When attempting to work with lithium metal a serious obstacle is met with since the molten metal reacts very strongly with ordinary glass, forming almost instantaneously a black compound on the surface of the glass; the action generally proceeds so rapidly as to cause fracture of the glass itself. It has been suggested (see, for example, Justi 1948) that the high melting temperature of lithium is primarily responsible for this behaviour; since, however, sodium can readily be heated in glass to temperatures well above this value without appreciable reaction, this hypothesis seems untenable

It was thought at first that the process might be one of replacement of the sodium in the glass by lithium, and, therefore, a special glass was made up which contained lithium as the only alkali ion. The well-known Lindemann glass is of this type (containing only lithium, beryllium and boric oxides), but it is difficult to work into the apparatus required by the experiments. The simple lithium-barium-silicate glass (C 51/65) of composition shown in the Table can be drawn into tubing (including capillary) by a skilled glass-worker, and although the glass has a low softening temperature and must be worked with care, the tube can be sealed directly to ordinary soda-lime-silicate glasses of similar expansion coefficient Thin platinum electrodes can be sealed into the glass without cracking

Unfortunately, tests soon showed that this glass was no more resistant to lithium than ordinary ' soft soda ' glass. Recalling, then, that fused silica is also attacked in the same way by lithium, it was thought that the silica in the glass was probably the responsible constituent An experiment was therefore made using tubing of the type employed in the construction of sodium discharge lamps; the tubing has an inner lining of a borate glass which is almost free from silica, and is known to be resistant to the attack of both sodium and potassium vapours. The composition of the glass (C 10) is also given in the Table. C 10 has proved sufficiently resistant to permit lithium to be cast successfully in it if the metal is solidified fairly rapidly (say 10 to 20 seconds) after running into the mould; thereafter a blackening does begin to occur It is hoped in the future to make experiments with other glasses in which the silica content will be reduced to zero and the Na_2O and K_2O replaced by Li_2O.

Clarendon Laboratory, Oxford. D. K. C. MacDonald.

British Thomson-Houston Co. Ltd., J. E. Stanworth.
Research Laboratory, Rugby.
4th April 1950.

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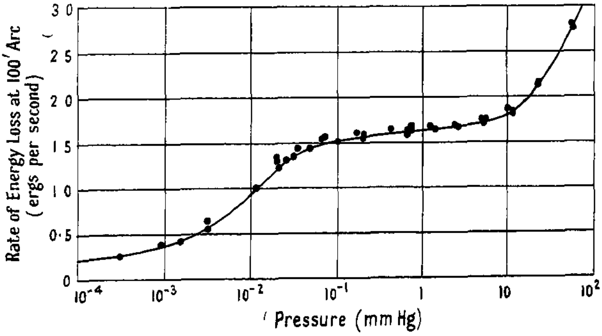
The Dissipation of Energy by a Pendulum Oscillating in Air at Low Pressures

The energy dissipation of a seconds pendulum has been measured by Atkinson (1938), who described experiments with different pendulums by means of which losses due to suspension, rod and bob were calculated. Such losses related to pendulums swinging in the open air, and these were found to be higher when the pendulums were inside cases. The loss of energy is due to four causes : (*a*) air resistance to the bob, (*b*) air resistance to the rod, (*c*) bending of the suspension spring, and (*d*) movement of the support The combined loss due to causes (*c*) and (*d*) can be determined directly from measurements made with the pendulum in a vacuum

The air pressure in the cases containing the ' Shortt clocks ' is normally reduced to a value 30–20 mm. Hg, and it was decided to measure the losses of one of these pendulums at lower pressures and, by extrapolation to zero pressure, determine the losses due to the flexure of the suspension spring and the movement of the support.

The seconds pendulum of the standard Shortt clock seconds type, used for the tests, was carried by a spring ground from a solid strip of steel 2 mm. thick. The upper thick end of the strip was gripped between the two halves of a cylindrical trunnion while the lower thick end carried a steel pin which engaged with two hooks formed at the top end of the 8 mm. diameter invar pendulum rod. The bob, made of type metal, was a cylinder 9 cm. in diameter, 10 cm long, weighing 6·5 kilograms. It was supported a little below its centre of gravity by means of an invar sleeve—pinned to the pendulum rod—carrying a brass collar of such a length that its upward expansion due to temperature compensated the corresponding downward expansion of the suspension spring and pendulum rod. The case was a copper tube of internal diameter 21·5 cm., fitted with heavy bronze flanges at the top and bottom carrying lugs by means of which it was solidly bolted to the wall. The trunnion, holding the top of the suspension, was supported by a four-legged bronze casting which stood on the inner edge of the top flange. This casting, which also carried the maintaining mechanism, was covered by a glass bell-jar, sealed to the outer edge of the flange. The base of the case was closed by a thick glass disc sealed to the bottom flange When the pendulum was swinging, the underside of the cylindrical bob was 8·2 cm. from this plate, but the rod was extended downwards to carry a silver ' beat plate ' which moved to and fro just clear of the glass. This beat plate was engraved with a series of cross-lines spaced 1·67 mm. apart which was the appropriate interval to represent 5′ of arc. The movement of these lines, as the pendulum oscillated, was observed by means of a microscope. When illuminated by a suitably placed lamp, one of the plate lines came into view at the end of a swing, slowed to a standstill, and then swung ' out of focus ' again, followed by a similar movement of another line entering from the opposite side. It was quite a simple matter to read off these ' standstill positions ' on the eyepiece scale at any particular time or, alternatively, to observe the times when the lines ' stopped ' at particular scale divisions, or at the same division.

The rate of energy loss of a swinging pendulum is $I\omega\, d\omega/dt$, where I is the moment of inertia of the pendulum and ω the angular velocity when passing through its equilibrium position. The value of I for the pendulum used was $6{\cdot}852\times10^7$ G.C.S. units and, representing the total arc of swing by A, the rate of energy loss in ergs per sec. was $14{\cdot}28A\, dA/dt$. To determine the relation between the rate of energy loss and the gas pressure it was only necessary to measure dA/dt at 100′ total arc swing at various pressures.



The air pressure in the case having been adjusted to the required value, the arc of the pendulum was raised to 110′ or more by utilizing the normal impelling mechanism; the impulsing was then cut off. The times were recorded at which the total arc became 105′ and 95′, respectively, and dA/dt determined. The gas pressure was measured by means of an oil manometer at the higher pressures and by a McLeod gauge at the lower values. The results obtained are shown in the accompanying diagram.

They indicate that the energy loss due to the flexure of the particular spring used, together with the losses due to the movement of the suspension brackets, i.e. of the head of the case, is less than 0·27 erg per sec., and probably reaches a limiting value of 0·20 erg per sec., that the damping at 3×10^{-4} mm. Hg is only about one-sixth the damping at 10^{-1} mm. Hg, and that gas viscosity damping still persists at a pressure of 10^{-4} mm Hg, which agrees with the fact that the quartz fibre vacuum gauge is operative at this pressure The limiting value of 0·20 erg per sec., which represents the suspension losses, is considerably less than that previously estimated by the author—a value criticized by Atkinson as being too high—but the earlier figure was based on tests which were confined to pressures above 1 mm. Hg. The present tests also confirm the statement by Loomis, quoted by Atkinson, that the decrement of a half-second pendulum was reduced to one-half by decreasing the gas pressure from 0·025 mm. to 0·001 mm. Hg.

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5th April 1950.

W. H. Shortt.

Atkinson, E C., 1938, *Proc Phys Soc*, **50**, 721

REVIEWS OF BOOKS

Higher Physics, by E. Nightingale. Pp xvi+808. (London: G. Bell and Sons Ltd., 1948.) 27*s*. 6*d*. Also in separate parts: Pt. I. *Mechanics and Properties of Matter*, 7*s*. 6*d*.; Pt. II. *Heat*, 7*s*. 6*d*.; Pt. III. *Light and Sound*, 10*s*.; Pt. IV. *Electricity*, 12*s*. 6*d*.

The clarity of style which has characterized Mr. Nightingale's many school texts in the past is in evidence in his latest effort. This book is of intermediate standard and is primarily intended for sixth form scholars.

The wide field of subject-matter which is covered within the confines of this single volume has necessitated considerable ' condensing ' in certain sections, but on the whole this process has been carried out quite efficiently. However, it is inevitable that some subdivisions become unduly compressed when room is found for such topics as the theory of flight, the quantum theory of spectra, etc.

An undesirable effect of the lag, so prevalent in the post-war era, between the preparation of an MS. and its publication is exemplified in the present instance by the author's failure to record the recent official acceptance (October 1946) of the absolute system of electrical units as the practical system, to the exclusion of the International Scale. Also no mention is made, rather surprisingly, of the M K S. system of units.

The author makes frequent use of the methods of dimensions in the various sections of the book and the use of graphs in exhibiting experimental results is also stressed in the text.

The errors noted are remarkably few, but one which should be noted is the mention, on page 633, of the use of an iron former for the suspended coil of a galvanometer.

Line diagrams which are capable of reproduction by the student are freely employed thoughout the text, and another feature which commends the book as one to be treasured by the scholarship candidate is the large selection of examination questions at the end of each chapter.

R. W. B. S.

Terrestrial Radio Waves: Theory of Propagation, by H. Bremmer. Pp. x+343. (New York, Amsterdam, London, Brussels: Elsevier Publishing Co., Inc.; British Agents: Cleaver-Hume Press, 1949).

The author asks us in his Preface to bear in mind that his aim is to describe the mathematical-physical methods for the computation of transmitter fields The statement of the problem is presented briefly in the opening pages and looks deceptively simple: it is required to compute the radiation field of a Hertzian dipole above a spherical earth The influence of the ionosphere and the refracting lower atmosphere is deferred until Part II of the book. It takes some hundred odd pages of concisely written mathematical analysis to arrive at the final formulae for the first part of the problem in a form suitable for numerical work, and the reader will readily agree with Nicholson that the problem was one of the most difficult at one time facing the theorist The author and his colleague Professor van der Pol