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SPACE STATION ALPHA

Lesson 5: Space Weather 2

Preparatory Readings

LP #	Unit 1: Mission Bfg/ App Process
Mission Briefing	
1	The Mission
1	We Need You
1	Space Station Alpha
opt	Verizon
How to Apply	
2	Apply Today
2,3	Personal Essay
2,3	Class Activity: Station Systems
opt	Mission Patch

LP #	Unit 2: Space Weather
4	Specialist Orientation
Chapter 1	
4	Here Comes the Sun
4	Inside the Atom
5	Sheer Magnetism (Hands On)
5	Dr. Z: Inside the Sun

LP #	Unit 3: Radiation Health
Chapter 2	
7	New Frontiers & New Dangers
8	Electromag Rad: Taming the Wild Energies
7	Do You Want the Recipe?
7	In the Kitchen with Poly
7	Measuring Exposure to Radiation
Enrichment Activities	
7	Ready, Aim, Mutate! (Hands On)
7	Sweet Dreams are Made of These (Hands On)
7	Are You Too Hot? (Hands On)

LP #	Unit 4: Power Systems
Chapter 3	
9	The Energy Supply Problem
9	Rechargeable Batteries
10	All About Power
10	Emergency Procedures
10	Practice Ex: Power on the SS (Hands On)
Enrichment Activities	
10	Electrical Current Mag Field (Hands On)
10	Electrical Circuit: Quick Guide (Hands On)
10	Nailing Down Energy (Hands On)
10	A Shocking Discovery (Hands On)
10	Electrolysis (Hands On)
10	It's Electric (Hands On)

LP #	Unit 5: Life Support
Chapter 4	
12	How I Discovered Air
12	A Weighty Discovery
12	Living in a Bubble
12	Breathing on the Space Station

LP #	Unit 6: Pre-Mission Prep
13	Overview of Teams
13	Mission Directives
13	Classroom Setup
Team Preparation Introductions	
13	STORM Team Overview
13	Radiation Team Overview
13	Power Team Overview
13	Life Support Team Overview
13	Communications Team Overview

Other Homework Due:

Closure questions from *Sheer Magnetism*

Subject

Fundamentals of magnetism (cont.)
Space weather and the sun-earth relationship.

Description of Student Activities

Students complete the *Sheer Magnetism* exploration; then they begin a review activity.

Duration

15 min. Conclude *Sheer Magnetism*
30 min. Article Review

Materials

Sheer Magnetism Hands-On: Use the materials listed in the activity.

Article review questions and answers

Main Topics

1. The sun is a major external source of energy. The energy that enables life on earth derives from the sun.
2. The atomic particles within plasma move and collide in conditions of extreme heat and pressure.
3. The sun produces energy from the fusion of hydrogen protons to form helium nuclei. Fusion is the joining of two nuclei at extremely high temperatures and pressures and is the process responsible for the energy of the sun and other stars. Fission is the splitting of a nucleus under extreme pressure and temperature. During these two thermonuclear reactions a fraction of the mass of the interacting particles is transformed into electromagnetic energy.
4. Electromagnetic waves, including infrared waves, light waves, radio waves, microwaves, X-rays, and gamma rays are forms of energy and tend to transfer some of their energy when they interact with matter.
5. The sun still holds many unanswered questions for scientists.
6. Solar weather is extremely unpredictable but an important scientific area of study for scientists involved in space.

Outcomes

1. Students will develop answers to key questions about the sun.
2. Students will draw connections between sun science and the need to protect astronauts from the hazards of space weather.
3. Students will describe how the sun can endanger the space station.

Special Comments:

Students will be assigned some of the readings for the Radiation Health chapter ahead of time. There are a number of readings, and this is an attempt to spread them out over several evenings.

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Procedure:

1) Conclude *Sheer Magnetism*: (15 minutes) Students' homework assignment will be to complete a *Mission Specialist Log* entry reflecting on the *Sheer Magnetism* exploration. The notes and sketches the students put in the *Logs* will reflect their learning and thoughts on the subject.

2) *Article Review* (30 minutes / 20 minutes during next class.)

Review questions are attached. Divide the class into groups of 3 or 4 students each. Copy the questions on individual slips of paper and assign 1 or 2 questions to each Article Review group. Tell students that they will have to present their answers to the rest of the class and defend them. If students have done their homework, they should be able to go to the section of the article that gives the answer. Give students 5 to 10 minutes to formulate answers. They should outline their answers on index cards or scratch paper, which they will turn in. Encourage them to draw a quick sketch if appropriate.

Have groups report by reading the question then reading the answer. (Keep discussion moving quickly. Less than 5 minutes per question/answer/defense.)

Homework for Lesson 6

- Read
  New Frontiers and New Dangers
  Electromagnetic Radiation: Taming the Wild Energies
- Complete *Mission Specialist Log* Entry

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Article Review

- *Here Comes the Sun*
- *Dr. Z: Inside the Sun*

Time

10 minutes prep time.
5 minutes presentation time per question

Questions

1. What are the layers of the Sun and in which layer does fusion take place? In which layer are coronal mass ejections seen during an eclipse? Present a rough scale drawing to support your answer.

2. Name one of three mysterious or unexplained solar phenomena mentioned in the article. How do scientists believe these three phenomena reflect solar weather trends?

3. What solar phenomena help space weather analysts predict periods of dangerous solar weather?

4. How does the earth's magnetic field and atmosphere help protect the earth from dangerous solar eruptions? List the types of dangerous eruptions. Present a rough scale drawing of the earth-sun relationship to support your presentation.

5. Describe the journey a gamma ray may take as it travels from the center of the sun to the earth and tell how long the journey may take.

6. How do radioactive (ionized or charged) particles interact with magnetic field lines around the earth? What examples can you give of this interaction?

7. Why is Space Station Alpha vulnerable to dangerous solar eruptions?

8. Consider the following quote: "In that second, 700 million tons of hydrogen ions, banging around at almost 15,000,000 degrees Celsius fused together to form 695 million tons of helium and a teeny amount of assorted random elements." What happens to the 5 tons of matter that is not accounted for? What formula explains this transformation of matter?

Article Review

- *Here Comes the Sun*
- *Dr. Z: Inside the Sun*

Time

10 minutes prep time. 5 minutes presentation time per question

Questions

Teacher: Write out each question on a separate slip of paper and present all questions to the student

1. What are the layers of the Sun and in which layer does fusion take place? In which layer are coronal mass ejections seen during an eclipse? Present a rough scale drawing to support your answer.

(Easy) A: The sun's layers are the core (15%), radiative zone (65%), convection zone (20%), photosphere, chromosphere, corona, outer corona. http://www.solarviews.com/eng/sun.htm. Fusion takes place in the sun's core. Coronal mass ejections can be seen in the chromosphere during an eclipse.

2. Name one of three mysterious or unexplained solar phenomena mentioned in the article. How do scientists believe these three phenomena reflect solar weather trends?

(Medium difficulty) A: The three mysteries are sunspot activity, solar magnetic activity, and the temperature of the chromosphere compared to the temperature of the photosphere. Increased activity in these solar mysteries has been linked to outbursts in extreme solar weather.

3. What solar phenomena help space weather analysts predict the coming of periods of dangerous solar weather?

(Medium difficulty) A: The solar cycle (min to max), sunspots, and increases in microwaves and X-rays from flares seen in the chromosphere.

4. How does the earth's magnetic field and atmosphere help protect the earth from dangerous solar eruptions? List the types of dangerous eruptions. Present a rough scale drawing of the earth-sun relationship to support your presentation.

(Medium Difficulty) A: Earth's magnetic field lines deflect many of the sun's radioactive particles (protons). The Van Allen Belts absorb high-energy particles. X-rays and ultraviolet rays collide with the gases in the earth's ionosphere and are de-energized.

5. Describe the journey a gamma ray may take as it travels from the center of the sun to the earth?

(Difficult) A: The journey could take 15,000,000 years. Gamma rays are produced during fusion. The gamma ray collides with plasma particles in the sun's layers. During each collision they lose energy. Eventually they become X-rays, then visible light, then microwaves, etc. As the electromagnetic energy leaves the sun it travels to the earth at the speed of light. When it hits the ozone layer or the Van Allen Belts it loses additional energy and may eventually strike the earth's surface in the form of visible light, infrared, or ultraviolet energy.

6. How do radioactive (ionized or charged) particles interact with magnetic field lines around the earth? What examples can you give of this interaction?

(Easy) A: Radioactive particles may follow the magnetic field lines down to the earth and enter the earth at the poles or they may be intercepted by the ionosphere and create what we see as Northern or Southern lights. They may also form a highly charged power grid above the earth.

7. Why is Space Station Alpha vulnerable to dangerous solar eruptions?

(Medium difficulty) A: SSA orbits above some of the earth's protective atmospheric layers and travels through the earth's magnetic field lines. It also travels through the South Atlantic Anomaly, the lowest level of the Van Allen belt. Because of this it can behave as a lightning rod for the electrically charged particles that can in turn interrupt the electrical systems on board the space station.

8. Consider the following quote: "In that second, 700 million tons of hydrogen ions, banging around at almost 15,000,000 Celsius fused together to form 695 million tons of helium and a teeny amount of assorted random elements." What happens to the 5 tons of matter that is not accounted for. What formula explains this transformation of matter?

(Medium difficulty) A: The matter is transformed into energy in the form of gamma rays. Einstein's formula $E=mc^2$ explains this process. E=gamma rays. M = mass lost. C = speed of light (186,000 m/sec) which is squared.