Writing with the SI

Byline: Elizabeth Benham

Writing is a regular part of most jobs. But in the Science, Technology, Engineering, and Mathematics (STEM) fields, it's especially important that measurement results are communicated clearly and unambiguously. Avoiding measurement unit writing errors is critical. Even slight measurement unit oversights undermine confidence in the resulting products and services, or worse…result in costly mistakes or deadly mishaps. In weights and measures, a metrology laboratory communicates calibrated values and uncertainties to the regulatory official using a calibration certificate. In manufacturing, a product label communicates the net quantity of contents to consumers. In a retail environment, a store shelf label communicates the unit price to shoppers. In some instances, we may never meet the end users of our measurement results face-to-face. However, they will certainly form an opinion about our organization based on their experiences with these written communications.

The accepted convention of scientific and technical writing is to use the International System of Units (SI), commonly known as the metric system. Becoming more familiar with proper SI writing style will help add clarity to work correspondence and build confidence when communicating measurement results.

The SI measurement system is built upon 7 base quantities, represented by 7 units and symbols: length (meter, m), mass (kilogram, kg), time (second, s), electric current (ampere, A), thermodynamic temperature (kelvin, K), amount of sub-stance (mole, mol), and luminous intensity (candela, cd). The system also includes derived units, which are formed for convenience of notation by combining base units algebraically with other derived units. While there are 22 SI derived units with special names, there are additional commonly used derived quantities that do not have special names, such as area (square meter, m^2) and volume (cubic meter, m^3). Additionally, there are some units that can be used with SI units. For example, the second (s) is the SI base unit of time but the units of minute (min), hour (h), and day (d) are also per-mitted for use. There are units that are given special names, such as the liter (L) and hectare (ha).

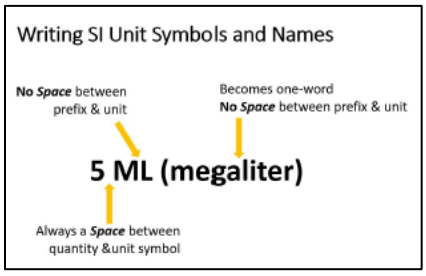

Figure 1. Basic SI quantity and unit symbol with prefix format

A series of 20 prefix names and symbols are used to form the names and symbols of the decimal multiples and submultiples of SI units (**www.nist.gov/pml/weights-and-measures/metric-si-prefixes**). The scale of a quantity can be in-creased or decreased using powers of 10. Using SI prefixes helps an author represent units that are of an appropriate magnitude for their application but are particularly helpful when expressing very small or very large quantities. For example, a surveyor may choose kilometers (km) on a map legend, while an engineer would select millimeters (mm) on a mobile phone design specification diagram. It is important to remember that when a prefix is used, the prefix name and the unit name are combined to form a single word, and similarly the prefix symbol and the unit symbol are written without any space to form a single symbol (Figure 1). For example, write milligram (mg), not milli gram (m g). Compound prefix names or symbols are not permitted. For example, nm (nanometer) is correct, NOT mμm (millimicrometer).

One of the primary benefits of using the SI in written communication is that unit symbols are the same in all languages, while spelling of unit names and pronunciation are language dependent. Using the SI provides broad understandability of quantitative information across a wide audience who may read our communications. Because spelling varies among languages, it is essential to use SI symbols to facilitate the interpretation of written measurement results. It is important to note that spelling differences even exist between American and British English. For example, the American spelling

of the prefix deka (da) uses a "k", not deca with a "c" and the element Cs is spelled cesium, not caesium, and the base unit of length is spelled meter, not metre. The National Institute of Standards and Technology (NIST) follows the American English writing practices found in Webster's Third New International Dictionary.

It's recommended to always consult NIST Special Publication (SP) 811, Guide for the International System of Units, when applying SI writing style rules and review written communications using the manuscript checklist (**www.nist.gov/pml/special-publication-811**). Here are a few writing best practices and tips.

Formatting Best Practices for Writing Quantities. SI units should be written in an upright typeface with a space between the numeric quantity value and the unit symbol (see Figure 1). Unit symbols are a "shorthand" way of representing a unit name. They should not be confused with abbreviations, or a shortened form of a word or phrase. Abbreviations are commonly used in non-SI measurements (e.g., U.S. customary units). A unit symbol represents both the singular and plural tense, so an "s" should not be added at the end of a unit symbol to represent more than one (e.g., kg, not kgs). If the spelled-out name of a unit is used in a sentence, the normal rules of English grammar are applied. For example, "35-millimeter film." Punctuation is not used after a unit symbol. For example, "the bottle has a 123 mm radius," not "the bottle has a 123 mm. radius."

The decimal marker in the U.S. is commonly a dot on the baseline, while a comma is frequently used outside the U.S., but both methods are permitted by the International Bureau of Weights and Measures (BIPM) SI Brochure for use with the SI (**www.bipm.org/en/publications/si-brochure/**). When numerical values have more than four digits on either side of the decimal marker, it is a formatting best practice to separate the numbers into groups of three using a thin nonbreaking space (Ctrl + Shift + Space) counting from both the left and right of the decimal marker. For example, 12 345.678 91 is highly preferred to 12345.67891. Commas are not used to separate digits into groups of three. For numbers less than one, a leading zero is written before the decimal marker. Leading zeros help minimize the risk of magnitude errors. For example, accidently interpreting 0.1 g as 1 g (a ten-fold error).

Use formatting practices to make it clear to readers which unit symbol belongs with a numerical value or mathematical operation. For example, write 35 cm × 48 cm, not 35 × 48 cm. Write quantity ranges with the text "to" instead of a dash; a dash may be misinterpreted as a negative symbol. For example, 20 °C to 30 °C or (20 to 30) °C, but not 20 °C - 30 °C.

Measure	Best Practice	Unacceptable
Numerical Values (4 or more) Grouping	12 345.678 91	12345.67891
Leading Zero	0.1 g	.1 g
Space Between Quantity & Symbol	0.25 %	0.25%
Formatting Ranges	20 °C to 30 °C or (20 to 30) °C	20 °C - 30 °C

Table 1. Tips for writing values of quantities

SI Writing Tips

The written names of all SI units begin with a lowercase letter, except when grammar rules require capitalization, such as at the beginning of a sentence or capitalizing a proper noun. For example, the base unit for time is the second (lowercase) and s (lowercase) is the unit symbol. For those units named after a person, the unit name is still written in lowercase, but the unit symbol is capitalized like a proper noun. For example, the SI unit for pressure is the pascal (lowercase), represented by the unit symbol Pa (uppercase), in honor of the French mathematician and physicist Blaise Pascal. One exception involves writing "degree Celsius" where degree is lowercase and Celsius is capitalized. Another exception has been made for the liter (L), where an uppercase L is used for the unit symbol to avoid confusion between a lowercase l and the numeral 1; in some fonts (like the present) they are indistinguishable!

Capitalization also gives meaning to prefix symbols. For example, the prefix symbol M (uppercase) represents the prefix mega, while the symbol m (lowercase) represents the prefix milli. In this case, an accidental capitalization would cause a huge error in magnitude. NIST SP 811 describes several capitalization best practices (**www.nist.gov/pml/special-publication-811**).

To quickly improve SI writing practices, be aware of these very common SI unit symbol writing mistakes (Table 2). These tips and more are highlighted on the Writing with Metric Units webpage (**www.nist.gov/pml/weights-and-measures/writing-metric-units**). Please keep in mind that some variations of SI writing format are allowed by regulation or within certain industry sectors. For example, "mcg" is accepted substitute in some healthcare applications for "millionth" instead of using the symbol μ (mu) for the prefix micro. Weights and measures writers should look to the Uniform Packaging and Labeling Regulation (UPLR) in NIST Handbook (HB) 130 for accepted SI labeling practices (**www.nist.gov/pml/weights-and-measures/publications/nist-handbooks/other-nist-handbooks/other-nist-handbooks-2-1**).

For more information, please contact Elizabeth Benham, NIST Metric Coordinator, at elizabeth.benham@nist.gov or **TheSI@nist.gov**.

Measure	SI Symbol	Unacceptable Examples	
		Symbol Format	Abbreviation
Mass	kg	KG KG. Kg Kg.	Kgr kgs
	g	G G. g.	GR GRM Grms gr gms
Length	km	Km KM km.	kms
	m	M m.	mtr
	mm	MM Mm mm.	mmtr
Volume	L	L. l l.	ltr
	mL	ML Ml mL.	mls
	cm^3	cm^3	cc
Pressure	kPa	KPa KPA Kpa	
	mmHg	mm Hg	
Temperature	20 °C	20°C 20° C	20 deg C

Measure	SI Symbol	Unacceptable Examples	
		Symbol Format	Abbreviation
Terminology	**Acceptable**	**Obsolete**	
	micrometer	micron	
	degree Celsius	degree centigrade	