BI-WEEKLY COMMENTS ON SI

Comment 3

MULTIPLES AND SUBMULTIPLES OF SI UNITS

3.1 Quantities that are very large or very small

Some physical quantities are very large while others are very small. If they were only expressible in terms of SI base units or SI derived units, the associated <u>numerical values</u> would be correspondingly very large or very small.

Consider, for example, the problem of expressing the average distance from the earth to the moon in terms of the meter, which is the <u>SI base unit</u> of length. The distance amounts to about three hundred and eighty five million meters. In symbolic form, this can be expressed as 385 000 000 m, or alternatively as 385×10^6 m.

At the opposite side of the spectrum, the diameter of an atom is about one hundredth, millionth, millionth of a meter which, in symbolic form, can be expressed as
 0.000 000 000 000 01 m, or as 10^{-14} m.

3.2 Multiples and submultiples of SI base units and SI derived units

The SI gets around this big-number and small-number problem by creating <u>multiples</u> and <u>submultiples</u> of the SI <u>base units</u>, as well as the SI <u>derived units.</u>   (From here on we will simply lump SI <u>base units</u>, and SI <u>derived units</u> under the name <u>SI units</u>).

The multiples range in steps of 10, 100, and thereafter in steps of 1000 up to 10^{24} times the SI unit. The submultiples range in steps of 1/10, 1/100, and thereafter in steps of 1/1000, down to 10^{-24} times the SI unit.

3.3 SI prefixes

The <u>multiples</u> of SI units are indicated by adding a <u>prefix</u> to the SI unit. For example, the prefix designating one million times is "mega" and its symbol is M. Consequently, the name for one million meters is "megameter", and its symbol is Mm. The distance from Earth to the moon may then be expressed as 385 Mm.

Similarly, <u>submultiples</u> of SI units are indicated by adding a <u>prefix</u> to the SI unit. For

example, the prefix designating one millionth is "micro" and its symbol is the Greek letter µ. Consequently, 15 millionths of a meter, in symbolic form, becomes 15 µm.

The Wildi SI Chart titled ⊗SI PREFIXES displays the entire range of SI prefixes, along with their names, symbols and multiplying factors. Using this prefix chart, and searching for an appropriate SI prefix, the approximate diameter of an atom (10^{-14} m) can be expressed as 10×10^{-15} m which is ten femtometers, or 10 fm in symbolic form.

3.4 Important note on prefixes

As an important side issue, SI prefixes are always written in upright form (never italic). Also, they are directly incorporated into the SI unit (no space between the prefix and the SI unit). Only one prefix is attachable to an SI unit. Two prefixes are NOT allowed.

For example, even though the base unit of mass is the kilogram, the term millikilogram for 1/1000 of a kilogram is not allowed. The correct term for one thousandth of a kilogram is gram.

3.3 Just for fun – try this SI quiz

Using the Wildi SI Charts, express the quantities listed in the the following table in symbol form. Remember that double prefixes are never allowed.

	A	B	C
1	14 petameters	0.23 nanometers	15 millikelvins
2	234 milligrams	15.2 picofarads	135 kilometers per hour
3	4.2 attojoules	17 cubic meters per second	24 kilovolts
4	5 million kilograms	0.34 micrometers	9.4 zettameters

The A1 to C4 solutions are given below. For example, the solution to B3 is 17 m³/s.
But don't look until you've tried to discover the appropriate symbols by yourself.

⊗ SOLUTIONS

THAT'S ALL FOR NOW FOLKS!

SEE YOU IN TWO WEEKS !

NIST-7 is the cesium-beam primary frequency standard for the United States. At an accuracy of 1 $\times$ 10^{-14}, this standard contributes significantly to the accuracy of the rate of international time and lends long-term stability to NIST's time scale. The standard also serves as a reference in evaluating the performance of advanced commercial frequency standards. (*Courtesy of NIST, the National Institute of Standards and Technology*)