turning until the cement no longer shows in streaks, until the mixture has a uniform color. Throw up the ragged edges, and, with sprinkling can or hose with spray nozzle, apply water in quantity, according to special directions obtainable for each particular kind of construction. Turn again and add as much more water as may be required. If dry streaks are still evident, continue the turning until they disappear. With wheelbarrows quickly remove the concrete and immediately use it in the work.

If crushed rock or screened gravel is to be used,

fill the bottomless frame with sand and distribute upon it two bags of cement. Drag the materials back and forth with the garden rake, then turn, as described above, until the mass has a uniform color. Spread the mixture so that two framefuls of crushed rock or screened gravel may be placed upon it. Wet the mass and turn as for bank-run gravel until each stone is coated with cement mortar. Remove as for the gravel concrete.

For the proportion of 1 : 2½ : 5 or 1 : 5 the method of mixing is the same.

Since crushed stone is more or less porous, in dry hot weather it is advisable to keep the stone pile wet or at least to water the stone well as it stands on wheelbarrows ready for the mixing board.

No vast amount of knowledge and experience is necessary to do first-class work in concrete. Success is dependent upon the care and thoroughness exercised in the

Selection of the materials,

Mixing of these ingredients, and

Protection of the freshly placed concrete.

The Mathematical Initiator

A Tangible Multiplication Table

A FEW years ago a French gentleman named Camescasse constructed, for the edification of his children, a tangible multiplication table, with the aid of the one-inch cubes of the Froebel kindergarten material. He has recently improved this apparatus for teaching the rudiments of mathematics by using cubes with deep grooves on two opposite sides and at right angles to each other, into which can be inserted straight bands of metal, which fit the grooves tightly enough to hold a row of blocks together, but not too tightly to be easily removed.

The improved apparatus, which is sold under the name of "the mathematical initiator," consists of 600 white blocks, 600 red blocks, and 144 metal bands of various lengths. The blocks measure a trifle less than one centimeter every way, so that a row of 10 blocks, with the inevitable narrow interstices between them, measures 10 centimeters, very approximately. The grooves are 5 millimeters deep and 0.8 millimeter wide, and the longest metal bands are 4 millimeters wide, 0.8 millimeter thick, and 92 millimeters long. Hence a band which binds ten blocks together is completely buried in them and the blocks form a smooth

Fig. 1.—Method of assembling the blocks by means of metal bands

square bar, one decimeter in length. By inserting bands in the other set of grooves, ten of these composite bars can be joined together to form a plate, one decimeter square, as is shown in Fig. 1.

The mathematical initiator will be found useful in forming the designs and patterns which constitute a regular part of kindergarten work. Fig. 2 shows one of the vast number of patterns that can be formed of

Fig. 2.—A mosaic pattern

the red and white blocks, assembled by means of the metal bands. By handling the blocks, children are unconsciously initiated into the mysteries of arithmetic and learn to count with hands and eyes before they can name or write the numerals. A young child is soon taught to affix to each metal band one block for each of its ten fingers, and the count can be verified by placing the fingers on the assembled blocks, as on the keys of a piano. Afterward the child learns to count the blocks and the bars of ten blocks. Ten bars of 10 can be assembled into a plate of 100 by inserting metal bands into two of the vacant grooves, and 10 plates can be piled up to form a cube of 1,000 blocks, or one cubic decimeter. In this way the child requires an objective knowledge of units, tens, and hundreds, and learns that a thousand represents 10 hundreds or 100 tens. At the same time a familiarity with the metric system is acquired. The child soon adopts the square centimeter as the unit of area and the cubic centimeter as the unit of volume,

and learns that a decimeter contains 10 centimeters, a square decimeter contains 100 square centimeters, and a cubic decimeter contains 1,000 cubic centimeters.

More abstruse arithmetical operations can also be materialized with the aid of the mathematical initiator. Among such operations are those which give the sum of n consecutive whole numbers, the square of the sum or difference of two numbers, etc. Fig. 3 shows a square of red and white blocks arranged to illustrate the formula $(a + b + c)^2 = a^2 + b^2 + c^2 + 2ab + 2ac + 2bc$, that is, the law that the square of the sum of three numbers is obtained by adding the sum of the squares of the numbers to twice the sum of their products, taken two and two. In the example illustrated the numbers are 2, 3, and 5, the sum of which is ten. A little inspection of Fig. 3 shows that the large square, having 10 blocks on a side, is made up of three smaller squares, having respectively 2, 3, and 5 on a side, and of three pairs of rectangles of 2 by 3, 2 by 5, and 3 by 5, but this fact is impressed on the

Fig. 3.—Demonstration of formula $(a + b + c)^2 = a^2 + b^2 + c^2 + 2ab + 2ac + 2bc$

child's mind far more firmly, and in concrete form, in the process of building up the large square. The above are only a few of the educational possibilities of the mathematical initiator.—*Revue des Sciences.*

Problems of Existence

By SIR OLIVER LODGE.

IN the first of a series of three lectures just delivered on "Problems of Existence," Sir Oliver Lodge said that the term science might be used in a narrow or in a broad signification. Sometimes the one was convenient, but always the other was permissible; and, if the use of the term in the narrow sense tended to obscure the larger significance, then, in that connection, such use must be deprecated. It was rather commonly supposed that the region amenable to strictly scientific study was a narrow one, and that it by no means embraced, nor would it ever embrace, the whole of possible knowledge. A boundary was often drawn between the scientific arena, on the one hand, and the literary, the philosophic, the religious domains, on the other. But, in truth, no such boundary could be drawn; there were no absolute barriers or discontinuities in nature. Every subject merged into, and had more or less connection with every other. It was true that subjects were in very different stages of maturity; more exact and precise knowledge was attainable in some of them than in others. Those subjects which, in a given epoch of the world's history, were susceptible of exact and demonstrative treatment—especially those which were amenable to the alternate analysis and synthesis of the Newtonian method—constituted the citadel of the scientific domain. But there were also sciences which, as yet, were almost wholly in the stages of observation and classification, and any one of these might develop sooner or later into something more like the deductive stage; as chemistry had within the last century—not only new compounds, but even new elements being predicted—and as biology had begun to show signs of doing under the stimulus supplied by the genius of Dar-

win and of Mendel. There could be no doubt that this tendency toward advance from the vague to the definite was a constantly progressive one, and that departments of human experience now apparently beyond treatment by rigorous methods would gradually be incorporated and fused in the conquered and explored territory. Meanwhile they were not shut off from human scrutiny merely because rigid treatment was not yet applicable. They must be treated by methods appropriate to the stage to which our minds had risen with respect to them. No contempt for such methods should be felt, except when they were applied in departments wherein they had already been superseded.

Some there were who regarded the scientific advance, or, as they called it, encroachment upon wild and unexplored territory, with dislike, thinking that the process would be death to mystery, and would reduce all nature to matter-of-fact and commonplace. In geography it must to some extent be so, since the surface of the earth was limited. But those who realized the infinitude of complexity in the simplest existence, and the way in which the whole of creation was bound together without barriers or boundaries or limitations, forming one continuous and infinite whole, would have no such fear; nor would they think it inappropriate for a scientific man to cast his eyes around, from time to time, to see what new departments of knowledge might be coming within his ken. Indeed, they would not hesitate to welcome such advances, and reach out a hand to catch as best they might some anticipation of the interest that must thus legitimately accrue to the accumulated wealth of knowledge now within our grasp.

THE PROBLEM OF EVIL.

The narrow specializing attitude was useful, and had performed yeoman service. The work of the

delver and digger was of the utmost value; but they must not, through use and wont, gradually acquire the notion that theirs was the only method of value, or that the work of the humanist, the inspired gleams of the poet, the guides available through the intuition and instincts of humanity, were deceitful will-o'-the-wisps which led to nothing. There was room for every class of worker; and the men of science themselves might in certain moods raise themselves out of their groove of steady work and look around, as one and another had always done, and tell the world what it was they saw from their point of vantage—whatever that point of vantage might be, whether elevated peak or subterranean cavern. For, however it might be regarded by others, still it was their point of view, the place they had attained through severe toil; and it was not only their right, but their duty, to tell such other workers as would listen what it was that thence they saw.

Sir Oliver elaborated a reasoned foundation for an optimistic attitude toward the Universe; dealing with the Problem of Evil as illuminated, and, to some extent, solved by the relativity of all things. He instanced the analogy of light and shade in an engraving, and pointed out how meaningless and monotonous existence would be if it were all high light. He considered that pessimism, if encouraged, led to a kind of practical atheism, and that this attitude was quite unnecessary and illogical. In his treatment of evil he discriminated, however, between the theological problem of evil in the abstract, and the human problem of sin or man-made evil, and insisted that an explanation of the one formed not the slightest justification for the other, though by casual readers and speakers the two aspects were sometimes confused.—*English Mechanic and World of Science.*