seemingly finds it still harder to believe that, if the symbol can mean all that, it may not be used to mean a host of other things of a somewhat similar nature, such as: "is the price of," "is the time taken to walk," etc. Only the very greatest care in using symbols can save disaster in this connexion.

And the symbols are not the only conventional abbreviations. We do not necessarily write 27 – 13 to denote the subtraction of 13 from 27; we may simply write 13 below 27 and subtract in the usual way, and this the children often learn to do before they have learned to use the symbol –.

W. G. Fraser.

Dynamics as a School Subject.—The inclusion of Dynamics in a school curriculum is a topic that affords always much scope for discussion among interested teachers, and widely opposed opinions are held. I venture to state my own opinion, and to suggest a somewhat fuller treatment in dealing with one or two sections of the subject than is usual in the text-book.

I think that the subject of Theoretical Dynamics (including Statics and Hydrostatics) is one that every boy who has reached the post-intermediate stage of his school career, and who intends to remain at school for one or two years longer, ought to study.

Provided that the school is equipped with a physical laboratory, the subject ought to be introduced to pupils at the stage I have suggested as a course of Experimental Dynamics and Statics extending in time to not less than six months. I do not mean that this course should be a course of "Practical Science" in the sense that the Chemistry and Physics of the modern school is. It must be largely a course of Experimental Demonstrations, supplementing the theoretical development, and must never become—as it is unfortunately too apt to become—a mere tabulation of results, excellent or otherwise, by pupils who have difficulty in seeing beyond their hands. The content of this introductory course will be that of the elementary text-book, while to the second year of study—almost entirely theoretical, of necessity—shall be relegated those sections of the subject that deal with circular motion, parabolic motion, simple harmonic motion, impact, centre of mass, couples, the general conditions of equilibrium among forces, and in addition there might be included some of the fundamental notions of Rigid Dynamics.

To return to the Experimental Course, I do not favour the practice that is somewhat prevalent nowadays of introducing Statics prior to Dynamics. This seems to be an admission that the latter is more profound, but the subject is mutilated thereby.

At the present day we need not lack the equipment for experimental illustrations of Dynamics. The trolley apparatus devised by Mr Fletcher is quite satisfactory, and Mr Eggar describes in his text-book on Mechanics the experiments that may be performed with it. A form of Atwood's machine recently put on the market by Cussons embodies the same principle in its construction, the two masses being joined by a paper tape on which the vibrating brush (tuned to a known frequency) leaves a record of the motion. A surprisingly good value of g can be obtained with this apparatus.

A well-made form of Hicks' Ballistic balance is worth the time that is often spent in its adjustment.

There are a few important sections of the subject which receive very scanty treatment in most of our text-books. Let me refer specially to the Parallelogram of Velocities (Relative Velocity – an important corollary which the intelligent pupil finds quite fascinating—is sometimes omitted altogether) and the Parallelogram of Accelerations.

In dealing with the first named theorem, a boy ought to mark in a diagram the position of the body at the end of stated fractions of the unit of time explicitly mentioned in the statement of the component velocities, so as to convince himself that the actual path of the body is along the diagonal of the parallelogram. If he can generalise this proof by the aid of geometry so much the better, but I think the previous exercise should not be omitted. Incidentally I may mention here that graphical methods of leading up to the equations of motion of a uniformly accelerated body are the most satisfactory in a first year's course at least; in fact, it might be better that the pupil at this stage should not use at all such formulae as $s = v_0 t + \frac{1}{2}at^2$. He is introduced by a few simple exercises to the full significance of a velocity time diagram, *e.g.*, he draws his axes, and plots a series of points whose co-ordinates, according to assigned units, specify the velocities of the body at stated intervals, infers readily the type of motion that is represented by a straight line curve, finds that the acceleration is represented by the tangent of the angle made by the curve with the x-axis, and that the space described is represented by the area of a triangle or quadrilateral. Only when this preliminary work has been accomplished should an exercise such as the following be given :—Draw a pair of rectangular axes. Let 1 inch on the x-axis represent 1 second, and 1 inch on the y-axis a velocity of 1 foot per second. Join the points (0, 2) and (4, $3\frac{1}{2}$). Read from the velocity time diagram so obtained the following information :—The velocity at the end of 5 seconds ; the time at which the velocity was 5 feet per second ; the acceleration ; the space described in 3·8 seconds ; the space described in the 4th second, etc.

With regard to the parallelogram of accelerations, the text-book leaves the young student in a state of vague bewilderment over this theorem. Here again I would suggest that the pupil ought to work out such an exercise as the following :—Draw a pair of rectangular axes XOX′ and YOY′. Let 1 inch on each axis represent a space of 1 foot. Suppose a point to move from rest at O subject to two simultaneous uniform accelerations along the axes, mark the positions of the point at the end of 1, 2, 3, 4, and 5 seconds. Join O to the last position of the point, *i.e.*, at the end of the 5th second. Do the other positions lie on this line?

The pupil will in this way convince himself that a body may have two component accelerations, and that the resultant acceleration is obtained by the Parallelogram Law.

The association of this law with the dynamical equation $f = ma$ makes the derivation of the parallelogram of forces theorem comparatively simple and straightforward, but if a boy feels that he does not grasp the parallelogram of accelerations he may suspect that he is being hoodwinked into a belief in the truth of the fundamental theorem of statics, unless he depends upon a purely experimental proof, in which event he must be prepared to agree that two forces may be represented by a single resultant, and that hanging weights over a pulley does not alter the force exerted on the knot.

W. ANDERSON.

Quadratic Equations.—The following is a scheme of classroom work designed to introduce a pupil to quadratic equations, graphically and algebraically.

Newton's Chord Rule is applied in (3) to calculate by Arithmetic close approximations to the roots of an equation. *One graph suffices*