LETTERS TO THE EDITOR.

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The Meaning of "Ionisation."

I AM sorry that Prof. Walker (p. 458) has avoided my question. At present I am not concerned either with his position or with mine, with van der Waals or with Newton—I wish simply to know *what exactly he would have us understand by the word ionisation.* I hold that it is our duty, as scientific workers, if possible, to be exact in word as well as deed. It is a matter of reproach to us that we should be lectured, year after year, from the chair of the Royal Society, for our carelessness as writers. Now that the attempt is being made to standardise all sorts of things—from amperes and ohms to the members of iron bridges, even by means of international congresses—we might well devote some attention to our words and attempt to standardise our scientific nomenclature. *Ionisation* is a word used with increasing frequency in these days—unfortunately also with increasing ambiguity. I would appeal to Prof. Walker, as a leader among British physical-chemists, at least to tell us what he wished us to understand when using the word recently—as his meaning is in no way made clear in his article.

HENRY E. ARMSTRONG.

The Flow of Sand.

ON Friday, February 11, I had the pleasure of hearing Mr. C. E. S. Phillips deliver the discourse at the Royal Institution, illustrated by many experiments, a number of which showed that when sand escapes from an orifice at the bottom of a long vertical tube it does not do so perfectly uniformly, but in a series of pulses which are sufficiently rapid to produce audible sounds. Mr. Phillips did not offer any suggestion as to the reason why the flow is regularly intermittent, but two of his other experiments, and the laws of friction, suggest a possible cause.

One experiment showed sand forming a cone on being poured from a funnel. The sloping sides of the cone gave the angle of repose, and it was noticed that the sand at first did not flow steadily down the slopes, but intermittently. This, I think, may be due to a combination of the momentum of the sliding sand and the difference between the statical and dynamical friction between the particles of the sand. A little heap of sand collects, then the statical friction is overcome, and the momentum carries the sand slightly too far, thus making the angle of repose too small; consequently the on-coming sand is able to remain stationary on the slope until in turn its angle of repose becomes too great, the statical friction is overcome, and the cycle is repeated. The other experiment showed how sand is self-supporting in a tube except for the cone of sand at the base. Allow this cone of sand to pass through the orifice, and the rest will fall intermittently in the manner indicated.

If this theory is correct, one would expect sand with a comparatively large coefficient of statical friction to give fewer pulses per second than a sand having a smaller angle of repose.

A. S. E. ACKERMANN.

25 Victoria Street, Westminster, London, S.W.,
February 14.

I AGREE with the explanation offered by Mr. Ackermann in the first part of his letter, for it is evident that sand must slip down itself by a series of rushes.

The process, however, by which a mass of sand falling in a glass tube produces musical sounds is somewhat more complicated. The column must be regarded as consisting of two parts, the upper portion acting simply as an intermittently moving piston. It is the central region of the lower part which becomes less dense, owing to escape of sand through the orifice; the upper portion, being no longer supported, slips downward as a whole.

The rapidity of its intermittent motion depends upon the friction between the glass and sand. Hence the pitch of the note is raised if the grains are better packed. The action appears to resemble that of pushing a moist fingertip along a polished table. The finger jumps rapidly and regularly.

As soon as the column so far lowers that the previously compact upper portion begins to fall away at its centre, all sound ceases. I showed at the Royal Institution that by coating the inner surface of the glass tube with oil, before filling it with sand, the column moved downward by slow, regular jerks, increasing in rapidity as the mass of the remaining sand in the tube grew less. Here all friction between the glass and the sand grains was eliminated, on account of the outer layer of particles adhering to the oil and remaining as a coating upon the tube.

The jerks became more rapid as the inertia diminished with the decreasing mass, which also explains why the pitch of the note given out by a tube rises somewhat as the sand column diminishes.

CHARLES E. S. PHILLIPS.

Castle House, Shooters Hill, Kent, February 15.

The Heredity of Sex.

CURRENT Mendelian theories of the heredity of sex are based on the assumption that gametes are pure with respect to sex characters; that is, that a gamete may carry the factor for maleness or the factor for femaleness, but not both. This view may be expressed thus:—a gamete carries M, the factor (or factors) for maleness, or F, the factor (or factors) for femaleness, but not both M and F.

The hypothesis proposed in this note suggests that the phenomena of sex are due, not to a single pair of allelomorphic characters, but to two independent pairs of characters, namely, maleness (M), with its allelomorph, absence of maleness (*m*), which constitute one pair, and femaleness (F), with its allelomorph (*f*), which constitute the other pair. On this hypothesis, since M*m*, F*f* are independent of one another, representatives of both pairs of characters occur in every gamete.

All gametes are therefore of one or other of the following sex constitutions, MF, M*f*, *m*F, *mf*. Hence all zygotes produced by the pairing of such gametes are of one or other of the following nine gametic constitutions:—

Dihybrid scheme
- 1 MMFF, 2 MMF*f*, 2 M*m*FF, 4 M*m*F*f* — 9 MF
- 1 MM*ff*, 2 M*mff* — 3 M*f*
- 1 *mm*FF, 2 *mm*F*f* — 3 *m*F
- 1 *mmff* — 1 *mf*

In zygotes MMFF and M*m*F*f* it may be predicted that circumstances, nutrition, &c., determine which type (male or female) of sexual organs is produced.

Thus double begonias, which bear female flowers, may be induced by starvation to bear male flowers. Fern prothalli, which bear normally male and female organs, produce, when subjected to special treatment, male organs only, and so on.

In general, the numbers of "males" and "females" among MMFF and M*m*F*f*, zygotes, will be about equal, though wide departures from equality may occur in any species owing to the prevalence of conditions which favour the production of male or female organs.

The following types of zygotes will, it may be supposed, produce male sexual organs, MMF*f*, MM*ff*, M*mff*, and the following, female organs, M*m*FF, *mm*FF, *mm*F*f*; hence the number of males will equal the number of females produced by such zygotes.

The *mmff*, pure recessive type of zygote, if viable, is sterile. The origin of sexuality connotes an origin of sterility. To give examples of the application of the hypothesis to biological facts:—

A zygote of the MF type produces gametes of which all or some carry MF. Species which have MF gametes will be capable of exhibiting parthenogenesis (natural or induced). Certain of the lower algæ produce "gametes" which may fuse in pairs to form zygotes, or may develop directly into new individuals. Those which behave in the former fashion may be such as carry M*f* or *m*F, and those which develop directly may be the MF gametes.