The pigment is freely soluble in hot water, though quite insoluble in cold water, and in most organic solvents. Its aqueous solution is strongly acid to litmus; and, though it appears to be quite innocuous to frogs when injected under the skin, it may well be ungrateful to the ranine palate. At the same time it must be noted in this regard that its solubility in the secretions of the frog's mouth is but very slight.

The substance is, as I have shown, undoubtedly a derivative of uric acid, yielding the latter body as one of its products of hydrolysis. It gives the murexide reaction direct. It forms quite definite salts with metals, its compounds with the alkalis being soluble bodies.

Having regard to the wide-spread presence of the body in the scales of diurnal Lepidoptera, I have ventured to call it *lepidotic acid*. In its physical properties it closely resembles mycomelic acid, a yellow derivative of uric acid; and, in my original paper, I ventured to suggest a formula for the body. I hope shortly to publish a more complete account of the subject, and to assign a formula to lepidotic acid based upon fuller evidence. Meanwhile, in common with many others of your readers, I am looking forward to the appearance of Mr. Beddard's book. The literature of the subject of animal coloration is not easily accessible, and a text-book thereon will be a valuable acquisition. We have, it is true, the interesting work of Mr. Poulton; but the subject is there treated from what is, perhaps, a somewhat limited standpoint.

F. GOWLAND HOPKINS.

Sir Wm. Gull Research Laboratory,
Guy's Hospital, December 16.

The Chromosphere Line λ 6676.9.

IN response to Father Cortie's implied question as to the identification of this line as belonging to the spectrum of iron, I would refer him to Appendix G of Roscoe's lectures on "Spectrum Analysis" (third edition). It is an extract from a joint paper by Ångström and Thalen, giving a list of several hundred (then) new identifications; among them appears K 654.3, ascribed to iron.

The original memoir was presented to the Stockholm Academy of Sciences in February 1865, and an English translation of it appeared the next year. I am unable to assign any reason why many of the identifications given in this memoir fail to appear in the map published three years later; but they do, and K 654.3 is among the missing.

C. A. YOUNG.

Princeton, N.J., U.S., December 15.

Grafts and Heredity.

I HAD not thought of grafts when I wrote my paper, and I have to thank Mr. Beeby for reminding me of an excellent illustration of my views; though I cannot gather from his letter whether he considers the "individuality" for which he contends to be represented by matter or force. Adopting his phrase I would apply it to both. The material form, *e.g.*, of the leaf of the scion, is due to molecular motion, set up by a group of forces acting in a way peculiar to the life of the scion; which forces, together with the resulting form, constitute its individuality—somewhat as a man is known by his mental and moral characters as well as by his face.

Now, no two individual plants could be fed more alike than a stock and its grafted scion; since they both receive identically the same food through the roots of the former. All I contend for is, therefore, that it would seem to be more probable that the organic molecules constructed out of this food are all alike, only differently arranged in the leaf of the scion and in that of the stock respectively. These arrangements must be due to molecular forces; while it is difficult to conceive in one's mind how any special kinds of matter can be concerned in the construction of the special forms of leaves; to say nothing of the total want of evidence of the existence of germ- or other plasm.

There is, however, a deeper question still which Mr. Croll asked:—"What determines molecular motion?"¹ He observed that although physical forces are not only interchangeable but can pass into those which, for want of a better expression, we may call vital energies; yet, as he says, nothing we know of in the properties of physical forces can

throw the smallest degree of light upon the above question. There is always, he adds, the "object" which runs through the whole of organized nature; which cannot be accounted for by means of the known properties of physical forces. In concluding his paper he says:—"If one plant or animal differs from another, or the parent from the child [and, we may add, the scion from the stock], it is because in the building up process the determinations of molecular motion were different in the two cases; and the true and fundamental ground of the difference must be sought for in the cause of the determination of molecular motion. Here, in this region, the doctrine of natural selection and the struggle for existence can afford no more light on the matter than the fortuitous concourse of atoms and the atomical philosophy of the ancients." This observation seems to agree with the following remark of Sir J. D. Hooker on the origin of secretory glands of *Nepenthes*:—"The subsequent differentiation of the secretory organs of the pitcher into aqueous, saccharine, and acid would follow *pari passu* with the evolution of the pitcher itself, according to those mysterious laws which re-ult in the correlation of organs and functions throughout the kingdoms of Nature; which, in my apprehension, transcend in wonder and interest those of evolution and the origin of species."¹

The nearest approach to an answer to Mr. Croll's question is, as it seems to me (though it be but cutting the Gordian knot after all), that there exists a *responsive and adaptive power inherent in living protoplasm* which is called into action by external forces; so that by a change of environment—especially if the old and the new one be strongly contrasted—a plant, as a rule, at once begins to alter its structure so as to re-establish equilibrium with its new surroundings; and further, if these be maintained long enough, the altered structures become fixed and hereditary, while more or less of readaptation can commence again at any time.

We can no more discover the ultimate cause of this power which determines or directs molecular motion in living beings, than we can that of crystallization or gravity, reflex action or instinct. Innumerable facts, however, justify the full recognition of its existence.

To apply this to grafts. It is obvious that, whatever determines the molecular motion in forming the leaf of the scion, it is different from that which determines the molecular motion in forming the leaf of the stock, since the resulting forms of the leaves are different; and it is just this ultimate determining power, which is unknown and apparently unknowable, which characterizes the individuality of the scion on the one hand, and of the stock on the other. Form is but the outward and visible expression of this power. It is this, too, which underlies the responsiveness of protoplasm, and determines a new form in adaptation to, or in equilibrium with, a changed environment.

GEORGE HENSLOW.

Mental Arithmetic.

THE very simple method of multiplying large numbers, published in NATURE (p. 78) by Mr. Clive Cuthbertson, is mentioned by Pappus, Book II. (ed. Hultsch), 2-29, as an invention of Apollonius. The same method was known to the Hindoos under the name *Vajrabhāṣa* (Algebra with Arithmetic and Mensuration from the Sanskrit Brahmagupta and Bhāscara, translated by H. Th. Colebrooke, London, 1817).

The method may be enlarged to multiplying three and even more numbers all at once in the following manner:—

$$\begin{aligned}
 &(100a_1 + 10b_1 + c_1)(100a_2 + 10b_2 + c_2)(100a_3 + 10b_3 + c_3) = \\
 &\quad c_1c_2c_3 \\
 &\quad + 10(b_1c_2c_3 + b_2c_3c_1 + b_3c_1c_2) \\
 &\quad + 10^2(a_1c_2c_3 + a_2c_3c_1 + a_3c_1c_2 \\
 &\quad \quad + b_1b_2c_3 + b_2b_3c_1 + b_3b_1c_2) \\
 &\quad + 10^3[a_1(b_2c_3 + b_3c_2) + a_2(b_3c_1 + b_1c_3) \\
 &\quad \quad + a_3(b_1c_2 + b_2c_1) + b_1b_2b_3] \\
 &\quad + 10^4(a_1a_2c_3 + a_2a_3c_1 + a_3a_1c_2 \\
 &\quad \quad + a_1b_2b_3 + a_2b_3b_1 + a_3b_1b_2) \\
 &\quad + 10^5(a_1a_2b_3 + a_2a_3b_1 + a_3a_1b_2) \\
 &\quad + 10^6a_1a_2a_3.
 \end{aligned}$$

¹ "What Determines Molecular Motion?—The Fundamental Problem of Nature" (*Phil. Mag.*, July 1872).

¹ Address to the Department of Zoology and Botany of the British Association, Belfast, 1874.

Special example:—

$$1\ 2\ 3 \times 4\ 5\ 6 \times 7\ 8\ 9$$

$$1\ 2\ 3$$

$$4\ 5\ 6$$

$$7\ 8\ 9$$

First figure.— $3 \times 6 \times 9 = 162$ 2

Second figure.— $16 + 2 \cdot 6 \cdot 9 + 5 \cdot 9 \cdot 3 + 8 \cdot 3 \cdot 6 = 403$. . 32

Third figure.— $40 + 1 \cdot 6 \cdot 9 + 4 \cdot 9 \cdot 3 + 7 \cdot 3 \cdot 6 + 2 \cdot 5 \cdot 9$
 $+ 5 \cdot 8 \cdot 3 + 8 \cdot 2 \cdot 6 = 634$ 432

Fourth figure.— $63 + 1 \cdot (5 \cdot 9 + 8 \cdot 6) + 4 \cdot (2 \cdot 9 + 8 \cdot 3)$
 $+ 7 \cdot (2 \cdot 6 + 5 \cdot 3) + 2 \cdot 5 \cdot 8 = 593$. . . 3432

Fifth figure.— $59 + 1 \cdot 4 \cdot 9 + 4 \cdot 7 \cdot 3 + 7 \cdot 1 \cdot 6$
 $+ 1 \cdot 5 \cdot 8 + 4 \cdot 8 \cdot 2 + 7 \cdot 2 \cdot 5 = 395$. . 53432

Sixth figure.— $39 + 1 \cdot 4 \cdot 8 + 4 \cdot 7 \cdot 2 + 7 \cdot 1 \cdot 5 = 162$. 253432

Seventh and eighth figures.— $16 + 1 \cdot 4 \cdot 7 = 44$. . 44253432

K. HAAS.

Vienna, VI., Matrosengasse 8.

The Migration of the Lemming.

HAVING resided during the summer months for more than twenty years on the plateau from which the migrations of the Norwegian lemming are supposed by many to take their origin, I can speak from personal observation. Some years ago I had the honour to read a rather lengthy paper before the Linnean Society on these animals, and, with one exception, to which reference will be presently made, I am happy in having nothing to alter or recant. The increase of the Lemmings is not cumulative, but rather periodic, as indeed is usual among the voles as well as among many other forms of life. The migrations are not caused by insufficient food *now*, whatever they may formerly have been, and this is evident from the fact that the swarms pass through, but do not exhaust the fertile districts which they encounter on their pilgrimage. Nor are they affected by any personal struggles between these most pugnacious of animals, for the young litters, when reared, go singly on the journey from which none have ever been observed to return. They do not follow the watershed, and they do not always migrate to the west—an error into which I was betrayed by trusting to common report and insufficient personal experience. But they do go straight. It is well known that the eyes of the lemming are so placed on the top of the head as to render it impossible for the animal when swimming, to discern any object not far above the plane of its horizon. On a calm morning last summer, I often placed my boat in the path of the swimmers, and noticed that they crossed my lake in an absolute “bee-line,” and that they could not discern my presence until the angle subtended by the boat was infinitely higher than that of the opposite shore. This latter migration was south-east, and in the late autumn the steamer on Lake Mjosen made its way through thousands of these hapless wayfarers; whilst, still later, large numbers were to be seen close to Christiania; but I venture to prophesy that none will be found in that neighbourhood next year, nor, for the matter of that, in Heimdalen itself, though it is obvious that some must remain. Probably the explanation of these apparently capricious and suicidal migrations may be that they are the result of hereditary instinct, which formerly was of service if not necessary to the species. The straight course which they pursue must be owing to the sense of direction common to migrants, and I would hazard the conjecture that the changes of destination may be due to an instinct which, owing to its present inutility, is gradually diminishing in precision and intensity. W. DUPPA-CROTCH.

Asgard, Richmond, December 24.

The Recent Earthquake in Japan.

DANS la lettre de M. J. Milne, Tokio, 7 novembre, sur le tremblement de terre du Japon du 28 octobre, 1891 (NATURE, xlv. 127), il y a entr'autres un fait intéressant: c'est la mise en oscillation de l'eau d'un bassin de 60 pieds de longueur sur 25 pieds de profondeur. Il est rare que dans un tremblement de terre l'eau des étangs ou des lacs soit mise en mouvement; le rythme des vibrations du sol ne correspond pas, le plus souvent,

au rythme de l'oscillation de l'eau. Dans le cas actuel, les vagues ayant atteint une hauteur de 3 à 4 pieds, il est certain que l'eau a pris un mouvement de balancement.

Le formule d'un tel mouvement d'oscillation pendulaire, si le bassin a un fond horizontal, est :

$$t = \frac{2l}{\sqrt{gk}}$$

$$l = 60 \text{ pieds} = 18.29 \text{ m.},$$

$$h = 25 \text{ pieds} = 7.62 \text{ m.},$$

$$t = 4.2 \text{ secondes de temps.}$$

Il serait intéressant de savoir si le rythme des vibrations du tremblement de terre à Tokio a correspondu à une durée aussi lente; ou peut-être à la moitié de cette durée, soit 2.1". Ce serait déjà des vibrations extraordinairement lentes pour un tremblement de terre. F. A. FOREL.

Morges, 12 decembre.

ON THE VIRIAL EQUATION FOR GASES AND VAPOURS.

ALTHOUGH I had, some time ago, written to Lord Rayleigh to the effect that I did not intend to prolong the discussion of this question, it may perhaps be expected that I should say a few words with reference to Prof. Korteweg's paper in the last issue of NATURE.

1. I do not agree with Prof. Korteweg's statement that Van der Waals's method, if it could be worked out with absolute rigour, would give the same result as the direct method. There is but one way of dealing with the virial equation:—if we adopt it at starting we must develop its terms one by one, and independently. In this connection I may refer to Lord Rayleigh's statement (NATURE, 26/11/91): “It thus appears that, contrary to the assertion of Maxwell, p is subject to correction.” I cannot admit that p is “corrected”; it is not even changed either in meaning or in value. It is introduced as, and remains (at the end of any legitimate transformations of the equation) the value of the pressure on the containing vessel. This, of course, depends upon what is going on in the interior. Other terms in the virial equation, which happen to have the same factor, may be associated with p for convenience; they assist in finding its value, but they do not change its meaning, nor do they “correct” it.

2. I do not think that much aid can be obtained by analogy, at least in the present question, from the case of one-dimensional motion. For the latter may be looked on as virtually the to-and-fro motions between fixed boundaries of a number of particles, each of which keeps its speed for ever unchanged, except at the moments when two *instantaneously* pass through one another. From this point of view the result of Lord Rayleigh and of Prof. Korteweg follows at once. Make the particles mere points, and diminish their free range by the sum of their original lengths, and everything will go on practically as before. Can a corresponding statement be made for three dimensions? Again, there is in the one-dimensional case a perfectly arbitrary set of speeds, which remains unchanged:—there is nothing analogous to the beautiful statistical distribution of Clerk-Maxwell. And what would be the result if molecular forces were introduced?

3. Prof. Korteweg seems not to have noticed the following sentence in my second letter to Lord Rayleigh (NATURE, 29/10/91, p. 628):—“The true mode of getting a cubic here . . . [*i.e.* in Prof. Korteweg's notation,

$$p_1 v = \frac{1}{3} \Sigma (m u^2) \left(1 + \frac{\beta}{v} \right)]$$

is to write $\beta/(v - \gamma)$ instead of β/v . This can, to a certain extent at least, be justified; the other method