Mass of the earth

Heavy man!

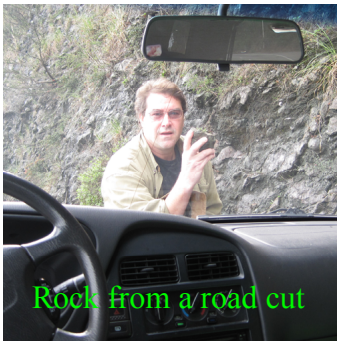
Estimate the mass of the earth.

Introduction:
The earth is made out of basically two things, rock and iron…that's it! If you know some basic measurements of the earth and have some pieces of earth materials lying around (a piece of rock and some iron), you can estimate the mass of the earth!

Materials:

- A piece of rock- (a chunk of basalt would work best for this activity) You can get rock pieces from a gardening/ landscaping supply store or right from the ground. Like a road cut.
- A hammer
- Graduated cylinder
- Balance or digital scale that can read to the 1/10 of gram
- Source of geophysical facts to check your answers…see references below
- Optional:
    - A diagram of the interior of the earth
    - Pieces of iron (steel nuts and bolts will work fine too)


Rock from a Landscaping lot


Rock from a road cut

To do:
<u>Finding the density your rock.</u>
Any rock will work, but basalt works well for this activity. Basalt is abundant on the earth and is a pretty dense rock (most the rock of the earth is as dense, if not denser than basalt). So…the denser the rock the better your approximation.

Density is defined by the simple formula:
Density = Mass / Volume
Where mass is defined in grams or g
Volume is defined in ml or cm^3
Density is in g/ml or g/ cm^3

<u>Find the mass of your rock:</u>
Your rock must fit inside a graduated cylinder. If it doesn't, break your rock with a hammer to obtain smaller pieces.

Mass your piece of rock on the scale. Mass should be measured in grams.

Mass is = _____grams

<u>Find the volume of your rock:</u>

Use the displacement method.
To do this:
Pour water into a graduated cylinder.
Note the starting level or volume of the water

Initial water volume is (V_i): _____ml

Insert the rock. Make sure it is submerged under the water.
Note the rise in water level or volume of water

Final water volume is (V_f): _____ml

The volume of your rock is:
Final volume of water (V_f) – Initial volume of water (V_i) = Volume of the rock

(V_f) - (V_i) = _____ml

Find the Density:
The density of a sample of your rock is:

Mass/volume = _____ g/ml

Since ml and cm^3 are the same, then:

Density = _____ g/ cm^3

Find the volume of the earth:
The earth is a sphere. The equation of a sphere is: $V = \frac{4}{3}\pi r^3$

The earth's radius is about 6400 km.
First, you need to convert kilometers (km) into centimeters (cm).

Remember: there are
1000m in 1km and 100cm in 1m

Do the following conversion:

$$6400\ km \times \frac{1000m}{1km} \times \frac{100cm}{1m} = \_\_\_\_\_ cm$$

Use that number for r in the equation: $V = \frac{4}{3}\pi r^3$

Figure out the volume of the earth = _____ cm^3

Find the mass of the earth:
Since Density = Mass/Volume, then Density x Volume = Mass.

Density of your rock _____ x Volume of the earth = _____

= Mass of the earth = _____ grams

Converting mass to kilograms:
Scientists like certain units to present information, especially when something weighs a lot. Instead of grams, scientists use kilograms.

You now need to convert your answer above from grams to kilograms.
Remember, there are 1000 grams in one kilogram so the conversion is:

Mass in grams from above _____g x $\frac{1\ kg}{1000g}$ = _____kg

If the earth were made only of your sample rock, your estimate of the mass of the earth is:

_____ kg

Optional addition of the iron core:
Since a huge amount of the earth is thought to be iron, you can add in the density of this core. You can add the extra weight of iron to the calculated weight above to get an even better estimate of the mass of the earth.

Find the density of iron (or steel…such as nuts or bots).

Density of iron = _____ g/ cm^3

What is the difference in density of your iron and rock from above?

Density of Iron _____ g/ cm^3 - Density of Rock _____ g/ cm^3

= Difference _____ g/ cm^3

Find the volume of the earth's core:
However, instead of using the diameter of the entire earth, use the diameter of only the earth's core or about 3480 km.

Volume of the earth's core = _____ cm^3

Using the difference in density of your iron and rock, figure out the additional mass of the earth's core.
Additional mass of earth = _____ g

Convert this to kilograms = _____ kg
(this is your additional estimate of the mass due to the core)

Add this additional core mass, to the mass of earth from your "rock only" calculation in the previous section.

Total estimate of the mass of the earth is: _____ kg

References and factoids:

The Mass of the earth is: 5.9737×10^{24} kg
Diameter of the earth is: 6400 km
Diameter of the earth core is: 3480 km
Density of the mantle is: 4 to 5 g/ cm^3
Density of basalt: about 3 g/ cm^3
Density of Iron is: 7.87 g/ cm^3

USGS layers- dynamic earth
http://pubs.usgs.gov/gip/dynamic/inside.html

Common Rock densities;
http://geology.about.com/cs/rock_types/a/aarockspecgrav.htm

http://en.wikipedia.org/wiki/The_mass_of_the_Earth

Density of the earth
http://hypertextbook.com/facts/2000/KatherineMalfucci.shtml

Free earth Anatomy posters at:
http://www.tufts.edu/as/wright_center/products/svl/posters/erth.html

Interior thickness
http://pubs.usgs.gov/gip/interior/