PROCEEDINGS
OF THE
NATIONAL ACADEMY OF SCIENCES
Vo ume 6 JANUARY 15, 1920 Number 1

AN EXAMPLE OF TORSIONAL VISCOUS RETROGRESSION

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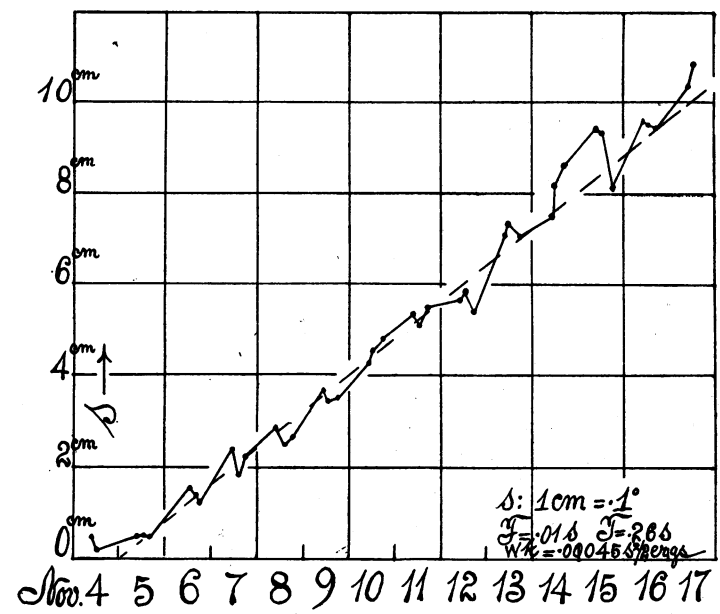
Communicated November 22, 1919

In order to determine to what degree it would be possible to eliminate radiant forces, I have recently installed a gravitational needle of the usual form, in a glass case, but with the balls at the end as heavy as the torsion wire would safely carry. The latter was hand-drawn (music) wire 0.022 cm. in diameter and 154 cm. long, hanging from a torsion head attached to the pier. The balls were each over 1500 grams in mass and 29.3 cm. apart, between centers. The torsion coefficient of the system was found to be 154. The deflections of an externally attracting mass (also 1500 grams) were read off with mirror and telescope at a distance of 290 cm. This makes the force to be measured $F = 0.009s$, if s is the deflection observed in cm. The period of the system would be about 14 minutes. As the two equal masses may be approached within less than 6 cm. of each other (between centers), a gravitational force of about 4.2×10^{-3} dynes is to be registered and this would be equivalent to a deflection of $s = 0.47$ cm. Hence, by commutation, a total deflection of about 1 cm. may be expected, which could be much increased by increasing the masses ($M =$ 1500 g.) on the outside and inside of the case. On the quadratic interferometer with achromatic fringes, the deflection s instanced, would be equivalent to a normal displacement of mirror $\Delta N = 0.023$ cm., readable to 10^{-4} cm. directly, or to 4×10^{-5} per fringe. So far as mere observation is concerned, the reading could be adequately made within 0.1%. I was in hopes, therefore, that the incipient motion of the needle, since air resistance, etc., is here negligible, could be studied as a case of uniformly varied motion.

Observations.—As these were made in a room, at first heated mildly and eventually more vigorously (see curve) they are useless for gravitational work. They are interesting, however, in their bearing on Maxwell's theory of viscosity, as they give evidence of a concealed torsional strain,

gradually but continuously vanishing; or of a spontaneous tendency of the wire to regain the original molecular condition, free from strain. An example of the observation taken in November is given in the figure, and it shows the deflection of the needle (left without direct interference) on successive days.

As to the kinks in the curve which increase enormously (with the advent of cold weather, the need of more heat increases), they may be due to thermal expansion in the supports of the telescope, or to radiant forces.



But as they are always accompanied by a corresponding vibration of the needle, the latter cause must be in preponderance, so that radiant forces are not, even in case of these large masses, to be disregarded.

Apart from the irregularities, the curve, as a whole, rises uniformly, because of the viscous detorsion specified, at a rate of about 0.08° of detorsion per day, and it has kept this up uniformly for months. One may notice that in view of the large weight (over 3 kg.) suspended, the wire is kept at relatively low viscosity, i. e., full of unstable molecular configurations. Utilizing these, the torsional set obtains facility of exit. How the wire acquired this torsional strain is hard to see, unless it was reeled helically. This was probably the case, as the free wire, placed on a plane, shows a helical form, with a pitch of about 2 feet. That the strong tensile strain, which is also vanishing, should, in the suspended wire, make its exit torsionally is improbable, for there would be no reason for the sign of the twist; but the tensile strain probably developed the torsional strain in the lapse of time on the reel.

To eliminate the viscous torsional discrepancy, it would suffice to use the method developed by Dr. Strouhal and myself, of boiling the wire for 20 or 30 hours in water. Such a wire is then practically free from instabilities at atmospheric temperatures.

Finally, since the torque is $0.26s$, the deviation angle $0.0017s$ and the daily detorsion $0.8 = s$, it is interesting to notice that energy is being dissipated at the rate of 0.00014 ergs per day, by the decay of torsion (very small as it is) above. Much more, no doubt, is released in the decay of the intense traction. If the body were not exceedingly opaque, the strained metal would probably be phosphorescent.

THE CHEMICAL ISOLATION OF VITAMINES

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Communicated by W. A. Noyes, November 17, 1919

Vitamines are substances of unknown chemical composition occurring in certain foodstuffs, vegetable and animal tissues. They are essential for the maintenance of health and for normal growth of animals and men. The lower organisms also, such as plants and bacteria, seem to require a certain amount of these vitamines for reproduction and growth. The existence of at least three vitamines is known at the present time, namely, the antiscorbutic vitamine, the deficiency of which in the diet causes scurvy; the so-called fat-soluble vitamine, occurring in butter fat and certain other fats; and the antineuritic vitamine, a sufficient amount of which must be consumed by animals and men in order to prevent the disease called beri-beri. All of these three vitamines are essential for normal growth in man.

During the last few years a study of the relation of vitamines to growth and the maintenance of health has been a fertile field for biologists. These researches have resulted in conclusions of great scientific and practical value. There can be no doubt, however, that many mistaken ideas have arisen in this brief period, due mainly to a lack of knowledge of the chemical character of vitamines. Thus, a few investigators have attempted to ascribe definite chemical and physical properties to substances which at best were possessed only in their crudest and impure form. These inaccuracies can be attributed only to a lack of fundamental, chemical knowledge on the part of these investigators. Every chemist thinks in terms of solubility, dissociation, and other physical chemical properties, but always only in case of a pure substance or mixtures of known composition and not in the case of crude mixtures and extracts of unknown com-