Calculus II Project: Geometric Units

Due date: Wed, 5 Dec 12

In the theory of Special Relativity, space and time are inseparable. One consequence of this is that time and distance can be measured in the same unit. For example, distance can be measured in (light) years.

Speed is the change in distance of a particle per unit time. But if distance and time are measured in the same unit, then speed becomes *dimensionless*; it's just a number. In Special Relativity, mass can also be measured in the same unit as distance and time. Such systems of measurement are called *geometric units*. Geometric units are especially useful because one can meaningfully compare distances, masses, and time intervals in a spacetime (see problem 4 below).

In the "cgs" (cm, g, sec) measuring system, the speed of light c and gravitational constant G are given by

$$\begin{aligned} c &= 3 \times 10^{10}\ \text{cm/sec, and} \\ G &= 6.67 \times 10^{-8}\ \text{cm}^3/\text{g}\,\text{sec}^2. \end{aligned}$$

If we set each of these equal to (dimensionless) 1, then we can obtain conversion factors between cm, g, and sec.

Problems: Give all answers in scientific notation, rounding to 2 decimal places.

1. Find the conversion factors:

i.)	cm → sec	*ii.*)	sec → cm
iii.)	g → cm	*iv.*)	cm → g
v.)	sec → g	*vi.*)	g → sec

2. In cgs, the distance between the earth and the sun is $x = 1.5 \times 10^{13}$ cm. Find x in sec, min, and hr. This is how long it takes light from the sun to reach the earth.

3. Suppose a spaceship has speed $v = 0.01$. Find the spaceship's speed in km/sec and km/hr. Repeat the calculations for $v = 0.15$.

4. The mass of the sun is $M \approx 2 \times 10^{33}$ g. Convert the mass of the sun to sec and cm. The radius of the sun is 7×10^5 km. Compare the sun's radius to its mass. What can you conclude?