of momentum we have loss of visible kinetic energy, except when the coefficient of restitution = 1. This kinetic energy is transformed into the vibrational kinetic energy of sound and heat in general.

But cannot we have it partly transformed into potential energy by "soaring" against gravity? On this supposition we have the two laws, conservation of momentum where no forces act, and conservation of energy, holding. But we have visible kinetic energy lost and *partly transformed into potential energy with respect to the earth*, partly (as usual) into vibrational kinetic energy of sound and heat. [The *sound* is evident in the "singing" of the wings.]

It seems to me that the swooping referred to by your correspondent is only a matter of convenience to the bird, and does not really affect the mechanical question; and that the comparison to a kite (which is held by a string) is not very satisfactory. But from my own observation of sea-gulls I do not think one can say that all the manœuvres and turns of the bird in the air are performed without real muscular effort, though certainly without *flaps* of the wing; and if there be muscular effort there can be work done—against gravity in this case.

The above is only a suggestion. I wish to induce some more mathematical reader to write a clear answer on this interesting question.

W. LARDEN

Cheltenham, November 8

The Photophone

ON reading the description published in NATURE, vol. xxiii. p. 15, of Prof. Graham Bell's wonderful discovery, the transmission of speech by light, I notice that in "the photophone" the varying of the intensity of the beam of light thrown on the receiving instrument is accomplished by the simple and ingenious means of allowing the sound-waves to beat on the back of a thin plane mirror. It seems to me, however, that this arrangement is not complete, and is open to some objection. As the plane mirror will, if provision be not made against it, become convex and concave alternately, it must, unless the vibrations be confined within very narrow limits, give in one vibration *two* periods of maximum and minimum illumination at the receiver, and therefore the received sounds, apparently, should be (assuming the periods between each maximum and minimum illumination to be of the same duration, which could never exactly occur) an octave higher than those transmitted. This I think follows from the fact that the rays from the mirror would be dispersed not only when convex, but also when concave, *after* they had passed the focus. If, therefore, the vibrations of the mirror are sufficiently great to bring its focus between the mirror and the receiving instrument, there would be a second point of minimum illumination. If however the mirror were made slightly convex, or were constrained by a spring or otherwise, this defect would be cured.

Curiously enough, *theoretically* "the photophone" is the more effective the greater the distance between the transmitter and the receiver, as the degree of variation of the intensity of light falling on the selenium will be, when perfectly adjusted, greater as the distance increases, and it is on this element that the intensity of the sound depends.

A. R. MOLISON

Ffynone Club, Swansea, November 15

[Our correspondent is obviously right in supposing that with a beam of light focussed accurately upon the selenium receiver a *single* complete vibration of the transmitting disk would produce *two* periods of maximum and minimum illumination. This would not however be the case if the lenses were not set originally to exact focus, for then a displacement of the disk in one direction would scatter the rays more, while a displacement in the other would concentrate them more. In practice, we believe, exact focussing is never obtained or even attempted.—ED.]

Salts of Zinc

IN Roscoe and Schorlemmer, vol. ii. p. 264, it states: "The salts of zinc do *not* impart to the non-luminous flame any tint;" and on p. 258, "the metal burns with a bright *white* flame."

What then is the green colour imparted to the Bunsen flame by zinc sulphate due to? Also the green flame obtained by heating metallic zinc on charcoal before the blowpipe?

S.

THE green tint referred to by "S." (*supra*) as imparted by zinc sulphate to the Bunsen flame is only observed whilst the water of crystallisation contained in the salt is being given off; the dry salt which remains imparts no colour to the flame. It therefore appears probable that the green colouration of the flame is caused by very finely divided particles of the salt being carried off into the upper part of the flame by the escaping water of crystallisation. These particles then become so intensely heated as to emit the peculiar greenish light and very likely suffer previous reduction by the carbon of the flame. Other zinc salts, especially the acetate, impart to the flame, when first heated, a greenish-blue tint resembling that observed when metallic zinc is burnt in the air, this being doubtlessly due to a partial reduction of the acetate. The characteristic zinc lines (6362 and 6099 in the red, and 4928, 4924, and 4911 in the blue) are not seen in the case of the salts or when the metal is burnt. A more correct description of the combustion of zinc than that referred to would be: "the metal burns with a bluish-white flame."

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W. BOTT

THE WORKS OF CARL VON NÄGELI

THE beginning of the forties in the present century marks an important epoch in the history of botany. The "Naturphilosophie" which had for many years so banefully influenced the development of the science, was being routed by the energetic attacks of Schleiden. Botanists were becoming alive to the fact that if their study was to have a place as a science by the side of physics and of chemistry, it must be pursued by the inductive method; that speculation must give way to research, and, above all, that development must be studied before any conclusions could be drawn from the investigation of mature forms. The early discoveries of von Mohl, and the demonstration of the cellular structure of the tissues by Schleiden, were among the first fruits of this awakening. To this period belongs also Nägeli's first contribution to science—a paper on the Development of the Pollen (1842). The first sentence in the introduction shows how thoroughly Nägeli was imbued with the same spirit which possessed Schleiden. He says:—"The right knowledge of an object includes an acquaintance with its mature form and a study of its development: the one is dependent upon the other, and the one without the other is insufficient to afford a complete conception of the object." The actual observations detailed in the paper appear from the drawings to have been accurate, and they were an important addition to the knowledge of the subject; but their interpretation was so far influenced by Schleiden's theory of cell-formation, which was then prevalent, that the process of the development of the pollen grains is described as being one of free cell-formation.

In the year 1844 appeared the first number of the *Zeitschrift für wissenschaftliche Botanik*, edited—probably on account of the sympathy existing between them—by Schleiden and Nägeli. This short-lived periodical (1844 to 1846) was practically an organ for the publication of Nägeli's researches and for the expression of his views, for it does not contain a single contribution from Schleiden's pen. The first number opens with an article —a sort of confession of scientific faith—"On the Present Aims of Natural History, and especially of Botany," in which he gives an account of the actual state of botanical knowledge, and strongly urges the necessity of empirical study in order that the generalisations of the science might be in the future, not baseless speculations, but inductions resting upon a firm foundation of ascertained fact. The *Zeitschrift* further contains an important paper "On the Nuclei of Cells and the Formation and Growth of Cells," in which the process of free cell-formation, which Schleiden had asserted to be universal, is shown to be only one of the processes by which a multiplication of cells is effected; these processes are clearly defined and classified. This is followed by a number of researches on the morphology of the lower cryptogams, which are of interest inasmuch as they open up new lines of approach to the study of the complicated morphology of more highly

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