The Nature Of Light

Teacher's Guide High/Middle School

Editors:
Brian A. Jerome, Ph.D.
Stephanie Zak Jerome

Assistant Editors:
Heidi Berry
Stephanie Rogers
Anneliese Brown

Visual Learning Company
Brandon, Vermont
1-800-453-8481
www.visuallearningco.com

Reviewers:

Reviewers:
Linda Arnone
Clark County Public School
Las Vegas, Nevada

Steve Welch
Rutland Middle School
Rutland, Vermont

John Peterson
Professor Emeritus of Physics
Providence, Rhode Island

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A Message from our Company...

Dear Educator:

Thank you for your interest in the educational videos produced by the *Visual Learning Company*. We are a Vermont-based, family owned and operated business specializing in the production of quality educational science videos and materials.

We have a long family tradition of education. Our grandmothers graduated from normal school in the 1920's to become teachers. Brian's mother was an elementary teacher and guidance counselor, and his father was a high school teacher and superintendent. This family tradition inspired Brian to become a science teacher and to earn a Ph.D. in education, and lead Stephanie to work on science educational programs at NASA.

In developing this video, accompanying teacher's guide, and student activities, our goal is to provide educators with the highest quality materials, thus enabling students to be successful. In this era of more demanding standards and assessment requirements, supplementary materials need to be curricular and standards based - this is what we do!

Our videos and accompanying materials focus on the key concepts and vocabulary required by national and state standards and goals. It is our mission to help students meet these goals and standards, while experiencing the joy and thrill of science.

Sincerely,

Brian and Stephanie Jerome

National Standards Correlations

National Science Education Standards

(Content Standards: 5-8, National Academy of Sciences, c. 1996)

Science as Inquiry - Content Standard A:

As a result of activities in grades 5-8, all students should develop:

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Physical Science - Content Standard B:

As a result of their activities in grades 5-8, all students should develop an understanding of how:

- Light interacts with matter by transmission (including reflection). To see an object, light from the object - emitted by or scattered from it - must enter the eye.
- The sun's energy arrives as light with a range of wavelengths, consisting of visible light, infrared and ultraviolet radiation.

Benchmarks for Science Literacy

(Project 2061 - AAAS, c. 1993)

The Physical Setting - Motion (4F)

By the end of the 8th grade, students should know that:

- Light from the sun is made up of a mixture of many different colors of light, even though to the eye the light looks almost white. Other things that give off or reflect light have a different mix of colors.
- Something can be "seen" when light waves emitted or reflected by it enter the eye.
- Light from the sun takes a few minutes to reach the earth, but light from the nearest star takes a few years to arrive.

Student Learning Objectives

Upon viewing the video and completing the enclosed student activities, students should be able to do the following:

- Differentiate between light that is created by objects and light that is reflected by objects;
- Describe the characteristics of electromagnetic waves;
- Explain how light can behave both as waves and as energy particles;
- Describe how light intensity varies with distance;
- Explain how light-years are used to measure the speed of light in space;
- Define and illustrate the concepts of wavelength and frequency;
- Describe the main categories of electromagnetic energy and the organization of the electromagnetic spectrum; and
- Provide real-life examples of the use of radio waves, infrared waves, visible light, ultraviolet rays, x-rays, and gamma rays.

Assessment

Preliminary Test:

The Preliminary Test, provided in the Student Masters section, is an assessment tool designed to gain an understanding of student preexisting knowledge. It can also be used as a benchmark upon which to assess student progress based on the objectives stated on the previous pages.

Video Review:

The Video Review, provided in the Student Masters section, can be used as an assessment tool or as a student activity. There are two main parts. The first part contains questions titled "You Decide" that can be answered during the video. The second series of ten questions consists of a video quiz to be answered at the conclusion of the video.

Post Test:

The Post-Test, provided in the Student Masters section, can be utilized as an assessment tool following student completion of the video and student activities. The results of the Post-Test can be compared against the results of the Preliminary Test to assess student progress.

Introducing the Video

Explain to the class that light from the sun creates an electromagnetic spectrum, and only part of this spectrum creates light visible to the human eye. Ask the students to think about what some of the invisible parts of the spectrum are. As a class, make a list on the chalkboard of examples of the invisible parts of the spectrum. After viewing the program, have each student write down one new example of how we use the invisible part of the electromagnetic spectrum. Collect the ideas and then redistribute them to the class so that each student has someone else's idea. Add to the list on the board by calling on students at random to read the new ideas. Discuss the updated list as a class.

Video Viewing Suggestions

You may want to photocopy and distribute the Student Master, "Video Review." You may choose to have your students complete this Master while viewing the program or to do so upon its conclusion.

The program is approximately 20-minutes in length and includes a ten-question video quiz. Answers are not provided to the Video Quiz on the video, but are included in this teacher's guide. You may decide to either grade student quizzes as an assessment tool or to review the answers in class.

The video is content-rich with numerous vocabulary words. For this reason you may want to periodically stop the video to review and discuss new terminology and concepts.

Student Assessments and Activities

Assessment Masters:

- Preliminary Test
- Video Review
- Post-Test

Student Activity Masters:

- Electromagnetic Waves
- Types of Waves
- Light Travel
- Electromagnetic Magic
- Destination: Barrow
- Vocabulary of *The Nature of Light*

Video Script- *The Nature of Light*

1. Light affects our lives in many ways. These fireworks illuminate the sky with many brilliant colors.
2. This vibrant flower attracts insects such as these bees.
3. We use cell phones to communicate with family and friends.
4. We get our teeth x-rayed to identify spots of decay.
5. We use microwave ovens to warm food.
6. And we warm ourselves in the rays of the sun.
7. What do all these examples have in common? They are examples of the different kinds of light in action.
8. During the next few minutes we are going to explore the many different kinds of light, and explore the many characteristics of light.
9. And take a look at how light affects our daily lives.
10. **Graphic Transition - Light Energy**
11. Light is a form of energy that we detect with our eyes.
12. You Decide!
13. What enables you to see the luger coming down the luge course? Is she producing or reflecting light?
14. If you said that she is reflecting light, you are right!
15. The surface of the water behind this bird is reflecting light from the sun.
16. Most things we see outdoors reflect sunlight.
17. The sun is the source of energy that creates daylight.
18. Even the moon reflects the light of the sun.
19. In some cases, objects do not reflect light, but instead they create or produce light energy. This flare produces light via a chemical reaction,…
20. ...while this fire produces light energy from the burning of wood.
21. This glow-in-the-dark stick produces light from a chemical reaction.
22. The light energy we receive from the sun is the result of nuclear reactions.
23. Now that we understand that the light we see is either reflected or created, let's take a closer look at how light is formed.
24. **Graphic Transition - Light Creation**
25. This is a piece of magnesium oxide, a metal that has the potential to . . .
26. . . . burn violently.
27. What creates this bright light? In short, light is created when small particles, called electrons, change position inside an atom.
28. This is a model of an atom. The small particles orbiting on the outside of this atom are electrons.
29. These electrons contain energy. The amount of energy in a given electron determines its distance from the center of the atom.

Script

30. When an electron absorbs energy it may jump to a higher energy level in an atom.
31. But when an electron falls to a lower energy level, it gives off energy in the form of light.
32. This packet of light contains electromagnetic energy and is referred to as a photon.
33. **Graphic Transition – Electromagnetic Energy**
34. (Fireworks exploding)
35. The light we see from these fireworks is in the form of electromagnetic energy.
36. We're surrounded by a sea of electromagnetic waves.
37. For example, this radio is receiving radio waves through the surrounding air from distant radio towers.
38. And we are bombarded by ultraviolet waves from the sun. The sun emits a wide range of different types of electromagnetic waves, referred to as the electromagnetic spectrum.
39. An electromagnetic wave is the result of alternating electric and magnetic fields. These fields are perpendicular to each other and are positioned at right angles to the direction of the wave.
40. Electromagnetic waves are also called transverse waves, meaning that the energy particles inside the wave move at right angles to the direction in which the waves are heading.
41. Certain other types of waves, such as sound waves blasted from this speaker, can cause matter, such as the water in this cup, to vibrate.
42. Electromagnetic waves, such as this laser, do not necessarily cause matter to vibrate.
43. Electromagnetic waves do not need a medium through which to travel and can therefore travel through space, where there is no matter.
44. Because of this, light from stars and other forms of electromagnetic energy travel easily through space.
45. **Graphic Transition – Nature of Electromagnetic Waves**
46. In the late 1600s, Isaac Newton developed the first explanation for the behavior of light. He stated that light behaves as a stream of tiny particles.
47. Other scientists disagreed, stating that light travels in waves.
48. They based their theory on the findings that light beams can bend around objects....
49. ...and can pass through each other. These behaviors are unique characteristics of waves. This was the dominant view of the behavior of waves for many years.
50. Over 100 years later, Albert Einstein, the great physicist, reopened the debate.
51. He stated that light is made up of tiny energy packets called photons.
52. Scientists now generally agree that light can behave both as waves and as photons.
53. When light travels, it acts like a wave.
54. But when light is reflected or absorbed by objects, it behaves like energy particles.
55. **Graphic Transition – Light Speed and Intensity**
56. You Decide! What's the difference between these two lights?

Script

57. That's right, the light on the left is brighter.
58. You also may have said that the light on the left is closer than the light on the right - this is also true.
59. Light intensity, or brightness, varies with the distance from the light.
60. This can of spray paint helps to illustrate the concept.
61. Notice the intense area of paint that is produced when the can is held close to the paper.
62. But when the can is held further away from the paper, notice how the color is less intense.
63. Similar to the paint, the intensity of light decreases with distance.
64. While the intensity of light varies with the distance from the light source,...
65. . . . the speed of light varies according to the medium through which it passes.
66. In space, light moves at a rate of nearly 300,000 kilometers per second. This is remarkably fast.
67. The light from our sun, which is approximately 150,000,000 kilometers from Earth, takes only 8 minutes to reach the Earth.
68. In other mediums, such as water and glass, the speed of light decreases by nearly thirty percent.
69. When discussing large distances in space, we use a unit of measurement called the light-year.
70. A light-year is the amount of distance light travels in one year. This distance is 9.46 trillion kilometers.
71. This star, for example, called Eta Carinae, is over 7,500 light-years from earth.
72. This means that much of the light we see from stars is hundreds or thousands of years old, originating long before we were born.
73. **Graphic Transition - Wavelength and Frequency**
74. You Decide! What makes this candle light different from this laser light?
75. The answer lies in their wavelength. The laser light has a shorter wavelength than the light from the candle's flame.
76. What is wavelength? Wavelength is the distance between a point on one wave and the same point on the next wave.
77. The wavelength of the orange wave is longer than the wavelength of the green wave.
78. Another term used to describe waves is frequency.
79. Frequency is the number of wavelengths that pass a point each second.
80. This orange wave has a low frequency, while this green wave has a high frequency.
81. Generally speaking, waves with short wavelengths have high frequencies,...
82. ...and waves with long wavelengths have low frequencies.
83. These are important concepts in helping us to understand the electromagnetic spectrum.
84. **Graphic Transition – Electromagnetic Spectrum**

Script

85. You Decide! What makes this microwave different from this oven?
86. While both are used to heat food, they utilize different kinds of electromagnetic waves.
87. There are a wide variety of electromagnetic waves, only a small portion of which can be seen by the naked eye. The rest are invisible! The electromagnetic spectrum classifies electromagnetic waves according to their wavelength and frequency.
88. This is a diagram of the electromagnetic spectrum. Notice how the waves on the left have a long wavelength and a low frequency, while the waves on the right have a short wavelength and high frequency.
89. On the far-left side of the electromagnetic spectrum are radio waves, which have a long wavelength and low frequency.
90. And on the far right are gamma rays, which have a short wavelength and high frequency. These waves possess a great deal of energy and can be dangerous.
91. The other types of electromagnetic waves are found on the spectrum between radio waves and gamma waves.
92. **Graphic Transition – Radio Waves**
93. This radio is trying to lock in a signal that is transmitted...
94. ...from this radio tower, hundreds of miles away. The tower is sending out radio waves.
95. Radio waves have long wavelengths and low frequencies and are therefore found on the left side of the spectrum.
96. Radio waves are extremely useful.
97. They are used in airport radar to track airplanes and to guide them safely to their destination.
98. Radio waves are used to transmit signals from satellites far above earth to satellite dishes.
99. Television sets that are not connected to cable but rely on antennas use radio waves to produce the picture and sound of a TV program.
100. High frequency radio waves, called microwaves, enable microwave ovens to cook food.
101. **Graphic Transition – Infrared Radiation**
102. This colorful picture shows differences in temperature in the Earth's oceans. Red indicates the warmest areas and blue indicates the coolest areas.
103. Infrared rays are also used in remote control devices, such as this one.
104. Infrared rays have a wavelength that is slightly longer than visible light.
105. You can detect infrared light when you feel heat.
106. Infrared radiation produces heat by causing the molecules in an object to vibrate more quickly, causing the temperature to rise.
107. Nearly half of the rays emitted by the sun are infrared rays.
108. Special infrared cameras take pictures of infrared radiation emitted by objects, such as this building. The areas of heat loss are indicated by the colors red,

Script

white, and yellow. They allow a carpenter or an electrician to determine where insulation is needed.

109. **Graphic Transition – Visible Light**
110. Located toward the center of the electromagnetic spectrum is visible light.
111. Visible light is light we can see and consists of the colors red, orange, yellow, green, blue, indigo, and violet.
112. Red has a lowest frequency of visible light, while violet has the highest.
113. The visible spectrum is essential to life on earth,.....
114. ...with nearly half of the energy emitted by the sun in the visible range.
115. This device, called a prism, refracts the different wavelengths found in the white light of the sun, causing the light to separate into the individual colors of the rainbow.
116. It is interesting to note, however, that visible light only represents a small portion of the entire spectrum.
117. **Graphic Transition – Ultraviolet Rays, X-rays, and Gamma Rays**
118. You Decide! What types of rays are the cause of painful, red sunburn?
119. Ultraviolet rays emitted by the sun pack a great deal of energy and can burn exposed human flesh.
120. That's why it is a good idea to cover up with hats, sunglasses and sunscreen if you plan to be outdoors.
121. X-rays are another part of the electromagnetic spectrum that are even more powerful and energetic.
122. Perhaps you have had a x-ray taken of your teeth...
123. ...or another part of your body.
124. X-rays have a high frequency. Bones absorb the x-rays but soft tissue allows x-rays to pass right through, exposing special film to create an x-ray picture.
125. Stars are believed to give off a great amount of x-rays when they explode.
126. Waves with the shortest wavelength and highest frequency are gamma rays.
127. These rays have the highest energy and therefore possess tremendous penetrating ability. Prolonged exposure to gamma rays can cause severe illness.
128. **Graphic Transition – Summing Up**
129. During the past few minutes we have explored some of the basic principles of light,...
130. ...beginning with the creation of light.
131. We took a close look at how light can behave like a wave or like energy particles.
132. We studied the intensity and speed of light ...
133. ...and took an in-depth look at the different types and characteristics of waves that make up the electromagnetic spectrum, including radio waves,...
134. ..infrared waves,...
135. ...visible light,.....

136. ...ultraviolet waves,...
137. ...x-rays,...
138. ...and gamma rays.
139. So the next time you use a microwave,...
140. ...turn on a light,....
141. ...or use a cell phone, think about the different characteristics of light. You just might think about light a little differently.

Video Quiz

Fill in the correct word when you hear this tone _____. Good luck, and let's get started.

1. A photon contains _____energy.
2. Light is transmitted by both small particles and by _____.
3. The intensity of light _____ when distance increases.
4. Distances in space are measured using units called _____.
5. Waves with longer wavelengths have _____ frequencies.
6. _____ is the number of wavelengths that pass a point each second.
7. _____ rays have the shortest wavelength and can be very harmful.
8. The types of electromagnetic waves that allow us to talk on cell phones are _____waves.
9. _____ light is located toward the center of the electromagnetic spectrum.
10. _____ waves can cause sunburn.

Answers to Student Assessments

Preliminary Test

1. lower
2. right angle
3. light-year
4. wavelength
5. frequency
6. low
7. created
8. visible
9. ultraviolet rays
10. high
11. false
12. true
13. true
14. false
15. true
16. false
17. true
18. false
19. true
20. true

Video Review

You Decide:

A. She is reflecting light.
B. The left light is brighter.
C. The laser light has a shorter wavelength than the flame of the candle.
D. They utilize different kinds of electromagnetic waves.
E. Ultraviolet rays.

Video Quiz:

1. electromagnetic
2. waves
3. decreases
4. light-years
5. lower
6. frequency
7. gamma
8. radio
9. visible
10. ultraviolet

Post Test

1. true
2. true
3. false
4. true
5. true
6. true
7. false
8. false
9. true
10. false
11. created
12. high
13. right angle
14. wavelength
15. lower
16. ultraviolet rays
17. frequency
18. visible
19. low
20. light year

Answers to Student Activities

Electromagnetic Waves

Answers will vary, but possible answers include:

1. television, radio wave
2. tanning bed, ultraviolet rays
3. doctor's x-ray machine, x-rays

Types of Waves

Conclusions: The first wave produced is a transverse wave, the second is a longitudinal wave. A sound wave is a longitudinal wave and a radio wave is a transverse wave. It is not possible to make a longitudinal wave with a piece of string. In a transverse wave, the medium moves at right angles to the direction of the wave. In a longitudinal wave, the energy moves in the same direction as the medium.

Calculating the Speed of Light

Conclusions:

1. 1.28 sec.
2. 498.65 sec.
3. 138.00 sec.
4. .05 sec.
5. 2594.33 sec.
6. 2095.68 sec.

Electromagnetic Magic

Conclusions: The seven colors that appear, in order, are red, orange, yellow, green, blue, indigo, and violet. These are also the seven colors of a rainbow. Moving from red to violet, the wavelength decreases and the frequency increases.

Destination: Barrow

Answers will vary.

Vocabulary

1. light year, j
2. compressional wave, a
3. ultraviolet rays, g
4. electromagnetic spectrum, f
5. medium, c
6. gamma rays, i
7. frequency, e
8. light, b
9. wavelength, h
10. transverse wave, d

Assessment and Student Activity Masters

Name_____

Preliminary Test

Directions: Fill in the blank with the correct word. A list of possible answers is provided at the bottom of the page.

1. An electron gives off light energy when its position changes to a _____ level.

2. The medium of a transverse wave is at a_____ to the direction of that wave.

3. A _____ is the unit of measurement used when discussing large distances in space.

4. _____ is the distance between a point on one wave and the same point on the next wave.

5. _____ is the number of wavelengths that pass a point each second.

6. A wave with a long wavelength usually has a _____ frequency.

7. Fire is an example of light that is _____.

8. _____ light is located toward the center of the electromagnetic spectrum and is the light we see.

9. _____ are the principle cause of sunburns.

10. X-rays have a _____ frequency that allows them to pass through the skin and create images of bones.

radio waves	wavelength
low	lower
transparent	created
visible	right angle
light-year	high
ultraviolet rays	frequency

Name_____

Preliminary Test

Directions: Decide whether the answer is True (T) or False (F).

11. Radio waves have short wavelengths and high frequencies. T F

12. Light is either created or reflected. T F

13. Infrared waves cannot be seen by the naked eye. T F

14. Red has the lowest frequency of visible light and green has the highest. T F

15. Gamma rays possess the highest amount of energy. T F

16. Light is formed when neutrons in an atom change position. T F

17. Isaac Newton developed the first theory to explain the behavior of light. T F

18. Visible light is seen in one color. T F

19. Long-term exposure to gamma rays can cause severe illness. T F

20. Light is a form of energy. T F

Name_____

Video Review

Directions: During the course of the program answer the "You Decide" questions as they are appear. Answer the Video Quiz questions at the end of the video.

You Decide:

A. What enables you to see the luger coming down this luge course. Is she producing or reflecting light? Answer: _____

B. What's the difference between these two lights? Answer: _____

C. What makes this candle light different from this laser light? Answer: _____

D. What makes this microwave different from this oven? Answer: _____

E. What types of rays are the cause of a painful, red sunburn? Answer: _____

Video Quiz:

1. A photon contains _____ energy.

2. Light is transmitted by both small particles and by _____.

3. The intensity of light _____ when distance increases.

4. Distances in space are measured using units called _____.

5. Waves with longer wavelengths have _____ frequencies.

6. _____ is the number of wavelengths that pass a point each second.

7. _____ rays have the shortest wavelength and can be very harmful.

8. The type of electromagnetic waves that allow us to talk on cell phones are _____ waves.

9. _____ light is located towards the center of the electromagnetic spectrum.

10. _____ waves can cause sunburn.

Name_____

Post Test

Directions: Decide whether the answer is True (T) or False (F).

1. Gamma rays possess the highest amount of energy. T F

2. Isaac Newton developed the first theory to explain the behavior of light. T F

3. Radio waves have short wavelengths and high frequencies. T F

4. Light is a form of energy. T F

5. Infrared waves cannot be seen by the naked eye. T F

6. Long-term exposure to gamma rays can cause severe illness. T F

7. Visible light is seen in one color. T F

8. Red has the lowest frequency of visible light and green has the highest. T F

9. Light is either created or reflected. T F

10. Light is formed when neutrons in an atom change position. T F

Name_____

Post Test

Directions: Fill in the blank with the correct word. A list of possible answers is provided at the bottom of the page.

11. Fire is an example of light that is _____.

12. X-rays have a _____ frequency which allow them to pass through the skin and create images of bones.

13. The medium of a transverse wave is at a _____ to the direction of that wave.

14. _____ is the distance between a point on one wave and the same point on the next wave.

15. An electron gives off light energy when its position changes to a _____ level.

16. _____ are the principle cause of sunburns.

17. _____ is the number of wavelengths that pass a point each second.

18. _____ light is located toward the center of the electromagnetic spectru, and is the light we see.

19. A wave with a long wavelength usually has a _____ frequency.

20. A _____ is the unit of measurement used when discussing large distances in space.

lower	high
created	transparent
light-year	ultraviolet rays
low	radio waves
frequency	right angles
wavelength	visible

Name_____

Electromagnetic Waves

Objective: In this activity you will learn about the different types of electromagnetic waves.

Background: Sunlight and x-rays have many similarities. They are both waves that carry energy! They are not waves that can be felt or heard, but are electromagnetic waves. An **electromagnetic wave** is a wave that consists of both an electric and magnetic field and does not require a medium through which to travel. Light is an electromagnetic wave that travels easily in space. Space has no medium and is referred to as a **vacuum**. Light from distant stars and from the sun travel through the vacuum of space.

Electromagnetic waves are categorized by their wavelength and frequency in what is know as the **electromagnetic spectrum**. The general types of electromagnetic waves are **radio waves, infrared rays, visible light, ultraviolet rays, x-rays,** and **gamma rays**. The small portion of the spectrum, referred to as **visible light**, contains the only waves that can be seen with the naked eye.

Directions: In the first column below, list seven common devices and/or appliances that produce electromagnetic waves. In the second column, identify which type of electromagnetic wave is used in the device. Identify which electromagnetic wave appears most frequently on your list and explain why this is so.

Device	Type of Electromagnetic Wave
1.	
2.	
3.	
4.	
5.	
6.	
7.	

Name_____

Types of Waves

Objective: In this activity you will identify the two different types of waves and gain a better understanding of the movement of waves.

Background: When you think of waves you probably think of the ocean, but most people do not realize that waves surround everything and everyone. There are light waves, sound waves, and even heat waves. Any disturbance that transfers energy through matter or space is a wave. Electromagnetic waves do not need a medium through which to travel. But other types of waves such as sound waves do need a medium. A **medium** is matter that is composed of molecules and takes up space.

There are two types of waves that carry energy: transverse waves and longitudinal waves. In a **transverse wave**, the medium is at right angles to the direction in which the wave travels. These waves move horizontally from left to right. Flags blowing in the wind, ocean waves, and tall grass moving in the wind are all examples of transverse waves. **Longitudinal waves** act like a spring, pushing together in one part while stretching in another part. The stretching of particles in a longitudinal wave is called **rarefaction**, and the pushing together of particles is called **compression**. In a longitudinal wave the medium moves in the same direction as the wave.

Materials:
Rope
Slinky

Procedure:
1. Pair up with a classmate.
2. While your partner holds one end of the rope stationary, slowly shake the other end of the rope up and down.
3. Vary the speed with which you shake the rope.
4. Describe the movement of the wave in your notebook.
5. To create a second wave, hold one end of the slinky still while your partner squeezes some of the coils on the other end and then releases them.
6. Record the movement of the second type of wave.

Conclusion:
Identify which wave is transverse and which is longitudinal. Which type of wave do you think produces sound? Which type of wave is a radio wave? Can you make a longitudinal wave with a piece of string? Describe the relationship between the movement of the medium and movement of energy for each wave.

Name_____

Light Travel

Objective: In this exercise you will determine the time it takes for light to travel between two points in our solar system.

Background: Light travels at various speeds depending on the medium through which it passes. While in the same medium, light travels at a constant speed in a straight line. Light travels through space at a speed of about **300,000 kilometers per second.** This means that a ray of light can travel around the circumference of the earth more than 7 times in one second. On Earth, light travels at 99% of its speed in space.

Directions: Review the geographic points listed in the chart below. To determine the travel time of light between two areas, you simply divide the distance between the destination points by the speed of light. Round your answer to the nearest hundredth of a second.

Point A	Point B	Distance (km)	Travel Time
Moon	Earth	384,365	
Sun	Earth	149,596,000	
Sun	Venus	41,400,000	
New York City	Sydney, Australia	15,994	
Sun	Jupiter	778,300,000	
Earth	Jupiter	628,704,000	

Name_____

Electromagnetic Magic

Objective: In this lab you will demonstrate the refraction of light and create your own electromagnetic spectrum.

Background: Isaac Newton realized that plain white light contains all of the colors of a rainbow. Most of the time these colors are hidden, but once the white light is refracted, the colors separate and are visible. When the sun shines during a rain shower, water droplets refract the sunlight, separating the white light and producing an array of colors called a rainbow. The colors differ not only in their appearance but also in their frequency. Frequency increases from left to right on the spectrum, such that red has the shortest frequency and violet has the longest.

Materials:

Part A:
Glass or plastic prism
Light source (flashlight or sunlight)
Blank, white sheet of paper

Part B:
Small mirror
Plastic container (shoebox size)
Water

Procedure:

Part A:
1. Darken the room as much as possible for better visibility.
2. Shine the light source through one side of the prism.
3. Line the paper up so that the light shines through the prism and onto the paper. What do you see?
4. List the colors in order of their appearance.

Part B:
1. Fill the plastic container with water.
2. Place the container in front of a light source.
3. Submerge the mirror in the water. Lean it against the side of the container at a five degree angle.
4. Manipulate the mirror and light source to produce a spectrum.

Conclusion:

Using your knowledge of refraction and wavelength, list the colors in order of shortest to longest wavelength. Of what does the order of colors formed by the prism remind you? Describe how the wavelength and frequency change as you move from red to violet in the spectrum.

Name_____

Destination: Barrow

Objective: In this writing exercise you will present a detailed description of what your life would be like if you lived in darkness for three months.

Background: Imagine living in a place where three months of each year are spent in total darkness. In such a place, the sun does not rise for 1/4 of the year, and night time does not differ from daytime. For the residents of Barrow, Alaska such an existence is part of their everyday lives. Between the months of November and January there is continual darkness, followed by a period of continual daytime throughout the months of May and August.

The changing of seasons is due largely to the tilting of the Earth in relation to the sun. During the winter months, Earth is tilted on its axis away from the sun. In the summer, Earth is tilted towards the sun. The angle of tilt determines how long the days and nights last. In some areas in the far north or south, the earth is tilted away from the sun in such a way that sunlight does not reach it for months at a time. When the Earth rotates around the sun, the areas previously untouched by sunlight are now flooded with light, so that they then have continuous daylight.

Directions: Write a two page description of what your life would be like if you lived without sunlight. Include how you think your daily activities would be affected. What tasks would become easier and what daily tasks would become more difficult? What would you do after school without any daylight?

It is also important to describe how you would feel during the summer months when the sun does not set. In your writing, take into account the condition called Seasonal Affective Disorder caused by light deprivation. This unique disorder causes the human body to have the same responses as hibernating mammals. It is speculated that the hormone melatonin, which regulates our biological cycles such as sleep, does not receive the sunlight necessary to stop production and allow the body to fully awaken. Continuous manufacturing of melatonin causes the body to think it should be asleep, and one's behavior and performance are therefore affected. While writing, begin to think of just how important the effects of sunlight are, especially on your mood.

Name_____

Vocabulary of *The Nature of Light*

Directions: Unscramble the following vocabulary words and match each word with its correct definition.

___ 1. gtilh-erya

___ 2. mpsnalcsoreoi vwea

___ 3. vuottlaeirl ysra

___ 4. lmtctceaiegeorn tseucmpr

___ 5. dimuem

___ 6. magma yrsa

___ 7. rqecfnuye

___ 8. lhgit

___ 9. geelhwvnat

___ 10. stseraenrv evwa

a. spring-like wave

b. energy that can be detected with our eyes

c. matter through which waves travel

d. a wave whose medium is at a right angle to the direction of the flow of energy

e. the number of wavelengths that pass a point each second

f. classification of waves according to their wavelengths and frequencies

g. radiation that causes sunburns

h. distance between the crests of two consecutive waves

i. most penetrating of all electromagnetic waves

j. the distance that light travels in one