ASTR 105 - Estimating Earth's Density

We are measuring shadow lengths to determine the Earth's volume, and we are measuring fall times of dropped objects to determine the Earth's mass. Then we can solve for the Earth's density.

Things to do outside:

1. Measure the length of the shadow of a meter stick.
   - Hold the stick as straight up as possible!
   - You can use chalk to mark the 2 ends of the shadow, then use your meter stick to measure its shadow.
2. Repeat step 1 with 2 different people.
3. Record your values in Table 9.1
4. Using stopwatches, have 2 group members record how long it takes a dropped object to fall from the roof of the astronomy building.
5. Record your fall times in Table 9.2

Things to do inside:

1. Calculate 4 angles in Table 9.1 (3 for LC, 1 for Boulder).
   - angle = ATAN(shadow length / post length)
   - This gives the angle in degrees.
2. Calculate the average LC angle in Table 9.1. (You don't need average shadow length or average post length.)
3. Calculate the Earth's circumference.
   - circumference = 857km $\times$ 360/(Boulder angle - average LC angle)
   - This gives circumference in km.
4. Calculate Earth's radius.
   - radius = circumference / 2 / π
   - This gives radius in km.
   - Multiply this value by 1000 meters/km to convert radius to meters, and put this number in Table 9.3.
5. Calculate the Earth's volume.
   - volume = $4/3 \times \pi \times radius^3$, where radius is in meters.
   - This gives volume in meters^3. Enter this number in Table 9.3.
6. Calculate acceleration in Table 9.2.
   - acceleration = 2 $\times$ distance / time^2
   - This gives acceleration in meters/second^2.
7. Calculate the average acceleration in Table 9.2. (You don't need average fall time or average fall distance.)
8. Calculate the Earth's mass.
   - mass = $(averageacceleration) \times radius^2/G$
   - G is the Gravitational constant (it's just a number, kind of like π.)
   - G = $6.67 \times 10^{-11} meters^3/kg/s^2$
   - This gives mass in kg. Enter this number in Table 9.3.
9. Calculate Earth's density
   - density = (mass in kg) / (volume in m^3)
   - This gives density in kg/m^3. Put this value in Table 9.3.
   - Divide this number by 1000 to convert to density in grams/cm^3. Put this value in Table 9.3.