**SOLAR WIND VELOCITY**

To find the magnitude of a vector in 3-dimensions we will use the following formula:

**|a|**=

In 2018 the DSCOVR spacecraft measured the three components to the solar wind velocity at a location 1.5 million kilometers from Earth. The table below (**table 1**) includes actual NASA data for a series of DSCOVR spacecraft measurements of the three components of the solar wind velocity. Use the 3-dimensional magnitude formula, together with the three magnetic field measurements (*x*, *y*, *z*) in the data table, to:

1. Calculate the total speed, *v*, of the solar wind on each date. Round your answers to the nearest kilometer per second.
2. Determine its transit time, *T* in hours from the sun to Earth. Assume that the distance from the earth to the sun is 150 million kilometers. Round your answer to the nearest hour.

**Table 1: Solar Wind Velocity**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Date** | ***x*** | ***y*** | ***z*** | ***v*2** | ***v (km/sec)*** | ***Time (hrs)*** |
| 1-6-18 | -570 | 5 | 19 |  |  |  |
| 2-6-18 | -647 | 75 | -75 |  |  |  |
| 3-6-18 | -619 | 96 | 18 |  |  |  |
| 4-6-18 | -613 | 125 | 37 |  |  |  |
| 5-6-18 | -419 | 17 | 9 |  |  |  |
| 6-6-18 | -419 | 30 | 16 |  |  |  |
| 7-6-18 | -343 | -3 | -9 |  |  |  |
| 8-6-18 | -373 | -22 | -1 |  |  |  |
| 9-6-18 | -342 | 1 | -5 |  |  |  |

**WHAT CAUSES A SOLAR STORM?**

1. **Solar flare**: A violent explosion of magnetic energy on the sun.
2. **Coronal Mass Ejection (CME)**: A billion-ton cloud of gas exploding from the solar surface.

Statistical data from these events can be used to draw conclusions about cause-and-effect relationships. Astronomers use Venn diagrams to organize statistical information and use it to make predictions about what will happen near Earth.

In 2000, 142 solar flares, and 89 CMEs were spotted on the Sun. Moreover, 34 flares happened at nearly the same time as CMEs.

1. What percent of CMEs are not accompanied by solar flares? Round your answer to the nearest whole number.
2. What are the odds of a CME not being accompanied by solar flares?

A NASA satellite called ACE measures changes in the magnetism of the gas flowing away from the sun. During 2000 it detects 56 severe magnetic changes. Another satellite called SOHO detects 55 CMEs of which 29 happen at the same time as the ACE disturbances. The IMAGE satellite detects aurora in the polar regions of Earth. A total of 63 bright Aurora are detected during the 56 ACE magnetic 'storms'. There are 31 cases where aurora are seen at the same time as the magnetic disturbances.

1) Why is it important to predict when the next Aurora will occur?

2) Using the data from the example, what percent of solar flares do not happen during CMEs? What are the odds of a solar flare not happening during a CME? Round your answers to the nearest whole number. What do the odds indicate?

3) A news reporter says that solar flares produce CMEs. Is this an accurate statement? Explain.

4) What percentage of CMEs happen at the same time as a severe magnetic disturbances? What are the odds of a CME happening at the same time as a magnetic disturbance? Round your answers to the nearest whole number. What do the odds indicate?

5) What percentage of magnetic disturbances lead to major aurora on Earth? What are the odds of magnetic disturbances lead to major aurora on Earth? Round your answer to the nearest whole number. What do the odds indicate?

6) Can CME's be reliably used to predict when the next Aurora will occur? Explain.