a different denominator. It is, in the present notation,

$$i=2\frac{(aa)(bb)-(ab)(ba)}{\left\{(aa)+(ab)+(ba)+(bb)\right\}^2-(aa)^2+(ab)^2+(ba)^2-(bb)^2}.$$

For Sergeant Finley's tornado-predictions, $(aa)=28$, $(ab)=72$, $(ba)=23$, $(bb)=2{,}680$. From these data, Mr. Gilbert finds $i=0.216$, while my formula gives $i=0.523$.

If the questions should present more than two alternatives, it would be necessary to assign relative values or measures to the different kinds of mistakes that might be made. I have a solution for this case.

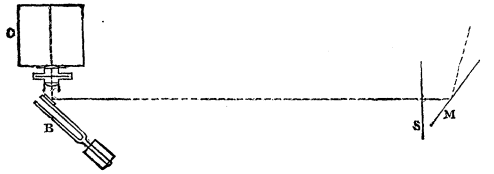
Another problem is to measure the utility of the method of prediction. For this purpose, let p be the profit, or saving, from predicting a tornado, and let l be the loss from every unfulfilled prediction of a tornado (outlay in preparing for it, etc.); then the average profit per prediction would be,

$$\frac{p\,.\,(aa)-l\,(ab)}{(aa)+(ab)+(ba)+(bb)}.$$

C. S. PEIRCE.

Measurement of the speed of photographic drop-shutters.

The usual method adopted for this purpose depends on photographing a white clock-hand revolving rapidly in front of a black face.[1] The chief difficulty in this case is to maintain a uniform rotation at high speed. To avoid this difficulty, and to determine the uniformity of exposure of any particular shutter under apparently like circumstances, the following method has been suggested. In carrying out the experiment in practice, I have had the assistance of Mr. J. O. Ellinger.



A tuning-fork, *B*, with a mirror attached to the side of one of the prongs, is placed in front of the camera-lens. This mirror is so arranged as to reflect into the camera, *C*, a horizontal beam of sunlight, which, before reaching the fork, has passed through a half-inch hole in a screen, *S*, placed about ten feet distant. This produces on the ground-glass a minute brilliant point of light. If the fork be set vibrating, the point will become a short, fine, horizontal line: if the fork be rotated about its longitudinal axis, the line will become a sinusoidal curve described on the circumference of a circle of long radius. A photographic plate is now inserted, and the drop-shutter attached. On releasing the latter, it will be found that a portion of the sinusoid has been photographed; and the precise exposure may be determined by counting the number of vibrations represented on the plate.

The mirror employed should be somewhat larger than the lens to be measured, so as to cover its edges during the whole exposure. The mirror may be glued directly to the prong of the fork with strong carpenter's glue, after first scraping off a little of the silvering at the edges of the glass. The rate of the fork is then determined, by comparison with a standard fork, by the method of beats. W. H. PICKERING.

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[1] For other methods, see *Brit. journ. photography*, Aug. 31, 1883, and May 23, 1884.

THE IMPORTANCE OF CHEMISTRY IN BIOLOGY AND MEDICINE.

THE position of chemistry in the biological sciences has long been, in English-speaking communities, a very indefinite one: in fact, it may be questioned whether the science has, even at the present day, any generally recognized position among biologists themselves. That this has been the case for many years, even in Europe, is evident from the fact that until recently the published results of investigation in the field of physiological chemistry have had to be sought for in widely diverse places. Many papers have been published in purely chemical journals, others in journals devoted to physiology, while still others have appeared in so-called 'natural-history' journals, — a fact which in itself plainly indicates the past status of this branch of science.

There can be no question that physiological chemistry should occupy a definite place among the biological sciences. Biology is confessedly a study of life, and, as such, has to do with the development, structure, and function of living organisms. The first two of these we suppose to be included under the heads of embryology and morphology; while the third, constituting, in the words of Herbert Spencer, "the second main division of biology, embracing the functional phenomena of organisms, is that which is in part signified by physiology." Further, "that part of physiology which is concerned with the molecular changes going on in organisms is known as organic chemistry," or, with equal propriety, as physiological chemistry: hence a study of the functions of the body, to be at all complete, must include a study of the chemical changes incident to life, and cannot be restricted to the purely physical phenomena of the organism. Yet it is very noticeable that wherever 'biology' is taught in this country, even in the most liberally conducted institutions, where the course of study embraces embryology, animal and vegetable morphology, experimental physiology, etc., physiological chemistry is rarely mentioned.

We need to inquire whether this is due to a