Expected knowledge of units and basic constants for Physics Preliminary Exam

It is an essential part of being a physicist to be able to demonstrate a physical intuition about basic observations, which includes being able to make simple calculations that include dimensions and numbers, without needing to consult textbooks. Such calculations are an integral part of an undergraduate education in physics, and expected of all of our PhD students. As part of the Preliminary Exam, we therefore ask that you be able to make basic calculations that demonstrate this ability, and demonstrate a physical understanding of the magnitude of physical effects, such as are seen in the supplemental example problems. We understand that these constants are readily available online or in reference books, but knowing the values of these basic constants such as the speed of light, in some consistent set of units, is part of physics. In such calculations, and in your knowledge of these basic numbers, we are looking for 1-2 digits of accuracy, not more, and there are various ways to get each of these numbers, and ways to get other numbers from these (e.g. μ_0 from c and $k=1/(4\pi\varepsilon_0)$).

List of constants we expect you to know numerically in some set of units that allow you to make calculations of other quantities – you are welcome to work in either cgs or mks units, but if in cgs units you need to be prepared to convert to measurable quantities like volts and amps

Earth radius

Speed of sound in air

Speed of light c

Electron charge e , and conversion from eV to ergs or J

Some constant that allows you to express E&M results in meaningful units e.g. volts, gauss or tesla, newtons -- this means either $k=1/(4\pi\varepsilon_0)$ or ε_0 and either μ_0 or c) for mks units, or an ability to convert from statcoulombs to coulombs and from statvolts to volts if you use cgs

Boltzmann constant (or R and Avogadro number, or some other comparable set)

Avogadro number (or R and Boltzmann constant, or some other comparable set)

Rydberg energy

Fine structure constant α

Planck's constant h or $\hbar$, and conversion between eV and wavelength (e.g. hc or $\hbar c$)

Age of the universe

m the mass of the electron

M the mass of the proton

Density of water at room temperature

Index of refraction of water

Standard atmospheric pressure

Size of the hydrogen atom in ground state

Acceleration due to gravity at the Earth's surface, g

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