

puerile, without giving him also a comparatively rigid standard in the shape of a book by which he can advance in a more or less mechanical manner. Many teachers, therefore, comply with the letter of the law, and with one of the many text-books called *Natural Philosophy* shorten the popular exposition of the subject to a minimum and demand a certain number of problems under the lever, the screw, the inclined plane, and the pendulum. This mechanical teaching succeeds to a certain extent with the bright boys of some mathematical tendencies; but it fails with the great majority, who speedily get a disgust for the whole subject. To add to the teachers' difficulties, many of them have not a sufficient knowledge of the subject to enable them to courageously reject the descriptions of machines with which many text-books are filled, in which the principles are lost sight of in a multiplicity of levers, pulleys, and connecting pieces.

In teaching a language or a branch of mathematics in a grammar school, one has all his materials ready at hand, a certain author, a certain dictionary, a grammar. In teaching physical science, almost every text-book requires to be supplemented by some apparatus which is not provided with the text-book, and contrivances must be resorted to, and judgment must be used in regard to aids in teaching upon which experience seems to be very indefinite. There are wide limits in regard to the cost of this or that piece of apparatus, and difficulties in deciding between instrument-makers. Very often there is no one available to repair an instrument, and the instruction has an added tendency to become mechanical.

On the other hand, there are enthusiastic teachers who are imbued with the modern popular method of teaching physics by the aid of a lime-light stereopticon. Small appropria-

tions are saved until an expensive instrument can be obtained; and what may be called a college course in physics is inaugurated in the second grade of schools. It is a laudable ambition to desire to illustrate the subject of physics by the method of projections; but the policy of expending from one to two hundred dollars for a lime-light for the use of a grammar or even a high school is questionable.

Professor Mayer, in his excellent little books on the experimental study of light and sound, shows how a water lantern can be constructed for three dollars, which answers every purpose; and if there is no sunlight one of the many forms of kerosene lanterns is admirable for showing diagrams, the deflections of a galvanometer, crystallizations, and minute experiments which a class could not otherwise see to advantage. With the aid of such a cheap method of projection, a grammar school master can give quite an extended course in physics with simple apparatus. He can draw his own diagrams on smoked glass, fixing the drawing by exposing it to the vapour of alcohol, which is evaporated from a shallow dish; and for the money which is expended for a lime-light apparatus enough apparatus can be bought which, supplemented by a water or a kerosene lantern, would illustrate a full course of elementary lectures on physics. In many school collections of apparatus, a few expensive instruments will be found: an air-pump; a Holtz electrical machine; a large induction coil. One or two of such instruments form the rallying point of the department of physics, and are accompanied by meagre and disjointed apparatus. The student collects, so to speak, his thoughts about the picture of a complicated machine; his ideas of the pressure of gases or rarefied air are complicated by the imperfect remembrance of certain valves.