

## Why include units on every numeral?

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1. The Mars Climate Orbiter<sup>1</sup> crashed into Mars because the scientists/engineers never communicated with each other about units.
2. It's good written communication to present an argument with units on every numeral.
3. You cannot assume that everyone will always use SI units. They won't.
4. Units are mathematical constants. If you were given  $b = 2c$  and  $y = mx + b$  then you would substitute in for  $b$  to find  $y = mx + 2c$ . Similarly, if you are given  $b = 2 \text{ cm}$  and  $y = mx + b$ , then you would substitute in for  $b$  to find  $y = mx + 2 \text{ cm}$ .
5. It is a rule that you cannot add two numbers with different units. (Quick! What's 1 gram plus 1 centimeter? The question itself is wrong.) It is good to be in the habit of checking for units on your terms to make sure that every term has the same units.
6. Multiple calculators (Google calculator and Mathematica are my favorites) are very well capable of calculating numbers with units. I have caught many of my own mistakes by finding that the units did not evaluate out the way I thought they would. There is no need to ever separate the numerals from the units.

(5.03 (newtons / meter)) \* 3 cm =

**0.1509 newtons**

7. Unitless numbers should be recognizably different from numbers with units of measurement. For example, only a unitless value can be used for a Taylor series.
8. When you separate a numeral from its unit, that value loses its physical meaning.
9. I recognize that writing the units every time is inconvenient, but this inconvenience can be a benefit. Beginning students in Physics often wish to substitute in numerals as soon as possible. The inconvenience of writing 299792458 m/s would hopefully convince these students of the elegance of writing  $c$  instead. In many problems, numerals are often specific to the situation, whereas the symbolic form can be applied to many situations. (The appropriate time to plug in values is after you have isolated the variable you are trying to solve for! This is more elegant and helps avoid a rounding-too-soon error.)

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<sup>1</sup>[https://en.wikipedia.org/wiki/Mars\\_Climate\\_Orbiter](https://en.wikipedia.org/wiki/Mars_Climate_Orbiter)