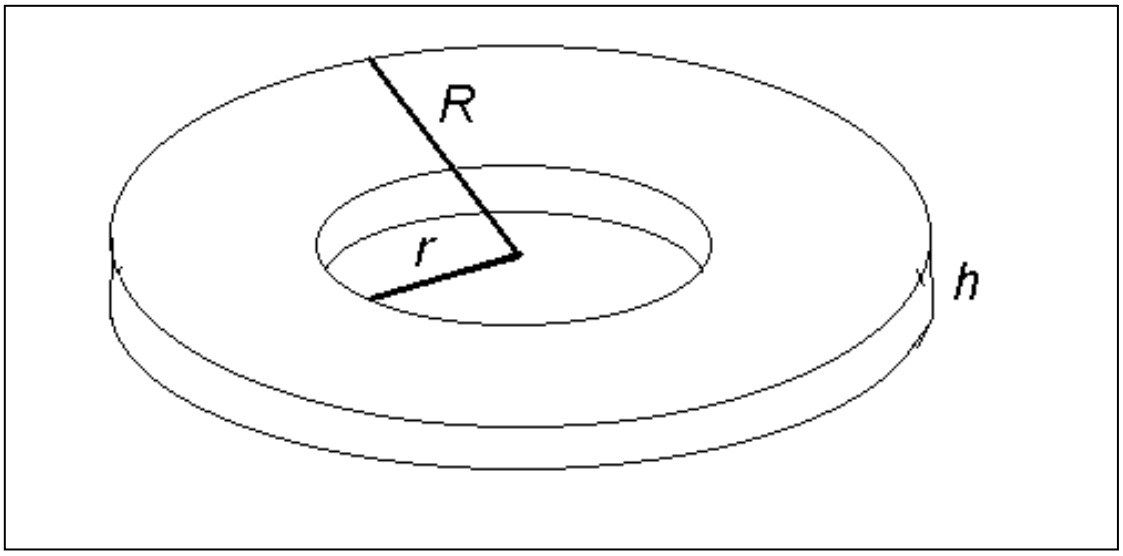
During a severe magnetic storm, Earth is surrounded by a disk of plasma called the Ring Current. The outer diameter of this disk is about 4 times Earth's radius (1 Re = 6,378 kilometers) while the inside radius is about 1.5 times Earth's radius. The thickness of this disk is about 2,000 kilometers. The volume of a ring-shaped disk is given by the formula

$V = \pi \times (R^2 - r^2) \times h$

where **R** is the outer radius, **r** is the inner radius, and **h** is the thickness of the disk. Use this formula to answer the questions below.

Question 1 - If the density of the Ring Current particles is about 10,000 atoms per cubic centimeter, how many atoms are present in this disk of plasma?

Question 2 – If the atoms are mostly oxygen atoms, and an oxygen atom has a mass of about 2.0×10^{-20} kilograms, what is the total mass of the Ring Current?



Answer - Extra Credit Problem

This problem is suitable for students who have taken Algebra 1.

In this activity, students will use the formula for the volume of a ring.
They will substitute numerical values into the formula.
They will use scientific notation throughout.
They will work with positive and negative exponents.

Question 1 - If the density of the Ring Current particles is about 10,000 atoms per cubic centimeter, how many atoms are present in this disk of plasma?

Answer: We have to multiply the density of the gas by the volume of the disk to find the number of atoms. The volume of a ring-shaped disk is given by $V = \pi \times (R^2 - r^2) \times h$, where R is the outer radius, r is the inner radius, and h is the thickness of the disk.

The outer radius $R = 4.0 \times 6378 \times 100000$ cm $= 2.55 \times 10^9$ cm.

The inner radius $r = 1.5 \times 6378 \times 100{,}000$ cm $= 9.57 \times 10^8$ cm.

The height $h = 2000 \times 100000$ cm $= 2.0 \times 10^8$ cm.

So from the formula:

$V = (3.14) \times [(2.55 \times 10^9)^2 - (9.57 \times 10^8)^2] \times 2.0 \times 10^8$ cubic centimeters

$V = 3.14 \times [6.50 \times 10^{18} - 9.16 \times 10^{17}) \times 2.0 \times 10^8$

$V = 3.51 \times 10^{27}$ cubic centimeters.

The total number of oxygen atoms is then Density x Volume or

$N = 10{,}000 \times 3.51 \times 10^{27}$ atoms.

$N = 3.51 \times 10^{31}$ atoms.

Question 2 – If the atoms are mostly oxygen atoms, and an oxygen atom has a mass of about 2.0 x 10-20 kilograms. If one metric ton equals 1000 kilograms, what is the total mass of the Ring Current?

Answer: Multiply the answer from Question 1 by the mass of an oxygen atom, and convert from kilograms to metric tons.

Mass $= (3.51 \times 10^{31}) \times (2.0 \times 10^{-20}) = 7.02 \times 10^{11}$ kilograms

$= 7.02 \times 10^8$ metric tons.