The last few days from November 6 - 9, 2004 have been very active days for solar and auroral events. A major sunspot group, AR 0696, with a complex magnetic field produced several Coronal Mass Ejections and flares during this time. The latest ones were an X2.0-class solar flare on Nov 7, 16:06 UT and a CME ejection. On November 9 and 12:00 UT, the beginnings of a major geomagnetic storm started. The NOAA Space Weather Bulletin announced that:

The Geomagnetic field is expected to be at unsettled to major storm levels on 09 November due to the arrival of a CME associated with the X2.0 flare observed on 07 November. Unsettled to minor storm levels are expected on 10 November. Quiet to active levels are expected on 11 November.

Many observers as far south as Texas and Oklahoma reported seeing beautiful aurora on Sunday night from an earlier CME/flare combination on Saturday, November 6th. In the space provided below, calculate the speed of the CME as it traveled to Earth between November 7th - 9th assuming that the distance to Earth is 93 million miles, or 147 million kilometers.

Question 1 - How long did it take for the CME to arrive?

Question 2 - What is the speed of the CME in miles per hour?

Question 3 - What is the speed of the CME in kilometers per hour?

Question 4 - What is the speed of the CME in miles per second?

Question 5 - What is the speed of the CME in kilometers per second?

Extra-Extra Credit : Many observers were able to see the Sunday night aurora across much of North America. On a separate piece of paper, describe what you saw on Sunday night November 7th, or on Tuesday night November 9th from your location. On the back of the paper, create a drawing of what you saw. To have your essay and drawing posted on the NASA-IMAGE web site send your drawing and essay to:

Dr. Sten Odenwald
Code 630
NASA Goddard Space Flight Center
Greenbelt, MD 20771

We will post the first 25 submissions.

This activity uses the following math concepts:

1 - Addition and subtraction of time units
2 - Working with speed = distance/time
3 - Conversion of miles to kilometers
4 - Time conversion from seconds to hours
5 - Writing descriptive sentences based on observations.
6 - Rendering observations into a visual medium.

The distance to the Earth is 93 million miles or 147 million kilometers.
Start time = November 7 at 16:06 UT
Arrival time = November 9 at 12:00 UT

Question 1 - How long did it take for the CME to arrive?
Answer: November 7 at 16:06 UT to November 8 at 16:06 UT is 24 hours.
From Nov 8 at 16:06 to Nov 9 at 12:00 UT is
(24:00 - 16:06) + 12:00
= 7:54 + 12:00
= 19 hours and 54 minutes.
Total time = 24 hours + 19 hours and 54 minutes = 43 hours and 54 minutes.

Question 2 - What is the speed of the CME in miles per second?
Answer: In decimal units, the travel time from question 1 equals 43.9 hours.
The distance is 93 million miles so the speed is 93 million miles/43.9hours
Or 2.1 million miles per hour.

Question 2 - What is the speed of the CME in kilometers per second?
Answer: Use the conversion that 1.0 miles = 1.6 kilometers, then
2.1 million miles/hour x 1.6 km/mile = 3.4 million kilometers per hour

Question 3 - What is the speed of the CME in miles per second?
Answer: Convert hours to seconds by
1 hour x 60 minutes/hour x 60 seconds/minute = 3,600 seconds.
Then from question 2: 2.1 million miles/hour divided by 3600 seconds/hour
= 583 miles/second.

Question 4 - What is the speed of the CME in kilometers per second?
Answer: From question 3 and the conversion of 1 hour = 3600 seconds:
3.4 million kilometers / second divided by 3600 seconds/hour
= 944 kilometers/sec.