Formula for the Perimeter of an Ellipse.

Will one of your mathematical readers kindly state whether the following empirical formula gives a nearer approximation to the perimeter of an ellipse than that usually given in pocket-books of formulæ?

x and y stand for axes.

$$\text{Perimeter} = \pi\left\{\frac{x^{\frac{\log 2}{\log \pi - \log 2}} + y^{\frac{\log 2}{\log \pi - \log 2}}}{2}\right\}^{\frac{\log \pi - \log 2}{\log 2}}$$

Molesworth's book gives the following:—

T = semi-major axis; C = semi-minor axis.

$$\text{Perimeter} = \tfrac{1}{2}\pi[\sqrt{2(T^2 + C^2)} + T + C] + 0{\cdot}2078(T - C).$$

State School, Beaudesert, H. Tomkys.
Nr. Brisbane, Queensland, Australia, February 26.

Sounds Associated with Low Temperatures.

There is one place where the sounds mentioned by Mr. Cave (p. 512) can be (or used to be) heard to perfection. This is at the lower end of Beaumont Street, Oxford, where the road widens out in approaching Worcester College. The pavement and the fence adjoining it take a crescent form, and while walking on the former quite a loud metallic musical note may always be heard. The fence consists, or consisted, of boards, in front of which are iron palings, the uprights of which had a square section. Spencer Pickering.

Woolacombe.

Sun Pillars.

This evening a sun-pillar was again visible at Swindon, not so brilliant or long-lived as that which recently attracted such widespread attention, but nevertheless quite definite. I first observed it about 6.15 p.m., when the sun was a few degrees above the horizon. It was of a clear yellow colour, and extended from the dull-red sun vertically upwards. The sun set behind a bank of murky haze, and shortly after—about 6.45—the pillar had faded from view. H. B. Knowles.

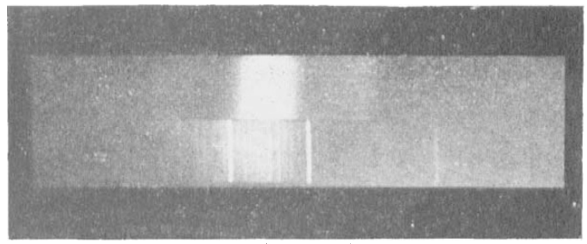
Swindon, April 7.

LUMINOUS BACTERIA.

Luminous bacteria constitute a group of organisms which under certain conditions have the power of emitting light. They occur principally, if not entirely, in sea-water. It is, however, doubtful whether they give rise to any general luminosity of the sea, such as is caused by noctiluca and other relatively high forms of marine life, although it is possible that in the tropics, where the amount of non-living nutritive material is present in sufficient quantities, that bacteria do occasionally cause a general luminosity; but the opportunities of verifying this are rare. One organism in particular, the *Photobacterium Indicum*, from its forming a surface pellicle in artificial fluid cultures, which is very luminous, may at times cause luminosity of sea-water at the surface. It is remarkable that an unicellular organism such as a bacterium should have the power of emitting light. There is no evidence of any special structure in the cell itself, and in the present state of our knowledge it is difficult to regard it as other than a result of functional activity, exactly as heat is evolved by other forms of life, as an accompaniment of the metabolism of the cell. What is, however, the exact difference between the evolution of heat by some organisms and that of light by others it is at present impossible to say. Oxygen is absorbed in both instances and carbon dioxide evolved, but there is evidently some other factor of which at present we know nothing. The fact that light and heat are manifestations of the same form of energy may apparently simplify the matter; but further consideration shows that there is a different problem to be solved in each.

We are not acquainted with any artificial method of light production, in which chemical action takes place, where light is evolved except through the medium of heat, yet in nature, by a simple cell, light is produced which is apparently unaccompanied by any invisible radiations whatever.

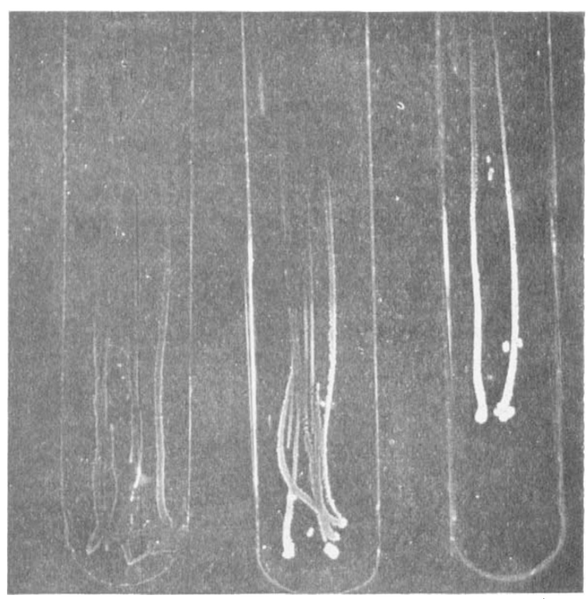
These organisms are sometimes referred to as "phosphorescent," but the term is hardly a suitable one, as the phenomenon is likely to be regarded as analogous to the emission of light by inert chemicals and minerals, or to the continued glow of vacuum tubes after an electrical current of high potential has been passed through them. In all marine light-producing animals, the light is not emitted continuously, but is given out at intervals in response to some stimulus or irritation. It is possible that bacteria act in the same way, but it is difficult to determine this point, as the individual organism is not sufficiently luminous to enable the observer to study it under the microscope by its own light. In fluid cultures they apparently respond to any agitation or excitation so long as the supply of oxygen is maintained, but they can be kept in a luminous condition on fluid media if oxygen is continuously supplied in other ways, although they may remain at rest. This can be done, for instance, by allowing the wool plug, used to close the orifice of the glass vessel containing a fluid culture, to become saturated with the culture, when the plug will continue to glow for days, although the culture in the vessel may only become luminous when agitated. This points to



a b

G F C

Fig. 1.—(*a*) Spectrum of luminous bacteria. (*b*) Spectrum of hydrogen for comparison.



a *b* *c*

Fig. 2.—Cultures of different ages. (*a*) seven weeks; (*b*) three weeks; (*c*) young culture.