Speed of Solar Wind

Overview:

Students determine when a solar blast will hit Earth's magnetic field (magnetosphere) based on current solar wind speeds.

Objectives:

The student will:

- research current space weather conditions; and
- convert units to determine the actual time of an auroral display.

Materials:

- Calculator (1 per student)
- STUDENT WORKSHEET: "Speed of Solar Wind"

Activity Procedure:

1. Ask students to think about things that cannot be seen, felt, or heard. Prompt them with ideas such as radio waves, television signals, or magnetism.
2. Explain that similar to television waves, solar wind itself cannot be seen. However, once it interacts with Earth's magnetosphere, the effects can be seen in the aurora borealis, just as television waves can be seen on television once they react with an antenna.
3. Remind students that the Kp Index is one piece of data to look at when predicting the aurora. Ask students to think about how they might be able to tell exactly when they could see the aurora.
4. Remind students that scientists take measurements of solar wind speeds. Knowing the speed of the wind and the distance between the sun and Earth makes it possible to determine how long it will take the solar wind to reach Earth, and how long it will take before the aurora is visible. Finding the time it takes the solar wind to get from the sun to Earth by knowing the speed is the same as finding out approximately how long it would take to fly from Fairbanks to Anchorage knowing the speed of the plane and the distance between the two cities.

   (Steps 5 and 6 are found on the following page of these Teacher's Instructions)

Answers to Student Worksheet:

<u>Data</u>:

Answers will vary. Check website for solar wind speed on the date of the assignment.

<u>Conclusion</u>:

1. *Answers are dependent on current solar wind speed.*
2. *If the calculated time is during daylight hours then it is not likely that the aurora will be seen.*
3. *Cloud cover, where the location is compared to the aurora oval, etc.*

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5. Present the following example on the board or overhead projector for reference while students work:
   a. We know that the sun is 93,140,000 miles, or 149,894,300 kilometers, from Earth.
   b. For this example, the solar wind is traveling at 308 km/second and the solar flare, which started the solar wind, took place on November 7th at 4:22 A.M.
   c. To calculate when the solar wind will reach Earth, we need to find how many seconds it will take for the solar wind to reach Earth.

$$\frac{149{,}894{,}300 \text{ km}}{1} \div \frac{308 \text{ km}}{1 \text{ second}} = \frac{149{,}894{,}300 \text{ km}}{1} \times \frac{1 \text{ second}}{308 \text{ km}} =$$

$$\frac{149{,}894{,}300 \text{ km} \bullet \text{second}}{308 \text{ km}} = 48{,}667 \text{ seconds (rounded to the nearest second)}$$

   d. Next, convert those seconds into minutes, then hours.

$$48{,}667 \text{ sec} \div \frac{60 \text{ seconds}}{1 \text{ minute}} = \frac{48{,}667 \text{ seconds}}{1} \times \frac{1 \text{ minute}}{60 \text{ seconds}} = \frac{48{,}667 \text{ seconds} \bullet \text{minute}}{60 \text{ seconds}} = 811 \text{ minutes (rounded to the nearest min)}$$

   e. Now, convert minutes to hours.

$$811 \text{ min} \div \frac{60 \text{ minutes}}{1 \text{ hour}} = \frac{811 \text{ minutes}}{1} \times \frac{1 \text{ hour}}{60 \text{ minutes}} = \frac{811 \text{ minutes} \bullet 1 \text{ hour}}{60 \text{ minutes}} = 14 \text{ hours (rounded to the nearest hour)}$$

   f. The aurora will occur 14 hours after the flare. Since the flare occurred at 4:22 A.M. on November 7th, count forward 14 hours.

6. Distribute STUDENT WORKSHEET: "Speed of Solar Wind." Assist students with calculations as necessary.

Name: _____ **Student Worksheet**

Speed of Solar Wind

Directions: Assume there was a solar flare today at 8:15 A.M. Look up the solar wind speed (velocity) on the Internet at http://www.spaceweather.com. Using that data, when will the aurora most likely be visible? Solar flares cause solar wind. Solar wind causes disturbances within Earth's magnetic field. When this happens the aurora becomes visible. Scientists take measurements of solar wind speeds so they can determine how long it will take the solar wind to reach Earth, and therefore, how long it will take before the aurora is visible. Complete the activity below to determine when the aurora will be visible.

Materials:

Calculator

Procedure:

1. Navigate to http://www.spaceweather.com and find the most current solar wind speed.
2. Calculate the time the aurora would mostly likely be visible assuming that there was a solar flare at 8:15 A.M. this morning and the solar wind is traveling at the most current speed.

Data:

Current solar wind speed _____

Analysis of Data:

1. Begin by calculating time for solar wind to reach Earth using the following formula:

   distance from Earth to sun (149,894,300 kilometers) ÷ solar wind speed
   = time needed for solar wind to reach Earth at current speed

2. Convert seconds into minutes, then hours. Finally, count forward from the time the solar flare occurred. Show calculations on the back of this worksheet.

Conclusion:

1. Assuming there was a solar flare today at 8:15 A.M, the aurora will become visible at _____ (day and time).

2. How likely is it that the aurora will be visible at the calculated time? Why?

   _____

   _____

3. What other factors need to be considered when predicting the aurora?

   _____

   _____

