Chapter 18. Units of Measurement

The uniform use of units of measure facilitates broad catalog searches across archive systems.The PDS standard system for units, where applicable, is the *Systeme Internationale d'Unites* (SI). The default units for data elements in the *Planetary Science Data Dictionary* (PSDD) are determined as each element is defined and added to the dictionary. Specific unit definitions are also included in the PSDD.

In cases where more than one type of unit is commonly used for a given data element, an additional data element is provided to explicitly identify the corresponding unit. SAMPLING_PARAMETER_RESOLUTION and SAMPLING_PARAMETER_UNIT are one such pair. The PDS allows exceptions to the SI unit requirement when common usage conflicts with the SI standard (e.g., angles which are measured in degrees rather than radians).

Both singular and plural unit names, as well as unit symbols, are allowed. The double asterisk (**) is used, rather than the caret (^), to indicate exponentiation. When the units associated with a value of a PDS element are not the same as the default units specified in the PSDD (or when explicit units are preferred), a unit expression is used with the value. These unit expressions are enclosed in angular brackets (< >) and follow the value to which they apply.

Examples

```
EXPOSURE_DURATION  = 10 <SECONDS>
DECLINATION        = -14.2756 <DEGREES>
MASS               = 123 <kg>
MASS_DENSITY       = 123 <g/cm**3>
MAP_RESOLUTION     = 123 <PIXEL/DEGREE>
MAP_SCALE          = 123 <KM/PIXEL>
```

Note that in the above example, MASS_DENSITY is not expressed in the SI default unit of measurement for density (kg/m**3).

PDS recommends (in order of preference) that measurements be expressed using the default SI units of measurements, as defined in the following paragraphs. If it is not desirable to use the default SI unit of measurement, then the unit of measurement should be expressed using the SI nomenclature defined in the following paragraphs. If a unit of measurement is not defined by the SI standard, then a unit of measurement can be derived (e.g., pixels per degree, kilometers per pixel, etc.).

18.1 SI Units

The following summary of SI unit information is extracted from *The International System of Units.*

Base units — As the system is currently used, there are seven fundamental SI units, termed “base units”:

QUANTITY	NAME OF UNIT	SYMBOL
length	meter	m
mass	kilogram	kg
time	second	s
electric current	ampere	A
thermodynamic temperature	kelvin	K
amount of substance	mole	mol
luminous intensity	candela	cd

SI units are all written in mixed case; symbols are also mixed case except for those derived from proper names. No periods are used in any of the symbols in the international system.

Derived units — In addition to the base units of the system, a host of derived units, which stem from the base units, are also employed. One class of these is formed by adding a prefix, representing a power of ten, to the base unit. For example, a kilometer is equal to 1,000 meters, and a millisecond is .001 (that is, 1/1,000) second. The prefixes in current use are as follows:

SI PREFIXES

Factor	Prefix	Symbol	Factor	Prefix	Symbol
10**18	exa	E	10**-1	deci	d
10**15	peta	P	10**-2	centi	c
10**12	tera	T	10**-3	milli	m
10**9	giga	G	10**-6	micro	
10**6	mega	M	10**-9	nano	n
10**3	kilo	k	10**-12	pico	p
10**2	hecto	h	10**-15	femto	f
10**1	deka	da	10**-18	atto	a

Note that the kilogram (rather than the gram) was selected as the base unit for mass for historical reasons. Notwithstanding, the gram is the basis for creating mass units by addition of prefixes.

Another class of derived units consists of powers of base units and of base units in algebraic relationships. Some of the more familiar of these are the following:

QUANTITY	NAME OF UNIT	SYMBOL
area	square meter	m**2
volume	cubic meter	m**3
density	kilogram per cubic meter	kg/m**3
velocity	meter per second	m/s
angular velocity	radian per second	rad/s
acceleration	meter per second squared	m/s**2

angular acceleration	radian per second squared	rad/s**2
kinematic viscosity	square meter per second	m**2/s
dynamic viscosity	newton-second per square meter	N*s/m**2
luminance	candela per square meter	cd/m**2
wave number	1 per meter	m**-1
activity (of a radioactive source)	1 per second	s**-1

Many derived SI units have names of their own:

QUANTITY	NAME OF UNIT	SYMBOL	EQUIVALENT
frequency	hertz	Hz	s**-1
force	newton	N	kg*m/s**2
pressure (mechanical stress)	pascal	Pa	N/m**2
work, energy, quantity of heat	joule	J	N*m
power	watt	W	J/s
quantity of electricity potential difference	coulomb	C	A*s
electromotive force	volt	V	W/A
electrical resistance	ohm	–	V/A
capacitance	farad	F	A*s/V
magnetic flux	weber	Wb	V*s
inductance	henry	H	V*s/A
magnetic flux density	tesla	T	Wb/m**2
luminous flux	lumen	lm	cd*sr
illuminance	lux	lx	lm/m**2

Supplementary units are as follows:

QUANTITY	NAME OF UNIT	SYMBOL
plane angle	radian	rad
solid angle	steradian	sr

Use of figures with SI units — In the international system it is considered preferable to use only numbers between 0.1 and 1,000 in expressing the quantity associated with any SI unit. Thus the quantity 12,000 meters is expressed as “12 km”, not “12,000 m”. So too, 0.003 cubic centimeters is preferably written “3 mm^3”, not “0.003 cm^3”.

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