Name: _____ Date: _____

The Lens That Changed Lighthouses

Circle group

For hundreds of years, sailors counted on lighthouses. They warned ships of rocks and guided them safely into harbor. Early lighthouses burned wood or coal fires on top of towers. Later ones used oil lamps. These lights were dim and wasteful. A lamp sends its glow out in every direction. Most of it shines out over empty sea or up into the sky.

In the 1820s, a French physicist named Augustin Fresnel fixed the problem with a new kind of lens. A normal lens strong enough for a lighthouse would have been very thick and heavy. It would have soaked up much of the light. Fresnel built his lens from many separate rings of glass. Each ring was cut at a careful angle. The rings bend the light that hits them. They gather it into one narrow, strong beam. The finished lens looked like a giant glass beehive. But it was much thinner and lighter than a solid lens of the same strength.

The lens usually sat on a turning platform. The beam swept across the sea like the hand of a clock. A sailor saw a flash each time the beam passed. Each lighthouse had its own pattern of flashes, such as two quick flashes and then a pause. A captain could tell which lighthouse was in view. Then he could work out the ship's position.

Fresnel lenses made lights shine much farther. The beams of the largest ones could be seen from more than twenty miles away. Today, ships mostly use satellite navigation. Many lighthouses now use electric bulbs or LEDs. But some old Fresnel lenses still work. Others are kept in museums.

Questions

1. What did early lighthouses burn?

_____

_____

2. What did Fresnel make his lens from?

_____

_____

3. How could a captain tell which lighthouse he saw?

_____

_____

4. Why was an ordinary lamp wasteful?

_____

_____

5. Why would a solid lens for a lighthouse have been a problem?

_____

_____

Words to know

lighthouse: a tall tower with a bright light that guides ships
harbor: a sheltered place where ships can stay safely
lens: a curved piece of glass that bends light
beam: a narrow stream of light
physicist: a scientist who studies matter, energy, and light

Talk together (every group has these)

1. Find one fact that every group read. How did your sheet say it?
2. What did your sheet tell you that you think another group's did not? Ask them.
3. What is one question about this topic that none of the sheets answered?

Name: _____ Date: _____

The Lens That Changed Lighthouses

Triangle group

For centuries, sailors depended on lighthouses to warn them of rocks and guide them safely into harbor. Early lighthouses burned wood or coal fires on top of towers, and later ones used oil lamps. These lights were dim and wasteful, because a lamp sends its glow out in every direction, and most of it shines out over empty sea or up into the sky.

In the 1820s, a French physicist named Augustin Fresnel solved the problem with a new kind of lens. A normal lens strong enough for a lighthouse would have been enormously thick and heavy, and it would have absorbed much of the light. Fresnel's idea was to build the lens from many separate rings of glass, each one cut at a carefully chosen angle. The rings bend the light that hits them and gather it into one narrow, powerful beam. The finished lens looked like a giant glass beehive, yet it was much thinner and lighter than a solid lens of equal strength.

The lens was usually set on a rotating platform, so the beam swept across the sea like the hand of a clock. A sailor saw a flash each time the beam passed. Each lighthouse was given its own pattern of flashes, such as two quick flashes followed by a pause, so that a captain could tell which one was in view and work out the ship's position.

Fresnel lenses made lights shine much farther, and the beams of the largest ones could be seen from more than twenty miles away. Today, ships rely mostly on satellite navigation, and many lighthouses now use electric bulbs or LEDs, but some old Fresnel lenses are still working, and others are preserved in museums.

Questions

1. What did early lighthouses burn?

_____

_____

2. What did Fresnel build his lens from?

_____

_____

3. How could a captain tell which lighthouse was in view?

_____

_____

4. Why was an ordinary lamp wasteful?

_____

_____

5. Why would a solid lens strong enough for a lighthouse have been a problem?

_____

_____

Words to know

lighthouse: a tall tower with a bright light that guides ships
harbor: a sheltered place where ships can stay safely
lens: a curved piece of glass that bends light
beam: a narrow stream of light
physicist: a scientist who studies matter, energy, and light

Talk together (every group has these)

1. Find one fact that every group read. How did your sheet say it?
2. What did your sheet tell you that you think another group's did not? Ask them.
3. What is one question about this topic that none of the sheets answered?

Name: _____ Date: _____

The Lens That Changed Lighthouses

Square group

For centuries, sailors depended on lighthouses to warn them of hidden rocks and to guide them safely into harbor. The earliest lighthouses burned wood or coal fires on top of their towers, and later ones relied on oil lamps. These lights were dim and inefficient, because a lamp radiates its glow in every direction, so most of the light is wasted on empty sea or on the sky overhead.

In the 1820s, a French physicist named Augustin Fresnel solved this problem with an ingenious new kind of lens. An ordinary lens powerful enough for a lighthouse would have been enormously thick and heavy, and it would have absorbed a considerable share of the light passing through it. Fresnel's insight was to construct the lens from many separate rings of glass, each one cut at a carefully calculated angle. The rings bend the light that strikes them and concentrate it into a single narrow, powerful beam. The finished lens resembled a giant glass beehive, yet it was far thinner and lighter than a solid lens of equal strength.

The lens was typically mounted on a rotating platform, so that the beam swept across the sea like the hand of a clock. Sailors observed a flash each time the beam passed. Every lighthouse was assigned its own distinctive pattern of flashes, such as two quick flashes followed by a pause, which allowed a captain to identify the lighthouse in view and work out the ship's position.

Fresnel lenses made lights shine dramatically farther, and the beams of the largest ones could be seen from more than twenty miles away. Today, ships rely primarily on satellite navigation, and many lighthouses have switched to electric bulbs or LEDs, but some of the old Fresnel lenses are still operating, and others are preserved in museums.

Questions

1. What fuel did the earliest lighthouses use?

_____

_____

2. How was Fresnel's lens constructed?

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3. How did a captain identify the lighthouse in view?

_____

_____

4. Why were the early lamps inefficient?

_____

_____

5. Why would an ordinary lens powerful enough for a lighthouse have been impractical?

_____

_____

Words to know

lighthouse: a tall tower with a bright light that guides ships
harbor: a sheltered place where ships can stay safely
lens: a curved piece of glass that bends light
beam: a narrow stream of light
physicist: a scientist who studies matter, energy, and light

Talk together (every group has these)

1. Find one fact that every group read. How did your sheet say it?
2. What did your sheet tell you that you think another group's did not? Ask them.
3. What is one question about this topic that none of the sheets answered?

For the teacher: The Lens That Changed Lighthouses

Each student sheet carries a shape, not a level. The same topic and facts, written three ways.

Circle: The Lens That Changed Lighthouses

Easier · 275 words · Flesch-Kincaid grade 3.9

1. Wood or coal fires, and later oil lamps.
2. Many separate rings of glass, each cut at a careful angle.
3. Each lighthouse had its own pattern of flashes.
4. It sent light in every direction, and most of it shone over empty sea or the sky.
5. It would have been very thick and heavy, and it would have soaked up much of the light.

Triangle: The Lens That Changed Lighthouses

This passage · 286 words · Flesch-Kincaid grade 9.2

1. Wood or coal fires, and later oil lamps.
2. Many separate rings of glass, each cut at a careful angle.
3. Each lighthouse had its own pattern of flashes.
4. It sent its light out in every direction, and most of it shone over empty sea or into the sky.
5. It would have been enormously thick and heavy, and it would have absorbed much of the light.

Square: The Lens That Changed Lighthouses

Harder · 300 words · Flesch-Kincaid grade 11

1. Wood or coal fires, and later oil lamps.
2. From many separate rings of glass, each cut at a carefully calculated angle.
3. By its distinctive pattern of flashes.
4. They radiated light in every direction, so most of it was wasted on empty sea or the sky.
5. It would have been enormously thick and heavy, and it would have absorbed much of the light.