Name: _____ Class: _____

A New Spin on a Space Horse

This cloud in outer space is turning to face us.

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In this informational text, Ken Croswell, Ph.D. discusses the Horsehead Nebula, an interesting feature in space. As you read, take notes on what astronomers have observed about the Horsehead Nebula.

[1] Clouds in the sky can look like rabbits, bears, and lions. They may even look like people. These clouds are made of water and ice.

Much farther away, other clouds are scattered through outer space. These clouds are not made of water. But like the clouds in the air, they can also make familiar shapes.

In fact, one space cloud looks like a horse.

Now astronomers may have found out why it has that shape: the cloud is spinning.

"This space object may look like a horse's head, but it's really a cloud of gas and dust. It's about 11 trillion (11,000,000,000,000) miles tall. Even if you traveled at the speed of light, it would take you nearly two years to go from top to bottom." by Very Large Telescope, European Southern Observatory is used with permission.

A Giant Game Piece

[5] This cloud is the Horsehead Nebula. (*Nebula* is the Latin word for "cloud.") It looks like a black knight in a chess game. It's eerie[1] and haunting, one of the most famous clouds in space.

Like other space clouds, the Horsehead Nebula is made mostly of hydrogen and helium gas, the two lightest and most common elements in the universe. These gases are clear. Light goes right through them. So why is the Horsehead black? Dust particles, made mostly of heavier elements, pepper the clear gas and block visible light.

The gas and dust in the Horsehead Nebula do not make any light that your eye can see. But the gas makes radio waves, which we can detect using special telescopes called radio telescopes. You can't look through a radio telescope the way you would look through a normal telescope. Instead, the radio telescope is a giant, dish-shaped antenna.

In 2003, astronomers in Europe used a big radio telescope in Spain to observe the gas in the Horsehead Nebula. They made a big discovery. They found that the Horsehead Nebula is slowly spinning.

1. **Eerie** ***(adjective):*** strange, mysterious

Clues in the Waves

Here's how they did it. They observed changes in the radio waves from the Horsehead Nebula's gas.

[10] When an object that gives off radio waves is moving toward us, its radio waves get scrunched up a little. So they have a shorter wavelength than usual.

We call this change to shorter waves a blueshift, because blue light waves are short.

In contrast, when an object that gives off radio waves is moving away from us, its radio waves are stretched out, so they're longer than usual. We call this change to longer waves a redshift, because red light has a longer wavelength than blue light.

You have probably heard blueshifts and redshifts, because sound waves make them, too. When a fire truck races toward you with its siren blaring, the siren's sound waves get scrunched up, making a shorter wavelength, and you hear a high-pitched siren: a blueshift. After the fire truck speeds by, the siren is moving away from you, so the sound waves get stretched out, making a longer wavelength, and the siren's pitch drops: a redshift.

Compared with the Horsehead's neck, the nose has scrunched-up radio waves, a blueshift, so it's moving toward us. Part of the horse's mane has stretched-out radio waves, a redshift, so it's moving away from us. Thus, the Horsehead is turning. It's as if the horse is trying to look our way!

Slowly Turning

[15] Astronomers estimate that the horse will take four million years to spin once. In contrast, the Sun takes just a month to spin, and Earth takes just a day to spin.

But the Horsehead Nebula is much bigger than the Sun or Earth.

Furthermore, the Horsehead's spin may explain its unique[2] shape. To see how, imagine riding a merry-go-round. Now imagine that the merry-go-round started spinning really, really fast. It would fling you off.

In the same way, the nebula's spin may be flinging out two pieces of gas and dust from the horse's neck. One piece has become the horse's nose. The other piece has become the horse's mane.

So if the Horsehead Nebula were *not* spinning, it probably wouldn't look like a horse.

[20] Then the nebula wouldn't be famous, and you wouldn't be reading this article, because it wouldn't exist!

2. **Unique** ***(adjective):*** unlike anything else

Text-Dependent Questions

Directions: For the following questions, choose the best answer or respond in complete sentences.

1. PART A: Which pair of sentences provides the best summary of the article?
    A. The Horsehead Nebula is a unique nebula because it can be seen unassisted by technology.
    B. Astronomers have determined that the Horsehead Nebula is moving by observing its radio waves.
    C. The Horsehead Nebula is made up of gas and dust that doesn't emit light and can't be easily seen.
    D. Astronomers aren't entirely sure what the Horsehead Nebula looks like as it doesn't give off light.
    E. The Horsehead Nebula is named for its movement rather than its resemblance to a horse.
    F. Astronomers are curious to see what the Horsehead Nebula will turn into as it continues to move and evolve.

2. PART B: Which TWO details from the text best support the answers to Part A?
    A. "Much farther away, other clouds are scattered through outer space. These clouds are not made of water." (Paragraph 2)
    B. "So why is the Horsehead black? Dust particles, made mostly of heavier elements, pepper the clear gas and block visible light." (Paragraph 6)
    C. "After the fire truck speeds by, the siren is moving away from you, so the sound waves get stretched out, making a longer wavelength, and the siren's pitch drops: a redshift." (Paragraph 13)
    D. "Part of the horse's mane has stretched-out radio waves, a redshift, so it's moving away from us. Thus, the Horsehead is turning." (Paragraph 14)
    E. "Astronomers estimate that the horse will take four million years to spin once. In contrast, the Sun takes just a month to spin, and Earth takes just a day to spin." (Paragraph 15)

3. Which of the following describes the structure of the information in the text?
    A. The author describes what the Horsehead Nebula is and then what its radio waves have revealed to astronomers.
    B. The author describes how the Horsehead Nebula formed and then compares it to the formation of other nebulae.
    C. The author discusses various nebulae and then why the Horsehead Nebula is the most unique.
    D. The author discusses what radio waves are and then explains how they apply to the Horsehead Nebula.

4. Which of the following describes redshifts and blueshifts in the text?
    A. They are radio waves that can turn different colors.
    B. They are radio waves that can convey whether something is hot or cold.
    C. They are radio waves of the same lengths but convey different sounds.
    D. They are radio waves of different lengths that can indicate movement.

5. Which of the following describes the connection between radio waves and movement?

Discussion Questions

Directions: Brainstorm your answers to the following questions in the space provided. Be prepared to share your original ideas in a class discussion.

1. Nebulae are one of the many amazing features in space. What is another natural feature in space that interests you? Why?

2. Astronomers have been able to use technology to learn more information about the Horsehead Nebula. How else has technology benefitted their knowledge of space? Has technology been able to help scientists discover new information about other places in the world? How?

3. The Horsehead Nebula cannot be easily seen. How have astronomers been able to learn more about the Horsehead Nebula? What are other tools that astronomers use to explore space? How do you learn about the natural world around you? Do you use any tools?