive and must probably always fail because the sterilising agent used, which is commonly heat, "eliminates not only life, but its potentiality at one stroke."

Most of us believe that the earth was at one time an incandescent globe. Neither life nor the potentiality of life could have existed in such circumstances. How would Mr. Hookham, on the theory of evolution, explain their first introduction?

GEOLOGIST.

<sup>1</sup> NATURE, December 12, 1901; *Lancet*, January 1, 1898.