Chapter 12: Layers of the Sun

Student Worksheet

Objective:

Draw a scale model cut-away diagram of the Sun, including information on temperature, composition, and density.

Engage:

Every second, over 4 million tons of the Sun's matter is converted into the light which brightens and energizes the Earth. The Sun is continually getting less massive. Imagine if Earth lost 4 million tons of matter every second. How long do you think it would take for Earth's mass to reach zero?

Your guess:

Calculate it now to see. Earth Mass is 5.97×10^{24} kg. 4 million metric tons is 4 billion kg, or 4×10^{9} kg. Divide the Earth's mass by the 4×10^{9} kg/s (where *s= seconds)* to see how many seconds it would take to reach zero. Convert seconds to a more reasonable unit if needed.

Introduction:

The Sun is gigantic compared to our planet. A million Earths could fit inside the Sun, and about one hundred Earths could line up across the diameter of the Sun. Compared to other stars, the Sun is a little on the small side. A lot of what we know about the Sun comes from the part we can see, the *photosphere*. The Sun has three layers beneath the photosphere and two atmospheric layers above it. A lot of what we know about the interior of the Sun comes by the same way as the knowledge of the center of our own planet—i.e., *seismology*. A lot of what we know about the atmospheric layers comes from observation during eclipses. Today there are many telescopes on Earth and in space dedicated to observing the Sun, our star. In this activity you will learn a bit more about the scale of the Sun and what each layer is like.

Procedure: **Overview**

Your teacher will provide you with a **blank model image of the Sun** on which you will draw the layers of the Sun *to scale*, and include information on temperature, composition, and density.

The radius of the circle drawn for this Sun is 7.5 cm. The actual Sun has a radius of 6.96×10^8 m. The scale of the Sun to your model Sun is 9,270,000,000 to 1, or $9{,}27 \times 10^9$ to 1. Below, you will be given the actual dimensions of different regions of the Sun. You will have to scale those dimensions using this factor, or by using the percentage of the radius given.

The layers of the Sun listed from innermost to outermost are:

- the core
- the radiative zone
- the convection zone
- the photosphere
- the chromosphere
- the corona

The chromosphere and the corona are atmospheric layers of the Sun which you will draw *outside* the circumference of your circle. The photosphere is treated as the surface of the Sun, though of course it is a gas. Let the circumference line of the circle serve as the outer edge of the photosphere.

Procedure: Drawing the Sun

1. Draw the core. The core of the sun extends from the center to about 0.2 solar radii.

2. Draw the radiative zone. The radiative zone extends from the edge of the core at 0.2 solar radii to 0.71 solar radii.

3. Draw the convective zone. The convective zone extends from the edge of the radiative zone to the surface of the Sun.

4. The photosphere has a depth of about 500 km. The circumference line will serve well as the photosphere. Label the photosphere.

5. Outside the circumference line draw the chromosphere. It has an actual depth of about 2,000,ooo m, or 0.0002 solar radii. It may be hard to draw this to scale.

Label the chromosphere.

6. Draw the corona. The corona is the outermost layer of the Sun. It actually extends all throughout the solar system in streams of solar wind. Most of the corona can be accounted for within 1 or 2 solar radii.

7. Sunspots typically range in radius from about 750,000 m to 25,000,000 m. Draw a few sunspots on the photosphere.

8. Arcing prominences reaching into the corona often emerge from sun spots. The largest prominences can reach 350,000,000 m in height. Draw a prominence.

9. The Sun's photosphere shows evidence of the convection below by way of granules. Each granule is about 1,000,000 m across (about the size of Texas). The magnified box to the upper left of the Sun represents 0.5 cm^2 on the model. About how many granules can fit in the box? Draw something to represent this.

10. The Earth has a radius of 6378,000 m. Draw the Earth for reference.

Conclusion:

1. Use the information in chapter 12 of your textbook by Arny (*Explorations: An Introduction to Astronomy, 7/E)* to find the temperature, density, and role of each layer in the functioning of the Sun. Not all of the density information is given. Label the temperatures on your diagram.

2. How long does it take a photon to make the trip through the radiative zone? Why does it take so long?

3. How many Earths could fit lined-up in the prominence?

4. The corona has a very high temperature. What could be misleading about this?

Extend:

- Go to SOHO's website to see real video footage of the Sun during a coronal mass ejection.

- What is a filtergram?

- Investigate a few of the space telescopes that study the Sun. Where are they located?