chief thing that is wrong with museums, national and provincial, is (as Bernard Shaw says of the poor) their poverty? WM. EVANS HOYLE.

National Museum of Wales, Cardiff,
March 15.

IN the timely and suggestive leading article on museums in NATURE of March 11 there are references to the Museum of Practical Geology that need explanation, not because they are incorrect, but because they are symptomatic of that forgetfulness of the fundamental purposes of this museum which has long been obvious in some quarters.

It is true that "the Museum of Practical Geology was a necessary concomitant of the Geological Survey," but this was not, and never has been, its sole *raison d'être*. It was founded as the Museum of Economic Geology—that is, of economic geology in its broadest aspects. It had, therefore, from its inception two functions to perform: (1) To serve as the storehouse and exhibition for all the concrete documentary material collected during the making of the geological maps—material of the greatest value as a demonstration of the facts of British geology and usefully employed for educational, industrial, and purely scientific purposes; and (2) to act as the national repository of material illustrative of all those mineral resources that form the basis of mining, metallurgical, and other industries.

The first of these functions is purely British in scope, the second is world-wide.

As regards overlapping with the Natural History Museum, there is none; and alternatively, as the lawyers say, if there is any it should cease, since the functions of the two institutions are clearly differentiated. The scheme of the geological and mineralogical departments of the Natural History Museum is academic, and that of the Museum of Practical Geology economic. On the other hand, the Imperial Institute in respect of its mineral exhibits does overlap the functions of the older institution. This is a question requiring attention in any scheme of reconstruction. WILLIAM G. WAGNER.

March 15.

Some Methods of Approximate Integration and of Computing Areas.

ENGINEERS and shipbuilders are continually requiring to find the area of a surface bounded by curved lines. If both the upper and lower boundaries are curved, it is a simple matter to divide the surface into two by a straight line, find the area of each part separately, and add them together.

Simpson's rule is almost universally used for this purpose, but a little consideration will show that a more accurate evaluation of the area can be obtained in most cases by using other rules.

We will consider an area contained by a base line, two vertical ordinates at the ends, and a number of intermediate ordinates placed at equal distances along the base line. If the base line be divided into m equal intervals, each of a length h, there will, of course, be $m+1$, or n, ordinates. When the height of these ordinates is known, and the value of h the interval also, an approximation to the value of the area can be obtained which increases in accuracy with the number of ordinates taken and measured, when the curve is of an anomalous shape.

(1) If the upper boundary be a straight line, an exact result will be obtained by merely the two end ordinates y_1 and y_2 and the length of the base line h; $A=\frac{1}{2}h(y_1+y_2)$.

(2) If the upper boundary be a parabola, an exact result will be obtained by bisecting the base line, and then

$$A=\frac{h}{3}\left(y_1+y_3+4y_2\right),$$

where h is half the base line.

This is Simpson's well-known rule: If any odd number of ordinates be taken, say 7, it is considered as a succession of three areas bounded above by three parabolas, *i.e.* the area from y_1 to y_3 is added to the area from y_3 to y_5, and this, again, is added to the area from y_5 to y_7. The formula used is then

$$A \approx \frac{h}{3}\left[\overline{y_1+y_7}+2\,\overline{y_3+y_5}+4\,\overline{y_2+y_4+y_6}\right].$$

If m denote the number of additional areas computed by this method, the general formula will take the form

$$A \approx \frac{h}{3}\left[\overline{y_1+y_{3+2m}}+2\,y_{1+2m}+4\,\overline{y_2+y_{2+2m}}\right].$$

It should be especially noted that this formula must be used only when the number n of ordinates is odd and the number of intervals even. In the second and third terms the values 1, 2, 3, etc., are assigned successively to the symbol m, ending with that value of m which denotes the number of additional areas that are to be computed. The formula is based on the assumption that $y=a+bx+cx^2$, and gives the best possible approximation to the true area if only three ordinates are given.

(3) If, however, four ordinates be given, we may assume that $y=a+bx+cx^2+dx^3$, and the resulting formula based on this assumption,

$$A \approx \frac{3h}{8}\left[\overline{y_1+y_4}+3\,\overline{y_2+y_3}\right],$$

will give the best possible approximation if only four ordinates are given. This formula should be used only when the number of ordinates is $4+3m$, and it then becomes

$$A \approx \frac{3h}{8}\left[\overline{y_1+y_{4+3m}}+2\,y_{1+3m}+3\,\overline{y_2+y_3+y_{2+3m}+y_{3+3m}}\right]$$

(4) If five ordinates be given, we shall obtain a more accurate result by assuming that y is a quartic function of x, and for 5, 9, 13, or $5+4m$ ordinates the following formula may be used:

$$A \approx \frac{2h}{45}\left[7\,\overline{y_1+y_{5+4m}}+14\,y_{1+4m}+12\,\overline{y_3+y_{3+4m}}+32\,\overline{y_2+y_4+y_{2+4m}+y_{4+4m}}\right]$$

(5) Similarly, if $6+5m$ ordinates be given, y may be regarded as a quintic function of x, and the formula becomes

$$A \approx \frac{5h}{288}\left[19\,\overline{y_1+y_{6+5m}}+38\,y_{1+5m}+75\,\overline{y_2+y_5+y_{2+5m}+y_{5+5m}}+50\,\overline{y_3+y_4+y_{3+5m}+y_{4+5m}}\right]$$

(6) Again, if $7+6m$ ordinates be given, y may be assumed to be a sextic function of x, and we then have the formula

$$A \approx \frac{h}{140}\left[41\,\overline{y_1+y_{7+6m}}+82\,y_{1+6m}+216\,\overline{y_2+y_6+y_{2+6m}+y_{6+6m}}+27\,\overline{y_3+y_5+y_{3+6m}+y_{5+6m}}+272\,\overline{y_4+y_{4+6m}}\right].$$

In all these formulæ the first term consists of the sum of the first and the last ordinate. In (2), (3), (4), (5), and (6) the values 1, 2, 3, etc., are assigned successively to the symbol m in the following terms according to the number of ordinates. Thus if in (6) nineteen ordinates are given, $19=7+6m$, so $m=2$.