

for their own time and circumstances. The logical development in a trade school, in the high school, in the college and in the university may be and generally are quite different. We must remember the object in view and the limited time which our crowded curricula give us for the attainment of that object. We must press forward with these things in mind, and not waste time and energy in exploring depths which the student is unconscious and unmindful of, nor in trying to drag a ponderous student through a capillary passage of the logical labyrinth. On the other hand, of course, we must not allow slovenly work. What is slovenly work must be decided by the circumstances. An obvious and evident and correct assumption whose proof would be difficult, tiresome and discouraging might not be slovenly, while an equally obvious assumption whose proof is easily made along the same lines as the other proofs of the course probably would be slovenly. Which side of the line the assumption as to limits in solid geometry lie, is still an open question. May be the next generation will close it. But the assumptions can hardly be relegated to the limbo of vileness yet; not so long as these other assumptions are accepted without question.

THE STUDY OF ACCELERATED MOTION BY MEANS OF THE INCLINED PLANE.

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The problem of uniformly accelerated motion is one which has long been a source of trouble both to students and teachers. This is due chiefly to the difficulty of providing suitable apparatus for its experimental study. The following adaptation of the

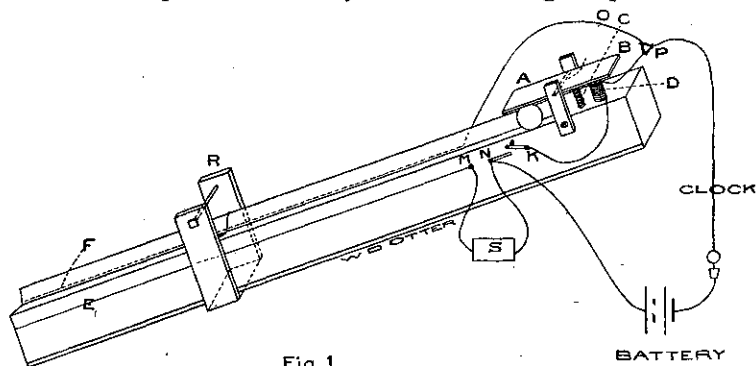


Fig. 1

inclined plane is one which can be used by any student and has given results of remarkable accuracy.

The plane consists of a straight piece of "two by four" about 16 or 18 ft. long having a **V**-shaped groove accurately planed in the upper edge. One end is supported in a suitable frame at an adjustable height. A steel ball 1 1-2 in. in diameter is held near the top of the plane by a wooden lever **A B**, (Fig. 1.) pivoted near the center at **O** and pressed up by the adjustable spring **C**. The end of the lever **B**. carries a soft iron armature and under it is mounted an electromagnet, **D**. By means of the contact Key **K**. an electric circuit can be closed through the magnet and the clock pendulum so that if the key is pressed the ball is released the next time the pendulum swings through the mercury contact.

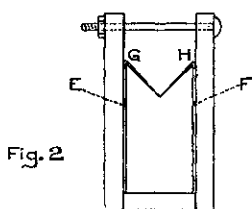


Fig. 2

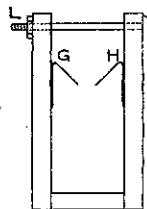


Fig. 3

Along each side of the plane is stretched a bare copper wire shown in cross section at **E** and **F**. (Fig. 2.) A clamp **R**, (Fig. 1.) shown separately in Fig. 3, bears on its inner faces two strips of thin copper **G** and **H**. This clamp slides along the plane with the copper strips fitting evenly in the **V** and when the set screw, **L**, is tightened the copper strips make contact with the bare wires **E** and **F**. These wires are connected one to the binding post **M**, the other to the wire from the clock at **P**. A sounder between **M** and **N** completes the outfit. It is evident from the connections that if the sliding clamp is so placed upon the plane that the ball rolls over it at the same instant that the pendulum swings through the mercury contact the circuit is closed and the sounder will click, but not otherwise. Hence by sliding the clamp along on the plane we may find exactly the distance which the ball rolls in 1 sec., 2 sec., etc. A scale may be ruled directly on the plane. If the clamp is set at the lowest point where a coincidence occurs the readings may be made to the upper edge of the copper strips. In this way settings may easily be made to an accuracy of half a centimeter and perhaps less. An interesting variation from the ordinary form of the

experiment is to determine the acceleration for two different heights of the plane when it can easily be shown theoretically if a_1 and a_2 represent the two accelerations and h_1 and h_2 the corresponding heights, that $\frac{a_1}{a_2} = \frac{h_1}{h_2}$

This formula has been verified with an error of less than one per cent. Another valuable modification is the use of the horizontal plane in connection with the inclined plane. Another piece of "two by four" precisely similar in arrangement to the first may be clamped horizontally in such a position that the ball rolls on to the horizontal plane at the end of 1 sec., 2 sec., or 3 sec., etc. The distance it travels in the next second can then be measured by the same means previously employed thus giving the velocity acquired in different lengths of time. If the farther end of the second plane is lowered below the level of the other, so that the ball will just continue to move if set in motion, the retarding effect of friction may be eliminated.

A considerable experience has convinced me that a student's understanding of a problem is vastly increased by actually verifying his theoretical equations by experiment. And nowhere is this more needed than in the problem of uniformly accelerated motion. To do this successfully the apparatus must be capable of yielding results of a fair degree of accuracy.

The apparatus described has proved so satisfactory for this purpose that it is recommended by the writer to other teachers.

Influence of Air on a Falling Body.—This may be very simply and clearly shown as follows: Cut out a disk of paper a trifle smaller than a half-dollar. Lay the disk upon the coin and holding the coin horizontally as high as possible, let it drop. The coin clears the way, so to say, so that the paper disk is shielded from the action of the air and falls as fast as the coin, both reaching the table together. When let fall separately, however, the paper flutters down.

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