HW4 Your Name Kyle Earp

We are going to turn the bouncing ball code into asteroid collisions in the asteroid belt.

Ceres, the largest object in the asteroid belt, has a mass of approximately 9.39 × 10^20 kg and a diameter of approximately 940 km in diameter.

What is the density of Ceres? 2.16×10^{12} kg/km^3

What is Ceres mostly made of? mostly Carbon and Silicon

If we were going to put a bunch of asteroids the size of Ceres in place of all the balls in your simulation, what would be a good unit for mass and length?

Mass Unit = 9.39 × 10^20 kg **Great answer!!!**

Length Unit = 940 km **Another great answer!!!**

What is the density of Ceres in our units? $\frac{6}{\pi} C_m/C_d^3 \cong 1.91\ C_m/C_d^3$

Now the force of gravity between two objects in space is G*M1*M2/(r^2). Where G is the universal gravitational constant, M1 is the mass of body 1, M2 is the mass of body 2, and r is the distance between the centers of the bodies.

The constant G has been measured to be approximately 6.67430×10^−11 N⋅m2⋅kg−2

I don't like G's units. It is a little bitty number in SI units. 10^-11 compared to the nice 1s you got for length and mass suck and may cause roundoff.

What unit do I still need to set? Time **Another great answer — you are on a roll!!!**

Can we set the time unit so that it complements the great units you have already found and maybe at the same time cleans up G?

Set your time unit so that G = 1 in your units.

Time Unit = 3640 s $\cong$ 1.01 hrs

Attach your neatly worked out solutions and transfer the appropriate answers to this page. I will not grade sloppy work!

$$V_c = \frac{4}{3}\pi r^3 = \frac{4}{3}\pi\left(\frac{940}{2}\text{ km}\right)^3 = \frac{4}{3}(470\text{ km})^3\pi \cong 434892765.4\text{ km}^3$$

$$\rho_c = \frac{\text{mass}}{\text{Volume}} = \frac{9.39 \times 10^{20}\text{ kg}}{\frac{4}{3}(470)^3\pi\text{ km}^3} \cong 2.16 \times 10^{12}\text{ kg/km}^3$$

Let $C_m = 9.38 \times 10^{20}$ kg, $C_d = 940$ km, then

$$V_c = \frac{4}{3}\pi\left(\frac{1}{2}C_d\right)^3 = \frac{\pi}{6}C_d^3 \cong 0.5236\, C_d^3$$

$$\rho_c = \frac{1\,C_m}{\pi/6\; C_d^3} = \frac{6}{\pi}C_m/C_d^3 \cong 1.91\, C_m/C_d^3$$

$$G = 6.67430 \times 10^{-11}\text{ m}^3\text{kg}^{-1}\text{s}^{-2}$$

$$= 6.67430 \times 10^{-11}\frac{\text{m}^3}{\text{kg s}^2}\left(\frac{9.39 \times 10^{20}\text{ kg}}{1\,C_m}\right)\left(\frac{1\,C_d}{940\text{ km}}\cdot\frac{1\text{ km}}{1000\text{ m}}\right)^3$$

$$= 7.54550 \times 10^{-8}\frac{C_d^3}{C_m\,s^2}$$

$$\Rightarrow \left(\frac{1\,s}{1\,C_t}\right)^2 = 7.54550 \times 10^{-8}$$

$$\frac{1\,s}{1\,C_t} = \sqrt{7.54550 \times 10^{-8}}$$

$$\frac{1\,C_t}{1\,s} = \frac{1}{\sqrt{7.54550 \times 10^{-8}}}$$

$$C_t = \frac{1}{\sqrt{7.54550 \times 10^{-8}}}\,s \cong 3640\,s \cong 1.01\text{ hr}$$