

DUBLIN STATISTICAL SOCIETY.

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ON A

# DECIMAL CURRENCY.

A PAPER READ BEFORE

THE DUBLIN STATISTICAL SOCIETY,

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BY THE

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*On a Decimal Currency.* By Rev. Joseph A. Galbraith, A. M.,  
Fellow of Trinity College, Dublin.

IN many essays which have lately appeared on the subject of a decimal currency, the distinction has not been sufficiently observed which exists between a decimal *coinage* and a decimal *currency*; between a system of coins proceeding by decimal gradations, and a decimal system of denominations in moneys of account. It cannot be denied that a coinage founded on such a principle would be most convenient, if decimal denominations were once adopted; but it should be clearly understood that any coinage may be used consistently with a decimal system of accounts, provided that no piece shall contain a fractional part of the lowest denomination. In the United States of America, for example, where a decimal system prevails, the coins in common use are gold pieces of ten dollars, five dollars, and two and a half dollars, and silver pieces of one dollar, a half dollar, and a quarter dollar. In France and Belgium, where accounts are kept according to a decimal system, the gold coinage consists of pieces of ten francs, twenty francs, and twenty-five francs; the silver of pieces of five francs, two francs, francs, half-francs, and quarter-francs, which latter consist of 50 and 25 centimes respectively.

It is necessary to point out instances such as these; as one of the objections commonly urged against the introduction of a decimal system into England assumes that we should wholly abandon the present coinage, with which the people are so familiar by long usage, and which could not be withdrawn from circulation without serious inconvenience to the public. There is another objection often made, and which, at first sight, is of great force; namely, that the introduction of a new system would involve the application of arithmetical rules so different from those in common use, that great confusion and disturbance would ensue in the keeping of mercantile accounts. To meet such objections, and particularly the last, is the object of the author in the following essay. Any attempt to do so which may meet with even partial success will be of great service; for as long as the public mind is influenced by such supposed difficulties, no government would venture to propose any change in our present very defective system of accounts.

With the view of expressing various sums of money, all civilized countries have adopted two or more denominations of money, connected with each other by some multiple relation. In England, for example, the denominations are £ s. d.; one pound being equal to twenty shillings, and one shilling equal to twelve pence. In the city of Hamburg accounts are kept in marks, schillings, and pfennigs; the mark containing sixteen schillings, the

schilling twelve pfennigs In the United States there are but two denominations, viz. dollars and cents; the dollar containing 100 cents.

The following characteristics may be laid down as essential to a good system of monetary denominations:

1. The number of denominations should not be excessive.
2. The highest denomination, or unit of value, should be sufficiently large
3. The lowest denomination should be represented by a coin, and be sufficiently small.
4. The different denominations should be connected by a uniform and simple relation

On the first of these characteristics it is unnecessary to dwell, as an experience almost universal shows that the number of denominations should not exceed three. China is the only country which has adopted four, viz. taels, mace, candareen, and cash; any inconvenience resulting from which is almost wholly compensated for by the perfect decimal relation which exists between them.

The second characteristic, namely, that the unit of value should be sufficiently large, is a point of some importance, and with regard to which considerable differences exist in practice. Thus, the unit of value adopted in this country, viz. one pound, is twenty-five times the French franc, twelve times the Dutch florin, and about five times the United States dollar. In this respect our system needs no change, as the pound seems better suited to large commercial transactions and financial statements than any unit at present used in other countries. The French system, which in all other respects is so admirable, has this one great fault, that its unit is far too small, its value being about nine pence halfpenny of our money. One necessary consequence of this is, that the lowest denomination is so small, that a coin representing it is inconvenient for circulation. Experience fully proves this, as in France the centime seldom or never appears in change, and gradations in price are generally made to differ by five centimes, which is equal to the old sous. The present Emperor has lately ordered a considerable coinage of centimes. It will unquestionably be found difficult to force a coin into circulation which does not weigh so much as twenty-eight grains

To our ears it appears absurd to state large incomes and vast revenues in terms of a unit which in value is not far above that of a quartern loaf. This is found to be so much the case even in France, that it is customary to state annual incomes as being so many Napoleons, the Napoleon being a gold coin of twenty francs. Thus, in consequence of having selected too small a unit, the French are obliged in many kinds of dealing to reject the use of their legal denominations, and to adopt others, one of which in value is nearly equal to the ancient Louis d'or; the other exactly equal to the sous, which was the smallest copper piece before the reformation of their system. A similar objection may be made to the Dutch and German florin or gulden, which in value is about twenty pence, and to the United States dollar, although not in so high a degree, which is about four shillings and two pence.

The third characteristic involves two points, both of which are important, viz. that the lowest denomination should be sufficiently small, and that it be represented by a coin. In our present system the lowest denomination is, properly speaking, a penny; but as this is found in practice to be too large, we are forced in England to encumber our arithmetic and disfigure our account-books with the halfpenny and the farthing; to introduce, in fact, in its very worst and most embarrassing form, a fourth denomination. The want of a sufficient amount of small coin, or any other circumstance which leads to a limited use of them, must be looked upon as oppressive to the poorer classes of the community. It may be said that we have farthings already. To this it may be answered that as the farthing is not a recognised denomination, and as the introduction of vulgar fractions into account-books is most inconvenient, it is practically banished from the market and the shop. It rarely reaches the hand of a respectable person, and is confined to the dealings of the poor, chiefly in bread. In many other articles in which it is just as much required, the dealers do not use it in raising their prices; such, for instance, as meat, candles, soap, &c. This ought not to be the case, and would not if we had a coin of the value of a farthing representing a real and recognised denomination of money, and entering into all accounts from the least to the greatest. It may be questioned whether a farthing be low enough. To give an instance, it is necessary that flour should fall three shillings per bag before the quartern loaf can fall one halfpenny, that is, one farthing on the 2lb. loaf, the form in which the poor usually buy their bread. From this it appears that the poor must look on at a gradual fall of flour, until it reaches three shillings per bag, before they can derive any the least advantage. It may be said on the other hand, and with great justice, that the baker must be a loser until the flour rises three shillings, and that thus the gain balances the loss. It must, however, be admitted that this system of compensation proceeds on a bad principle, and if possible should be avoided. It is more than probable that in the calculation of these compensations, arising from alternate rises and falls, the factor and the baker gain at the expense of the poor buyer. It is evident that a system which admits of an exact ratio between the prices of the raw and manufactured article is by far the best, and that this can be accomplished in no other way than by making the lowest denomination sufficiently small, and having it represented by a coin. In France, as has been already pointed out, the lowest denomination is so small that the coin representing it is inconvenient for circulation, and consequently has fallen into disuse. In the United States the cent, or one hundredth part of a dollar, is about the value of our halfpenny, and may be said to be too large. In Holland the cent is about eight-tenths of our farthing, and may be therefore considered a most convenient denomination.

The fourth characteristic, namely, that the different denomination

should be connected by a uniform and simple relation, remains to be considered. In the formation of systems of money, weights, and measures, there has been always manifested a strong tendency to proceed by what may be called the *binary* method, which consists in deriving from the unit of value all lower denominations, by halving, and quartering; dividing in every case by two, or a multiple of two, in order to obtain the next denomination. A good example of this method may be pointed out in that division of the poundweight, which has prevailed from the earliest times throughout nearly the whole of Europe. According to it, the poundweight is divided into two marks, the mark into eight ounces, the ounce into two loths, the loth into four quintins, the quintin into four pfennigs, with further subdivisions on the same principle. The division of the pound avordupois, at present in use in this country, is exactly this, the mark and loth having fallen into disuse. This and a kindred system, sometimes called the *duodecimal*, in which the unit is divided into three equal parts, each of these into halves and quarters, &c., seems at first sight to be the best adapted to retail transactions in which the buyer and seller are unacquainted with the principles of arithmetic. Its advantages in this way are extremely limited, and are happily becoming less so every day. The disadvantages, on the other hand, are so numerous, that no doubt can be entertained of the propriety of making it give way to a *decimal system of division*. The only question of importance to be considered is, In what manner may a change so extensive be effected without inconvenience to the public? The fact of a decimal currency having been adopted by all the nations of the civilized world, within the last sixty years, should be a sufficient proof of its practical advantages. The following countries at present use a decimal system in their moneys of account, viz. France, Belgium, Holland, the United States, Russia, Portugal, Greece, Sardinia, Tuscany, Lombardy, Naples, Rome, Switzerland, and China. By adopting a decimal system, we can readily secure all the characters of a good system which have been already dwelt upon; the first, by stopping at two or three denominations; the second, by selecting a sufficiently large unit, such as a pound sterling; the third, by using three denominations, and thus arriving at, as we shall presently see, a sufficiently small lowest denomination. On its possessing the fourth character, namely, that it should proceed by a uniform and simple mode of subdivision, it is needless to dilate, as it will be readily admitted that its great claim for adoption is its possession of that character in an eminent degree. Its complete accordance in this respect with the decimal scale of arithmetic would enable us at once to dispense with many rules which at present encumber mercantile arithmetic, and remove the necessity of committing to memory those numerous puzzling and complicated tables which are found by sorrowful experience to be so great an obstacle to the progress of learners in arithmetic. The decimal system which has been proposed by the most practical men in the country, as

most likely to replace the present denomination of £ s. d., with the least possible inconvenience to the public, is the following. Let the pound sterling be divided into ten florins, and each of these into 100 cents. This would be a perfect decimal system; embracing, as will be shewn, the four characters which have been already set down as essential to a good monetary system. According to this plan, the unit of value, the pound sterling, would remain unchanged. This is a matter of great importance, as all great financial statements, contracts, rents, and prices, are for the most part made in terms of this unit, and there can be no question but that any alteration in its value would be productive of great confusion of ideas. As the florin, according to this system, is exactly two shillings in value, there would be no trouble in reducing our present second denomination, shillings, to the new system; every two shillings making one florin, and each odd shilling which may remain fifty cents. Our gold coinage and bank notes would remain without the slightest alteration; and as for the silver coins, no *sudden* change would be required, the crown, half crown, shilling, and sixpence being quite consistent with the proposed denominations. Half-crowns and crowns would doubtless soon give way, and be replaced by florins and double florins. Fourpenny and threepenny pieces, being somewhat inconsistent with the new system, should be called in; but this would cause very little inconvenience, as they have a very limited circulation, and are not in much favour with the public. Shillings and sixpences would still remain in their present extensive circulation, as most useful coins, representing fifty and twenty-five cents respectively. The shilling might retain its name, the sixpence would soon find a new one. The principal change would fall on the copper coinage. According to the present regulation of the mint, copper is coined at the rate of two shillings per pound avoirdupois; and as the pound avoirdupois contains 7000 grains, the farthing weighs 72.9 grains or nearly 73 grains. Under the new system, if the copper were coined at the same rate, one pound avoirdupois would be coined into 100 cents, from which it follows that the cent would weigh exactly seventy grains. This piece, then, representing the lowest denomination, as it differs so little from the farthing in weight or value, would naturally replace it in all ordinary dealings. From the fact of its representing a denomination, a great proportion of the new copper coinage should consist of these coins; but, for the convenience of counting change, a considerable number of five cent pieces should be also issued. These pieces would weigh 350 grains each, which is seventy grains lighter than many of the old ounce penny pieces, which remain at present in circulation. A number of two cent pieces might also be issued with advantage to the public, as they would coincide so nearly in value with the present half-penny.

The present juncture might be seized on with great advantage for making the change, as it is a well known fact that the copper coinage of this realm is at present not only deficient but debased

to a very large extent. Any small inconveniences, therefore, which might result from the proposed change, would be amply compensated for by the public obtaining an abundant supply of genuine coins, better fitted for retail dealings than the present. As any attempt to call in an old coinage could not be expected to meet with complete success, it is probable that some of the old coins would still remain in circulation. These might be allowed to pass at the rate of one cent for a farthing, two cents for a halfpenny, and four cents for a penny. This would entail a loss of four per cent on such holders of copper coins as neglected to bring them in for exchange; but, so far from being this an objection, it would operate as a most wholesome stimulus to holders of copper coins to bring them in. It may be here observed, that four-penny and three-penny pieces would be nearly all called in by the operation of a similar rule, ordering that all four-pennies and three-pennies outstanding after a certain date should pass for sixteen cents and twelve cents respectively. An inevitable loss, but of trifling amount, would fall on retailers who held a stock of ready-made articles which are sold for small sums, such as a halfpenny or a penny. Thus a halfpenny candle must after the change of system sell for two cents; a penny box of lucifer matches must sell for four cents; thus entailing on the dealer a loss of upwards of four per cent. This would soon right itself. In the next stock of candles each would contain a little less tallow; in the next stock of matches, each box would contain a few less.

Any change of system requiring a new set of account-books in a merchant's office would prove a formidable obstacle to its adoption. It is easy to see that any sum of money expressed in £ fl. c. may be entered in ordinary cash columns of three lines, which are ruled for £ s. d. Thus, for example, £3 8s. 6d. would be written in the new denominations, £3 4fl. 25c.; £1 19s. 11 $\frac{3}{4}$ d. would be written £1 9fl. 99c.; so that no objection on this score can be made to the proposed system.

A much more formidable objection remains to be stated, and if possible removed; namely, that a new system would involve a complete change in all our arithmetical operations, and that it would be unreasonable to expect that men of business, already habituated to the present system, would consent to learn arithmetic over again. If a change so complete as this were really required, any proposal of a new system could not be entertained for a moment. Among the many objections that are made to a decimal system, this appears to have most weight, and is most deserving of attention. The author has accordingly devoted the latter part of this communication to a full consideration of it, and has endeavoured to give it a practical refutation by shewing that the old denominations may be converted into the new, and *vice versa*, by the simplest possible rules; so simple, that they can be worked *mentally* with the greatest ease; that nearly all calculations on the new system are cases of ordinary addition, subtraction, multiplica-



tion, and division; that the troublesome reductions of the present system are at once wholly superseded; that all the questions of Practice and Interest which can arise are worked by exactly the *same rules*; with this important difference, that the result is arrived at with greater simplicity, greater exactness, and with much fewer figures; that, in short, any intelligent clerk or book-keeper, who gives the subject the slightest attention, can draw a line in his books on an appointed day, carry forward his balance in the decimal denominations, and proceed with the new system without the slightest trouble, so that not an hour's delay need occur in the business of any office.

Were it not for the very near coincidence of the proposed system with that at present in use, we could entertain very little hope of its adoption. Nothing can be more difficult than the introduction of extensive changes of this kind in a settled community like ours. In those countries which have adopted, or partially adopted, a decimal system, the change has for the most part followed either revolution or foreign occupation. Thus, in the United States of America it was adopted in 1789, as an immediate consequence of the separation from the mother country, and to supersede a most complicated system, or rather systems, of currency into which British £ s. d. had degenerated in the different States. In France an unexampled revolution, which overwhelmed all her ancient institutions, enabled the Constituent Assembly to impose on the country their truly magnificent system of money, weights, and measures. In the Netherlands, the adoption of the decimal system was the result of French occupation; and a system which was imposed by conquerors was retained in its integrity after their expulsion—a singular tribute indeed to its excellence and practical utility. In almost all the countries of Europe in which a decimal system prevails, it may be traced to French occupation or French influence. May no revolution, with its accompanying horrors, ever occur which will enable a government to impose this or any other measure, no matter how desirable, upon us! May no occupying conqueror ever be able to say that he has left us such a boon, such a vestige of his presence! Let it rather be the glory of our country to obtain this, as it has obtained all its other great reforms, by peaceful and constitutional means.

## RULES AND EXAMPLES.

### PROPOSED DENOMINATIONS

If the pound sterling be divided into 10 florins, and the florin into 100 cents., any sum of money may be expressed in the denominations £ fl. c., as consisting of so many pounds, florins, and cents. Thus, £129 8s. 6d. is evidently equivalent to £129 4fl. 25c. in the proposed denominations; for the pounds remain the same; 8s. are equal to 4 florins; and 6d. the quarter of two shillings or of one florin, are equal to 25 cents.

### RULE FOR CONVERTING £ s. d. INTO £ fl. c.

Any sum expressed in pounds, shillings, and pence may be converted into its equivalent in the new denominations by the following rule:—

#### RULE.

- 1° *Let the pounds remain as before.*
- 2° *Divide the shillings by 2; the quotient is the number of florins. If there be an odd shilling, count it as 50 cents.*
- 3° *Multiply the pence by 4, and to the product add one-sixth the number of pence; the result is the number of cents.*

The reason of this rule is easily explained. The pounds, of course, remain the same as before; as one florin is equal to two shillings, it follows that half the number of shillings, if that number be even, expresses the number of florins; and if it be not even, the shilling which remains being half a florin is equal to 50 cents. The last part of the rule follows from the fact that six pence are equal to 25 cents, in which case it appears that 4 times the number of pence, viz. 24, falls short of the equivalent number of cents, 25, by 1, which is the sixth part of the number of pence. The same reasoning follows from the fact that 12 pence are equal to 50 cents; and it is evident that in all other cases the reduction must follow the same law. In general, a fraction of a cent will occur in taking the sixth part; this fraction may be neglected if it be less than one-half, or counted as an additional cent if greater. The error in either approximation is less than half a cent, which in a commercial point of view may be considered as of no account. For example, if it be required to express 8d. in cents, we proceed thus: 4 times 8 = 32, to which, according to the rule, we must add the sixth part of 8, or  $1\frac{1}{3}$ ; the equivalent number of cents is therefore  $33\frac{1}{3}$ ; or 33 cents, if we neglect the fraction  $\frac{1}{3}$ .

The following list exhibits the number of cents which are equi-

valent to the number of pence from 1 to 12, both exactly and approximately:—

Pence	Cents	Cents
1 -----	$4\frac{1}{6}$ exactly	----- 4 approximately.
2 -----	$8\frac{2}{6}$ "	----- 8 "
3 -----	$12\frac{3}{6}$ "	----- 12 "
4 -----	$16\frac{4}{6}$ "	----- 17 "
5 -----	$20\frac{5}{6}$ "	----- 21 "
6 -----	25 "	-----
7 -----	$29\frac{1}{6}$ "	----- 29 "
8 -----	$33\frac{2}{6}$ "	----- 33 "
9 -----	$37\frac{3}{6}$ "	----- 38 "
10 -----	$41\frac{4}{6}$ "	----- 42 "
11 -----	$45\frac{5}{6}$ "	----- 46 "
12 -----	50 "	

In forming this last column, it is a matter of indifference whether 3 pence be considered equal to 12 or 13 cents, as the fractional part  $\frac{3}{6}$  of the exact value is equal to  $\frac{1}{2}$ . For the same reason it is indifferent whether we consider 9 pence equal to 37 or 38 cents. We have selected the even number in each case as most convenient; and as one is above and the other below the true value, any consequent errors may be expected to balance each other.

The same rule applies when the number of pence includes farthings; thus,  $8\frac{3}{4}$ d. is equal to 36 cents; for 4 times  $8\frac{3}{4}$ d. = 35, increased by 1, which to the nearest fraction is the sixth part of  $8\frac{3}{4}$ d., gives 36 cents.

In the following examples, the equivalent sums are given to the nearest cent:—

#### EXAMPLES.

	£	s	d.	=	£	fl	c
1. ....	312	4	5	=	312	2	21
2. ....	29	7	10	=	29	3	92
3. ....	113	14	$5\frac{1}{2}$	=	113	7	23
4. ....	14	11	$4\frac{3}{4}$	=	14	5	70
5. ....	17	1	$2\frac{1}{2}$	=	17	0	60
6. ....	23	6	$9\frac{1}{4}$	=	23	3	39

#### RULE FOR CONVERTING £ fl. c. INTO £ s. d.

The conversion of the new into the old denominations, although from the nature of the case it would not be so often required, is effected as readily as that just explained by means of the following rule:—

#### RULE

- 1° Let the pounds remain as before.
- 2° Multiply the number of florins by two; the product gives the number of shillings, which should be increased by one for 50 cents. taken from the number of cents, if that be possible.
- 3° Divide the number of cents which remain by 4, and from the quotient take one hundredth part of the number of cents.; the result gives the pence.

The reason of this rule follows from the fact that 100 cents = 24 pence, in which case it appears that the number of cents divided by 4, viz. 25, exceeds the equivalent number of pence by 1, which is the one-hundredth part of the number of cents. Let it be required, for example, to convert 80 cents into pence,  $\frac{80}{4} = 20$ , from this subtract  $\frac{80}{100}$ , and the result is  $19\frac{20}{100}$ , which is as near as possible to  $19\frac{1}{4}$ d. or 1s.  $7\frac{1}{4}$ d. It is evident that in this case we might in the first instance have counted 50 out of the 80c. as one shilling, and converted the remaining 30c., according to the rule, into  $7\frac{1}{4}$ d. If it be required to convert 22c. into pence.  $\frac{22}{4} = 5\frac{1}{2}$ , or  $5\frac{50}{100}$ ; from this subtract  $\frac{22}{100}$  and the result is  $5\frac{28}{100}$ , which is nearly equal to  $5\frac{1}{4}$ d. In the same way,  $35c. = 8\frac{1}{2}$ d., for  $\frac{35}{4} = 8\frac{3}{4} = 8\frac{75}{100}$ , from this subtract  $\frac{35}{100}$  and the result is  $8\frac{40}{100}$ , which is nearly equal to  $8\frac{1}{2}$ d.

In the following examples, the equivalent sums are given to the nearest farthing:—

## EXAMPLES.

	£	s	d	=	£	s	d
1. ....	183	2	75	=	183	5	6
2. ....	72	5	60	=	72	11	$2\frac{1}{2}$
3. ....	26	9	18	=	26	18	$4\frac{1}{4}$
4. ....	120	0	68	=	120	1	$4\frac{1}{4}$
5. ....	100	4	8	=	100	8	2
6. ....	35	8	46	=	35	16	11

## ADDITION

Columns of money expressed in the new denominations are added together just as numbers are in *simple addition*. This is quite evident from a single example:—

£	s	d
32	4	31
29	2	13
56	8	72
48	3	36
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166	8	52

The great advantage of the decimal over the common system is here most apparent. In addition of £ s. d., it is necessary to apply mentally a pence and shilling table after adding up each column, in order to see what figure we must put down, and what figure we must carry; whereas here we proceed precisely as in *simple addition*. Any process by which the number of intermediate steps is diminished not only saves labour, but contributes very much to exactness.

The following examples of addition are proposed for the sake of illustration; and, if it be necessary, of proving that the introduction of a decimal system will throw no difficulty in the way of totting up a column of cash:—

## EXAMPLES.

£	fl	c.	£	fl.	c.	£	fl	c.
21	3	25	3	2	5	1	5	96
16	7	18	11	6	16	32	1	2
15	3	27	12	3	2	120	6	40
129	8	15	22	7	5	11	2	19
63	9	82	43	4	60	3	0	48
15	1	35	21	8	53	27	1	29
161	5	40	0	7	7	22	0	46
92	6	37	61	3	25	5	5	5
57	1	13	4	0	6	69	2	35
21	2	19	3	5	0	32	0	9
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594	8	11	184	6	79	324	5	29

## SUBTRACTION.

One sum of money is subtracted from another in the new denominations, precisely in the same way as in *simple subtraction*. For example, let it be required to subtract £29 3fl. 41c. from £126 1fl. 26c. :—

£	fl.	c.
126	1	26
29	3	41
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96	7	85

Let it be required to subtract £124 9fl. 28c. from £329 5fl. 7c. :—

£	fl.	c.
329	5	7
134	6	28
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194	8	79

In this example, it may be observed that a cipher is understood to be prefixed to 7 in the first line, for in subtracting we say 8 from 17 and 9; 2 and 1 = 3, 3 from 10 and 7 remain; and so on as in simple subtraction. It is evident that when the numbers of cents is expressed by one figure a cipher should be understood to be prefixed. In the present case, for instance, £329 5fl. 7c. when reduced to cents is evidently 329507 cents, and not 32957 cents, which would appear to be case if 0 was not understood before 7.

## EXAMPLES.

£	fl	c.	£	fl.	c.	£	fl.	c.
56	8	51	135	2	6	1175	7	4
29	9	63	59	1	32	389	3	9
<hr/>			<hr/>			<hr/>		
26	8	88	76	0	64	786	3	95
<hr/>			<hr/>			<hr/>		
£	fl	c.	£	fl	c.	£	fl	c.
14	5	11	327	0	2	2	6	53
3	6	2	15	1	3	1	3	29
<hr/>			<hr/>			<hr/>		
10	9	9	311	8	99	1	3	24

## REDUCTION.

To reduce pounds, florins, and cents, use the following rule:—

## RULE.

- 1° *If the number of cents is expressed by one figure, prefix a cipher.*
- 2° *Remove the points of division.*

The result is the required number of cents.

Thus, £57 6*fl.* 45*c.* is equivalent to 57645*c.* The reason of this is obvious; as the pound consists of 1000 cents, and the florin of 100 cents, the equivalent number of cents is equal to

57 thousand + 6 hundred + 45.

£193 7*fl.* 8*c.* is equivalent to 193708*c.* In this example it is necessary, according to the rule, to insert 0 before the 8. The reason of this follows from observing that 7*fl.* 8*c.*, is equal to 708*c.* If the sum contains neither florins nor cents, it is only necessary to add three ciphers, thus £973 is = 973000 cents.

In order to reduce cents to £ *fl.* *c.* use the following rule:—

## RULE.

- 1° *Cut off the last two figures for cents.*
- 2° *The figure which precedes these, expresses the number of florins.*
- 3° *Those which remain, express the number of pounds.*

Thus, 385672*c.* are equal to £385 6*fl.* 72*c.* 1756413*c.* are equal to £1756 4*fl.* 13*c.*

In many arithmetical operations it is necessary to reduce £ *s.* *d.* to farthings, which is done by multiplying successively by 20, by 12, and by 4; and before the result is arrived at, to perform the inverse process by dividing successively by 4, by 12, and by 20. The decimal system enables us to dispense with these processes, which are not only very troublesome, but greatly increase the chances of error.

## MULTIPLICATION.

All sums in multiplication of money are performed as in *simple multiplication*, as may be seen by the following rule and examples:—

## RULE.

- 1° *Reduce the sum to cents.*
- 2° *Multiply as in simple multiplication.*
- 3° *Reduce the product back to £ *fl.* *c.**

Multiply £312 4s. 26c. by 137. We proceed as follows —

$$\begin{array}{r}
 312426 \\
 137 \\
 \hline
 2186982 \\
 937278 \\
 312426 \\
 \hline
 42802362
 \end{array}$$

Answer, £42802 3s. 62c.

Multiply £19 3s. 5c. by 365.—

$$\begin{array}{r}
 19305 \\
 365 \\
 \hline
 96525 \\
 115830 \\
 57915 \\
 \hline
 7046325
 \end{array}$$

Answer, £7046 3s. 25c.

The following examples are annexed for the sake of illustration:—

	£	s	d		Ans.	£	s	d
1. Multiply	31	2	16	by 32	998	9	12	
2. „	14	3	8	„ 119	171	1	22	
3. „	6	6	21	„ 17	112	5	57	
4. „	31	2	17	„ 9	280	9	53	
5. „	120	1	80	„ 5	600	9	0	
6. „	42	7	75	„ 11	470	5	25	

## DIVISION.

In division we may use a similar rule.

### RULE.

- 1° Reduce the sum to cents.
- 2° Divide as in simple division.
- 3° Reduce the quotient back to £ s. d.

For example, divide £2073 3s. 81. by 597.

$$\begin{array}{r}
 597) 2073381 (3473 \\
 \underline{1791} \\
 2823 \\
 \underline{2388} \\
 4358 \\
 \underline{4179} \\
 1791 \\
 \underline{1791} \\
 0
 \end{array}$$

Answer, £3 4s. 73c.

Divide £73 9s. 6c. by 14.

$$\begin{array}{r} 7) 73906 \\ \hline 2) 10558 \\ \hline 5279 \end{array}$$

Answer, £5 2s. 7c.

In the following examples the answers are given to the nearest cent:—

EXAMPLES.

	£	s.	d.	by	Ans.	£	s.	d.
1. Divide	113	7	36	96		1	1	85
2. „	100	9	14	121		0	8	34
3. „	108	9	6	71		1	5	34
4. „	599	0	17	201		2	9	80
5. „	342	0	0	313		1	0	93
6. „	400	0	0	365		1	0	96

It will be readily acknowledged that these processes are much simpler, and therefore less liable to error than corresponding operations in £ s. d.

PRACTICE.

This is generally considered to be one of the most useful rules in commercial arithmetic, and it is a curious although not an obvious fact, that it derives its great value from our complicated and unscientific system of money, weights, and measures. Had we a perfect decimal system, this rule would be entirely superseded, as all questions included under it would then be worked by simple multiplication. As we can at present only contemplate a decimal system of money, it will be necessary to show how it may be used with our present weights and measures, in the different questions which ordinarily occur in Practice.

In the examples which follow, simple multiplication is all that is used.

EXAMPLE 1.

Required the price of 479 Cwt. at £4 4s. 7c.

$$\begin{array}{r} 479 \\ 4475 \text{ cents.} \\ \hline 2395 \\ 3353 \\ 1916 \\ 1916 \\ \hline 2143525 \text{ cents.} \end{array}$$

Ans. £2143 5s. 25c.



## EXAMPLE 2.

Required the price of 1649 Cwt. at £7 1s. 5c.

1649
7105 cents.
8245
1649
11543
11716145 cents.

Ans. £11716 1s. 45c.

			£	s.	c.		£	s.	c.
3. ....	113 Tons at		1	1	36		Ans. 128	3	68
4. ....	563 „		0	8	75		492	6	25
5. ....	1107 Cwt. at		3	1	7		3439	4	49
6. ....	520 Yds. at		0	7	80		405	6	0

In the questions which occur in Practice, the weight or measure generally contains several denominations, as for instance, cwt. qrs. lbs. There are two ways of proceeding, either to multiply the price by the cwts, and take aliquot parts for the qrs. and lbs.; or to find the price at one pound, multiply by the pounds, and take aliquot parts for the shillings, pence, &c. This latter, although it is an indirect method, is preferred in practice, on account of the difficulty of multiplying a sum of money expressed in £ s. d. by a large factor. As no such difficulty exists in the decimal system, we may in all cases adopt the direct method of multiplying the price by the highest denomination of the commodity, and taking aliquot parts for the inferior denominations. This method is adopted in the following examples:—

## EXAMPLE 1.

15 cwt 3 qrs. 12 lbs. at £3 2s. 32c.

3232 cents.
15
16160
3232
48480
2 qrs. $\frac{1}{2}$ 1616
1 qr $\frac{1}{4}$ 808
7 lbs. $\frac{1}{4}$ 202
4 lbs. $\frac{1}{2}$ 115
1 lb. $\frac{1}{4}$ 29
51250 cents.

Ans. £51 2s. 50c.

## EXAMPLE 2

39 cwt. qrs. 19 lb at £1 3s 34c.

1334 cents.

39

---

12006

4002

---

52026

2 qrs. $\frac{1}{2}$	667
14 lbs. $\frac{1}{4}$	167
2 lbs. $\frac{1}{4}$	24
2 lbs. $\frac{1}{4}$	24
1 lb. $\frac{1}{2}$	12

---

52920 cents.

Ans. £52 9s. 20c.

	Cwt	qrs	lbs	at	£	s	c.		£	s	c.
3. ....	75	3	21	at	4	7	25		358	8	4
4. ....	117	1	7		0	8	67		101	7	10
5. ....	84	3	14		12	5	83		1067	9	82
6. ....	15	2	3		5	2	35		81	2	82

N.B.—In the above examples, if the computation be carried to decimal parts of cents, answers more correct may be obtained, but not differing in any case more than a cent or two.

	£	s	c.		£	s	c.
7. ....	219	16	3	at	11	3	75
8. ....	128	15	2	,,	21	1	25
9. ....	25	1r.	11p.	,,	1	5	75
10. ....	180	3r.	28p.	,,	2	4	25

Another method, quite different from this, may be proposed for calculating practical questions, viz. find the price of the commodity at £1; then multiply by the price in £ s. c. Let us take, for instance, EXAMPLE 8, 128 tons 15 cwt. 2 qrs., at £21 1s. 25c. At £1 per ton, 128 tons cost £128. As 1 cwt. costs 50c., 15 cwt. cost 750c.; and as 1 qr. at the same rate costs  $12\frac{1}{2}$ c., 2 qrs. cost 25c.; it follows, therefore, that 128 tons, 15 cwt. 2 qrs. cost £128 7s. 75c.; let this be multiplied directly by 21125 and the result gives the required answer in £ s. c. The work stand thus:—

Tons.	cwt.	qrs	
128	15	2	at £21 1s. 25c.
	50	$12\frac{1}{2}$	
	750	25	
	128 775	21 125	
	643 875	2575 50	
	12877 5	12877 5	
	128775	257550	
	2720371	875	

By the rules for decimal fractions, six decimal places must be cut off from this product, the first three of which are florins and cents; the remaining may be rejected, as expressing only a fraction of a cent. The answer is, therefore, £2720 3*fl.* 71·8*c.*, or £2720 3*fl.* 72*c.* nearly.

It may be observed that in the above sum the figures to the right of the vertical line are superfluous, as we do not require more than three decimal places in the result. The work may therefore be performed in the following contracted form, in which the least possible number of figures is required.

Tons	cwts	qrs.	at	£21 1 <i>fl.</i> 25 <i>c.</i>
128	15	2		
	50	12½		
	750	25		
	25			
128	775			
	21	125		
	643			
	2575			
	12877			
	128775			
	257550			
	2720370			

Ans. £2720 3*fl.* 70*c.*

In EXAMPLE 7, 219 tons 16 cwt. 3 qrs. at £11 3*fl.* 75*c.*

Tons	cwts	qrs.	at	£11 3 <i>fl.</i> 75 <i>c.</i>
219	16	3		
	50	12½		
	800	37		
	37			
219	837			
	11	375		
	1099			
	15388			
	65951			
	219837			
	219837			
	2500645			

The answer here appears to be £2500 6*fl.* 45*c.*; but as we have in the work estimated 12½ times 3 as 37, we thereby commit an error of ½ a cent, and as this is multiplied by 11,375 the final error is nearly 6 cents. If this be added to the result, we obtain

Answer £2500 6*fl.* 51*c.*

In calculating the price of cwt. qrs. lbs. according to this method, we multiply the qrs. by 250; for if 1 cwt. cost £1, 1 qr. costs 250 cents; and the lbs. by 9. This latter, although not exact, is very

near the truth, as 1 qr. or 28 lbs at 9c. per lb costs 252 cents. An error in excess is committed of 2 c. for every 28 lbs., and less in proportion. It can easily be estimated and allowed for in the final result. Let us take EXAMPLE 5:—

Cwts	qrs	lbs	at	£12 5fl. 83c.
84	3	14		
		250		9
		750	126	
		126		
		84	876	
		12	583	
		254		
		6789		
		42438		
		169752		
		84876		
		1067993		

The answer here appears to be £1067 9fl. 93c.; but as 14 is the half of 28, the error committed is 1 cent in excess, which as it is multiplied by 12.583, gives 12 cents as the final error to be subtracted; therefore

Answer, £1067 9fl. 81c.

Find the price of 15 cwt. 2 qrs. 18 lbs. at £3 2fl 6c.

Cwts	qrs	lbs	at	£3 2fl. 6c.
15	2	18		
		250		9
		500	162	
		162		
		15	662	
		3	206	
		94		
		3132		
		46986		
		50212		

from this we subtract 4c.

Answer, £50 2fl. 8c.

The following rules are laid down for obtaining the price at £1:—

If the commodity be expressed in tons, cwts. qrs.

*Multiply the cwt. by 50, the qrs. by 12½.*

If the commodity be expressed in cwt. qrs. lbs.

*Multiply the qrs. by 250, the lbs. by 9.*

If the commodity be expressed in oz. dwts. grs.

*Multiply the dwts. by 50, the grs. by 2½.*

If the commodity be expressed in acres, roods, and perches.

*Multiply the roods by 250, the perches by 6¼.*

Any error committed in multiplying the lowest denomination may be easily estimated and allowed for in the final result, as in the examples already given:—

## EXAMPLES.

			£	fl	c.		£	fl	c.		
1	127 tons	12 cwt.	3 lbs.	at	8	5	28	Ans.	1088	4	92
2.	48 cwt.	2 qrs.	11 lbs.	,,	5	2	9		253	1	48
3.	28 oz.	13 dwts.	21 grs.	,,	3	8	94		111	7	34
4.	98 acres	1 rood	36 perch	,,	2	1	25		209	2	58

## INTEREST.

All questions in Interest may be calculated by the same rules that are at present used. Of this the following examples are illustrations. To find the interest for a year:—

## RULE.

1° *Multiply the principal by the rate.*

2° *Divide the product by 100.*

The quotient is the required interest.

Example 1.—Find the interest on £130 5fl. 60c for one year at 6 per cent:—

$$\begin{array}{r} 130560 \\ 6 \end{array}$$

783360 cents.

Ans. £7 8fl. 34c.

In this example the principal reduced to cents is multiplied by the rate; from the product the last two figures are cut off; this is equivalent to dividing by 100; the result is 7833 cents, or £7 8fl. 33c. In the answer stated above, it is £7 8fl. 34c.; the reason of which is, that the fraction of a cent 60, which is cut off, is greater than one-half.

Example 2 —Find the interest on £378 6fl. 5c. for 3 years at  $3\frac{1}{2}$  per cent.

$$\begin{array}{r} 378605 \\ 3\frac{1}{2} \end{array}$$

$$\begin{array}{r} 1135815 \\ 189302 \end{array}$$

$$\begin{array}{r} 1325117 \\ 3 \end{array}$$

$$3975351$$

Ans. £39 7fl. 53c.

Find the interest on the following sums —

	£	fl	c.	at				Ans.	£	fl	c.		
3.	59	6	8	at	3	per	cent.	for	1	year.	1	7	88
4	168	3	25	at	5	,,		for	5	years	42	0	81
5.	1028	0	9	at	$7\frac{1}{2}$	,,		for	2	years	154	2	1
6.	756	1	98	at	6	,,		for	1	year	45	3	72

## DISCOUNT.

In calculating the discount on Bills of Exchange it is generally necessary to find the interest on the amount for which the bill is drawn for a certain number of days. In this the following rule may be used:—

## RULE.

- 1° *Multiply the amount by double the rate, cut off the last three figures, and multiply the result by the number of days.*
- 2° *Divide this product by 3, the result by 10, and this last result again by 10, in each case neglecting remainders.*
- 3° *Add up the last four lines, and from the sum cut off five figures.*

The result gives the number of pounds, and the first three figures of those cut off express the florins and cents.

## EXAMPLE 1.

Find the interest on £291 3s. 50c. at 3 per cent. for 98 days.

$$\begin{array}{r}
 291350 \\
 \quad 6 \\
 \hline
 1748 \text{ (100} \\
 \quad 98 \\
 \hline
 13984 \\
 15732 \\
 \hline
 171304 \\
 57101 \\
 5710 \\
 571 \\
 \hline
 234686
 \end{array}$$

Ans. £2 3s. 47c.

## EXAMPLE 2.

Find the interest on £357 5s 45c. at  $3\frac{1}{2}$  per cent for 72 days

$$\begin{array}{r}
 357545 \text{ cents} \\
 \quad 7 \\
 \hline
 2502 \text{ (815} \\
 2503 \\
 72 \\
 \hline
 5006 \\
 17521 \\
 \hline
 180216 \\
 60072 \\
 6007 \\
 600 \\
 \hline
 246895
 \end{array}$$

Ans. £2 4s 69c.

In this example, the product of the amount in cents multiplied by double the rate is 2502815c which is equal to £2502 8s. 15c. This we count as £2503, because 8s 15c. is more than half a pound. The error arising from this approximation is inappreciable in the final result.

It may be observed that this expeditious rule is in principle the very same with that which is at present used in £ s. d. As it is so well known, it is not necessary here to enter into explanations of it.

3.	....	£	fl	c.	for	231	days	at	5	per	cent.	Ans.	£	fl	c
		473	6	28									14	9	88
4.	....	879	8	75	„	45	days	at	4	„			4	3	40
5.	....	131	2	6	„	113	days	at	2	„			0	8	13
6.	....	96	1	16	„	93	days	at	2½	„			0	0	55

In concluding this paper, the author feels that some apology is required for presenting the reader with the foregoing arithmetical operations in such detail; his only excuse for doing so is the fact, that the most formidable obstacle to the reception of a decimal currency is the common opinion that its introduction would require a new system of arithmetic. By going through each rule in detail, the author hopes he has proved to demonstration that every question which presents itself in mercantile arithmetic, may be solved by the very same rules that are at present used in every bank and counting-house; with this sole difference, that the details of calculations are shorter and simpler, and that greater accuracy is secured than can be obtained in operations under the present system of denominations.