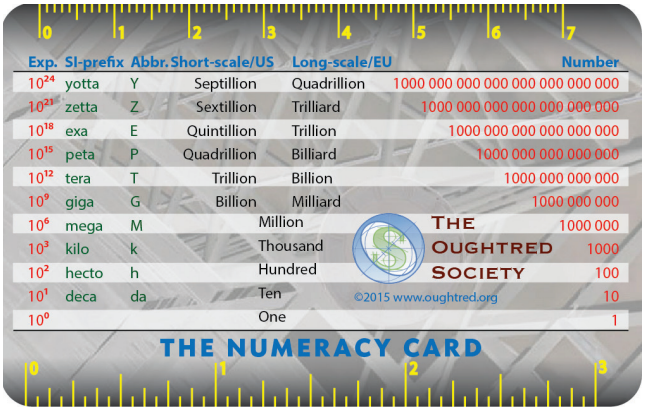
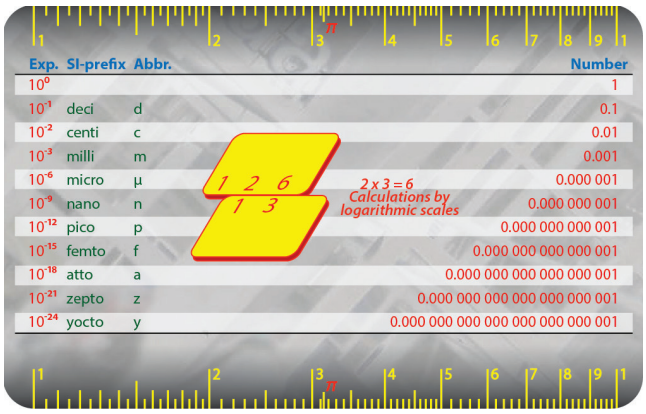
THE OUGHTRED SOCIETY NUMERACY CARD
Instruction Booklet





NUMERACY

"NUMERACY" has sometimes been defined as the quantitative version of "literacy", leaving the burden of definition to that older term. Many definitions of "Numeracy" have been created, from "ability to do arithmetic", or "handling a 4-function calculator", up to the more mathematical/cultural-oriented:

> "*Numeracy is the ability to process, interpret, and communicate numerical, quantitative, spatial, statistical, even mathematical, information, in ways that are appropriate for a variety of contexts, and that will enable a typical member of the culture or subculture to participate effectively in activities that they value*" (UK).

Opinions appear to be divided between emphasis on basic number awareness on the one hand, and mathematical understanding (up to and including statistics) on the other hand. Instead of a watertight definition, we just give here some keywords to get a rough idea of what is meant by the concept:

> "*Numeracy is about grasping numbers and units, their names, values, and calculations*."

The Oughtred Society (OS) Numeracy Card can be used as an aide-mémoire to remember the names of numbers by their values, as measurement tool for units of length, and as a slide rule for basic calculations. The OS Numeracy Card is a handy companion of credit-card size, a perfect fit to carry along in the wallet at all times.

Most English-speaking countries use the decimal point as separator between integer and fractional part of a number, while most EU countries use the decimal comma. So we use the decimal dot on the OS Numeracy Card, as the card is written in English.

A comparable choice is needed for the 1000-separator, the OS Numeracy Card uses the more neutral space separator between 3-digit groups within a number (instead of the decimal comma). ISO has defined a Unicode character for this purpose, called a thin space separator.

NUMBERS by NAME and VALUE

Two kinds of number designators are shown on the OS Numeracy Card: the range of large integer numbers “million”, “billion”, etc., and the range of prefixes to scientific unit values, as defined by ISO (International Organization for Standardization).

BILLIONS HERE and THERE

Thanks to the decimal system, we name any number by the base numbers 1 to 10 in combination with powers of ten such as ten, hundred, and thousand. Beyond that range, additional names have been defined for powers of 1000, such as million, billion, etc.

The problem is the existence of two different systems, called “long-scale” and “short-scale”, sometimes causing disastrous confusion.

Long-scale is the oldest system of names in which every new term greater than million is 1,000,000 times the previous term: billion (from bi and million) means a million to the power of two or a million millions (10^{12}), trillion (from tri and million) means a million to the power of three or a million billions (10^{18}), and so on with Latin names. For numbers that are only a thousand times greater, the postfix ”–ion” is replaced by “–iard”. This system is used in most European countries (excluding the UK).

Short-scale is the system in which every new term greater than million is 1,000 times the previous term: billion means a thousand millions (10^{9}), trillion means a thousand billions (10^{12}), and so on.

The short-scale system is used in the USA, and most other English-speaking countries (including the UK) have chosen this system in the last decades of the 20th century.

UNITS by CM and INCHES

The SI system of units is an extensive structure, impossible to summarise on credit-card scale. Only the unit of length is represented on the OS Numeracy Card, by way of a 7-centimeter (cm) and a 3-inch ruler along upper and lower edge respectively.

The SI-defined cm and the non-SI inch form a nice example of the need for unit conversions, especially as the inch is often still divided in a binary way: ½, ¼, up to 64^{th} parts. When the cm and inch ruler scales of two OS Numeracy Cards are joined and aligned, a direct conversion is visible between metric cm and binary fractions of inches. Alternatively, one could use the slide rule function of two OS Numeracy Cards, and set the multiplication factor of 2.54 for conversion from inches to cm.

When the ruler edges of two OS Numeracy Cards are joined, arranged on a flat surface, showing the basic summation by sliding two linear scales along each other is possible. Values of inch and centimeter units can be added or subtracted from each other. If the two Numeracy Cards are repositioned so that both cm rulers are joined, one could in principle even demonstrate regular summations, although this process takes some upside-down reading talent, and the number range is obviously too limited.

CALCULATIONS by LOGARITHMIC SCALES

The next step in calculations is the multiply/divide operation by summation on the logarithmic scales at the other side of the OS Numeracy Card. The picture "2 x 3 = 6" in the middle of the OS Numeracy Card can be considered as the shortest manual ever to explain multiplication on a slide rule. The log-scales have been kept as simple as possible, only a π gauge mark remains to show the mathematical connotation.

ACKNOWLEDGMENTS

The OS Numeracy Card was originally developed by the IM 2010 Committee and the fine artwork of graphical designer Willem van der Veere. This revised version is used with the permission of the Dutch Slide Rule Society (KRING) and the Oughtred Society is deeply grateful for their contributions, in particular Otto E van Poelje.

THE OS NUMERACY CARD

with extreme numbers from Mini to MORE

This basic credit-card sized OS Numeracy Card is used to retrieve knowledge:

- knowledge and information about numbers, from very small to very large
- to give you credit for knowing your numbers
- from 0.000 000 000 000 000 000 000 001 to 1 000 000 000 000 000 000 000 000
- powers of ten, decimal points, names, prefixes, and symbols for SI unit values
- from 10^{-24} to 10^{+24}
- only extremes such as Googol or Scrooge McDuck's multiplujillion are missing
- multiply and divide as two OS Numeracy Cards, together, form a 2-digit slide rule
- measure lengths in centimeters and inches

You, with a high level of "Numeracy", will surely have most of the OS Numeracy Card's information readily available in your head. However, there is more to the cards.

A very important function of the OS Numeracy Card is the didactic value provided when discussing the concepts of "Numeracy" with others who may be less numerate. You can use OS Numeracy Card to point out the exponential approach to extreme numbers, to demonstrate adding and subtracting on sliding scales, and to explain calculations on logarithmic scales.

SI PREFIXES

During the metrication efforts of the last 200 years, a consistent system of physical units has been agreed at BIPM, CIPM, and CGPM ("Bureau International des Poids et Mesures", etc.: the International Bureau, Committee and General Conference for Weights and Measures) and is currently standardised by ISO in the standards series 31 (to be renamed ISO-80000). In that international standard of units, called the "Système International d'Unités" (SI), a list of prefixes is included to impose an unambiguous notation for very small and very large unit values. This system defines names and abbreviations of prefixes for factors of multiple thousands (powers of 10^3), of which kilo, mega, milli, and nano are well-known examples.

USE of EXTREME NUMBERS

The prefixes and names of extreme numbers may be seldom used today, but this may change soon. In current developments we see dimensions grow both to extremely large numbers as well as extremely small. For example, current globalization trends will lead to numbers being expressed on a worldwide scale; world trade and financial figures exceed the range of (USA) billions of dollars, so we may see new names such as "terabucks" (we are already using the term "megadollars").

In astronomy we will have to adapt to larger dimensions as the exploration of the solar system progresses. Travels to Mars will need the use of terameters, even petameters for the outer planets and beyond. Typical solar and stellar units such as the Astronomical Unit (~ 0.1496 Tm or ~ 93,000,000 miles), light-year (~ 9.461 Pm or ~ 5.87849 x 10^{12} miles), and parsec (~ 30.857 Pm or ~ 3.262 light-years) might also be used, but these are non-metrical and would look alien with prefixes, for example "milliparsecs".

In extreme miniature engineering we are already used to "nano"-technology. Production of digital chips already has reached etching resolutions of ~ 10 nanometers, and the next break-through in technology may bring us well into the range of picometers (if there is no limit to Moore's law).

Pico also is known already a long time to those who have tinkered since the 1960s with discrete component electronics, using capacitors in the pF range.

Many other SI-units will have, or have already, a need for using extreme prefixes.

A warning is needed for extreme numbers expressed in binary exponents, as used in computer technology. A megabyte (MB) of disk memory is now approximately 10^6 bytes, but mega was originally used to mean the binary value $(2^{10})^2$ = 1,048,576. For that binary value the IEC (International Electrotechnical Committee) has designed the term mebibyte (MiB) for "mega-binary-byte".

NOTE: A range of binary prefixes has been defined, representing powers of 2^{10}: kibi, mebi, gibi, tebi, etc., deriving the first two letters from the ISO prefixes for the powers of 10^3. **Beware!**