



OUT OF THIS WORLD

Solar-Wind-Riding Electric Sail

With today's technology, reaching the edge of the solar system takes decades, in part because rockets need fuel and heavy fuel slows down the rockets. Traveling without the weight of fuel would be faster, but what would the craft use to move forward? Read *Solar-Wind-Riding Electric Sail* to learn more!

What did you learn?

QUESTIONS

- Activity within Earth's core generates ...
 - An atmospheric field
 - A debris field
 - A force field
 - A magnetic field
- The first craft to leave the solar system was ...
 - Voyager 1
 - Titan 3E
 - Voyager 2
 - Viking 2
- The idea of electric sail was developed by ...
 - Albert Einstein
 - Leonardo da Vinci
 - Grace Hopper
 - Pekka Janhunen
- Protons have ...
 - Less mass than electrons
 - More mass than electrons
 - No mass
 - Equal mass to electrons
- What does NIAC stand for?
- Who is this?



TRUE OR FALSE?

- | | |
|---|---|
| _____ 1. Storms, flares, and other solar activity can alter the heliosphere. | _____ 4. The third law of motion is that every action has an equal and opposite reaction. |
| _____ 2. The electric sail is a form of propulsion. | _____ 5. Electric sails need fuel to work. |
| _____ 3. Protons have a negative charge and electrons have a positive charge. | _____ 6. The solar sail is powered by the sun. |

ANSWERS

- 1. d. Magnetic field.** According to section "The solar wind" on page 9, we know that "Activity within Earth's core generates an invisible area of magnetic influence around the planet, called a magnetic field." So, the correct answer is D.
- 2. a. Voyager 1.** According to section "Reaching the heliopause" on page 15, we know that "In 2013, NASA announced evidence that Voyager 1 had crossed the heliopause, becoming the first craft to leave the solar system." So, the correct answer is A.
- 3. d. Pekka Janhunen.** According to section "Inventor feature: Building a dream" on page 18, we know that "The idea of the electric sail was developed by Pekka Janhunen." So, the correct answer is A.
- 4. b. More mass.** According to section "Longer wires" on page 12, we know that "Protons may have more mass than electrons ... " So, the correct answer is B.
- 5.** According to page 7, NIAC stands for NASA Innovative Advanced Concepts.
- 6.** As can be seen on page 7, the illustration shows Bruce Wiegmann.

TRUE OR FALSE? ANSWERS

- 1. True.** According to section "Changes in the heliosphere" on page 13, we know that "From time to time, areas on the surface of the sun erupt, or blow up, into storms, flares, and other activity. These alterations cause the heliosphere to change in size." So, the correct answer is True.
- 2. True.** According to section "The need for speed" on page 16, we know that "There, he learned of a unique new form of propulsion (pushing a spacecraft) ... this form of propulsion is known as the electric sail." So, the correct answer is True.
- 3. False.** According to section "Electric repulsion" on page 20, we know that "There are protons, which have a positive charge, and electrons, which have a negative charge." So, the correct answer is False.
- 4. True.** According to section "Protons and Electrons" on page 26, we know that "The third law of motion states that every action has an equal and opposite reaction." So, the correct answer is True.
- 5. False.** According to section "Outside of the ecliptic" on page 40, we know that "Electric sails do not need fuel." So, the correct answer is False.
- 6. True.** According to section "Electric sail vs. solar sail" on page 34, we know that "It is called the solar sail, and like the electric sail, it is powered by the sun." So, the correct answer is True.