understanding of principles. *Why is this, and how is this,* are questions continually put by children, and a proper explanation will generally be intelligently appreciated. Children are better philosophers than they are commonly supposed to be.

To carry out fully the ideas of this paper, there needs to be a very considerable reform both in the modes of the school-room and in a large proportion of the text-books. Without this it is up-hill work to teach on correct principles. To do it the teacher must stem currents, and run the risk even of displacement. A teacher of high reputation said to me after hearing a lecture delivered a dozen years ago, – You are right; but if I should teach on those principles, I should lose my place in less than six months." A female teacher, who felt sorely the trammels of established routine, once said to me, "I am in doubt as to my duty. If I teach my scholars geography in one way, they will make a good show of knowledge when the Superintendent visits my room; but if I teach them in another way, they will make a poorer show, but know a great deal more about it."

Massachusetts Teacher.

Teaching Natural Philosophy.

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The limits prescribed to this report preclude extended discussion of the topic assigned. Accordingly all consideration of principles of teaching, other than those peculiar to the subject, have as far as possible, been avoided.

The suggestions offered are intended to apply to ordinary classes in ordinary schools; the principles on which they are based are the result of some reflection, and the methods have stood the test of the school-room. Whatever their value may be, they are at least certain to receive a candid hearing and intelligent consideration at the hands of this Association.

The student of Natural Philosophy must be taught to observe carefully what takes place in nature around him, the order and succession of phenomena, their relations, whether of cause and effect or of mere contiguity, in short he must learn to think philosophically. He is not, as some have phrased it, to study nature instead of the text-book,—for that would be asking him to do in one life-time what has required the lifetime of thousands,—but he *may* and *should* learn to verify in many cases the statement of the book by an appeal to nature around him, and in many more by the reproduction of nature's processes in an artificial way, in the laboratory. He should also learn to express philosophical truth with accuracy and neatness, since this is needed to give clearness and consistency to his own thoughts and enable him to add his mite to the treasury of philosophical knowledge.

A bristling array of technical terms meets the student of Philosophy at the outset. The use of these cannot well be avoided, they must be taught thoroughly as often as they recur, or the right kind of progress becomes impossible. The secret of teaching them rapidly lies in so arranging the exercises that the pupils are compelled to use such terms frequently. Answers that involve the use of technical terms may be written by the whole class at once.

These and similar devices must be persevered in till facility is acquired. This point is insisted on as one of primary importance.

The difficulty of making technical words familiar, is a serious obstacle to the success of the lecturing system of teaching the sciences. After a pupil has studied a text-book until familiar with the elements and the nomenclature—he may extend his knowledge rapidly by means of lectures, but without this preliminary study, he may be entertained by scientific lectures, but will not be likely to receive much permanent benefit.

Natural Philosophy deals principally with matter and force, but of matter we know nothing except through the manifestations of force. Light, heat, and other physical agents formerly considered as material existences, are now generally believed to be simply modifications of force and motion Indeed, the progress of modern physical discovery is principally in the direction of a closer knowledge of the inter-relation of the great forces of the universe.

A full, clear, and comprehensive conception of force cannot be obtained by a pupil from any number of definitions. His attention should be called to the attractive and repulsive effects of magnetism and electricity, the expansive power of heat, the immense force exerted by water in freezing, the explosion of gunpowder, and thus through an induction of particulars, a pretty complete idea may be obtained of the protean forms of this many-sided, mysterious thing we call force.

The commonly received view of the constitution of matter which supposes it to consist of minute atoms not in absolute contact, but held in their relations by the operation of the antagonistic forces of attraction and repulsion, should be soon and thoroughly taught. The fundamental idea may be illustrated with a compass needle and a permanent steel magnet. A clear conception of the philosophical side of the atomic theory will be of great service to pupils, and will enable them to understand the various modifications of cohesion, the change of bodies from solid to liquid and gaseous; the expansive power of heat; the propagation of the luminous, calorific, electrical and magnetic influences; in short, every thing that depends on a change in the internal structure of bodies, better than they could without it.

Force as producing motion either uniform or accelerated, should be carefully distinguished from the case where only pressure results.

Not a few of the mistakes of early philosophers arose from a failure to notice this distinction. Aristotle's doctrine, that bodies fall with a rapidity proportioned to their quantity of matter, is an illustration of this mistake.

The doctrines of pressure may be developed in the study of the centre of gravity problems, in the principles of Hydrostatics and Pneumatics.

In connection with the consideration of force as producing motion, come resultant or compound motions and accelerating motion, as in falling bodies. Under the topic of uniform motion comes the use of motion in time as a measure of force, and the unit of measure for force,—the foot-pound. Should the teacher find it necessary to explain the whole philosophy of measurement, he had better undertake it, than to let his pupils pass over without understanding clearly the use and utility of this unit of measure.

The principal difficulty in teaching the laws of falling bodies is in leading them to see that when a body starts from a position of rest and falls freely, increasing its velocity at a uniform rate, the final velocity acquired is just double the *uniform* velocity which a body must have, to pass over the same space in the same time.

Experience seems to show that time and effort may be economized here by teaching the conventional method representing motion by one side of a rectangle, time by the other, and the space passed over is naturally represented by the area of the rectangle.

This device leads easily to the use of the triangle to represent uniformly accelerated motion, the altitude representing the number of seconds and the base the acquired velocity. When the relations of space and time in the first second are clearly apprehended, no further difficulty need be feared.

In connection with gravitation, it is well to teach thoroughly the law of the variation of any force emanating from a central point, until "inversely as the square of the distance" is as perfectly comprehended as anything can be. The most satisfactory illustration of this principle is derived from shadows cast by screens of known size on the wall. It may be said that this illustration belongs to Optics and is out of place here, but the principle to be illustrated belongs equally to the laws of light and attraction, and is easiest understood when both are brought together.

The relations of force and motion form a most important part of Natural Philosophy, and no pupil should be allowed to pass over them without having acquired sufficient knowledge to enable him to understand something of that most comprehensive and striking of modern generalizations—the conservation of force.

The foregoing principles are given, not as the only ones worthy of attention, but as among the most important. Certain clear and distinct general principles which can be applied to special facts are of great value to the student. These general ideas are best reached through a brief inductive process, not necessarily as extensive as was needful to establish the principle in the first place. Some one has said that these general notions are the language in which the philosopher thinks, a consideration that enforces still further the necessity of accurate and comprehensive understanding of these great general principles.

But while the utility of first principles is urged, it is with no desire or intention of ignoring practical considerations. Principles are to be copiously illustrated by facts and figures. Pupils should be encouraged to discover illustrations and confirmation of laws and evidences of their operation. To illustrate: When your class is studying the "Properties of Matter," give one of them a bit of some substance, let him keep it with him for a few days before you call upon him to name and define its properties. You may see him take it from his pocket as he goes along, turn it over, look at it from all points of view, balance it on his hand to try its weight, try it with his teeth perhaps,—in every possible way seeking to discover its properties, both by experiment and reflection. These exercises furnish valuable training.

In my own classes I have been in the habit—when the class had passed over the subject of meteorology—of detailing two to take