## ANSWERS TO EVEN-NUMBERED CONCEPTUAL QUESTIONS

**2.** Atomic clocks are based on the electromagnetic waves that atoms emit. Also, pulsars are highly regular astronomical clocks.

**4.** **(a)** $\sim 0.5$ lb $\approx$ 0.25 kg or $\sim 10^{-1}$ kg

**(b)** $\sim 4$ lb $\approx$ 2 kg or $\sim 10^{0}$ kg

**(c)** $\sim 4000$ lb $\approx$ 2000 kg or $\sim 10^{3}$ kg

**6.** Let us assume the atoms are solid spheres of diameter $10^{-10}$ m. Then, the volume of each atom is of the order of $10^{-30}$ m$^3$. (More precisely, volume = $\frac{4}{3}\pi r^3 = \frac{1}{6}\pi d^3$ .) Therefore, since 1 cm$^3$ = $10^{-6}$ m$^3$, the number of atoms in the solid is on the order of $10^{-6}/10^{-30} = 10^{24}$ atoms. A more precise calculation would require knowledge of the density of the solid and the mass of each atom. However, our estimate agrees with the more precise calculation to within a factor of 10.

**8.** Realistically, the only lengths you might be able to verify are the length of a football field and the length of a housefly. The only time intervals subject to verification would be the length of a day and the time between normal heartbeats.

**10.** In the metric system, units differ by powers of ten, so it's very easy and accurate to convert from one unit to another.