

$$a + 0.5000b + 0.3333c + 0.2500d + 0.2000g + 0.1667h + 0.1429j + 0.1250k + 0.1111l + 0.1000m,$$

that is, with

$$a + \frac{1}{2}b + \frac{1}{3}c + \frac{1}{4}d + \frac{1}{5}g + \frac{1}{6}h + \frac{1}{7}j + \frac{1}{8}k + \frac{1}{9}l + \frac{1}{10}m,$$

which is  $\int_0^1 f(x) dx$ .

An approximate evaluation of  $\int_0^1 f(x) dx$  is therefore given by

$$4[F(\frac{1}{10}) + F(\frac{4}{10}) + F(\frac{6}{10}) + F(\frac{9}{10})].$$

2. The following table shows for several functions the value of the integral and the approximate evaluation by this four-ordinate rule and by two seven-ordinate rules in common use, viz. :—

Simpson's rule :—

$$\int_0^1 f(x) dx = \frac{1}{28} [F(\frac{0}{8}) + F(\frac{2}{8}) + 2\{F(\frac{4}{8}) + F(\frac{6}{8})\} + 4\{F(\frac{1}{8}) + F(\frac{3}{8}) + F(\frac{5}{8}) + F(\frac{7}{8})\}], \text{ approx.}$$

Weddle's rule :—

$$\int_0^1 f(x) dx = \frac{1}{20} [F(\frac{0}{6}) + 5F(\frac{1}{6}) + F(\frac{2}{6}) + 6F(\frac{3}{6}) + F(\frac{4}{6}) + 5F(\frac{5}{6}) + F(\frac{6}{6})], \text{ approx.}$$

$F(x)$	$\int_0^1 f(x) dx$	New rule	Simpson	Weddle
Semicircle $(x-x^2)^{\frac{1}{2}}$	$\frac{\pi}{8} = 0.3927$	0.3949	0.3815	0.3835
Quadrant $(1-x^2)^{\frac{1}{2}}$	$\frac{\pi}{4} = 0.7854$	0.7868	0.7775	0.7789
$(4x-x^2)^{\frac{1}{2}}$	$\frac{2\pi - \sqrt{3}}{2} = 1.228$	1.231	1.217	1.219
$\log(1+x)$	$2 \log 2 - 1 = 0.3863$	0.3859	0.3863	0.3863
$\frac{1}{e^x}$	$e - 1 = 1.718$	1.720	1.718	1.718
$\frac{1}{1+x}$	$\log 2 = 0.6931$	0.6937	0.6932	0.6931
$\frac{1}{2+x}$	$\log \frac{3}{2} = 0.4055$	0.4056	0.4055	0.4055
$\sin x$	$1 - \cos \frac{180^\circ}{\pi} = 0.4597$	0.4593	0.4597	0.4597

3. The approximation is convenient for the practical determination of the area of a closed curve, such as an indicator diagram. The arithmetical mean of the ordinates at one-tenth, four-tenths, six-tenths, and nine-tenths of the range is the mean ordinate for the range.

The decimal division of the range, the use of only four ordinates, the extremely simple arithmetic involved, and the degree of accuracy attained should make the rule of practical value.

A. F. DUFTON.

Trinity College, Cambridge,  
April 30.

### British and Metric Systems of Weights and Measures.

ARE not those who discuss the relative claims of 4 mils and 5 mils as the substitute for the penny in a decimal division of the pound merely trying to minimise the disadvantages of what must in any case be a change for the worse? It seems that the advantage of any given system of weights or measures lies largely in the facilities that it offers for the division of a sum or quantity into equal parts. In this respect

any decimal system is deficient by the absence of the factor 3, and by the frequency of the factor 5, which is of much less use than 4 for practical purposes. The *reductio ad absurdum* of the metric system seemed to be reached in the issue in Portugal some years ago of a 2½ reis postage stamp (they now call it ½-cent). A rei is one-thousandth part of a milrei or dollar, about equal to one-twentieth of a penny—surely a small enough unit for any purpose, and yet it is found necessary to halve it!

The following comparison seems instructive :—

No. of farthings in one pound = 960 =  $2^6 \times 3 \times 5$ .

This has 11 factors between 1 and 20,  
20 factors between 1 and 100.

No. of inches in one mile = 63,360 =  $2^7 \times 3^2 \times 5 \times 11$ .

This has 14 factors between 1 and 20,  
34 factors between 1 and 100.

No. of ounces in one ton = 35,840 =  $2^{10} \times 5 \times 7$ .

This has 9 factors between 1 and 20,  
17 factors between 1 and 100.

No. of grains in one lb. troy = 5760 =  $2^7 \times 3^2 \times 5$ .

This has 13 factors between 1 and 20,  
26 factors between 1 and 100.

No. of seconds in one day = 86,400 =  $2^7 \times 3^3 \times 5^2$ .

This has 13 factors between 1 and 20,  
32 factors between 1 and 100.

Contrast with these :—

No. of millimetres in one kilometre, or of grammes in one metric tonne = 1,000,000 =  $2^6 \times 5^6$ ,  
which has only 7 factors between 1 and 20,  
14 factors between 1 and 100.

If all the above five English systems be taken together, it will be found that :—

The factor 2 occurs 37 times

" " 4 " 17 "

" " 8 " 11 "

The factors 3, 6, and 12 occur 8 "

" " 5, 10, 16, and 20 " 6 "

The factor 15 occurs 5 "

The factors 9 and 18 occur 3 "

And the factors 7, 11, and 14 " once each.

Now, though it cannot be contended that the man who wants to divide 100l. into seven parts is helped by the fact that there are 28 lb. in a quarter, or he who would divide a ton into eleven parts by the number of yards in a furlong, yet it seems worthy of note that in our admittedly heterogeneous system all the numbers below 20, except 13, 17, and 19, should be represented as factors, and that to an extent so nearly proportional to their probable utility.

M. E. YEATMAN.

Parliament Mansions, May 7.

### Scientific Apparatus and Laboratory Fittings.

I AM surprised to see that Prof. W. M. Bayliss, who writes in NATURE of May 6 on the proposed Anti-Dumping Bill, has misunderstood the Bill so far as it relates to scientific instruments. This Bill does not propose a tariff, but prohibition, except under licence.

The British Optical Instrument Manufacturers' Association has urged the Government to act by prohibition except under licence rather than by tariff, and this is what the Bill proposes. It has always considered that the effect of a tariff might, as Prof. Bayliss suggests, give "no inducement to the makers to improve the quality"; and it has urged that licences should always be freely granted where articles were not being made in the required quantity or up to the standard of quality of goods that could be imported from abroad.

Prof. Bayliss's desire for "free import of such apparatus *until* equally good material is to be had cheaply at home" is provided for by the Bill with the exception of the one word "cheaply," and I suggest that he has, perhaps unintentionally, given the impression that a tariff on goods which either are not or cannot be made in this country has been proposed.

The whole question appears to be: Are scientific men prepared to pay more for British-made scientific instruments of approved quality to meet higher wages or the depreciation of foreign currency rather than have the whole industry extinguished in this country?

With the mark at something like one-tenth its pre-war value, it is obvious that no instrument can be produced in this country to compete as regards price with those made in Germany. The Government, through the British Scientific Instrument Research Association, is giving State aid as regards perfecting processes. Sir Herbert Jackson (who is director of the association) is already producing most valuable results; but if financial considerations make it impossible to sell the articles so produced, it does not meet the case.

Quite apart from the danger to the State which will ensue in case of another war if the scientific industry does not exist, surely it must be evident that science cannot develop properly in any country that cannot produce at least the majority of its own scientific instruments.

A much closer combination between scientific and practical men than existed before the war is required. It has already commenced, and I desire to take this opportunity of explaining that the association of which I am president has a technical committee the members of which place their services at the disposal of the scientific world to discuss all questions the solution of which depends on the production or development of scientific instruments.

CONRAD BECK,

President of the British Optical Instrument  
Manufacturers' Association.

2-3 Duke Street, St. James's, West-  
minster, S.W.1, May 10.

PROF. BAYLISS's letter in *NATURE* of May 6 raises a subject which is of the greatest interest to manufacturers, as well as to users of all classes of scientific apparatus. We do not think that anyone will dispute the contention that scientific workers should have the very best apparatus which is available, and wherever British apparatus is not up to the standard of foreign competitors there is no doubt that the importation of the foreign articles should be allowed. It is, however, quite a different matter when orders are placed by scientific workers, hospitals, etc., with foreign firms on account of the latter being able to quote lower prices than the English manufacturers can do at the present time.

It has recently come to our knowledge that an important hospital supported chiefly by voluntary contributions has placed a large order for X-ray equipment abroad on account of the lower price quoted, not because the staff was of the opinion that better apparatus could be obtained from this source, as, in fact, we were definitely assured that, except for price, our models were preferred. We would ask the committee which was responsible for placing that order whether it had carefully considered the effect of its act, especially should it be repeated to any considerable extent. It is generally acknowledged that, prior to the war, the British manufacturers were not giving to the medical world the very best service, and both medical men and manufacturers

have often asked the reason why. It is too large a question to go into the fundamental reasons, and opinion would no doubt differ as to these; but there is no doubt that in the year 1914 there did not exist a sufficient demand for British X-ray apparatus to allow manufacturers to work on a large enough scale to ensure satisfactory service and economical production. During the war the cutting off of foreign supplies and the increased demand for apparatus enabled the firms concerned to venture on a bolder policy, until by the end of the war there were established in the country adequate manufacturing facilities. After the armistice the Government orders dropped to zero, but the demands for up-to-date equipment from private hospitals, and from foreign quarters which had been starved during the war, were sufficient to fill the gap and to enable various firms to carry on their manufacturing programme without undue alarm for the immediate future.

The past year has been one of great difficulty in the manufacturing world, and, with the publication and issuing of catalogues and price lists scarcely yet complete, a great deal of the heart will be taken out of British manufacturers if they find that, owing to a circumstance over which they have no control, they are going to lose a large part of their home trade. The circumstance to which we refer is that of the rate of foreign exchange, against which tariffs, unless extremely heavy, are of no value whatsoever. It is very difficult to obtain trustworthy information as to the prices at which German and Austrian goods can really be delivered in this country, but in one specific instance we ourselves are being offered one of our staple articles of manufacture at a price which is very considerably below the actual cost of the raw material which we use in the manufacture. Prior to the war the articles were not made in this country at all, and it was only by the employment of considerable research and a heavy initial expenditure that their production was assured and perfected. We do not think that some scientific workers, medical men, and others quite realise that under present conditions high prices are essential in connection with scientific apparatus as with all other commodities, and that if they wish to obtain really good service from British manufacturing firms it is necessary that the amount of apparatus purchased from them should be considerable. Then when our Colonial and foreign friends come to this country for instruction and advice, and find that instruments of British manufacture are employed by the doyens of the scientific world, our foreign trade will develop, and increased production will then lead to lower prices with better quality.

B. H. MORPHY, Man. Director,  
The Cox-Cavendish Electrical Co., Ltd.  
Twyford Abbey Works,  
Acton Lane, Harlesden, N.W.10.  
May 12.

REFERRING to Prof. Bayliss's letter on scientific apparatus from abroad, we cannot quite agree with his view that the instruments made in this country are more costly than those purchased from the Continent. We think that when conditions in this country are more settled Prof. Bayliss will find that foreign prices are equal to, if not in excess of, those ruling on this side, owing to the considerable increase in wages and raw materials. At the moment the rate of exchange makes the prices seem low as compared with those in this country, but can Prof. Bayliss obtain delivery at the low prices?

If manufacturers in this country do not receive the