Name: _____ Date: _____

● Optics Reading Passage

OPTICS

The science of light properties and behavior is called **optics**. Optics helps us study how light interacts with matter. When we talk about optics, we usually refer to visible light. However, it is the study of *all* types of light.

Like all waves, light can reflect, refract and diffract when it interacts with matter. Light waves can also pass through matter. The type of matter will determine whether all, some or no light waves can pass through.

Matter that allows all light to pass through is **transparent**. Transparent matter is easy to see through. Glass and air are examples of transparent matter.

Matter that allows some light to pass through is **translucent**. Most light waves are scattered by translucent matter. In other words, light waves reflect off the matter. For this reason, translucent objects are difficult to see through. Paper and plastic are examples of translucent matter.

Matter that does not allow light to pass through is **opaque**. Opaque matter completely blocks light. Light waves are absorbed or reflected off opaque matter and so you cannot see through an opaque object. An opaque object produces a shadow. A **shadow** is the region where light is obstructed or blocked and appears on the opposite side of the light source. Wood, metal and stone are examples of opaque matter.

Questions

1. What are optics?
2. How can light waves interact with matter?
3. Compare and contrast a transparent, translucent and opaque material.
4. Do you think a transparent or translucent material could produce a shadow? Justify your answer.
5. Draw simple diagrams to show how light interacts with a transparent, translucent and opaque material.

Name: _____ Date: _____

● Optics Answer Sheet

Questions

1. What are optics?

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2. How can light waves interact with matter?

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3. Compare and contrast a transparent, translucent and opaque material.

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4. Do you think a transparent or translucent material could produce a shadow? Justify your answer.

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5. Draw simple diagrams to show how light interacts with a transparent, translucent and opaque material.

Name: _____ Date: _____

■ Wave Behavior Reading Passage

WAVE BEHAVIOR

When a wave encounters a barrier, it behaves a certain way. Its behavior depends on the type of wave, its properties and properties of the barrier. There are four ways to describe how a wave can behave when it encounters a barrier.

When a wave encounters a barrier, it can bounce off the surface of that barrier. This is called **reflection**. Waves tend to reflect best off flat, hard and shiny surfaces. Light waves best reflect off mirrors. A **mirror** is a smooth and shiny surface that reflects light to produce clear images. A mirror's smooth surface causes light to reflect evenly off it. This is why mirrors can produce images.

When a wave passes across a barrier into a new medium, such as from air into water, the wave bends. The bending of a wave is called **refraction**. A wave refracts because its speed changes in the new medium. When speed of the wave changes, the direction of the wave changes and so it bends. A **prism** causes a unique type of light refraction. A prism is a transparent, triangular object that causes white light to separate into seven different colors. We call this **dispersion**. When white light enters a prism, the different colors refract differently. This causes white light to separate into a spectrum of colors.

Waves can also bend to get around small barriers or to "squeeze through" small openings within a barrier. This is called diffraction. Waves can diffract if the obstacle is small or if the opening in the barrier is just wide enough to accommodate the wavelength of the wave. When light waves diffract, they produce a banding pattern.

When waves come into contact with each other, they interact. Specifically, they overlay or superimpose each other This is called **interference**. When waves interfere with each other, they combine to produce one wave called a resultant wave. The amplitude of the resultant wave depends on the amplitude of the interfering waves and the phase of those waves. Light waves can constructively interfere to produce brighter light or they can destructively interfere to produce dimmer light.

Name: _____ Date: _____

■ Wave Behavior Answer Sheet

Questions

1. What is reflection?

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2. What is interference?

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3. What is the difference between refraction and diffraction?

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4. How does constructive and destructive interference change light differently?

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5. Do you think a prism affects other types of electromagnetic waves the same way as visible light waves? Justify your answer.

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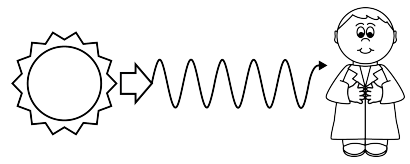
Name: _____ Date: _____

◆ Doppler Effect Lenses Reading Passage

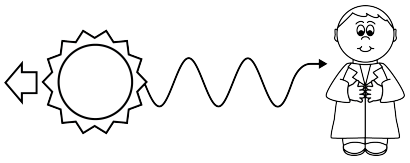
DOPPLER EFFECT

When an object moves, the waves produced by that object are distorted. Specifically, the frequency of the wave changes. This phenomenon is called the **Doppler Effect**. The Doppler Effect depends on the relative position of the object emitting the waves and observer. If the observer is stationary and the object is moving, the frequency of the waves produced by the object will change for the observer.

The frequency of an electromagnetic wave is constant so long as the wave travels through the same medium. The frequency will change for an observer of the wave if the object producing the wave is moving towards or away from the observer. If the object moves towards the observer, the frequency of the EM wave increases. We call this **blueshift**. If the object moves away from the observer, the frequency of the EM radiation decrease. We call this **redshift**.



Blueshift



Redshift

The Doppler Effect is important to astronomy. Scientists can calculate how fast stars and galaxies are moving towards or away from Earth using redshift and blueshift. The frequency of light emitted from stars that are moving towards from us increases, which causes the color of light emitted from the star to "shift towards the color blue." This is why we call this blueshift. The frequency of light emitted from stars that are moving away from us decreases, which causes the color of light emitted from the star to "shift towards the color red." This is why we call this redshift.

Questions

1. What phenomenon is described by the Doppler Effect?
2. What happens to light as an object producing it moves *towards* an observer?
3. What happens to light as an object producing it moves *away from* an observer?
4. What is the difference between blueshift and redshift?
5. When scientists observe distance stars in the universe, they most often appear redshifted. What do you think they infer about our universe from this observation?

Name: _____ Date: _____

◆ Doppler Effect Answer Sheet

Questions

1. What phenomenon is described by the Doppler Effect?

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2. What happens to light as an object producing it moves *towards* an observer?

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4. What is the difference between blueshift and redshift?

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5. When scientists observe distance stars in the universe, they most often appear redshifted. What do you think they infer about our universe from this observation?

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