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# metric measures

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## CONTENTS



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# metric measures

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# New Astronomical Definition of Unit of Time


**A. DANJON***
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France


AS far back as we go into the past, we find that man has related the standard of time with celestial phenomena. The day, the month, the year used by the various almanacs are astronomical standards of time. The progress of astronomy, mechanics and physics required an increasingly rapid development of the precision of the measure of time, and it was necessary to define the fundamental unit of time in as precise terms as possible because, with the fundamental units of length and mass, it constitutes the basis of all metrology.

### Old Definition

Up to the last few years, the second of time was the fraction 1/86,400 of the length of the mean solar day. Astronomers believed that the earth rotated around itself with a constant angular velocity and that there was no mechanical or physical force capable of altering the period of this rotation. The theory of the motions of the earth around the sun and around itself taking into account the precession led to the conclusion that the period of the mean solar day varied by only a millionth of a second per century. It seemed, therefore, that the natural standard of time was much better defined than the international standards of length and mass.

Researches which lasted for over 50 years and culminated only in 1926, demonstrated that this optimistic conclusion was illusory and that, in reality, the rotation of the earth deviated more than was considered possible of a uniform movement. Only a brief sketch of these laborious researches can be given here, but the principle is very simple.

Celestial mechanics permits us to forecast with great accuracy the motion of the moon around the earth and that of the planets, including the earth, around the sun. It is, therefore, possible to compare the positions of these astral bodies obtained by observation with those given by theory. It was noted that at certain epochs, the movements of the celestial bodies appeared all at the same time to be faster or slower than determined by theory. After vain attempts to surmount these anomalies by

*Monsieur A. Danjon, besides being the Director of the Paris Observatory, France, is also the President of the International Committee of Weights and Measures and the President of the Consultative Committee for the Definition of the Second. This article which has been translated from the original French has been specially written by him for the readers of *Metric Measures*.

applying corrections to the calculations of celestial motions, it was finally proved that, in fact, the advances or retardations made simultaneously by all the stars were fictitious and were really due to the variations in the standard of time, that is to say, the period of the rotation of the earth. It is evident that the courses of all the stars would appear to be fluctuating, in a day of variable length. If the rotation of the earth slowed down, the day would grow longer and consequently all the celestial motions would appear to be accelerated; or *vice versa*.

It is from a study of the orbital motions of the moon, the Mercury and the earth that we can study the variations in the rotation of the earth and analyse their complexity. The length of the day increases by 0·00164 second per century, as a result of the dissipation of the energy of rotation of our globe through the tidal phenomenon. To this secular variation are added an irregular variation, the mechanism of which has not yet been elucidated, and a seasonal variation due probably to meteorological causes. In fact, in some years, the day undergoes relative variations of the order of $10^{-7}$.

The requirements of the physicists, however, are much finer. Certain resonance phenomena connected with atomic (caesium beam) or molecular (inversion of the molecule of ammonia) transitions can be amplified and detected by electronic processes, these frequencies corresponding to millimetre or centimetre radio waves. To-day, therefore, we have at our command reliable physical frequency standards which can be reproduced at will. When a sufficiently prolonged use of these standards definitely proves their stability and comparison of the standards constructed in various laboratories demonstrates their reproducibility, the astronomers will be the first to adopt one of them as the fundamental standard. A physical definition of the second can then be substituted for its astronomical definition. This radical change in the metrology of time will certainly require a few years of preparation; perhaps, a decade, or more.

#### New Astronomical Definition

Meanwhile, the adoption of an astronomical standard more stable than the mean solar day was absolutely necessary. For this purpose, the enormous amount of work on orbital motions accomplished from 1875 to 1926 has been profitably utilized. It was shown that the annual translatory motion of the earth around the sun was not subject to the same unpredictable irregularities as its motion of rotation. The period of the tropical year is not influenced by meteorological or geophysical phenomena which affect the length of the day. As a result of the correspondence between the International Committee of Weights and Measures and the International Astronomical Union, the following definition of the second was promulgated in the month of October 1956 by the International Committee:

'The second is the fraction 1/31 556 925 .9747 of the tropical year for 1900 January 0 at 12 hours ephemeris time'.

This text requires some explanation.

The tropical year is the interval between two consecutive vernal equinoxes, the equinox itself being the instant when the sun crosses the celestial equator, its declination then being zero. The length of the tropical year diminishes slowly by half a second per century. According to the American astronomer S. Newcomb its duration in days is 365 days 5 hours 48 minutes 45.9747 seconds $-$ 0.53 seconds $\times t$, $t$ being the time counted in centuries starting from 31 December, 1899 (or better still 0 January 1900) at Greenwich mean noon.

The length of the tropical year for $t=0$ has been adopted as the constant standard. It is in certain respects a fictitious year as it is not spaced between two consecutive equinoxes, but this is only a seeming and inconsequential difficulty.

As for ephemeris time, it is the uniform scale of time used since 1952 by the astronomers for the computations of celestial mechanics, a scale of which the unit of time is precisely the second conforming to the new definition.

#### Further Research for Physical Definition

At the same time as it devised the definition, the International Committee of Weights and Measures set up a Consultative Committee for the Definition of the Second whose task was to follow up the development of the physical standards of time. This Committee met in 1957 and it has made recommendations calling upon the laboratories engaged in the construction of frequency standards :

(1) to pursue the study to the maximum extent possible and to furnish the most complete data on the results obtained,

(2) to organize comparisons in all possible combinations (in such a manner as to bring out their intrinsic qualities), the International Radio Scientific Union being requested to lend its support in these comparisons.

It must be understood, however, that the second derived from the tropical year alone is now in force and will remain so till a decision to the contrary is taken by the General Conference of Weights and Measures.

# French School Arithmetic

**GUY KNOCHE**
French Economic & Technical Bulletin,
France

THE real study of the decimal metric system begins in the 'cours moyen' (intermediate classes, children 9 to 11 years old), the preceding years having been devoted to a concrete study of numbers and the four operations. The problems set in this article were intended for pupils in the intermediate classes, and show the ease with which the decimal metric system is applied.

It is on leaving the intermediate classes that children begin their secondary studies.

#### Calculation of an Area

*Multiplication of decimal numbers*

A rectangular field is 252·5 m long and 6·04 dam wide. Calculate its area in ares.

This very simple problem brings out two important points of the decimal system: the use of the decimal point and the change of units.

The first thing the pupil must note is that length and width are not expressed in units of the same magnitude. The length is given in metres, the width in decametres. As the area to be calculated is the result of multiplying the length by the width, it is essential to use the same unit; this unit will be the metre and the pupil must begin by writing :

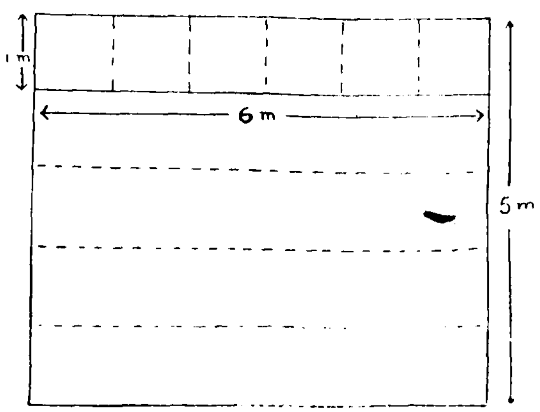
$$6{\cdot}04 \text{ dam} = 60{\cdot}4 \text{ m}$$

moving the decimal point by one figure towards the right, so as to obtain the unit of the immediately lower magnitude.

Once the terms have been made uniform, the multiplication can be done; it will be expressed as follows :

$$1 \text{ m}^2 \times 252{\cdot}5 \times 60{\cdot}4 = ?$$

[This manner of presenting the computation shows the pupil that the operation bears on abstract numbers : metres are not multiplied by metres, but a number by another number. Moreover, the following sketch explains the advantage of proceeding in this way (the sketch is made for simple integers):








By definition, the $m^2$ is the area of a square with 1 m sides. 6 squares of 1 $m^2$ can be arranged side by side, on the longer side of the rectangle. The area of the strip thus defined, is, therefore, 6 $m^2$ (1 $m^2 \times 6$). To cover the rectangle completely, 4 other similar strips will be required, *i.e.* 5 in all. The area is, therefore, 5 times 6 $m^2$, or 6 $m^2 \times 5 = 30$ $m^2$, which can be written ; 1 $m^2 \times 6 \times 5 = 30$ $m^2$.]

Reverting to the first problem, the area of the field under consideration is, therefore :

$$1 \text{ m}^2 \times 252{\cdot}5 \times 60{\cdot}4 = 15\ 251 \text{ m}^2$$

The calculation was made regardless of the decimal point, ($2525 \times 604 = 1\ 525\ 100$).

But, by proceeding in this way, the multiplicand was multiplied by 10, and the multiplier also by 10. The final product is, therefore, 100 times ($10 \times 10$) too large, and must be written as follows :

$$15\ 251{\cdot}00 \text{ or, more simply, } 15\ 251$$

The measurements of the field having been given in metres, the area is expressed in square metres. But the final result must be given in ares, *i.e.*, in a unit 100 times larger (one are $= 100\text{m}^2$). The number expressing it must, therefore, be 100 times smaller :

$$15\ 251 \text{ m}^2 = 152{\cdot}51 \text{ ares}$$

#### Calculation of a Volume (*Multiplication of an integer by a decimal number*)

A garden 15 metres long and 6 metres wide is covered by a layer of leaf-mould 5 cm thick. What is the volume of the necessary leaf-mould ?

After calculating the area of the garden ($1 \text{ m}^2 \times 15 \times 6 = 90 \text{ m}^2$), we have two terms : an area expressed in $m^2$, a dimension (thickness of leaf-mould, that is to say, the height of the rectangular parallelepiped formed by the leaf-mould) expressed in cm. Therefore, to calculate the volume, the thickness must first be expressed in metres :

$$5 \text{ cm} = 0{\cdot}05 \text{ m}$$

The volume will therefore, be :

$$1\text{m}^3 \times 15 \times 6 \times 0{\cdot}05 = 1\text{m}^3 \times 90 \times 0{\cdot}05 = 4{\cdot}5 \text{ m}^3$$

#### Division of Two Decimal Numbers

For transporting this leaf-mould a wheel-barrow of parallelepipedic shape is used, measuring 50 cm in length, 30 cm in width and 30 cm in height. How many trips will be required ?

Here again, calculation of a volume must be made to obtain the cubic content of the wheel-barrow :

$$1 \text{ cm}^3 \times 50 \times 30 \times 30 = 45\ 000 \text{ cm}^3 = 45 \text{ dm}^3$$

We then make the terms uniform by expressing them in the same unit, which could be the $m^3$.

$$45 \text{ dm}^3 = 0{\cdot}0\ 45 \text{ m}^3$$

which leads to the division :

$$4{\cdot}5 : 0{\cdot}045$$

In fact, the division of two decimal numbers must always be expressed as the division of a number (decimal or integer) by an integer :

$$4{\cdot}5 \text{ m}^3 = 4500 \text{ dm}^3$$
$$0{\cdot}045 \text{ m}^3 = 45 \text{ dm}^3$$
$$4\ 500 : 45 = 100$$

#### Rule of Three

This is an essential method in calculation, which can be applied by the decimal metric system with amazing facility thanks also to the simplification possibilities afforded by divisibility. Take the following problem :

A farmer sold 18 quintals of wheat for 90 000 f. For how much will he sell a total crop of 270 quintals?

The simplest method consists in first calculating the sale price of one quintal, and then the price of 270 quintals. According to the rule of three we have the following reasoning :

(1) 18 quintals are worth 90 000 f

(2) 1 quintal is worth 18 times less

(3) 270 quintals are worth 270 times more.

which is written thus :

$$\frac{90\ 000\times 270}{18} = \frac{90\ 000\times 30}{2} \text{ (after simplification by 9)}$$

$$= 90\ 000\times 15$$

$$= 1\ 350\ 000 \text{ f}$$

**Fractions**

A factory has available 126 tonnes of coal to supply three steam-powered machines. The first machine will consume the whole stock in 12 days, the second in 15 days, the third in 18 days. The three machines are operated simultaneously for 4 days. How much coal will be left?

To solve this problem, what must actually be done is to multiply 126 tonnes by the fraction remaining after 4 days' operation, which means calculating the fraction of the stock used during the 4 days :

In one day the *first* machine consumes—

$\frac{1}{12}$ of the stock

In one day the *second* machine consumes—

$\frac{1}{15}$ of the stock

In one day the *third* machine consumes—

$\frac{1}{18}$ of the stock

In one day the three machines together consume : $\frac{1}{12}+\frac{1}{15}+\frac{1}{18}$ of the stock of coal which after reducing the fractions to their common denominator (which is the least common multiple of the three denominators)

$$=\frac{15}{180}+\frac{12}{180}+\frac{10}{180}=\frac{37}{180}$$

In 4 days, four times more coal is consumed, *i.e.* :

$$\frac{37}{180}\times 4$$

Here, the rule for multiplication of a fraction by a number applies: *the numerator is multiplied*, or more simply, *the denominator is divided* by this number, which is possible in this case :

$$\frac{37}{180}\times 4=\frac{37}{180:4}=\frac{37}{45}$$

There will, therefore, remain after 4 days' operation:

$$\frac{45}{45}-\frac{37}{45}=\frac{8}{45} \text{ of the stock, or 126}$$

$$\text{tonnes}\times\frac{8}{45}=\frac{126\times 8}{45}=\frac{14\times 8}{5} \text{ (after simplification by 9).}$$

$$=22\cdot 4 \text{ tonnes}$$

**Measurement of Time—Speed**

A motorist left A at 8 a.m. and after covering 527 km arrived at B at 6·50 p.m. (18 50 hours). He stopped 2 hours for lunch and twice 10 minutes for petrol. At which speed did he drive ?

Total time spent on trip = 18·50 h − 8h.
= 10 h 50 min.

Total time spent on stops 2 h + 10 min. + 10 min.
= 2 h 20 min

Actual travelling time = 10 h 50 min − 2 h 20 min.
= 8 h 30 min

$$\text{Average speed} = \frac{527 \text{ km}}{8 \text{ h } 30 \text{ min}}$$

which, after converting the time into minutes is written as :

$$\frac{527\times 60}{510}=\frac{527\times 2}{17}=62\text{km/h}$$

It would also be observed that 30 minutes equal half of one hour, which permits of writing 8.5 h (a decimal number) instead of 8 h 30, and dividing 527 by 8.5.

**Recapitulation Problem**

The following problem only comprises a final question but it covers most of the concepts acquired at the end of the 'cours moyen'. They are the bases for the development of the teaching of mathematics, which is a subject requiring, of course, a thorough mastery of the basic elements of arithmetical calculation.





*Terms of the problem*

On a plan, a rectangular field, drawn to the scale of 1 : 2000, measures 2·5 cm by 15 cm. Its owner surrounds it by a fence 2 m high for which he paid 250 f per $m^2$.

He sows wheat over 1/3 of the field ; he plants beets on half the remaining area, and potatoes on the remainder. The average yields he obtains per annum are : wheat 25q/ha; potatoes : 160q/ha; beets : 300q/ha. He sells his crops for 3 600 f per quintal of wheat, 1 200 f per quintal of potatoes, 500 f per quintal of beets. Total farming costs are estimated at 30 percent of the gross income.

*Question*

How many years will it take the owner to amortize the fence enclosing his field, and what will his remaining profit be for that year ?

*Answer*

A. *Calculation of price of the fence*

(1) Measurements of the field (concept of scale) :
To the scale of 1 : 2000, 2·5 cm = 50 m
15 cm = 300 m

(2) Length of fence (perimeter of a rectangle)
(300 m × 2) + (50 m × 2) = 700 m
or (300 m + 50 m) × 2 = 700 m

(3) Area of fence (lateral area of a rectangular parallelepiped)
1 $m^2$ × 700 × 2 = 1 400 $m^2$

(4) Cost of fence (multiplication of two integers)
250 f × 1 400 = 350 000 f

B. *Income from field*

(1) Area of field (area of rectangle)
1$m^2$ × 300 × 50 = 15 000 $m^2$ = 1·5 ha

(2) Area planted in wheat (fraction of a quantity)
1·5 × 1/3 = 0·5 ha

(3) Area remaining (subtraction of fractions)
$\frac{3}{3}-\frac{1}{3}=\frac{2}{3}$, or $1\cdot 5\times\frac{2}{3}=1$ ha

(4) Area planted in potatoes (fraction of a quantity)
$1\times\frac{1}{2}=0\cdot 5$ ha

(5) Area, planted in beets (subtraction of a decimal number from an integer)
1 − 0·5 = 0·5 ha

(6) Wheat crop (multiplication by a decimal number)
25 × 0·5 = 12·5 q

(7) Potato crop (multiplication by a decimal number)
160 × 0·5 = 80 q

(8) Beet crop (multiplication by a decimal number)
300 × 0·5 = 150 q

(9) Sale price of wheat (multiplication by a decimal number)
3 600 f × 12·5 = 45 000 f

(10) Sale price of potatoes (multiplication of two integers)
1 200 f × 80 = 96 000

(11) Sale price of beets (multiplication of two integers)
500 f × 150 = 75 000 f

(12) Gross income from field (addition of integers
45 000 f + 96 000 f + 75 000 f = 216 000 f

(13) Farming costs (calculation of a percentage)
$\frac{216\ 000\times 30}{100}=64\ 800$ f

(14) Net income (subtraction of integers)
216 000 f − 64 800 f = 151 200 f

C. *Amortization time* (quotient rounded off to the next higher unit)
$\frac{350\ 000}{151\ 200}=3$, *i.e.* three years

D. *Profit earned in the 3rd year* (multiplication and subtraction)
(151 200 × 3) − 350 000 = 103 600 f

*N.B.*—Some of the above calculations could, of course, have been simplified, but it was thought advisable to set them forth in their entirety so that the example should be complete.

**Very Important**

As this article mainly consists of problems specially drafted to draw attention to the various applications of the metric system, the rules governing this system have been observed :

(1) Neither a dot (nor a comma, as in Anglo-Saxon practice) must be used to separate figures into groups of three.

(2) When writing numbers, decimal points must be used exclusively for separating decimals from integers. Continental practice is to use a comma.

Thus, the form 3,521.03 has been absolutely done away with. According to the rules applicable to the metric system, this number must be written as follows :

3 521·03 or 3 521,03

# Metric System for Britain?*

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Eire

MANY attempts have been made to introduce the metric system in Britain since the system was devised in France and introduced there in 1795. Its introduction there arose partly from the need to rationalize the extreme confusion which prevailed with the then existing French system of measures and also as a result of the atmosphere of change and improvement which prevailed during the French Revolution. The system did not have a happy introduction into French life and indeed the older systems of measures were once more permitted in 1813, although finally abandoned by the formal legalization of the metric system as the sole system in 1837. British Acts of Parliament in 1864 and 1897 made the use of the metric system permissive here, but only in a few specialized sections of industry and trade has it been adopted. The International Metric Convention was set up in 1875 to further the adoption of the system; Britain joined in 1884, permission to join having been withheld initially by Parliament. A British Association Committee studied the revision of units of measurement in 1875 and recommended the adoption of the CGS system (Ref. 1). Little organized action since that date has occurred, until recently.

Heated discussion has always followed any proposal to adopt the metric system in this country. This was perhaps the strongest at the end of last century when various books or booklets were published arguing against the change (Ref. 2 and 3). Mr. Herbert Spencer's Booklet (Ref. 4), published at that time, makes interesting reading and even quotes Napoleon's criticisms of the decimal system and its inconvenience in normal commerce. Almost all these arguments, however, are directed more to the difficulties that the ordinary trader or householder will meet rather than to the advantages which would accrue to industry, in particular engineering industry, with a single international system of measurement and units. Anyone who is acquainted with the recent problems of introducing the unified thread in Britain will appreciate the difficulties which any proposal to introduce the metric system will encounter ; indeed it could be said that the difficulties with the change of

*Extracted with permission from a paper presented at the Fourth Conference of Engineers Responsible for Standards, held in London, May 1958 (organized by a joint committee of the British Standards Institution and the Institution of Production Engineers).





thread have not left many sections of British industry in the mood for a further change of a more drastic nature. Certainly any plan for change-over to the system would have to draw on the lessons learned with the unified thread and avoid some of the mistakes that have been made here.

What has re-awakened interest in recent years in the introduction of the metric system into British trade was the publication in May 1951 of the Hodgson Report (Ref 5). This report recommended that 'the Government should take steps in concert with the Commonwealth and the U. S. A. to abolish the Imperial system of measurement in favour of the complete adoption of the metric system over a period of about 20 years (21-26)'. The report also goes into considerable detail on the difficulties with the present British practice and underlines the complicated position with the present system of units particularly with the apothecaries, troy and pennyweight systems. It points out certain deficiencies with Imperial Standards for length and draws attention to the need for agreement between Britain and America on a re-defined and equal inch accurately related to the metre.* More recently the Federation of British Industries, the Association of British Chambers of Commerce and the British Association have formed committees to go into these matters further and make more detailed recommendations. The general reception given to these proposed discussions has so far been favourable ; there is no doubt that the recent interest in the European Free Trade Zone has awakened British industry to the advantages in making a change at this time. Many sections of British industry are already supplying export goods dimensioned in millimetres, in centimetres and litres and the advantages of the single system are becoming more apparent. Many firms are already making full use of both systems.

*This has since been done for scientific purposes, *See* Metric Measures May 1959, p 22.

### What Is The Metric System?

Although everyone has a general knowledge that the metric system is largely the centimetre-gram-second system, very few British engineers are likely to be able to define the system in any detail; in fact it is not easy to find any British reference book which gives full details for the system currently used on the Continent (some information is given in Refs. 6 and 7). In the first place the CGS system is commonly used in scientific circles and the MTS (Metre-Ton-Second) system is more generally used in engineering. It is true that the differences between the one and the other are matters of decimal scaling. It is also necessary for British engineers if they are to use the system to understand the practice and terminology for those units commonly made use of on the Continent, *e. g.* engineering drawings are rarely, if ever, dimensioned in centimetres, always in millimetres or metres. Similarly practice differs in the use of the hectopieze or kg/ $cm^2$ for pressure. There are a number of terms for which there is no existing and recognized English translation. Some clarification on these points is obviously the starting off point for further consideration of the metric system—no doubt a job for the British Standards Institution.

It is important, however, to appreciate that the use of the metric system does not merely imply an inch-pound system specified in the corresponding metric dimensions. If British industry is to quote metric dimensions on drawings in inches (*e. g.* 20 millimetres=0·7874 inches) this is not to adopt the metric system. The whole range of nominal dimensions for lengths, areas, weights etc., as used currently on the Continent must be adopted and conversion of one system to the other avoided as far as possible.

Already difficulties have occurred with conversion from one system to the other, *e.g.* if a millimetre dimension (*e.g.* 20 millimetres) is rounded off to four decimal places in inches (*e.g.* 0·7874 inches), the error in rounding is a maximum of 0·00005 inches (1·25 microns). Now on precision components it is possible that the tolerance on the unit is only a few microns or tenths of thousands of an inch. This means that the error in rounding approaches that of the tolerance and involves a departure from the theoretical size which cannot be ignored. For example, American ball bearings are metric but catalogued and made in 4 decimal place inches. They are not strictly interchangeable with 'genuine' metric bearings, particularly the precision categories. As discussed in B.S : 2856 'Precise Conversion of Inch and Metric Sizes in Engineering Drawings' the degree of precision involved must be defined before conversion can take place.

Thus the introduction of the metric system implies that the full range of industrial standards which are available in Europe must be made available to British industry before the metric system can be adopted properly—a formidable undertaking.

**Advantages of the Metric System**

The advantages of the metric system can be briefly summarized as follows :

(1) The system is 'logical'. This argument is usually overstated as the logical nature of the original definition of the metre and the litre have disappeared as the original standards were found to be in error. The metre is no longer a simple fraction of the earth's circumference but has had to be defined as a number of wavelengths of a particular light; there are no longer 1000 cu cm in a litre of water and so on.

(2) Decimalization. In spite of the arguments of the advantages of being able to divide the British units up into binary fractions there is no doubt that on balance the use of decimals would be a considerable advantage to all sections of the community. Common fractions such as halves and quarters would be retained but eighths, sixteenths, the abominable thirty-secondths and the even more abominable sixty-fourths would be abandoned.

(3) To engineers, the main advantage of the metric system in practice is found to be the convenience of the basic unit. The inch itself is too large for most engineering work. The designer spends a great deal of his time dividing it. The author has argued this case elsewhere and has pointed out the manifold advantages of drawings dimensioned in millimetres as compared with those dimensioned in inches. In a typical example he showed that a drawing which would have 58 numerals on it if it were in the metric system would have 126 numerals in its original form based on decimalized fractions of an inch He did, however, point out that by rationalizing the inch and using 0·1 and 0·05 in. as the main units the number of figures on the typical drawing could come down to 71—more nearly approaching that of the metric drawing. Anyone who has worked in the metric system (as the author has) will appreciate the convenience of the unit. The best way of illustrating the advantage is to give a small component to a draughtsman to measure





and to make a sketch of quickly. If the unit was made in millimetres he can do a sketch accurate as a basic size within a few minutes by simple rule or caliper measurement. He may also be able to produce a sketch fairly quickly if the basic dimensions of the part are in 1/16 in. units but as this is unlikely today, he will have to borrow a micrometer before he can give you the nominal size of many of the dimensions, if the part has been made to the normal British or American drawing practice.

(4) International standardization. As already indicated the prime advantage of the metric system is the fact that it is an international standard in wide usage. Although it may not be true that the greatest volume of industrial production is made in it and that the inch (particularly the American inch) exceeds it, it is undoubtedly true that the greater part of the population of the world works in the metric system and that it is Britain and America who are out of step. There is indeed an atmosphere of inevitability about the adoption of the metric system.

**Disadvantage of the Metric System**

(1) The adoption of decimalization with the metric system is not without minor snags. Errors do occur due to that 'damned decimal point'. This seems, however, to be fully offset by the considerable inconvenience of the irregular and unmemorizable British system of scaling.

(2) The strangeness of the metric system to the ordinary person and indeed most engineers arises from the lack of any education at primary levels in the system. Although most schoolboys who have some scientific experience have come across the CGS system, very few non-technical boys and girls will have any experience of it at all. Most firms in Britain who make use of the metric system or produce parts specially for export, manufacture to drawings or specifications converted into conventional British units. For example, how many engineers could recognize the common B. A. threads as metric threads (OBA=6 mm dia., 2 BA=4·7 mm dia. etc.) ? Invariably drawings and tools etc., and even the British Standard for B.A. threads quotes the converted inch figures.

(3) Can we really, in practice, ever change over to one new system or will the old system drag on for years ? For many years now engineering industry has made use of BSF threads. Yet it is extremely difficult to buy anything other than an old-fashioned Whitworth screw and nut in the ordinary ironmonger's shop.

(4) If Britain makes a change, would it be out of step with the United States ? Is a change likely in that country? Having no interest in an export trade of the type that we in Britain have what reason could that country think of for making a change? Futhermore, the lack of Federal power to force a change would be a big factor involved in any proposal of this nature. With major industries in the United States so committed to the present inch system it is difficult to conceive under what circumstances they might decide to use the metric system.

(5) The cost of any change to British industry would be enormous. It would be at least £50,000,000 and probably £200,000,000 or more. Hundreds of component or industrial standards published by the B. S. I. and other standards bodies would have to be re-published and stocked in the metric system and run in parallel for many years with the old types, *e.g.* sizes of bar, hexagons, rolled steel channels,

angles, tubing, piping, etc.; a full range of fasteners from bolts and lock nuts to washers and split pins; milling cutters, reamers, keys and keyways, serrations and splines, wire sizes, sheet gauges and numerous small standard parts universally made use of such as dowels, clevis pins, shackles, pulleys, sprockets and so on. It has already taken some 10 years to publish and partially introduce into industry a fairly comprehensive range of fasteners with unified threads and even longer would be required to make the additional change to introduce corresponding metric equivalents.

#### Means of Facilitating a Change

Although somewhat doubtful of the prospects of achieving success by voluntary industrial action the author, from personal experience, prefers the metric to the inch system and feels that in the long run British industry would also prefer it. He makes the following suggestions for means of facilitating the change :

(1) Education. It is essential that from the kindergarten onwards children should forthwith stop being given examples in most of the archaic units of the British system, such as rods, poles, perches and the like ; some education should be given on the advantages, on the one hand of decimals and on the other hand of the metric system. The next two generations should be taught both systems, thereafter mainly the metric system. Engineering schools and technical colleges can assist considerably by making sure that students have had a good experience with practical metric dimensions and equipment, including drawing work and in the workshops.

(2) The Government must give a solid lead in this matter. Defence spending should be arranged so that the introduction of the metric system is made obligatory. The weak approach to the introduction of the unified thread where industry was asked 'to be so kind as to do their best to introduce it', will not suffice!

(3) The B. S. I. must publish a full range of standards as soon as possible. Government funds should be made available for this purpose. The number of standards involved is probably of the order of 250.

(4) Wider use of preferred numbers can facilitate the change, particulary when new standards not requiring exact following of present Continental pactice are involved. This suggestion has been made on a previous occasion (Ref. 9) and is of interest due to the closeness of equivalent metric and inch series (since the conversion factor 25·4 is nearly a preferred number). An interesting example of this process is in the listing by the ICI Company of titanium bar in a series of preferred number inch diameters which can also be offered for sale in metric units without change; *viz* :

| | | | | | | |
|---|---|---|---|---|---|---|
| inch | .. | 0·5 | 0·63 | 0·8 | 1·0 | 1·25 |
| mm | .. | 12·5 | 16 | 20 | 23 | 31·5 |

This procedure can only be used when the error of conversion is masked by the tolerance on the dimension.

(5) Wider use of decimal inch-pound units now would facilitate an eventual adoption of the metric system. As already mentioned (and discussed in Ref. 8 and 9) a good designer's unit is 0·05 in., as often as possible 0.1. As originally proposed by Sir Joseph Whitworth in 1857, the Whitworth thread series used steps of 0·025 and included such simple diameters as 0·2 and 0·3 rather than the fractional sizes 0·1875 and 0·3125. It is a great pity that his advice was not followed.





Similarly many other British units could be rationalized by eliminating such unnecessary units as furlongs, chains, fathoms, (use decimal multiples of the foot), acres and rods (use decimal square feet) ; by choosing either the Imperial or the US (Queen Anne) gallon, using decimal pounds in place of ounces in engineering and recognizing the 'cental' in place of the hundredweight ; eliminating Fahrenheit scales and using the pound-calorie in place of the B. Th. U., and so on.

Finally, a decimal coinage of 100 cents to the £ (*i.e.* 10 to the florin) would seem an easy change to introduce, especially if newspapers and postage could be 1 cent (=2·4 pence).

#### Conclusion

These brief notes have been intended only to outline a few of the practical points which any proposal to introduce the metric system will meet. All attempts to make the change in the past have failed. A similar approach once more will certainly fail again. Let those concerned study the difficulties and plan to overcome them rather than concentrating on the technical advantages of the system. And perhaps the two most important recommendations that can be made are to concentrate on education and a national (*i.e.* parliamentary) approach to the change-over.

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# Metric System in Chemical Industry

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Alwaye

IN the production of chemicals in the heavy chemicals industry, the need for the use of the appropriate units for variables before, during and at the end of a process is felt at every stage from the raw material to the finished product. In addition to the common use of weights in all phases of procurement, production and distribution, one has to make use of measures of volume, flow, temperature, pressure etc.

**Confusion of Units**

Till the introduction of the metric system in our country, many of our chemical plants had been using two or more systems which depended on the country from which the machinery and equipments were imported. For a country like ours which has to depend largley on imported machinery, American technicians had been urging the use of their terms, while their British and European counterparts had been suggesting and following the use of their own national terms. Here is an example. In a factory making heavy chemicals, the machinery and equipment up to and inclusive of those for making a mixture of gases were supplied by British manufacturers. In their dealings, in their drawings and in their chemical and engineering calculations, they were using such terms as Imperial gallons, long tons etc. The rest of this factory, wherein other chemicals were made from this mixture of gases, was equipped with machinery supplied, erected and serviced by American technicians. In their turn they were using such terms as US gallons, short tons, etc.

The confusion created among the people who operated and managed the entire factory was great indeed. Very often it led to lack of uniformity in the collection, co-ordination and presentation of data, resulting in much wasteful paper work every time one wished to work out or calculate some important problem concerning development or production. This confusion was due to the fact that the Imperial gallon is equal to 4·546 litres, while the US gallon is 3·785 litres; the long ton is 2,240 pounds, while the short ton is 2,000 pounds. As a result of this much difficulty was experienced, in the calculations of process efficiency, balancing of input and output and general accounting. Thanks to the introduction of the metric system, such problems of calculation and costing have been simplified considerably.

**What Change Means**

In addition to the ordinary weights and measures with which one is familiar





in daily work, in the chemical industry, one comes across other problems like the measurement of pressures. All along one had been using expressions like inches of mercury, feet of water, pounds per square inch etc. The manometers and pressure gauges used in many places in the chemical industry were manufactured either in Great Britain or the USA. Hence they had been calibrated, checked and were intended to be used under their systems only. After the change-over, the scales have to be changed from inches to millimetres of mercury for the manometers and pounds per square inch to kilograms per square centimetre for pressure gauges. In the initial stages this has to be done without upsetting production. An easy way to change over is to paste a label on each of these pressure gauges giving the conversion factor.

Further, the log sheets and operating data blank forms for each operating unit could be gradually modified by incorporating the metric system of units side by side with the old British system of units. Incidentally, this would also help to educate the operators in the use of the metric system. In the British system one atmoshphere of pressure is equal to 14·7 pounds per square inch and almost all the British and American gauges are calibrated in terms of pounds per square inch only. As one atmosphere is equal to 1·0332 kg per square centimetre, the real problem is not the mere changing of the scale but the testing and recalibration of these pressure gauges totally, using standard test gauges and weight testers which have been standardized in the metric system. For example, in a large chemical plant the number of pressure gauges and their types are bound to be varied and many. In such places the task of conversion has to be carried out as a part of a systematic and phased programme and not in a haphazard manner.

This planned programme should include the following steps:

(1) Educate the operators down the line in the use of the metric system by conducting orientation classes for their benefit.

(2) Help them to familiarize themselves with the new concepts like kg per square centimetre, mm of mercury etc. in the background of their past operating experience and knowledge.

(3) Provide them with log sheet blanks which would contain columns giving both the terms for a few months during the transition period.

(4) Indicate the conversion factors on the existing instruments.

(5) Recalibrate the pressure gauges one by one in a planned manner, gradually replacing the dials and scales with metric instruments.

In the chemical industry, the temperatures are often expressed in degrees of Fahrenheit scale. As a result of the change-over, the Centigrade scale has to take its place. The Centigrade scale is numerically less than the Fahrenheit scale of temperature. The mind of an operator which has accustomed itself, for example, to a figure, say, 900° F over the years would take time to familiarize itself with a numerical value near about 483° C. In such cases, instead of allowing the operator to resort to the usual calculation every time, it would be advisable to provide him with a printed card with vertical lines reading Fahrenheit degrees on one side of the line and equivalent Centigrade degrees on the other side.

The problems of pressure and temperature are important in the chemical industry, not only because of their impact on the reaction rates and operating conditions for the production of the end product, but also because any little confusion on the part of the operator about the scale would become a potential safety hazard.

**In Flow of Fluids**

In the measurement of flow of fluids like water, chemical liquors and the like the expression gallons per minute or gallons per hour had been used till now. Depending on the nature and size of the process, terms like kilolitres per hour or litres per minute have to take their place. In the manufacture of steam, instead of expressing the rate as pounds per minute, the term kilograms per minute has to be used. This would call for the recalibration of flowmeters and rotameters that are being used at present for the measurement of flow of fluids in the chemical industry.

In several places where the concentration of materials has been expressed as pounds per cubic foot, the new terms used would be kilograms per kilolitre or grams per litre. Also for expressing the calorific value of fuels, heats of reaction etc., the expression British thermal units per pound has to give place to the term calories per kilogram.

The shipment of liquids was done till recently in terms of gallons in a drum. The term litres per drum has to take its place. Bags of cement and fertilizers, drums of caustic soda and other chemicals were being sent to the market all these years in terms of hundredweights or pounds. Terms like 50 kilograms or 100 kilograms (quintal) have to take their place. The weigh scales of some of the existing weighing machines have to be readjusted and recalibrated to suit the change-over. For future requirements, new machines incorporating the metric system should be ordered by the manufacturers of chemicals.

**Metric Future**

In future, with the expansion of the industrial field, the public and private sectors would be purchasing more and more machinery and materials from indigenous and foreign sources. During the execution of the orders, release of blue prints and drawings, fabrication of machinery, drawing up of specifications, the tenderers and contractors should be made to undertake the use of the metric system at every stage during the execution and progress of a project. It should be made imperative and obligatory on the part of the engineers, contractors, chemists and suppliers of machinery to deal only in metric units. In the meantime the operators and staff of the various chemical and other industrial units could be educated in the use of the metric system.

In a few factories a beginning has already been made on the above lines Though initially some spadework was necessary, it was found that after a few months, the use of the metric system paid ample dividends in achieving better results, less confusion, easier work and more saving of time compared to the old British and other systems of measurement.



## *News & Views*

**Decimal Coinage for South Africa**

It is understood that the South African Parliament on 26 June 1959 passed through all its stages the Bill to introduce decimal coinage by the establishment of a basic ten-shilling unit. It is understood that the new unit is to be called 'Rand'. The 10 shilling unit will be divided into 100 cents.

**Decimal Coins in India**

Up to the end of April 1959, a total of 161·11 crores of decimal coins have been put into circulation all over the country. Out of this 24.02 crores were 10 nP coins, 26.80 crores were 5 nP coins, 35.67 crores 2 nP coins and 74.62 crores 1 nP coins.

Simultaneously the withdrawal of the old coins has been progressing apace. Between 1 April 1957, when decimal coins were introduced and 31 January 1959, 66.14 crores of the coins belonging to the anna-pie series were withdrawn.

**Education in Metric System**

It is understood that the Education Department in Bombay has introduced the teaching of metric system of weights and measures in almost all the primary and secondary schools in the State. Some of the more important steps taken are :

(1) More examples in arithmetic are set up based on the metric system.

(2) Charts are used showing the relation between various weights and measures and comparative studies are arranged.

(3) Talks are arranged on the new metric system.

(4) Practices and demonstrations in the conversion of old weights and measures into new are arranged.

It is also understood that the introduction of metric weights has been extended to some more cities in the State of Bombay. The new cities to which the act has been extended are :

| | | |
|---|---|---|
| Ahmednagar | Dhulia | Osmanabad |
| Amreli | Godhra | Palanpur |
| Anand | Himatnagar | Panvel |
| Bhandara | Jalgaon | Parbhani |
| Bhavnagar | Jamnagar | Ratnagiri |
| Bhir | Junagadh | Sangli |
| Bhuj | Mehsana | Satara |
| Broach | Nanded | Surat |
| Buldhana | Nasik | Surendranagar |
| Chanda | | Thana |

**More Australian Hospitals Change over**

In the July 1959, issue of *Metric Measures* an article had been published on the change-over to the metric system effected by the Royal Melbourne Hospital. It is now understood that two more hospitals have changed over to the metric system in Melbourne. The latest among these is the Queen Victoria Hospital. It also appears that many industrial and trade concerns are now marketing their products for use in hospitals in the metric system to be in line with this change-over.

**Atomic Clock to Check Theory of Relativity**

It is understood that a 'bird of time'— an atomic clock able to 'tick' at 24,000 million times a second and designed to orbit the earth to check Einstein's theory of relativity—is being developed under a Government contract in the USA.

The clock would weigh 13.6 kg, measure 30 by 15 cm and gain or lose not more than one second in 1,000 years, according to Dr. Harold Lyons, head of the Atomic Physics Department of Hughes Aircraft Company, of California.

Dr. Lyons told a press conference the clock he is developing under a 200,000-dollar contract from the National Aeronautics and Space Administration 'should be the most accurate instrument package in the history of man'.

Its chief purpose, he said, would be to test Einstein's theory that a clock operating in a different gravitational field would apparently run 'fast' in relation to a clock on the ground.

The test of the Einstein theory could be completed with a satellite flight of three weeks and the atomic clock would have a life span of 500 hours, Dr. Lyons said.

He added that although the launching date was probably several years away, he thought a rocket of a type already in existence could be used to put the clock into orbit.

Once in orbit, Dr. Lyons said, the clock would periodically transmit its time readings by telemetry to earth, where the time would be compared with that of another atomic clock on the ground.

If the relativity theory is correct, the orbiting clock could be 'fast' in relation to the earthbound clock if it were travelling at an altitude greater than 3,200 kilometres.

At a lesser altitude it would be 'slow'. At exactly 3,219 kilometres the satellite and ground clocks should agree, he said.

**Kerala Change-over**

From 1 October 1959, the optional use of metric weights is to be extended to 6 more districts in the state of Kerala. The districts concerned are Alleppy, Cannanore, Kottayam, Palghat, Trichur and Trivandrum.

It will be recollected that metric weights are already in optional use in three districts in Kerala with effect from 1 October 1958. Thus from next October, entire Kerala will be in the process of change-over.

**Standardization of Postal Stationery in U. K.**

It is understood that Britain is to introduce international standard sizes of paper and envelopes to help in the introduction of mechanized sorting of postal packets.

The change-over will begin with headed note-paper, of which the GPO uses about 7,000,000 sheets annually. Official forms also are to be changed to meet the new dimensions—but this will be a gradual process.

At present, there are about 50 different sizes for envelopes. This hinders the Post-Office in the introduction of automatic sorting equipment.

The recognized standard sizes for envelopes and note-paper are derived from a basic sheet of paper one square metre in area, ( the A series).

**Metric System in U. K.**

It is understood that the County Councils' Association have prepared a memorandum which advocates the introduction of the decimal system into British weights and measures and coinage systems.

**National Atlas of India**

The National Atlas Organization of the Government of India, Ministry of Education and Scientific Research have recently published a National Atlas of India, which uses metric scales for the maps. The atlas contains 26 plates comprising





21 maps of India on the scale 1: 5,000,000, 16 maps on the scale 1:10,000,000 and 30 maps on smaller scales. Besides these, there are other important maps also. This series of maps depicts social and economic facts concerning India. The metric system has been adopted for this purpose and heights are shown in metres, distances in kilometres, areas in hectares and square kilometres, rainfall in centimetres and temperature in degrees centigrade. The atlas is in Hindi.

**Inching Along**

In the May, 1959 issue of *Metric Measures* a report had been made on the adoption of a definite relationship between the inch and the pound and the metre and the kilogram for international use. The following comment which appeared in the *Christian Science Monitor* is interesting:

Attention Americans and Canadians :

Get out your tightest sandpaper and pass it ever so gently across one end of your yardstick. Save the microscopic sawdust.

If you're a true craftsman you will have taken about 1/16,000th of an inch off that household measure and will be in step with the new inch length that went into effect at midnight, June 30, like a kind of permanent daylight saving of the yardstick.

Now take the wisp of sawdust saved a moment ago. Put it in an envelope. And send it to a friend in Britain, Australia, New Zealand, or South Africa. He'll need it because, according to the new standard of inches and pounds agreed upon by these English-speaking nations, his yardstick is going to be an infinitesimal bit short.

You can afford to be expansive about giving away part of your yardstick because, in fact, you are more expansive—or at least measure so.

When the great shift to the new standard inch and pound went into effect, the average American or Canadian six feet tall gained 1/8,000th of an inch in height and 1/300th of an ounce in weight. But their British cousins were both shorter and lighter because Britain's inch and pound took on a speck of extra size to give all six nations a standard for precision-measure industrial work.

In case you are skeptical about this overnight change, try measuring this editorial. Britons should find it shorter than usual; Americans, longer.

And that's about the long and short of it.

**Conference of Controllers of Weights & Measures**

A conference of the Controllers of Weights and Measures of various States and Union Territories is being convened by the Ministry of Commerce and Industry on 4 September 1959, to discuss common problems and pool experiences. Among the problems to be discussed are recalibration of tank trucks, drum fillers etc., used by the Oil Companies, verification of working standard weights, supply of Inspectors' balances and precision balances and pattern of organization for enforcing weights and measures. The most important item, however, is the extension of metric commercial weights to the whole country from 1-4-1960.

# *Readers' Forum*

**Metric System in School Syllabus**

Dear Sir,

India has legally switched over to the metric system of measurements and in calculations in the near future it will be used in practice. That the metric system is the only suitable system for India is quite evident from the fact that no intellectual of outstanding merit has uttered a single word in opposition.

It is a matter of pity, nay of concern, that the metric system has not yet replaced the varied traditional systems in the school syllabus. Many State Governments either have already revised or are contemplating revisions of syllabi. The Madras Government has already redrafted the syllabus for elementary and secondary education with some alterations. The revised syllabus is in force for the first three standards of elementary schools. The metric system should dominate in the school syllabus. But this principle has been applied in reverse in the revised syllabus for elementary schools of the Madras State. Half the importance due to the metric system has not been recognized.

While a body of V Standard has to master some scores of basic structures of English language he is not fairly or adequately acquainted with the system of decimal calculations. There will be a vast scope for the use of metric measures in the post-school life of a boy whereas there will only be a scanty application of English by the V Standard boy provided his education ceases in that stage, as is the case with the majority of school-going children. But this does not mean that English should be necked out of the V Standard syllabus. This is only to stress that the metric system should be given due importance in the school syllabi from the earliest stage of education.

From the lowest rank of the educational pyramid, mastery should be preferred to the accumulation of facts and figures. The latter has baffled the genius of many children and not a few boys are termed 'dull' on this account even though their intellect is far brighter than others'. This can also mar the gainful employment of the advantages of the metric system in the schools syllabi and for use in life. If the school curriculum is progressively revised by adopting the metric system and if it is skillfully taught it will be of great advantage in making skilled technicians for the future.

A. Vadivel Nainar

*Head Master,*
*Board Higher Elementary School,*
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*N. A. Distt., Madras State*

**Indian Abbreviations for Metric Units**

Dear Sir,

The Joint Committee of the Parliament on the Standards of Weights and Measures Bill recommended that efforts might be made to evolve suitable Indian terms for the secondary and subsidiary units of the metric weights and measures. Section 12 of the Standards of Weights and Measures Act, 1956, also contemplates issue of Notification on this particular point.

From a close examination of the problem it, however, appears to me that the best course is to adopt the international nomenclature as it is. This will bring us in line with the international usage and at the same time enable us to avoid different nomenclatures for scientific learning and ordinary day to day transactions.

But the metric units and the subsidiary units have internationally accepted abbreviated forms which are most commonly used in schools and colleges and in the field of scientific learning. In recording the metric units and subsidiary units in school and college text-books as well as in the books on science written in Indian languages, there should be similar uniform practice, so as to minimize wastage of labour and time. In my opinion the metric units and subsidiary units may be recorded in Indian languages as follows :

**Length**

| | |
|---|---|
| Millimetre mm-मिमि | Decametre-dam-डामि |
| Centimetre-cm-सेमि | Hectometre-hm-हेमि |
| Decimetre-dm-डेमि | Kilometre-km-किमि |
| Metre-m-मि | |

**Weight**

| | |
|---|---|
| Milligram-mg-मिगा | Decagram-dag-डाग |
| Centigram-cg-सेगा | Hectogram-hg-हेगा |
| Decigram-dg-डेगा | Kilogram-kg-किगा or better किलो |
| Gram-g-गा | Quintal-q-कु (कुन्तल) |

**Liquid Measures**

| | |
|---|---|
| Millilitre-ml-मिलि | Decalitre-dal-डालि |
| Centilitre-cl-सैलि | Hectolitre-hl-हेलि |
| Decilitre-dl-डेलि | Kilolitre-kl-किलि |
| Litre-l-लि | |

A. K. Acharya

*Joint Secretary,*
*Indian Decimal Society,*
*Calcutta*

**In Defence of the Protection Bar During Dual Conversion of No-loose Weight Platform Machines and Weighbridges**

Dear Sir,

The protection bar (pro-bar) in a no-loose weight weighing machine or weighbridge steelyard is a flatbar with square-section notches with distances (centre to centre) equal to the distance between V-notches on the steelyard. From a maintainers' point of view, this bar not only protects the V-nib but also guarantees long time accuracy.

When the poise is moved into a notch the downward vertical movement of the V-nib into the V-notch takes place on releasing the catch-handle. This does not happen until it is accurately above the centre of the notch. Thereby, an accurate horizontal moment arm of the centre of gravity of the poise is ensured. Even a little horizontal misplacement of the poise makes it rest on pro-bar or more precisely on the projection between two square section notches. In this condition, the V-nib does not come into contact with the steelyard flat bar, unless a vertically downward movement is made possible by a further horizontal movement right above the centre of the V-notch. It is possible inadvertently to position the poise in a V-notch a little on either side of the exact point, *if the pro-bar is not there*, but it is impossible to do it if this bar is fitted. That is to say, when a pro-bar exists, the only direction of movement for the V-nib into the V-notch is the vertical one and no other. This can only account for a wear of the nib on its sides or a deepening of the V-groove vertically, but thereby its horizontal position is not at all disturbed. The ultimate criterion for accurate weighment is the horizontal distance from the fulcrum. When there is no protection bar-the nib of the poise is capable of cutting into a side of the V-groove thereby jeopardizing the accuracy of the horizontal movement arm and consequently accurate weighment, also the edge of the nib can be damaged.

The name protection bar is not quite happy. Better nomenclature would have been guaranteed accuracy bar. Had this nomenclature been adopted, some of the people who went in for dual conversion would not have dared to do away with this protection bar. In his haste, this designer of dual conversion, conveniently ignores the long-term guarantee which a pro-bar offers towards accuracy. He has probably been misled by the name and underestimated its value, purely interpreting its nomenclature as a guarantor of protection to the V-nib or V-notch, unwittingly forgetting its more important function as a guarantor of accuracy throughout the long life of the machine.

I do not for a moment dispute the initial accuracy of the newly converted dual machine which has discarded its pro-bar. It may be easy even for a layman to switch on to either system at a moment's notice. It may also work accurately for some time. But as time passes, the same machine will start giving different readings for the same goods, due to the blunted V-nib or inaccurate horizontal position of the poise. Therefore, I strongly advocate the retention of the pro-bar. It may be useful to re-design its shape and make it turn simultaneously with the turn-over of the index plate—by means of suitable gears—or the existing bar may be milled on the unmilled side and reversed by hand at the time of switch-over. Whatever be the reason for doing away with the pro-bar it cannot be disputed that it is the life-line of accuracy for no-loose weight platform machines or weighbridges.

In fact, the rules of certain States in India under the existing law, (having, therefore, the force of law) prescribe the pro-bar as a necessary fitting.

I advocate strongly against any new law or rule allowing the elimination of the pro-bar or making its usage optional, in the interests of guaranteed accuracy of no-loose weight machines.

I do admit that the mechanism without a pro-bar is an easier job for the dual conversion contracter or manufacturer, a still easier job for the easy switch over on an auspicious day, simultaneously, say at all stations on Indian Railways and the like. But they definitely mean sacrifice of guaranteed long standing accuracy at the altar of simplicity.

May I humbly draw the attention of those concerned to this vital factor of accuracy which a pro-bar caters to and call upon them not to allow stamping of any new no-loose weight machine without a pro-bar or in case it has so far been allowed, to insist on re-fitting protection bar for all machines already introduced into the market.

R. Rajagopalan

*Weighing Machine Inspector,*
*Central Railway,*
*Secunderabad Division.*





# Guide to Paper Sizes

**The following interesting information has been given in the May 1959 issue of 'BSI News' regarding the international paper sizes. This has appeared under the title 'A plain Man's Guide to Those 'A' International Paper Sizes'. It is hoped that this information will be useful in India and is, therefore, reproduced below.**

Since March 1, 1958, when the B.S.I. announced that it was changing over to 'A' size paper for all its publications and stationery, many firms and trade organizations have followed suit; a large number of others have expressed interest and asked for details. For those who are not quite clear as to what is meant by international paper sizes or what is involved in a change-over, the following short notes have been prepared.

**Q. What are international paper sizes?**

**A.** The 'A' series consists of a logically-planned range of trimmed sizes formed in such a manner that each size is obtained by dividing the one immediately above it into two equal parts, the division being parallel to the shorter side. The *basic* size has an area of one square metre. The most widely-used sizes are 'A4' measuring 210 mm by 297 mm (approximately 8¼ in. by 11¾ in.) which can replace the traditional British 8 in. by 10 in. and 8 in. by 13 in. sizes, and 'A5' which is exactly half the size of 'A4' (*B. S. I. News* is printed on 'A5' paper). By halving or doubling these sizes one obtains an 'A' size to meet virtually any requirement from a sizable poster to a small visiting card. (There is, in addition, a subsidiary 'B' series for special requirements).

**Q. Who uses the 'A' sizes?**

**A.** The 'A' series is truly international, being used in 26 countries. Notable exceptions are the United States, France and the British Commonwealth (though India is committed to the change and even in the U.K., U.S.A. and France these sizes have been used for certain limited purposes for some years and interest in them is growing rapidly). A British Standard for the 'A' and 'B' series is being prepared and an international standard recommendation on the subject is shortly expected from the ISO.

**Q. Is it easy to buy 'A' size paper?**

**A.** Yes. Papermakers and merchants will supply paper from which the 'A' sizes can be cut. Orders for 'A' size paper may be placed with stationers.

**Q. What about printing?**

**A.** Any printer can produce 'A' size printed matter. In case of difficulty contact the British Federation of Master Printers.

**Q. What are the advantages of a change-over?**

**A.** The benefits to be derived from a series of sizes which retains the same proportions throughout are recognized by engineers, architects and all those concerned with the reproduction of illustrations, especially by photographic enlarging and reduction processes. Moreover, in some fields of industry, exporters are being asked by overseas buyers to provide their sales literature, working instruction sheets and so forth in the 'A4' size.

**Q. Is it difficult to effect a change-over?**

**A.** Naturally, problems will confront any organization making a change-over but those who have done so consider that the greater ultimate convenience justifies the initial period of inconvenience. So far as correspondence is concerned, the usual foolscap files will accommodate the 'A4' size of papers. Manufacturers can supply envelopes in some of the 'A' sizes already. In case of difficulty you should contact the Stationers' Association or the Envelope Manufacturers' Association; the common 9 in. by 4 in. envelope is quite suitable for several 'A4' sheets folded in four across their width. Most of the current office duplicating and other equipment can handle 'A4' without difficulty.

**Q. What about cost?**

**A.** At the moment a change-over should not involve firms or organizations in any significant extra expenditure. It is noteworthy that in countries which have largely adopted the 'A' sizes it has been found that very substantial long-term economies have resulted.

* * *

# *Metric Progress in Industries*

(In December 1956, the Standing Metric Committee recommended that conferences should be convened with the cooperation of associations or organizations concerned, for groups of industries, to recommend programmes for the adoption of the metric system. This is being done. The progress made in chalking out and implementing the first phase of the programme in various industries is reported. Earlier reports appear in the previous issues of *Metric Measures*.)

**Sugar**

The sugar industry would begin the change-over to the metric system of weights from the beginning of the crushing season of 1959, *viz.*, 1 November 1959 for the purchase of sugarcane and sale of sugar. The Central Government notification allows a period of two years during which the weights in use immediately before November 1959 and the new metric weights could be used side by side.

It is interesting to note that prices of sugarcane are already being fixed in terms of both the maund (40 seers) and the quintal (100 kg).

**Vanaspati**

The vanaspati industry will begin the change-over to the metric weights from 1 April 1960, insofar as they undertake sale of vanaspati. The change-over is to be completed within a period of 6 months from April 1960. During the interim period the weights now in use in this industry and the metric weights will be in concurrent use. The change-over has been announced in two notifications issued by the Central Government.

As the industry sells its products mostly in prepacked containers, the change-over will mean that the contents will also be in rational units of the metric system. It appears that packages of 4 kg, 2kg, 1 kg, and 500 g are likely to be accepted.

**Paints**

The paint industry is scheduled to begin the use of the metric system in the sale of paints with effect from 1 April 1960. The period for complete change-over will be one year from 1 April 1960. These decisions have been announced by the Central Government in two notifications issued recently.





**Biscuits**

The biscuit industry will begin the change-over to metric weights from 1 April 1960 insofar as they undertake sale of biscuits. The change-over is to be completed in 2 years' time, *i.e.*, by 1 April 1962. This decision has been announced in two Government notifications recently.

It may be mentioned here that a few reputable biscuit manufacturers have already started indicating the converted weights of their products in metric units on the containers, particularly for wholesale purposes.

**Drugs**

The drugs and pharmaceutical industry is already familiar with the metric system as it has been using it along with the British system in the marketing of its products.

Consultations are now in progress to effect change to the metric system in this industry. The general opinion appears to favour a beginning being made from 1 April 1960 in the sale of drugs and purchase of materials. The general expert opinion desires that the interim period should be only 6 months which means that from 1 October 1960, the metric system will be the only system used by this industry for the purposes specified.

The matter is still under discussion and the Central Government will issue the necessary notifications as soon as a decision is taken.

**Alcohol**

The possibility of a change-over in the alcohol industry at an early date is being considered by the interests concerned.

Recently, a meeting of the Metric Subcommittee of the Development Council for Alcohol and Fermentation Industry was held in New Delhi, in which the following conclusions were reached :

The volume of alcohol would be expressed as litres instead of gallons (London proof).

(2) The Excise Department would begin recalibration of storage tanks after a decision is taken on the date of change-over. Complete recalibration may take a number of years and in the interim period use of conversion tables will be inevitable.

(3) The unit for the purchase of molasses would be quintal (100 kg.).

(4) As the adoption of the metric system will require the amendment of excise tariff.

It is not necessary to replace bottles for portable spirits immediately on the adoption of the metric system. The existing bottles will continue to be used till specifications are laid down for the new sizes and bottles conforming to these specifications are produced in quantity.

**Tobacco**

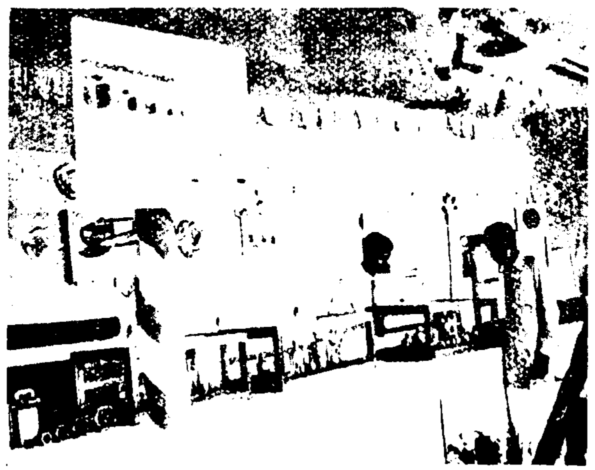
The question of the adoption of the metric system in the tobacco industry is now being discussed with the various interests. As a result of two meetings the following conclusions have been arrived at:

(1) The metric system should be introduced from the beginning of the calendar year following the financial year from which the Excise and Railway Departments adopt the metric system.

(2) The introduction of the metric system would be for the entire industry and not by regions or districts. Effective propaganda would be undertaken to acquaint everybody concerned with the industry with the metric system and its relation with the old system.

# *Metric Stall in Red Cross Exhibition*

The Department of Weights and Measures, Madras took part in the Red Cross Centenary Exhibitions by putting up a stall on 'Metric System'. Besides the reference, secondary and working standard weights, working standard balances and commercial cast iron, bullion and brass weights etc., were put up in the stall.

Various types of weights and measures now in use in various parts of the country, charts showing conversion factors of metric weights and measures, the areas where and industries and trades in which metric system has been introduced with effect from 1 October 1958 and the metric system of measures of capacity etc., exhibited in the 'India 1958' exhibition at New Delhi, were also exhibited in the metric system pavilion. The film on metric system produced by the Government of India was shown (in the exhibition) to the visitors and pamphlets, conversion tables etc., explaining the metric system were widely distributed. Demonstrations as to the differences in weighing in the existing system and in the metric system were held by actually weighing some of the common commodities in viss weights and in kilogram weights. Hoardings displaying kilogram weights and viss weights were put up and the Inspectors of Weights and Measures explained to the people the advantages of metric system over the existing system and also the working of the Weights and Measures Act.

The Avery Company of India had put up free a person weighing machine, weights





marked both in lb and kilograms, some of the weighing machines marked in both the systems and also models of beam scales. The stall attracted a large number of people and they showed keen interest in learning the metric system. The Red Cross authorities presented the Department a certificate for the most instructive pavilion put up.

# *Standards News*

(Indian Standards which have a particular bearing on the change-over to the metric system are indicated here. Copies would be available from the Indian Standards Institution, Manak Bhavan, 9 Mathura Road, New Delhi or their branch offices at Bombay, Calcutta and Madras).

**Indian Standard for Preferred Sizes for Wrought Metal Products (IS : 1136-1958).**

The decision of the Government of India to adopt the metric system as the only recognized system of weights and measures had made it necessary that the preferred sizes of metal products should be standardized in metric units.

Accordingly, the Indian Standards Institution's Standard for Wrought Metal Products (IS : 1136-1958), which has just been published, and specifies preferred sizes, in millimetres, for wrought metal products, is expected to serve as a guide for evolving standard metric sizes.

In the standardization of preferred sizes in metric units, the following aspects have been kept in view:

(1) Taking maximum possible advantage of the inherent qualities of the metric system.

(2) Keeping the range and gradation of sizes sufficient to meet consumer requirements efficiently and economically.

(3) Making the change-over of Indian industry to the metric system as easy as possible.

(4) Achieving international co-ordination to as great an extent as possible.

(5) Ensuring that the standards do not impose difficulties on the producers by prescribing too many standardized sizes.

**Price : Re. 1.00**

**Indian Standard Specification for Cut Sizes for Timber (IS : 1331-1958).**

An Indian Standard Specification for Cut Sizes of Timber (IS : 1331-1958) has been published by the Indian Standards Institution.

Timber sawn to various sizes is used in the country in a variety of ways; planks, battens, scantlings and baulks are used in furniture making, constructional work, wagon and coach building, marine installations, packing cases and for a number of other constructions.

The need for a standard for cut-sizes in general use in the interests of both producers and stockists on the one hand and consumers on the other, is apparent. Every saw mill produces a certain amount of timber in odd sizes, by way of salvage from what would otherwise be wasted in the course of normal timber conversion. While these odd sizes may find a use, this standard would refer only to those sizes which experience had shown to be in general demand for use in building and other purposes. The standard also covers sizes of converted timber for the guidance of stockists in the timber trade and the general users. The standard is expected to canalize the demand for timber and thus help in timber being stocked in suitable sizes and in making it readily available to the consumer.

**Price : Re. 1.00**





**Handbook of Indian Standards for Structural Engineers (IS : 808-1957, IS : 1173-1957 and IS : 1252-1958).**

The Indian Standards Institution under its Steel Economy Programme has brought out a number of standards with a view to conserving steel. The work included preparation of Codes of Practice for Use of Steel in General Building Construction, Use of Tubes in Building Construction and Use of Lightgauge Sections in Buildings. Efficient metric sections have also been developed and included in the following Indian Standard Specifications,

(1) IS : 808-1957 **Rolled Steel Beam, Channel and Angle Sections.**

(2) IS : 1173-1957 **Rolled Steel Sections, Tee Board.**

(3) IS : 1252-1958 **Rolled Steel Sections, Bulb Angles.**

Further, in order to reduce the work involved in design computations and use of Indian Standard Code of Practice for Use of Structural Steel in General Building Contruction. ISI has undertaken to make available a number of design handbooks showing typical designs of different structures.

The first Handbook published in the series is that pertaining to Structural Steel Sections. The material contained in the Handbook is arranged from the point of view of maximum convenience in using the Handbook in the design office. Broadly speaking, the contents have been grouped as follows:

Section A Structural Sapes and Other Steel Products (Tables I-X).

Section B Beams, Channels and Compound Sections Used as Girders (Tables XI-XXIII).

Section C Angles, Single and Double, Used as Struts and Ties (Tables XXIV-XXXI).

Section D Beams, Channels and other Compound Sections Used as Columns (Tables XXXII-XXXVIII).

The requirements laid down in IS: 800-1956 Code of Practice for Use of Structural Steel in General Building Construction, have been taken note of in working out the properties contained in this Handbook. References to the appropriate clauses of IS : 800-1956 with the help of which the properties have been worked out, have been included in suitable footnotes.

**Price : Rs. 12·50**

**Draft Indian Standard Specifications for Rolling and Cutting Tolerances for Hot Rolled Steel Products [Doc.: SMDC 6(138)].**

Rolling and cutting tolerances for some of the hot rolled metal products followed in this country, are based mostly on the British practice. These have been specified by the Indian Standards Institution, from time to time, in its individual Indian Standards. In some cases these tolerances have not been specified. It was felt that more detailed tolerances were necessary for metal products, specially in view of the decision of the Government of India to adopt the metric system of weights and measures throughout the country.

Accordingly, the Institution has drafted a separate standard giving the tolerances for hot rolled steel products. The draft Indian Standard Specification for Rolling and Cutting Tolerance for Hot Rolled Steel Products [Doc. : SMDC 6(138)], lays down rolling and cutting tolerances for hot rolled structural steel sections and other steel products, such as bar (excluding rivet bar), flat, plate, strip and sheet.

Formulation of this Indian Standard at this juncture is most opportune, since it coincides with the production of structural sections and other steel products in metric dimensions in this country.

**Draft Code of Architectural and Building Drawing Office Practice [Doc : BDC 1(144)].**

Architectural and building drawing office practices followed in the various architectural and civil engineering departments are based generally on the practice followed in the U.K., though these have been modified to some extent to meet individual requirements. It has been found desirable to codify these numerous modifications, and to rationalize them so that the drawings prepared in any office could be read and interpreted with care. With this aim in view the ISI has drafted the Code of Architectural and Building Drawing Office Practice [Doc. BDC 1(144)].

This Code of Practice lays down recommendations for size and layout of drawings, methods of projections, sectioning and sectional views, sizes of lettering, dimensioning, abbreviations and symbols used in architectural and building drawing office practice. The code is also intended to serve as a basis for providing instructions and guidance to architectural and civil engineering students, in recommending standard sizes for drawings. In the draft code, the Institution, taking into consideration the paper sizes recommended in IS: 1064-1957 Specification for Paper Sizes has recommended the desirability of relating the sizes of drawing boards and printing frames to the sizes of drawings. It is hoped that this mutual relationship would lead to simplification in handling of drawing at all stages.



# *Licensed Manufacturers, Dealers and Repairers of Weights and Measures (3)*

In the March and July 1959 issues of *Metric Measures* lists of manufacturers, dealers and repairers of weights and measures and weighing and measuring instruments licensed under the new Weights and Measures (Enforcement) Act in Bombay, Andhra, Delhi and Punjab were published.

Similar steps are being taken for licensing manufacturers, dealers and repairers in other States and the list of licensees would be published in *Metric Measures*, as the work of licensing progresses. A list of licensees further to that published in March and July 1959 issues of *Metric Measures* is given below:

## PUNJAB (2)

In the July 1959 issue of *Metric Measures* a list of licensed manufacturers, dealers and repairers of weights and measures in Punjab State was published. The following is a list of manufacturers and dealers subsequently licenced by the Government of Punjab under the Punjab Weights and Measures (Enforcement) Act, 1958.

### Manufacturers

| Sl. No. | Name and Address of Manufacturer | Details of Articles Manufactured |
|---|---|---|
| (1) | Ambica Industries, Tehsil Road, Jagadhri. | *Cast Iron Weights*<br>100 g, 200 g, 500g, 1kg., 2 kg., 10 kg. |
| (2) | East Punjab Traders, Idgah Road, Ambala Cantt. | *Gallon Measures*<br>4 gallon 1 gallon 1/2 gallon 1/8 gallon |
| (3) | Partap Iron Works & Mills, Phagwara. | *Cast Iron Weights*<br>1 maund to 1/8 seer.<br>*Brass Weights*<br>1/16, 1/32 seer. |

## Dealers

| Sl. No. | Name and Address of Dealer | Details of Articles Sold |
|---|---|---|
| (1) | Babu Ram Kidar Nath, Jagraon Mandi .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (2) | Banarsi Dass Lalji Dass, Sabhan Bazar, Ludhiana .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (3) | Basant Mall Kashmiri Lal, Main Bazar, Panipat .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (4) | Bedi Oil Company, G.T. Road, Batala .. .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (5) | Behari Lal Aggarwal, Railway Road, Tarn Taran .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (6) | Bihari Lal Ved Parkash, Railway Road, Rajpure .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (7) | Chandan Lal Baru Mal, Ganaur Mandi, Rohtak .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (8) | Dhani Ram Saini, Railway Road, Rajpure .. .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (9) | Darshan Singh and Brothers, Raink Bazar, Jullundur .. | Weights, Measures and Weighing and Measuring Instruments. |
| (10) | Daulat Ram Paras Ram, Panipat .. .. .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (11) | Ganpati Rai Ganesh Dass, Iron & Hardware Merchants, Kapurthala. | Weights, Measures and Weighing and Measuring Instruments. |
| (12) | Goel Hardware & Mills Stores, G.T. Road, Batala .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (13) | Gupta Hardware Stores, Pansari Bazar, Jagadhari .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (14) | Gurdial Singh, Main Bazar, Karuli .. .. .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (15) | Gurdas Mal & Sons, Chowk Bazar, Sabathu .. .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (16) | Gopi Chand Prem Kumar, Moga .. .. .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (17) | Hari Chand Rajinder Kumar, Ludhiana .. .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (18) | Hazari Lal S/o Shri Moti Ram, Mohindergarh .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (19) | Harish Kumar Ashok Kumar, Bazar Kaserian, Kapurthala .. | Weights, Measures and Weighing and Measuring Instruments. |
| (20) | Indian Cottage Industries, Batala .. .. .. .. | Weights, Measures and Weighing and Measuring Instruments. |





## Dealers

| Sl. No. | Name and Address of Dealer | Details of Articles Sold |
|---|---|---|
| (21) | Jagdish Ram Tarseem Lal, Nawanshehar .. .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (22) | Jaiswal Metal Mart Ltd., Sector, 19-C, Chandigarh .. .. | Weights, Measures and Weighing and Measuring Instruments, |
| (23) | Janeshwar Lal Rajeshwar Lal Jain, Simla .. .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (24) | Jiwan Dass Charan Dass, Saban Bazar, Panipat .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (25) | Kundal Lal Jit Ram, Main Bazar, Panipat .. .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (26) | Lahori Mal Janada Mal, Bange District, Jullundur .. .. | Weights, Measures, and Weighing and Measuring Instruments. |
| (27) | Madan Lal, Mansa Mandi, Bhatinda .. .. .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (28) | Madho Ram, Mukerian .. .. .. .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (29) | Mala Mal Sulakhan Mal, Amritsar .. .. .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (30) | Mayya Dass Harbans Lall, Ludhiana .. .. .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (31) | Mehnga Ram Sham Lal, Bagha Purana, District Ferozepur .. | Weights, Measures and Weighing and Measuring Instruments. |
| (32) | Moti Ram Rameshwar Dass, Ferozepur City .. .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (33) | Murari Lal Tara Chand, Bichla Bazar, Bhiwani .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (34) | Net Ram Tirath Ram, Moga Mandi, Ferozepur .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (35) | Paras Ram Mehar Chand, Bhatinda .. .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (36) | Pahlad Ram Banwari Lal, Bazar Kalan, Ferozepur .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (37) | Prem Chand & Sons, Hill Road, Ambala Cantt. .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (38) | Raja Ram Kishan Chand, Anaj Mandi, Ambala City .. | Weights, Measures and Weighing and Measuring Instruments. |
| (39) | Rajinder Nath Gupte & Co., Hoshiarpur .. .. .. | Weights, Measures and Weighing and Measuring Instruments. |
| (40) | Ram Surrender Kumar Fatehbad, Hissar .. .. .. | Weights, Measures and Weighing and Measuring Instruments. |

## Dealers

| Sl. No. | Name and Address of Dealer | Details of Articles Sold |
|---|---|---|
| (41) | Ram Parkash Banarsi Dass, Ludhiana | Weights, Measures and Weighing and Measuring Instruments. |
| (42) | Ramji Dass Behari Lal, Patiala | Weights, Measures and Weighing and Measuring Instruments. |
| (43) | Ramji Mall Ram Gopal, Hoshiarpur | Weights, Measures and Weighing and Measuring Instruments. |
| (44) | Ramji Dass & Sons, Hall Bazar, Amritsar | Weights, Measures and Weighing and Measuring Instruments. |
| (45) | Ram Chand Ram Saran Dass, Saban Bazar, Ludhiana | Weights, Measures and Weighing and Measuring Instruments. |
| (46) | Rampal Mal Hukam Chand, Fazilka | Weights, Measures and Weighing and Measuring Instruments. |
| (47) | Sardari Lal Nagin Chand, Saddar Bazar, Sultanpur Lodhi, Kapurthala. | Weights, Measures and Weighing and Measuring Instruments. |
| (48) | Sham Dass Mehar Chand, Old Misri Bazar, Amritsar | Weights, Measures and Weighing and Measuring Instruments. |
| (49) | Shankar Dass, Baij Nath, Rohtak | Weights, Measures and Weighing and Measuring Instruments. |
| (50) | Shiba Mal Ramji Dass, Mandi, Dabwali, Hissar | Weights, Measures and Weighing and Measuring Instruments. |
| (51) | Shibban Lal Ram Sarup, Palwal | Weights, Measures and Weighing and Measuring Instruments. |
| (52) | Shiv Dayal Gujjar Mal, Partap Bazar, Hoshiarpur | Weights, Measures and Weighing and Measuring Instruments. |
| (53) | Shish Ram Suraj Bhan, Sonepat Mandi, Sonepat, District Rohtak. | Weights, Measures and Weighing and Measuring Instruments. |
| (54) | Somnath Jagdish Raj, Mandi Gurdaspur | Weights, Measures and Weighing and Measuring Instruments. |
| (55) | Suresh Chand & Brothers, Gurgaon | Weights, Measures and Weighing and Measuring Instruments. |
| (56) | Sunder Singh Satya Paul, Kotkapura | Weights, Measures and Weighing and Measuring Instruments. |
| (57) | Tek Chand & Sons, Ferozepur City | Weights, Measures and Weighing and Measuring Instruments. |
| (58) | Trilok Chand Ashok Kumar, Pathankot | Weights, Measures and Weighing and Measuring Instruments. |

# CONVERSION TABLES OF PRICES FOR WEIGHTS

## TABLE A

(Factor used: 1 kg=1·0717 seers)

Rupees per seer to Rupees per kg

| Rs./seer | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Rs/kg | Rs/kg | Rs/kg | Rs/kg | Rs/kg | Rs/kg | Rs/kg | Rs/kg | Rs/kg | Rs/kg |
| 0 | 0 | 1·07 | 2·14 | 3·22 | 4·29 | 5·36 | 6·43 | 7·50 | 8·57 | 9·65 |
| 10 | 10·72 | 11·79 | 12·86 | 13·93 | 15·00 | 16·08 | 17·15 | 18·22 | 19·29 | 20·36 |
| 20 | 21·43 | 22·51 | 23·58 | 24·65 | 25·72 | 26·79 | 27·86 | 28·94 | 30·01 | 31·08 |
| 30 | 32·15 | 33·22 | 34·29 | 35·37 | 36·44 | 37·51 | 38·58 | 39·65 | 40·72 | 41·80 |
| 40 | 42·87 | 43·94 | 45·01 | 46·08 | 47·15 | 48·23 | 49·30 | 50·37 | 51·44 | 52·51 |
| 50 | 53·58 | .. | .. | .. | .. | .. | .. | .. | .. | .. |

## TABLE B

(Factor used: 1 kg=1·0717 seers)

Naye Paise per seer to Naye Paise per kg

| nP/Seer | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| | nP/kg | nP/kg | nP/kg | nP/kg | nP/kg | nP/kg | nP/kg | nP/kg | nP/kg | nP/kg |
| 0 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 8 | 9 | 10 |
| 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 20 | 21 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
| 30 | 32 | 33 | 34 | 35 | 36 | 38 | 39 | 40 | 41 | 42 |
| 40 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 53 |
| 50 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 |
| 60 | 64 | 65 | 66 | 68 | 69 | 70 | 71 | 72 | 73 | 74 |
| 70 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 83 | 84 | 85 |
| 80 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 |
| 90 | 96 | 98 | 99 | 100 | 101 | 102 | 103 | 104 | 105 | 106 |
| 100 | 107 | .. | .. | .. | .. | .. | .. | .. | .. | |

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