

The *theoretic* reasons in favor of such a change have often been urged; that an experiment along this line could not *practically* prove very disastrous, is guaranteed by the concordant and satisfactory usage of the leading European nations. Such an experiment could be made by any one school without disturbing its relations either with the schools that fit for it, or the institutions for which it fits; the experiment could be made by the department of mathematics itself, without altering its hour schedule, or its relations to other departments. Has not the time come for a little conservative experimenting along this line? Do not misunderstand me. I am not proposing a "fusion" of algebra and geometry for a first, conservative experiment. I am not even proposing any very thorough interweaving of the two, but simply a juxtaposition in time; that they be taught simultaneously throughout the years in which they are now taught separately; that the long estrangement between algebra and geometry be healed; that they march along side by side, ready and willing to lend each other a hand on occasion. Within these limits, that are surely safe, and not expecting the best results on the first attempt or the second, would it not be worth while to give the *simultaneous teaching of algebra and geometry* a thorough trial?

APPARATUS FOR THE DETERMINATION OF THE COEFFICIENT OF LINEAR EXPANSION OF A METAL TUBE.

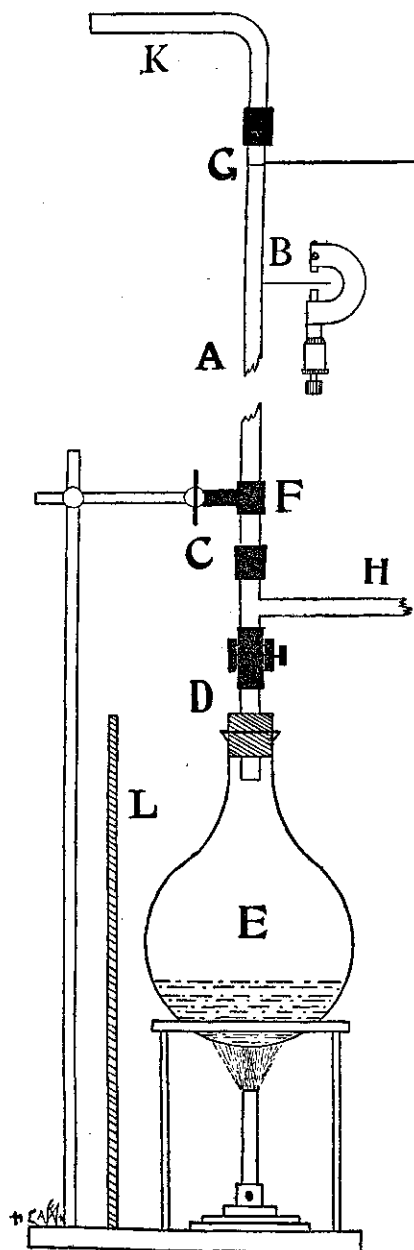
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The apparatus for this determination may be fitted up quite easily from materials generally in use in a physical or chemical laboratory. As a rule, the determination of a coefficient of linear expansion involves a somewhat costly piece of apparatus, and, moreover, the experience of fitting up is denied the student when he is provided with the finished article. Beyond a few metal tubes, which may be obtained for a few pence, the following method is cheap and simple, and, if performed with the care and precaution which one may reasonably expect from a second-year student, is capable of yielding very fair results.

A long tube *a* of, say, brass, more than a metre long, has a

needle soldered (eye end) to it at *b* about two inches from one



end. The end of the tube remote from *b* is fitted, by means of a short piece of indiarubber tubing, to the three-way tube at *c*. Continuing down, the three-way tube is fitted, by means of a piece of indiarubber tubing carrying a screw pinch-cock, to the outlet tube *d* of the glass flask (or tin can) *e*, which is used for generating steam. The brass tube is tightly clamped at *f*, and is maintained vertically by a ring of copper wire, clamped to a retort stand, at *g*. A micrometer screw-gauge, reading to the 1-100th of a millimetre, is clamped firmly in position at *b*.

A determination is carried out in the following manner: Screw up the pinch-cock at *d* until the passage into the flask is completely closed. Connect *h*, by means of rubber tubing, to a cold-water tap, and turn on the latter until a fairly rapid stream of water passes up the brass tube and out of the exit tube at *k*. (The latter is a piece of glass tubing bent at right angles and attached to the top of the brass tube by means of rubber tubing. It is preferable to have this el-

bow tube in communication with the sink by means of either glass or rubber tubing.) Take the temperature of the water after it has been passing for a few minutes; this will be the temperature of the brass tube.

Now measure carefully, with a metre rule, the length of the brass tube between the bottom of the needle and the point at which the tube is clamped, and then adjust the micrometer screw-gauge so that the top of the screw just touches the bottom of the needle. There is no difficulty whatever in making this adjustment as long as there is a good light behind the gauge and needle, *e. g.*, a window. Note down the reading of the gauge.

Turn off the cold-water tap, open the pinch-cock at *d*, and place a Bunsen burner under the flask. When the water boils steam will pass rapidly up through the brass tube and out by the exit tube at *k*. It will now be seen that the needle has moved away from the top of the screw, due to the vertical expansion of the tube.

After the steam has passed through the tube for some little time, and there is no further expansion, adjust the micrometer screw-gauge so that the top of the screw just touches the bottom of the needle once more, and again take the reading.

The necessary data for the calculation of the coefficient of linear expansion of the tube has now been obtained. The following example is the result of an experiment carried out by a student in the school laboratory:—

Length of brass tube = 1000 mm.

Temperature of cold water = 12.3°C .

Temperature of steam = 99.3°C . (Barometer = 741 mm.)

1st reading of micrometer screw-gauge = 4.18 mm.

2nd reading of micrometer screw-gauge = 2.56 mm.

\therefore Expansion through 87°C . = 1.62 mm.

Then 1000 mm. of brass tube expand 1.62 mm. through 87°C .

\therefore C. of E = 0.000186

The following tubes, diameter about 2-5ths of an inch, are suitable for determinations similar to the above: iron (0.000012), brass (0.000019), copper (0.000017), and glass (0.0000086). Since the needle cannot be fused into the glass tube, owing to the difference in expansion of glass and steel, a short piece of platinum wire may be fused in to take the place of the needle.—

School World.