PDHonline Course G519 (1 PDH)

American Reticence against the DMS

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AMERICAN RETICENCE AGAINST THE DMS
(THE DECIMAL METRIC SISTEM)

PROLOGUE

Since biblical times the needs for a free trading and commerce exchange demanded for a uniform, logical and accurate system of weights and measurements. Although it was not easy at first, the natural process of trial and error took traders, merchants, scientists, builders and engineers into several rustic methods that eventually evolved into the more elaborate systems we have available today.

In this course we will review some of those systems beginning with the times of the Persian and Arabian traveling traders, as they struggled to conduct business in a manner that was somewhat dependable and comprehensible to all of those involved, as well as for the public in general.

Both, the Persian and Arab traders used for measurements whatever they had available (see the Appendix at the end of this course), such as their fingers, hands, palms, arms and feet. That is why in the tables we show ahead, it is quite common to find the designation of those body parts as measurement units. Some of those traditions were passed along to the Romans and Saxons whose kings adopted those methods to their favorite royal issue: taxation. Below is a transcription of a certain 10th century English royal edict regarding *Money & Measures:*

> "And let one money pass throughout the king's dominion;
> and that let no man refuse, and let one measure and one weight pass;
> such as is observed at London and Winchester;
> and let the *wey of wool* go for 120 *pence;* and let no man sell it cheaper,
> and if anyone sell it cheaper, either publicly or privately,
> let each pay 40 *shillings* to the king;
> both him who sells it, and him who buys it."

We will examine the good and bad sides of the English Weight and Measures System versus the Decimal Metric System and will conclude with the reasons (valid and no so valid) which often provide support to the American public reticence against the present or future use and implementation of the DMS.

1.0 HISTORICAL FACTS

The initial concept of a decimal system of units was first conceived by a mathematician named Simon Stevin (1548-1620). He is credited by being the first one to use decimal fractions in his routine work and calculations. In 1670, a French vicar named Gabriel Monton proposed a comprehensive decimal system of measurement with a unit of length based on the equivalence of *one minute* of the circle of the earth.

The proposal remained dormant for over a hundred years until the advent of the intellectual ferment brought up by the French Revolution. In 1791 and following advice of the scientific community, the popular French foreign minister Monsieur Talleyrand introduced the proposal of an international decimal system of measurement based on the *meter* as the basic unit of length and defined as *one ten-millionth* part of the northern meridian's quadrant of the earth.

However, in order to establish the meter as the base unit of measurement, it was first necessary to accurately measure such northern meridian quadrant. In March 1791 the French Assembly approved and funded the survey of the meridian* passing by Paris (France), as well as by Barcelona (Spain) and Dunkirk (Dunkerque) at both ends of firm land in the European continent. The work was commissioned to Pierre Mechain and Jean Baptiste Delambre. Such project also brought up an unexpected benefit consisting of an accelerated advance in the practice of geodetic survey.

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*The Paris meridian is located approximately at 2 degrees 22 min. of longitude East of Greenwich, England.

Please peruse the details contained as part of Figures 1.1 showing a map of France and part of England and Spain, as well as Figure 1.2 illustrating the quadrant running from the North Pole down to the Equator. Consequently, the French government authorized the measurement of such quadrant and the work was completed in the year 1799. This event made possible the approval, adoption and implementation of the metric system in France and its example was seconded and implemented by several European countries in a very short period of time to follow.

In 1875 a *Meter Convention* for international cooperation took place, in which the different countries using the metric system were signatory of the treaty and right there and then they approved metal prototypes cast of platinum and iridium for both, the meter and kilogram, so that every member country could use them as uniform reference standards.

By 1921 the convention expanded the metric system to cover other units in addition to the meter and the kilogram, such as the *ampere* as part of the electrical measurements. In 1954 the convention confirmed the following six (6) significant base units:

Meter (for linear, square and volumetric measurements)
Kilogram (weight)
Second (time)
Ampere (electric current)
Kelvin (absolute temperature)
Candela (luminosity)

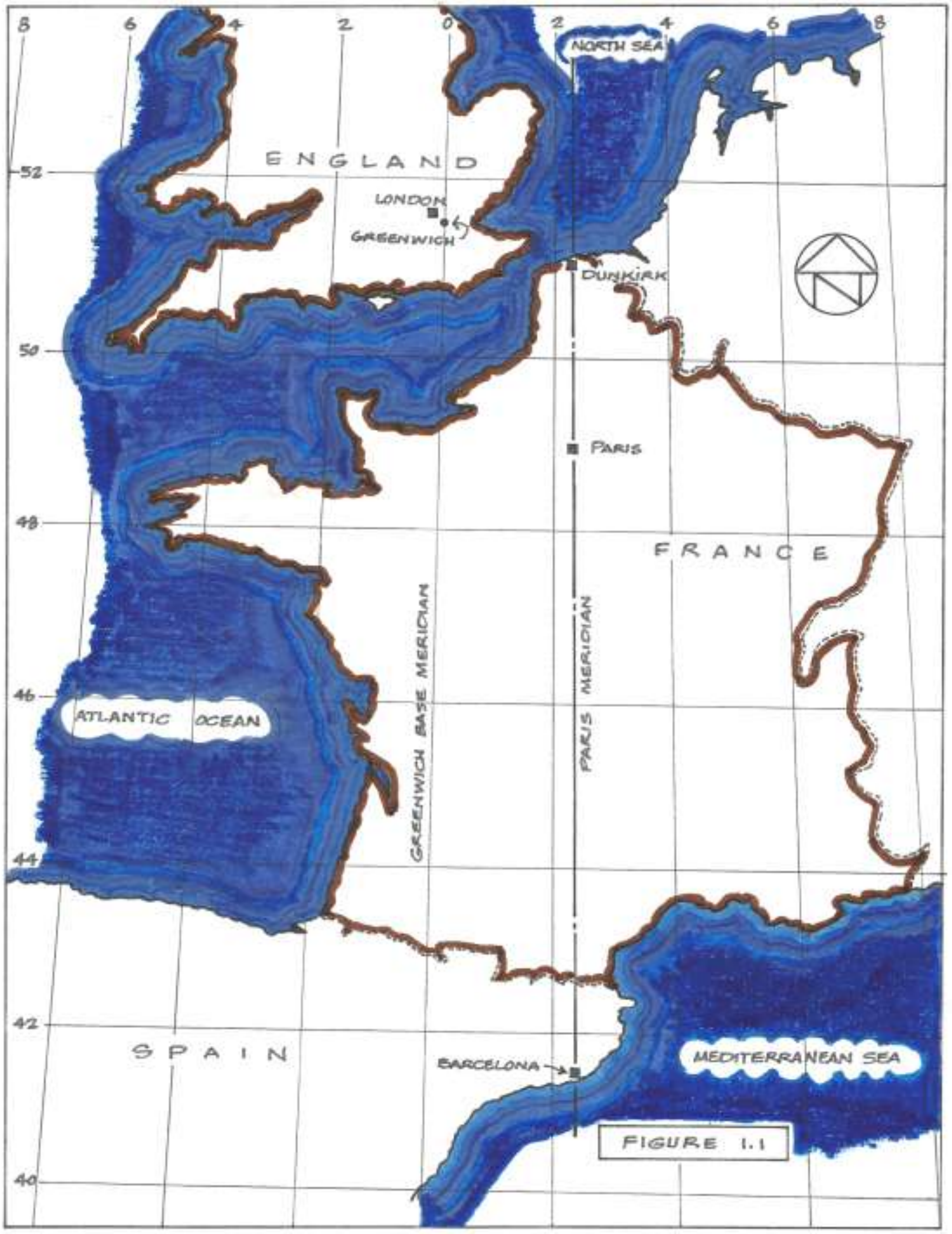
During the convention of 1971, a seventh base unit was added, *the mole*, as a measure of the molecular weight of a substance in mass-grams.

In the Appendix at the end of this course, we show the meaning and explanation for every one of those base metric units as currently accepted by *Le Systeme International d'Unites* (International System of Units), also called Systeme International for short and commonly abbreviated as *the SI.*

Regressing in time, since the beginning of its creation, the United States' system of units has always been similar to those of the British imperial system as both were derived from the original English units, as they evolved over the millennia from their roots in the Roman and Anglo-Saxon units of measurement.

The customary system was always championed by the U.S. International Institute for the Preservation and Perfecting Weights and Measures since the 19th century. As the title implied, they made every effort to preserve the English units by fighting all "metric schemes" to supersede what they called "a perfect inch, a perfect pint" as they were only deemed "acceptable to the Lord".

Nevertheless, in 1988 the U.S. Government passed the Omnibus Trade and Competitive Act which made the metric system –perhaps in too much of a soft language- "the preferred system of weights and measures for the U.S. trade and commerce". In spite of all that, the United States of America still remains a bastion of resistance against the metric system with no much of a chance for change in the horizon.


8
6
4
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42
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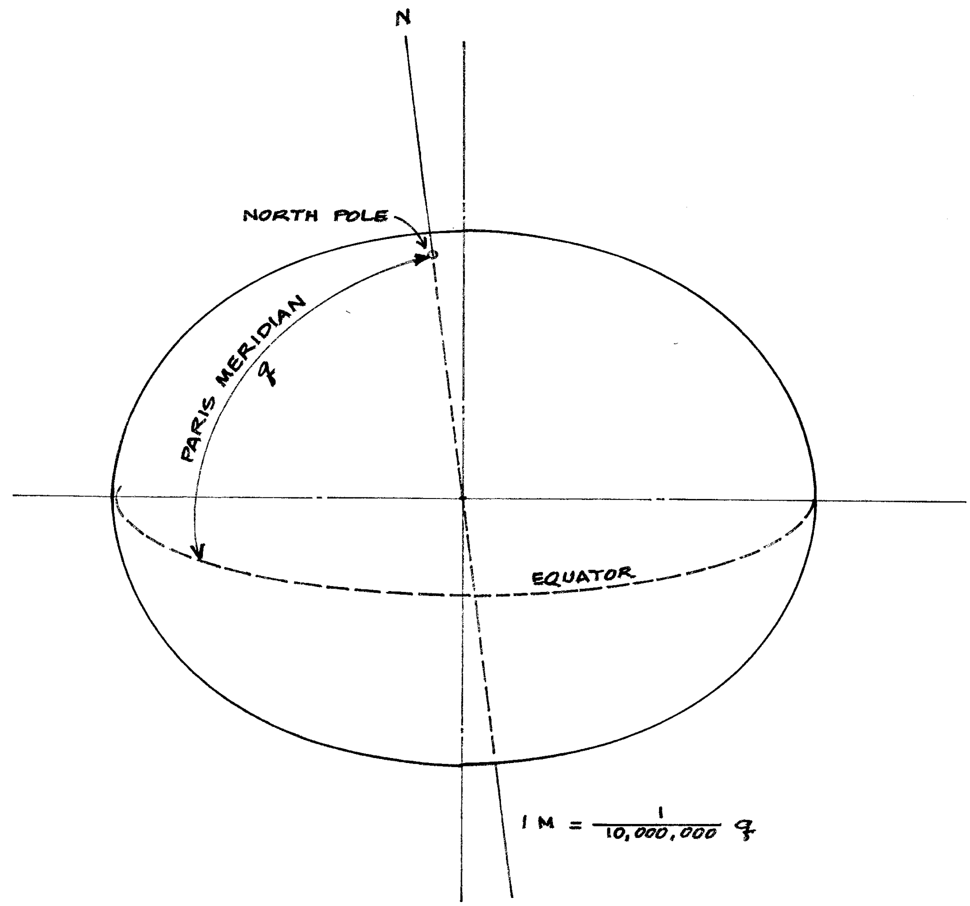
NORTH SEA
ENGLAND
LONDON
GREENWICH
DUNKIRK
PARIS
FRANCE
ATLANTIC OCEAN
GREENWICH BASE MERIDIAN
PARIS MERIDIAN
SPAIN
BARCELONA
MEDITERRANEAN SEA
FIGURE 1.1



NORTH QUADRANT OF PARIS MERIDIAN

FIGURE 1.2

2.0 STANDARD AMERICAN UNITS OF MEASURE

The U.S. customary system of measures developed from the English units as they were in use through the British Empire before the American independence.

For measuring lengths, the U. S. customary system uses the inch, foot, yard and mile, which are the only four customary length measurements in every day usage. In 1959 those four units of measurement were defined on the basis of the yard being equal to 0.9144 meter.

The table below shows commonly accepted divisions and subdivisions in the foot-pound system:

Units	Divisions	Meter Equivalence
1 point (p)		352.778 um
1 pica (P/)	12 p	4.233 mm
1 inch (in)	6 P/	25.4 mm
1 foot (ft)	12 in	0.3048 m
1 yard (yd)	3 ft	0.914 m
1 mile (mi)	5,280 ft*	1.609 km
1 link (li)	7.92 in	0.201 m
1 rod (rd)	16.5 ft	5.029 m
1 chain (ch)	4 rd**	20.117 m
1 survey mile (statute mi)	8 fur	1.609+ km
1 league (lea)	3 mi	4.828 km
1 fathom (ftm)	2 yd	1.828 m
1 cable (cb)	120 ftm	219.456 m
1 nautical mile (nmi)	1.151 mi	1.852 km
1 furlong (fur)	10 ch	201.168 m

*Or 1,760 yds.
**Also equal to 66 ft.

3.0 STANDARD INTERNATIONAL METRIC UNITS

As the number of *metric countries* increased, the need for an international coordination became a compelling necessity. A treaty designated as the *Convention du Metre* was signed in Paris, France in 1875, by the plenipotentiaries of eighteen countries and later revised in 1921 under an increased membership. After that, any other country was allowed to join by simply notifying the French Government of their intention to do so and signing the agreement.

As already indicated above, the SI consisted of six basic units: the meter, kilogram, second, ampere, Kelvin and candela. The other not less important units -such as force and electrical resistance- could be derived from and in coherence with those basic units. In this case "coherence" was intended to mean that either the product or quotient should be made of any two of the basic units above referred to. Further, it also meant that all so derived units would be directly inter-related with two or more of the basic units.

The SI was (and is) also responsible to provide uniformity in terminology as well as to the use of the proper mathematical symbols. A partial view of the official list of *multiples* and *sub-multiples* is given below:

SI Multiples and Sub-multiples

Units	**Prefix**	**Symbol**
1,000	Kilo	(k)
100	Hecto	(h)
10	Deca	(da)
0.1	Deci	(d)
0.01	Centi	(c)
0.001	Milli	(m)

4.0 DECIMAL OR DUODECIMAL?

The same way that the Metric System did not necessarily need to be decimal, the English (Foot-Pound) System did not have to be duo-decimal either. To illustrate such a mere fact, we have prepared a decimal adaptation of the latter system -as the millimeter is to the metric system- based on a constant unit: the *inch,* which, and for all the purposes of this assumption, we will keep unchanged with all its known standard fractional and decimal values.

As an additional step in this demonstration, we will create a new unit: the *mini-foot* equal to 10 inches rather than accustomed 12 inches, and therefore also equal to 0.254 meter. The table below provides a breakdown of the applicable multiples, which is for the most part self-explanatory:

Decimal Foot-Pound System

Designation	Symbol	Value	English Equiv.	Metric Equiv.
Mini-Foot	mft	10 in.	10 in.	0.254 mt.
Deca-Foot	dft	10 mft	100	2.54
Hecto-Foot	hft	100 mft	1,000	25.40
Kilo-Foot	kft	1,000 mft	10,000	254.00
Mile	mi	10,000 mft	100,000	2,540.00
Mega-Foot	mmft	100,000 mf	1,000,000	25,400.00

In this manner, the acclaimed decimal operational ease would be added to the foot (in this case the mini-foot), while at the same time preserving the traditional advantages of the English system.

CONCLUSION

After having examined the benefits and advantages of the Decimal Metric System (DMS), very particularly the natural advantage of using the number 10 as a base of mathematical operation, which indeed simplifies the basic arithmetical calculations as compared against any other number, convenience that has made it the favorite throughout the world as attested by the fact that 90% of the world population has preferred it against any other system of weights and measurements. In the remaining 10% of such population is included the United States of America, sharing such a dubious honor with Burma and Liberia.

Despite of all that, the American public has stubbornly resisted implementation of the Metric System for a variety of reasons that we will see below, and as some candidly have admitted and some other ones have tacitly implied, as well as by the actions of those responsible for its implementation.

Aside of the fact that in cases such as a change in the system of weight and measures may represent unsubstantiated and even negligible gains in the eyes of the casual observer, in the same way, a non-action is also a manner of decision, both in form and content.

These are the specific opposing views that we have been able to collect from the many different sectors and sources where changes would have a direct and meaningful impact as result of any DMS forceful implementation:

#1- Despite the convenience of ten as a *natural base* number, it has some inconveniences as compared to the number twelve, as it cannot be divided by three, four or six.

#2- Some members of the carpentry and building trades contend that it is far easier to remember and integer plus a fraction than any given number of millimeters.

#3- The generalized perception conducive to believe that the combination of foot-inch measurements are much more suitable when distances must be frequently divided into halves, thirds and quarters than the alternative.

#4- The supporters of the foot-pound system claim that the DMS is dehumanizing because it disconnects their system based of the human parts for a system that is total foreign to the human nature.

#5- The religious zealots were not about to waste the opportunity to express their views, therefore they made their feelings clear at the end of the 19th century when said that "the French Revolutionary metric system was not only atheistic but also the work of the Devil".

Lastly, it should not be a surprise that persons such as scientists, industrialists, engineers, architects, land surveyors, geologists, builders, carpenters, merchants and traders, who in the course of their practices constantly use measurements to perform their work, would commonly develop "a way of thinking" and a well defined sense of dimension, volume and weight within the boundaries of their own system of measures, and therefore, would be the first ones to oppose firm resistance against any changes that could disrupt their hardly gained experience.

APPENDIX

1- METRIC BASE UNITS

METER (m)
Unit measure of length originally defined as *one ten-millionth of the meridian passing through Paris between the North Pole and the Equator.* However, in our modern times it is defined as *the distance traveled by light in a vacuum in 1/299 792 458 second.*

KILOGRAM (kg)
Unit measure of mass determined as being *the weight of one cubic decimeter of pure water at its freezing point.* However, presently is taken as the mass of the international prototype kept in Paris, France and the other signatory countries.

SECOND (s)
Originally defined as the 1/86 400 part of a day. Nowadays defined as *the duration of 9 192 631 770 periods of radiation corresponding to the transition between the two hyperfine levels of the ground state of the Caesium 133 atom.*

AMPERE (A)
Originally defined as *one-tenth of the electromagnetic unit of current flowing in an arc 1 cm. long of a circle of 1 cm. in radius which creates a field of one Oersted at the center.* Now defined as *the constant current which, if maintained in two straight parallel conductors of negligible cross-section, infinite length and placed one meter apart in a vacuum, would produce between those conductors a force equal to 0.00000002 Newtons* per meter of length.*

KELVIN (K)
Originally conceived as *obtained by assigning 0 deg C to the freezing point of water and 100 deg C to the boiling point of water.* Now being defined as *0.0037 times the thermodynamic temperature of the triple point of water.*

MOLE (mol)
Originally *the molecular weight of a substance in mass grams.* Now conceived as *the amount of substance of a system which contains as many elementary entities as there are atoms in 0.012 kilogram of carbon 12.*

CANDELA (cd)
Originally designated as *the value of a new candle with such brightness as the full radiator at the temperature of solidification of platinum equals the brightness of 60 new candles per square centimeter.* In our time is seen as *the source which emits monochromatic radiation of a frequency of 0.000000000540 hertz with a radiant intensity in the given direction of 0.00146 watts per steradian.*

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*A “Newton (N)” is defined as the unit of force which, when applied to a mass of 1 kg will produce an acceleration of 1 m/sec/sec.

2- ANCIENT PERSIAN UNITS OF MEASUREMENT

The oldest known system of weights and measures was established in the ancient Persian Empire in the year 550 BC under the Achaemenid Dynasty, which spanned until about the year 350 BC.

The table below shows the approximate relationship amongst the Persian units and their equivalents to modern units of weights and measures:

Unit	Persian Name	Multiples	Metric Value	English Value
Finger	Aiwas	Base Unit	20 mm	0.8 in
Hand	Dva	5 aiwas	100 mm	4 in
Foot	Trayas	3 dva	300 mm	12 in
Four Hands	Remen	4 dva	400 mm	16 in
Cubit*	Pank'a	5 dva	500 mm	20 in
Six Hands	Swacsh	6 dva	600 mm	24 in
Pace	Pank'aa	5 trayas	1.5 m	5 ft
Ten Feet	Daca Trayas	2 pank'aa	3.0 m	10 ft
Hundred Feet	Chebel	8 daca trayas	24 m	80 ft
League**	Parasang	250 chebel	6 km	3.75 mi
Mansion	Stathmos	5 parasang	30 km	18 mi
Asparsa***	Asparsa	Unknown	195 m	

*The Cubit was also equivalent to Five-Hands. The reader should notice that the *cubit* was a measuring unit also mentioned in the Bible as the book describes (1 Kings 6:2) "the house which King Solomon built for the Lord, the length thereof was threescore cubits, the breadth thereof twenty cubits, and the height thereof thirty cubits."
**The League was also described as "the distance a horse could walk in the period of one hour."
***The Asparsa was a unit of measurement that seemed to have been used somewhat loosely and anywhere between 180 to 195 meters. It was also equated to 360 cubits.

Units of Volume and Weight

Volume was usually described by *shekels, minas or talents.* The shekels and talents were also designations of currency. While the *shekel* was equivalent to 8.3 ml of liquid volume but also a coin; the *talent* equaled 25 liters and was also a measure of weight for gold bullion and bulk coins.

Again, by using the Bible as a historical reference book, we invite the reader to examine some of the biblical descriptions of King Solomon's riches in 1 Kings 10:14 "And Hiram sent to the king six-score *talents* of gold." That was indeed a large amount of gold.

3- ANCIENT ARABIC UNITS OF MEASUREMENT

We make reference here to the Arabic units of measure as originally proclaimed as the official tender units of the Ottoman Empire.

Please notice that although the name designations were similar to those of the Persian units, they had certain differences of magnitude.

Arabic Name	Relative Value	Metric Equivalence	English Equivalence
Assba	1/16 foot*	2.25 cm	0.89 in
Cabda	¼ ft	9 cm	3.54 in
Cubit	1.5 ft	54 cm	21.3 in
Orgye	6 ft	1.92 m	6.30 ft
Qasab	12 ft	3.84 m	12.60 ft
Seir**	600 ft	192 m	630 ft
Ghalva	720 ft	230 m	754 ft
Parasang***	18,000 ft	5.75 km	3.60 mi
Barid	4 parasang	23 km	14.30 mi
Marhala	8 parasang	46 km	28.60 mi

*The feet shown on this column are Arabian feet (approx. 14.2 in), as opposed to the 12 in. English foot.
**Normally seen as a stadium length. It is not surprising, for in modern times we use the expression "equal to, or larger than so many football fields".
***Seemingly adopted from the Mesopotamian parasang.

4- CONVERSION FACTORS FROM THE DMS TO ENGLISH FOOT-POUNDS

The conversion of units from the metric system to the foot-pound system is facilitated by the use of the table below which is mostly intended for the needs of engineers:

Metric Units	Multiplied by	Results in
Centimeters	0.0328	Feet
Centimeters	0.3937	Inches
Hectares	2.4710	Acres
Kilograms	2.2046	Pounds
Kilogram-meters	7.2330	Foot-pounds
Kilograms per meter	0.6720	Pounds per foot
Kgs. per square centimeter	14.2234	Pounds per square inch
Kgs. per square meter	0.2048	Pounds per square foot
Kgs. per cubic meter	0.0624	Pounds per cubic foot
Kilometers	0.6214	Statute miles
Kilometers	3,280.83	Feet
Meters	3.2808	Feet
Meters	39.37	Inches
Meters	1.0936	Yards
Square centimeters	0.1550	Square inches
Square kilometers	247.104	Acres
Square kilometers	0.3861	Square miles
Square Meters	10.7639	Square feet

END