5. Use logarithmic or other tables of only the required accuracy, and correct them from the table of errata or otherwise. Errors are somewhat numerous in many of the older tables.

6. Obtain a quantity of "mark paper," ruled in small squares, and rule each fifth or sixth vertical line in red.

7. Write the nine multiples of numbers, which are frequently required, on slips of card; these slips can be arranged as required on a board by the aid of drawing pins. Blater's Table of Napier or Sawyer's Automatic Multiplier may be used instead of the slips.

8. A few wooden or metal slips are useful for ranging long rows of figures or covering up any not required.

9. It is a counsel of perfection to repeat a tedious calculation from a different formula with different tables.

It is to be remembered that in the value of π, published by Rutherford in 1841, to 208 places, only 152 figures are correct. Two errors crept into Shanks' result to 530 places in 1853. If such computers publish erroneous figures it may well behove their inferiors to be careful. SYDNEY LUPTON.

CORRESPONDENCE.

APPROXIMATION IN METHOD VERSUS APPROXIMATION IN ARITHMETIC.

TO THE EDITOR OF THE *Mathematical Gazette.*

DEAR SIR,—In the welcome Report on the Correlation of Mathematical and Science Teaching by the Joint Committee of the Mathematical Association and the Association of Public Schools' Science Masters, two examples are given (p. 6) on the method which should be followed in treating problems in Physics.

There can be no question of the main contention that great care should be taken that the pupil is not finding a numerical result simply by substitution in a given formula. But the first example as given raises another point also. The example is on the linear expansion of a brass rod, and is begun by directing the pupil's attention to the meaning of the coefficient of linear expansion as "the amount by which unit length (no temperature given) expands when heated through unit temperature." In working the example this unit length is tacitly assumed to be at 10° C.—or else it is tacitly assumed that there will be no appreciable difference in the result whether this unit length be taken to be at 0° C. or at 10° C.

This vagueness in method raises a point of considerable importance in the teaching of such questions when clothed with all the authority of occurring in a specially recommended example in a Report of such weight. But I venture to ask whether it is well to allow unnecessary inaccuracies in method simply for the sake of shortness and saving a little mathematics? I am not here speaking of approximations to what really occurs in Nature which must be assumed sufficiently to simplify Physical problems. But would it not be far better to work the theoretical parts of the problem clearly and logically from the accepted definitions for the Physical quantities (these definitions having probably been explained carefully and at length to the class), and then find the approximate numerical answer by accurate approximate arithmetic? By accurate approximate arithmetic is here meant such that the student knows to which significant figure he can trust. With logarithms or a slide rule this final arithmetic is short and easy, and will not withdraw the student's attention from the main principles of the problem.

A clever boy or girl will not be confused by such a treatment of the problem as that given in the Report, but, in my experience, the average pupil is only confused by such tacit approximations in method. In this particular case of expansion this vague confusion in such a pupil's mind causes trouble when the gaseous laws are considered, viz.: why should the volume of a gas be referred back to 0° C. and not to the temperature of the room? Or difficulties arise in problems where the Fahrenheit scale is used, and so on.

The example is—"A brass rod is 25 metres long at 10° C., find its length at 50° C., if the coefficient of linear expansion of brass is ·000018."

One metre of brass at 0° C. heated 1° C. expands so as to have length

$$1+{\cdot}000018 \text{ metres.}$$

One metre at 0° C. heated to 10° C. expands so as to have length

$$1+10\times{\cdot}000018 \text{ metres.}$$

∴ one metre at 10° C. if cooled to 0° C. has length

$$1/(1+10\times{\cdot}000018) \text{ metres.}$$

∴ 25 metres at 10° C. if cooled to 0° C. has length

$$25/(1+10\times{\cdot}000018) \text{ metres.}$$

One metre of brass at 0° C. when heated to 50° expands so as to have length $1+50\times{\cdot}000018$ metres.

∴ $25/(1+10\times{\cdot}000018)$ metres at 0° when heated to 50° expands so as to have length $25\dfrac{1+50\times{\cdot}000018}{1+10\times{\cdot}000018}$.

This can be worked out by logarithms, or else continued

$$=25(1+50\times{\cdot}000018)(1-10\times{\cdot}000018) \text{ nearly } \ldots\ldots\ldots\ldots(a)$$
$$=25(1+40\times{\cdot}000018) \text{ nearly } \ldots\ldots\ldots\ldots\ldots\ldots(b)$$
$$=25{\cdot}018,$$

and the degree of approximation at stages (a) and (b) can be seen at once by any student familiar with elementary approximate methods in Algebra.

This is certainly somewhat longer than as given in the Report, but if our object be to correlate Mathematics and Physics at school, why should we teach our Physics both vaguely and illogically from the given definitions merely in order to avoid giving our boys and girls a little practice in elementary mathematics? Yours, etc.,

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TO THE EDITOR OF THE *Mathematical Gazette.*

SIR,—In a recent issue you threw out a suggestion for a pillory for examination questions. I beg to enter the following:

"The external measurements of a closed box are 36 inches, 2·2 feet, and ·50$\dot{6}$ yards. Find the cubic space within if the wood of which it is made has a uniform thickness of one-tenth of a foot."—Board of Education, 1904.

Note the useful 'it,' the mixture of units, and the recurring decimal. English grammar, ordinary common sense, and physical possibility smashed in one question! Can anyone beat this?

Some obvious and rather painful reflections are suggested by the fact that the question emanates not from an obscure and ill-paid schoolmaster, but from the Board of Education. Yours faithfully, ALEPH.