the thousand publications of those who bark at the dead lion.

As Prof. Dakin has been good enough to suggest that I am ignorant, may I supply him with proof and the readers of NATURE with a test? I do not know what naturalists (the biologists of Prof. Dakin) mean by their key-words "innate," "acquired," and "inherited" when applied to characters. Does Prof. Dakin know? Will he tell us?

G. ARCHDALL REID.

Southsea, February 19.

A Relativity-predicted Mechanical Effect in the Electromagnetic Field.

THE present writer would certainly starve if his bread depended on supplying a certain experimental verification here asked for. It should, however, be mere Boys' play to those who measure the gravitational constant with a little pile of sovereigns and a quartz fibre, or who photograph the wake of a flying bullet. The mathematical argument leading to the prediction indicated below is sent to England by the mail carrying this letter, for publication, but I cannot say where and when it will appear.

A body, say a crystal, at rest in an electromagnetic field should experience a force per unit volume, in Maxwell's notation and in E.M. units, equal in magnitude and direction to

$$\mathrm{V}\mathbf{KB} - \mathbf{E}\mathrm{S}\nabla\mathbf{D} + \frac{d}{dt}\mathrm{V}(\mathbf{DB} - \mathbf{EH}/4\pi c^2),$$

where **K** is conduction current and c the velocity of light *in vacuo*. It is possible that the third term has been given before, but I have not seen it anywhere. The verification here asked for is that of the existence of this term. V**EH** is in the direction of a light ray and V**DB** is normal to the corresponding front. In an isotropic transparent body, V**DB** $= k^2(\mathrm{V}\mathbf{EH}/4\pi c^2)$, where k is the index of refraction.

Unfortunately, $4\pi c^2$ is about $10^{22} \times 1{\cdot}131$, but my son, Dr. A. L. M'Aulay, tells me that the magnitude of V**EH** may readily be made equal to 10^{16}, so that the effect may be detectable.

The term indicates that when a wave-train traverses a point the matter at the point is always urged along the ray *towards* the nearest wave-crest or wave-trough, and normal to the front *from* the nearest crest or trough. Can any reader suggest a plausible physical reason why this should occur?

I may remark that Maxwell's expression for the force per unit volume is

$$\mathrm{V}(\mathbf{K} + d\mathbf{D}/dt)\mathbf{B} - \mathbf{E}\mathrm{S}\nabla\mathbf{D},$$

and that probably most relativists would drop the $d\mathbf{D}/dt$ from this expression. Let the physicist tell us which, if any, of the three expressions is verified experimentally.

ALEX. M'AULAY.

University of Tasmania, November 28, 1922.

The Measurement of the Rates of Oxidation and Reduction of Hæmoglobin.

WE have recently been engaged on the determination of the velocities of the chemical reactions of hæmoglobin. These are of interest both to the physiologist because of the important part played by this pigment in respiration, and also to the physical chemist because this pigment is an almost unique example of a large complex protein molecule which combines with gases in a simple chemical manner. Some of the results that we have obtained and the methods we have used may therefore be of interest to readers of NATURE.

In order to measure the rate of reduction two solutions were prepared: (*a*) a 1·5 per cent. solution of whole blood in tap water, (*b*) a solution of sodium hyposulphite ($Na_2S_2O_4$) in tap water which was rendered neutral to brom-thymol-blue by the addition of sodium carbonate solution. These two solutions were by suitable means forced under a pressure of, roughly, 500 mm. of mercury into the mixing chamber of the measuring apparatus through conical jets of small bore, so that the two solutions underwent vortex motion at a high rate of speed. Preliminary tests of the measuring apparatus, using as fluids a sodium hydroxide solution containing phenol phthalein and a rather stronger solution of acid, showed that mixing and chemical combination were complete with one measuring apparatus in less than 0·0055 sec., and with another apparatus in less than 0·0005 sec. The mixed blood solution and reducing agent passed from the mixing chamber of the apparatus in use down a glass tube with known velocity, being examined at different positions by means of the reversion spectroscope, by which we could ascertain the ratios of those amounts of hæmoglobin still combined with oxygen and those in the reduced state.

We thus obtained the concentration of oxyhæmoglobin (O_2Hb) at a series of instants, the intervals between which could be readily obtained from the rate of linear flow of the solution down the tube, and the positions of the points examined by the spectroscope.

Experiments on the rate of reduction of oxyhæmoglobin (O_2Hb) by the reducing agent ($Na_2S_2O_4$) have shown that with increase of concentration of the latter the rate of reduction increases to a maximum, beyond which it cannot be raised by a further increase. This we take to mean that the process consists of two stages:

(1) Reduction of oxyhæmoglobin, *i.e.*
$$O_2Hb \rightarrow O_2 + Hb.$$
(2) Removal of O_2 (liberated from O_2Hb) by combination with the reducing agent.

As the concentration of the reducing agent is increased, the free oxygen formed from O_2Hb by stage 1 is removed more quickly, until a concentration is reached at which the "free" oxygen is removed so quickly that the reaction $O_2Hb \rightarrow O_2 + Hb$ is not appreciably opposed by the reverse reaction $O_2 + Hb \rightarrow O_2Hb$. Further increase in concentration of the reducing agent cannot therefore further accelerate the velocity of the reduction of the O_2Hb, the latter being now solely determined by the velocity of the reaction $O_2Hb \rightarrow O_2 + Hb$. We have other evidence in support of this view, which we hope to present at length elsewhere. The time taken for complete reduction of O_2Hb when the concentration of $Na_2S_2O_4$ was sufficient to secure the "maximum" rate of reduction was about 0·5 sec. at 12° C. This rate of reduction is such as to be a factor of importance in considering the conditions which determine the rate of uptake of oxygen by organs within the body. We found further that the logarithm of the concentration of O_2Hb when plotted against time gave a straight line relationship, as should indeed be the case if the reduction of O_2Hb is a monomolecular process.

The measurements of the velocity of oxidation of hæmoglobin required the preparation of large quantities of reduced hæmoglobin solution. This was obtained by spraying a solution of blood in tap water heated to 50° C. into a large vacuous container, thus causing the gases combined with the hæmoglobin to be liberated. This reduced blood solution was mixed with water containing dissolved oxygen by