object of the problem, the bisection of the angle, though the line H K will converge in common with the two given lines. We must further enter protest against the *unqualified* proposal "to draw a straight line equal to the true length of the circumference of a circle" (Prob. 184) as misleading to the learner. But, any such defects notwithstanding, here is a most wonderful eighteenpenny book.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his Correspondents. No notice is taken of anonymous communications.*]

Geometry at Oxford

IN the last number of NATURE Mr. Proctor remarks that "no one who considers carefully the mathematical course at either University, can believe that it tends either to form geometricians or to foster geometrical taste."

With regard to Oxford, I think it is only fair that some qualification should be offered to this conclusion. In Cambridge, candidates for mathematical honours have to run their race in a course clearly marked out for them, and loss of place is naturally the result of individual vagaries. But in Oxford the order of merit is not carried further than distribution into classes, and I do not believe there is anything to prevent a skilful geometrician finding himself in the first class with those who put their trust most in analytical methods.

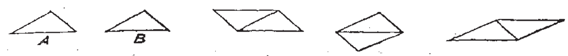
I cannot pretend to much geometrical capacity, but I know something of Oxford mathematical teaching. Speaking for myself, the fascinating lectures of the present Savilian Professor of Geometry will never cease to hold perhaps the most prominent place in my recollections of university work. It is quite true that I remember conversing with a college tutor who was rather doubtful about modern geometrical methods, and seemed disposed to look upon these lectures as "dangerous." He was a great stickler, however, for "legitimacy," thinking it wrong, for example, to import differential notation into analytical geometry; but I do not think he had a large following amongst younger Oxford men. I certainly did not find, in reading with some of them, that geometry was at all in disfavour. I have often had neat geometrical solutions pointed out to me of problems where other methods proved cumbrous or uninteresting; and conversely I have found geometrical short cuts were far from objected to. On the whole, the characteristic feature of the Oxford examination system (most marked in the Natural Science School, but making itself felt in all the others) being to encourage a student after reaching a certain point in general reading to make himself strong in some particular branch of his subject, I believe special attention to geometrical methods would pay very well.

Oct. 13 W. T. THISELTON DYER

Elementary Geometry

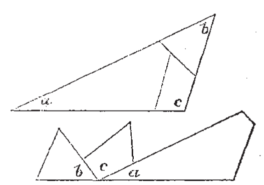
YOUR correspondent, "A Father," has in view a very desirable object—to teach a young child geometry—but I fear that he is likely to miss altogether the path by which it may be reached. His principle, that "a child must of necessity commit to memory much that he does not comprehend," appears to me to be totally erroneous, and not entitled to be called a fact. To this time-hallowed principle it is due that a large proportion of all who go to school learn nothing at all, while those more successful learn with little improvement of their faculties. It is a convenient principle which allows the title of teacher to be assumed by those who only hear lessons. Children labour under this difficulty that they learn only through language, which is to them a misty medium, particularly when the matter set before them is in any degree novel or abstruse, and no pains are taken to clear up the obscurity of new expressions. Children know nothing of abstraction, and learn to generalise from experience, not from words. Committing to memory what is not understood is a disagreeable task; begetting a hatred of learning, and causing many to believe that they want the special faculty required for the task set before them. The art of teaching the young ought to be the art of enabling them to comprehend, and memory ought to be strengthened not by drudgery but by being founded on understanding and by the rational connection of ideas.

Now geometry is the science of figure; it theorises reality, and the truth of every proposition in it may be made apparent to the senses. Double a piece of paper and cut out a triangle in duplicate. The two equal triangles thus formed, A and B, may be put together so as to form a parallelogram in three different ways. The child who makes this experiment will learn at once



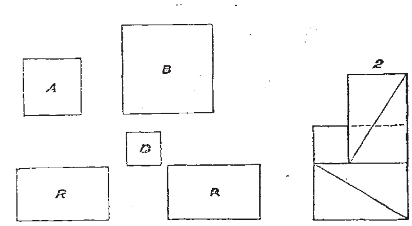
what is meant by a parallelogram, and he will perceive its properties, viz., that its opposite sides and angles are equal; that it is bisected by the diagonal, &c. But if he learns all this by rote, he acquires only a cloud of words, on which his mind never dwells. Propositions touching abstractions and generalisations can never be understood by the young without abundant illustration. When a geometrical truth is made apparent to the senses, when seen as a fact and fully understood, the language in which it is expressed having no longer a dim and flickering light, is easily learned and remembered, and the learner listens with pleasure to the discussion of the why and wherefore.

It is not enough for a child to learn by rote the definition of an angle. He ought to be shown how it is measured by a circle; and by circles of different sizes. In short, he ought to be taught what words alone will not teach him, that an angle is only the divergence of two lines. Let us now come to the important theorem that the three angles of any triangle are equal to two right angles (Euclid i. 32). Cut a paper triangle, mark the angles, then separate them by dividing the triangle and place the three angles together. They will lie together, filling one side of a right line, and thus be equal to two right angles. Let the learner test the theorem with triangles of every possible shape to convince himself of its generality, and then, fully understanding what it means, he will also understand the language in which it is proved.



It is a mistake to decry the use of symbols. They enable us to get rid of the wilderness of words, which form a great impediment in mathematical reasoning. Ordinary language can never group complex relations for comparison so compactly as to bring them within the grasp of the understanding. When we would compare objects, we place them close together, side by side. But the features and lineaments of objects described in language are too widely scattered to be kept steadily in view. It is easier to learn the use of symbols than to commit to memory what is not understood. Those who would learn mathematics without symbols can advance but a little way.

Neither is there any good reason for rejecting the second book of Euclid, though it certainly may be much abridged. The relations of whole and parts, sum and difference are easily exhibited, and an acquaintance with them is of great value to arithmeticians. Let us take for example the following propositions: "The squares (A and B) of any two lines (or numbers) are equal to double the rectangle under those lines (R and R, or the product in case of numbers) and the square of their difference D."



Now these figures being constructed, it will be found that when the two squares are placed together as in Fig. 2, the rectangles cover exactly the parts marked with diagonals, and the square of the difference the remainder.

In numbers, the square of 5 = 25
,, 3 = 9
—
34
Double product of 5 and 3 30
Square of diff. 4
—
34