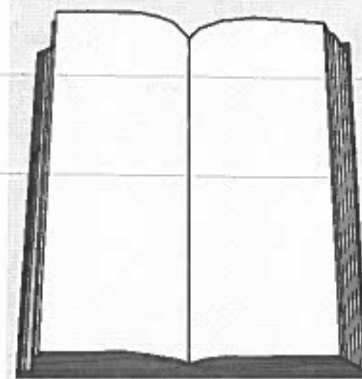
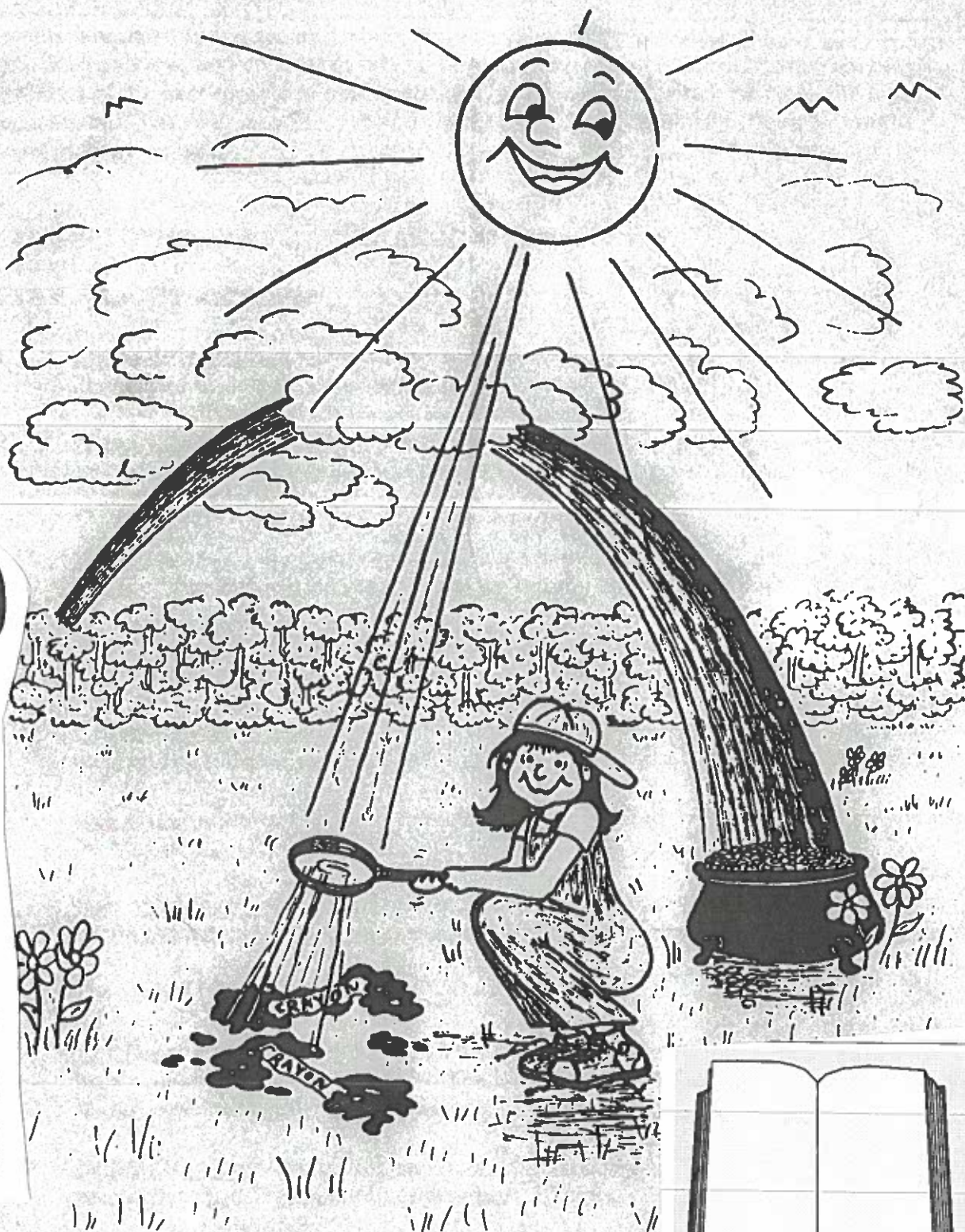


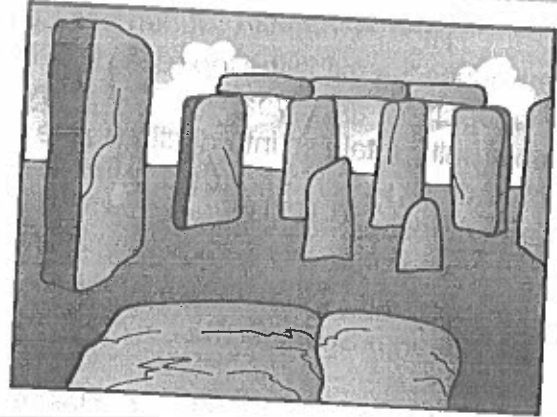
# Reading Resource

## LIGHT, COLOR AND THE EYE



## HISTORICAL PERSPECTIVE

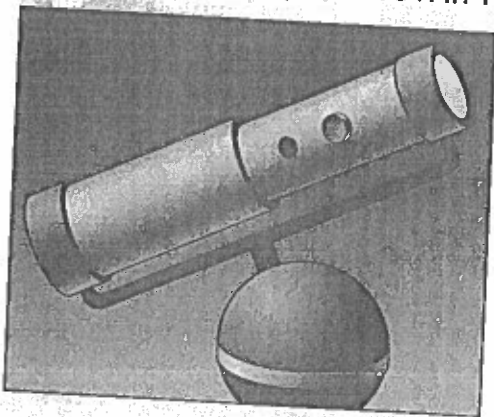
The primary source of light on Earth is the sun. Historically, sunlight and shadows were studied and used to tell time. Stonehenge is thought to be an ancient astronomical observatory that dates back to 1848 B.C. The monument at Stonehenge may have served as an accurate astronomical calendar that predicted seasons and eclipses of the sun and moon, calibrated to their rising and setting.



Anaximenes (570–500 B.C.) was one of the first to believe that a rainbow was a natural phenomenon. In 1304, Theodoric of Freiburg, Germany, conducted experiments with globes of water and correctly explained many aspects of the formation of rainbows. René Descartes explained the formation of a rainbow, as well as the formation of clouds, in 1638.

Scientists conducted investigations of the refraction of light. These led to the development of convex lenses as early as 300–291 B.C. Between 1010 and 1029, Alhazen correctly explained how lenses worked and developed parabolic mirrors. Witelo's *Perspectiva*, a treatise on optics dealing with refraction, reflection, and geometrical optics, was published in 1270. Witelo rejected the idea that sight was due to rays emitted from the eyes. People once believed that light traveled from a person's eyes to an object and reflected back to the eye to make sight possible. In 1604, Johannes Kepler described how the eye focused light and showed that light intensity decreased as the square of the distance from the source, a concept known as the *Inverse Square Law*.

The lenses we now use were introduced in the late 1200s. In 1401, Nicholas Krebs used the knowledge of lenses to construct spectacles for the nearsighted, and Leonard Digges invented a surveying telescope in 1551. In 1570, Dutch scientist Hans Lippershey invented the astronomy telescope, which Galileo modified to increase the magnification to 30X in 1609. Galileo used it to find the moons of Jupiter, Saturn's rings, the individual stars of the Milky Way, and the phases of Venus. Gregory James was the first to describe a reflecting telescope in 1663.



Zacharias Janssen and Hans Lippershey separately invented the compound microscope between 1590 and 1609. In the mid-1600s, Anton van Leeuwenhoek made a microscope that could magnify up to 270X. It was more powerful than the compound microscopes of the time and was the first to observe and record microscopic life.

In the 1600s, light was described as a form of energy that could travel freely through space. In 1666, Sir Isaac Newton discovered that white light was made up of many colors and that the colors could be separated, using a prism. Leonhard Euler (1746) worked out the mathematics of the refraction of light, by assuming that light is a wave and that different colors corresponded to different wavelengths. From 1160–1169, Robert Grosseteste began to experiment with light, mirrors, and lenses to study rainbows.

## HISTORICAL PERSPECTIVE (CONT.)

Newton proposed that light consisted of particles that travel in straight lines through space. At the same time, Christiaan Huygens suggested that light consisted of waves. In 1900, Max Planck proposed that radiant energy comes in little bundles called **quanta**, later called **photons**. His theory helped other scientists to understand that light behaved both as particles and waves, which helped develop the theory of **Quantum Mechanics**.

In 1808, Étienne-Louis Malus discovered that reflected light is polarized, introducing the concept of polarization. Sir David Brewster, in 1812, suggested that there was a relationship between the index of refraction and the angle of incidence, at which reflected light becomes completely polarized.

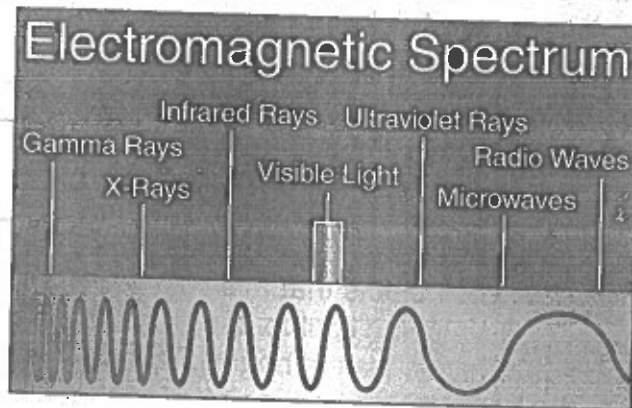
## CONCEPTS

This book will examine light energy. The primary source of light is from the sun. Light energy from the sun warms the earth when it changes to heat energy as it passes through the atmosphere. Light energy is also stored as energy in green plants, which become food for animals and humans or become fossil fuels, such as coal, natural gas, or oil.

Energy from light is **radiant energy**, energy transmitted by electromagnetic waves. Types of radiant energy include infrared rays, radio waves, ultraviolet waves, and X-rays. We only see a tiny part of all different kinds of radiant energy; the part we see is called the **visible spectrum**. Light is visible only when it is the source of light itself, or when it is reflected off something else. Most objects do not emit their own light but reflect it from other sources. Sources of light can be hot, glowing materials, such as the filament or gases in light bulbs. Fire is another source of light, as in burning candles, campfires, etc. The sun and stars are also burning gases that produce light. Sources of light include fluorescent, incandescent, and chemical.

Light travels in straight lines from its source and can change matter. Historically, there have been two theories of how light travels. The **particle theory** suggests that light is made up of particles, and the **wave theory** suggests it is made of waves. Newton proposed that light consisted of particles that travel in straight lines through space. In 1900, Max Planck proposed that radiant energy comes in little bundles called **quanta**, later called **photons**. His theory helped other scientists to understand that light behaved both as particles and waves, which helped develop the theory of **Quantum Mechanics**. In 1905, Einstein's theory of photoelectric effect suggested that light consisted of bundles of concentrated electromagnetic energy that have no mass (photons). Current thought is that light travels in bundles of energy called photons, which are emitted and absorbed as particles, but travel as waves.

In 1880, Albert Michelson conducted an experiment to determine the speed of light. He found that the speed of light in a vacuum was a universal constant. This means that the



## CONCEPTS (CONT.)

electromagnetic spectrum of light always travels through a vacuum at the constant speed of 186,000 miles per second (300,000 kilometers per second).

Light energy is carried in an electromagnetic wave that is generated by vibrating electrons. The energy from the vibrating electrons is partly electric and partly magnetic; that is why this form of energy is referred to as **electromagnetic waves**. Light waves are classified by frequency into the following types: X-rays, radio waves, microwaves, infrared, visible light, ultraviolet, and gamma rays. The ultraviolet light has a higher frequency than visible light, and infrared has a lower frequency than visible light. Visible light, the light we can see, vibrates at more than 100 trillion times per second, and it includes all of the colors of the spectrum: red, orange, yellow, green, blue, indigo, and violet. (You can use the acronym ROY G. BIV to remember the order of the colors).

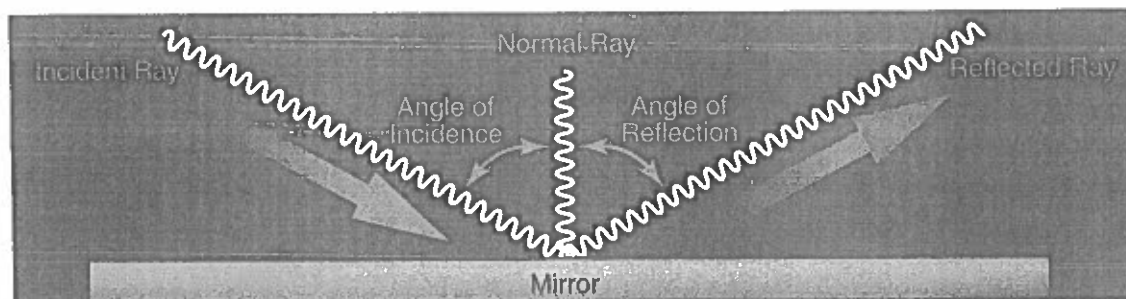
The brightness or intensity of light depends on distance and the brightness of the source. Light intensity decreases by the square of the distance. This is known as the *Inverse Square Law* (Intensity is approximately 1 divided by the distance squared, or  $\frac{1}{d^2}$ ).

For example, if the distance from the light source was 2 m, the intensity of the light would be 1/4 of the strength.

Light travels in straight lines. Shadows are formed when objects block out light. This illustrates that light cannot bend around corners without something slowing it down or reflecting it. When a small light source is near an object, or a large source is far away from an object, the image will be sharp. Most shadows are usually blurry, with a dark shadow in the middle and a lighter shadow around the edge. The dark shadow is the **umbra**; the lighter part of the shadow is the **penumbra**. A solar eclipse, when the moon passes between the earth and the sun, is a natural example.

When light strikes an object, it is reflected, absorbed, or passes through. Light colors reflect more light, and dark colors absorb more light. This absorbed light is transformed into heat energy. Objects that allow all light to pass through are called **transparent**. **Translucent** objects allow some light to pass through, and **opaque** objects allow no light to pass through.

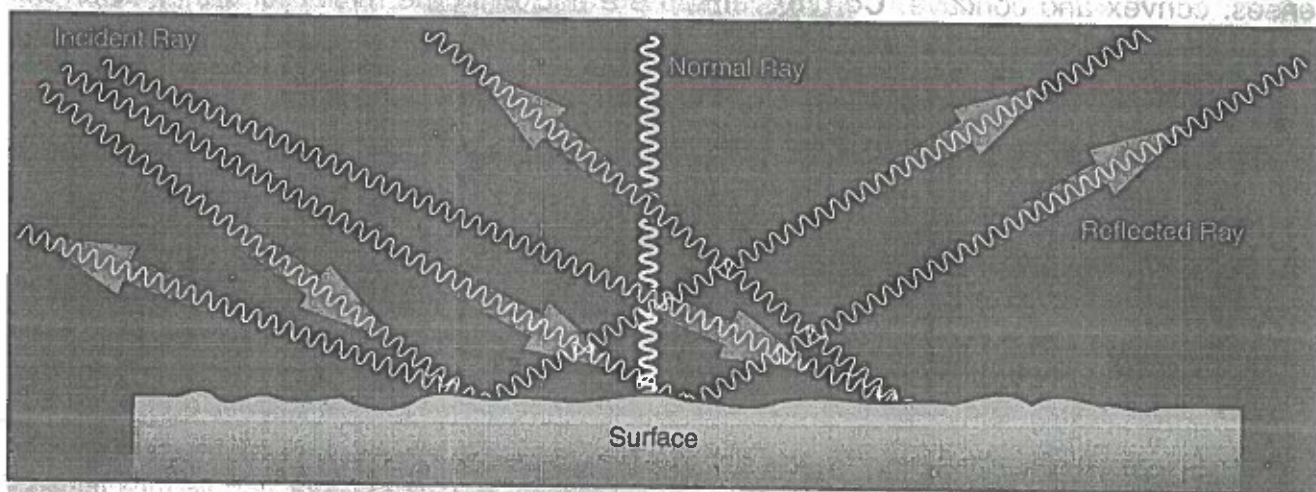
**Reflection** is the bouncing back of a particle or wave off a surface. As light strikes a flat mirror, the light rays bounce off at an equal angle, so the image is clearly shown in the mirror. When light reflects from a mirror, the angle of incidence and the angle of reflection are equal. The **angle of incidence** is the angle formed from the normal light ray that is perpendicular to the surface and the angle made by the incident ray or incoming ray. The **angle of reflection** is the angle made by the normal ray and the outgoing reflected ray. The image you see in a mirror is actually a virtual image because the light does not start at the mirror.



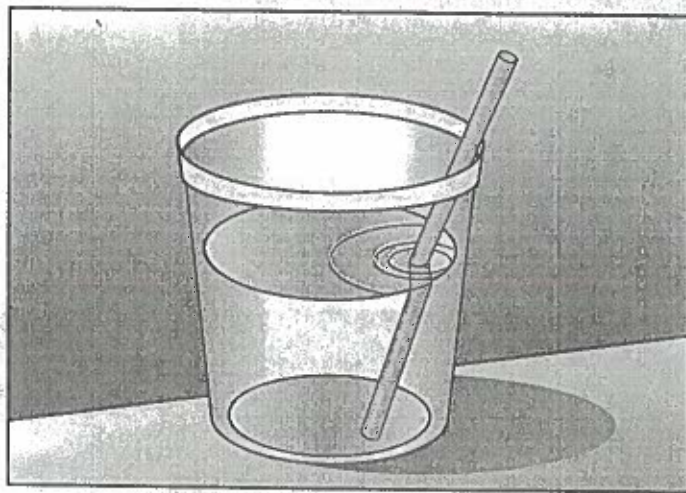
## CONCEPTS (CONT.)

Not all mirrors are flat—some are concave mirrors that are curved inward, and some are convex mirrors that are curved outward. When light strikes these mirrors, you will get different images. Looking at your image in the bowl or the back of a shiny spoon will illustrate both of these mirrors. Even though the angle of reflection and angle of incidence are equal, the images formed are different.

Uneven reflection (**diffusion**) happens when the surface is not smooth, which causes the light rays to bounce off at unequal angles. When this happens, there is a reflection, but no clear image.



**Refraction** of light is the bending of light that happens when light travels through different mediums (substances). When light goes from one medium to another and is not at an angle, it does not bend, but the object appears to be closer. If light enters at an angle, it slows down and changes directions, due to the different densities of the mediums. When a straw is put into a glass of water, the straw looks broken, because as the light goes from the air through the glass and the water, which are more dense, it slows down and bends. The **index of refraction** (how much the light bends) is the ratio of the speed of light in a vacuum to the speed of light in a given medium.

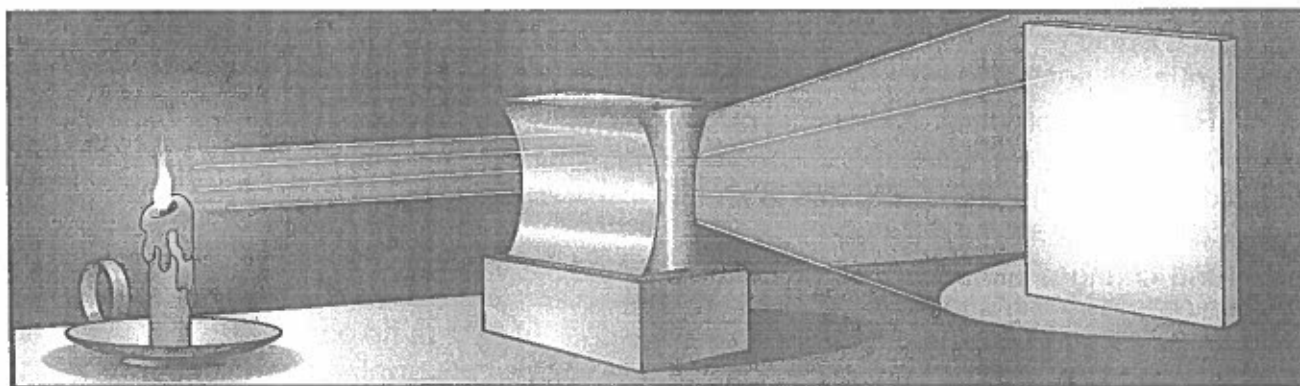


**CONCEPTS (CONT.)**

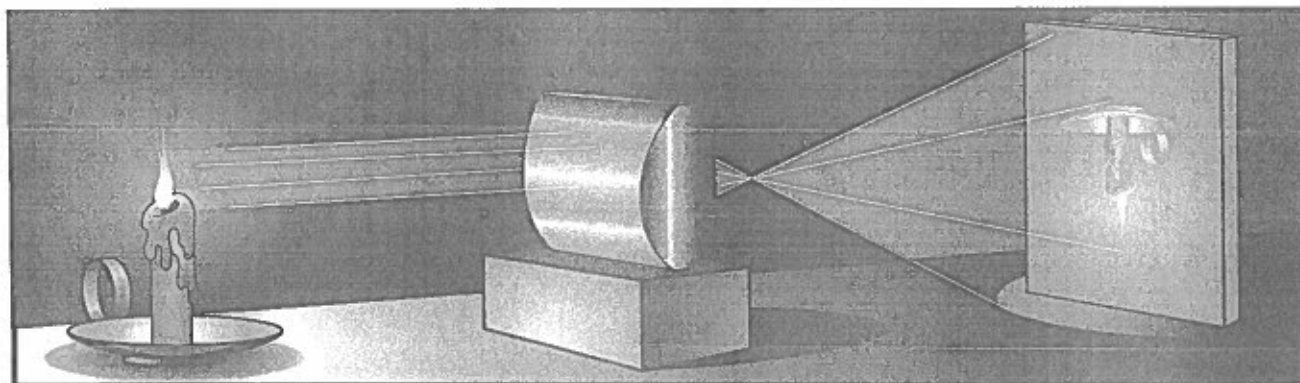
A **mirage** is caused by atmospheric refraction. On hot days, there may be a layer of hot air on the ground. In hot air, the molecules are farther apart and moving faster than in the cold air above it, and light travels faster through it than the cooler air above it. When the light travels faster through the hot air on the ground than it does in the cooler air above, the light rays are bent. One example of a mirage is when a person is driving on the highway on very hot days, and it sometimes looks as if the pavement is wet.

Lenses work because of refraction. **Lenses** are transparent objects with at least one curved surface. They are carefully shaped to control the bending of light. There are two types of lenses: convex and concave. **Convex lenses** are thicker in the middle and thinner on the edges; light converges or comes together when it passes through the lenses. **Concave lenses** are thin in the middle and thicker on the edges; light diffuses or spreads when it passes through the lenses. In looking at the diagrams below, you will find that only the convex lens can project the flame on the screen, and it is upside-down. The concave lens diffuses or spreads out the light, so it is not projected on the screen. The diagram below has emphasized the light traveling from the candle through the lens to make it easier to understand. As indicated by the diagram, non-polarized light, like the light coming from the candle flame, actually vibrates in all directions. The light coming from the flame is more diffused than the straight lines going to the lens in the diagram.

**Light passing through a double concave lens does not project an image on the paper.**



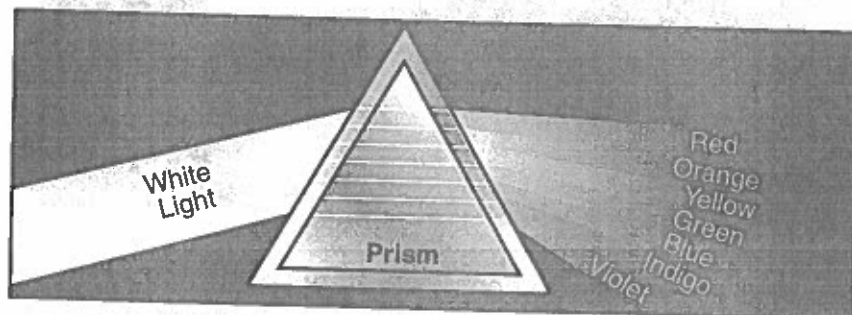
**Light passing through a double convex lens projects an upside-down image on the paper.**



## CONCEPTS (CONT.)

Concave lenses correct nearsightedness by making the image smaller but less blurry. Convex lenses correct farsightedness by making the image larger and less blurry; they are also used in refracting telescopes.

White light is made up of many colors. If white light strikes an object, it may absorb or reflect any or all of the parts of the spectrum; that is why we see different colors. We see a red shirt because only red light is reflected off the shirt; all other colors of the spectrum that make up white light are absorbed. White objects reflect all colors; black objects absorb all colors.

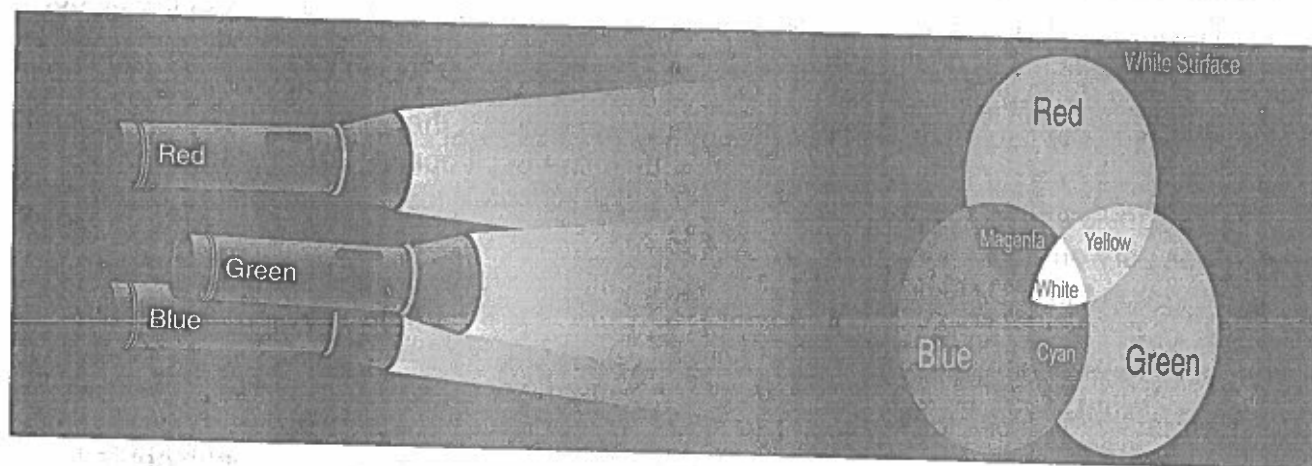
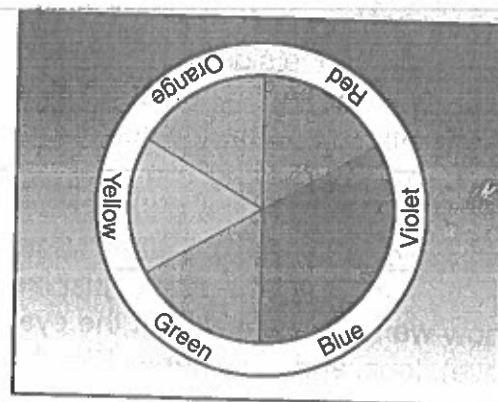


A prism separates light into the colors of the visible spectrum (ROY G. BIV). The separation of light by frequency is called **dispersion**. Different colors of light have different frequencies. As the light enters the prism at an angle and passes through, it slows down

and is bent: once going in, and once going out of the prism. Since the speed of light changes, so does the frequency. The lowest frequency is red; the highest is violet.

A prism disperses white light, and a color wheel can put all of the colors of the visible spectrum back together again. A color wheel has pie-shaped sections colored with all of the colors of the visible spectrum, and it is spun around. When the wheel spins around fast enough, individual colors are held by the retina only for a short time so they blend, making the wheel look white.

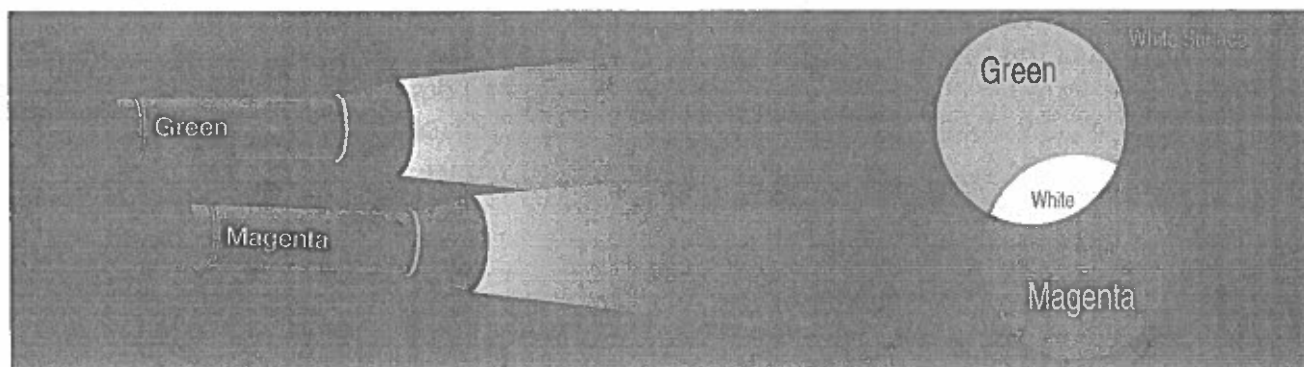
When different colors of light are mixed, they are **additive**. This means that when the colored lights are shone on a white surface, the colors combine to form new colors.



Additive colors

## CONCEPTS (CONT.)

When two complementary colors of light are shone on a white surface in the same spot, they are also additive and show as white light. The complementary colors of light are blue and yellow, green and magenta, and red and cyan.



Complementary Colors

Lingering images (persistent vision) can illustrate complementary colors of light. If you stared at a brightly colored piece of paper, and then a piece of white paper, the complementary color will appear on the white paper. This is because the eye becomes tired of staring at the color, so you see the complementary color. Another example of persistent vision is the gerbil in the cage activity. In this activity, the gerbil appears to be inside the cage, even though one image is on one side of the card, and one image is on the other side (see page 65).

In mixing pigments or paints, the colors are **subtractive**, rather than additive. When pigments are mixed, the colors are absorbed instead of reflected. If blue and yellow pigments are mixed together, green is formed. If red is mixed with green, the red absorbs the green, and the green absorbs the red, and the resulting mixture looks black. You will never get white when mixing color pigments. When more than two pigments are mixed, black is made.

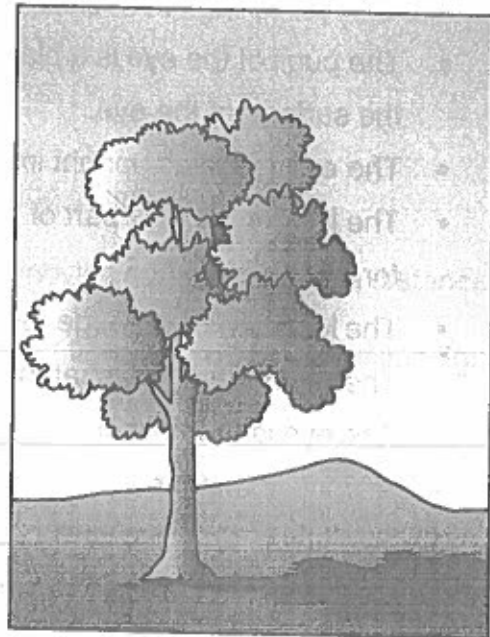
Using what we have just learned about the behavior of light and color, we can explain how we see. The inside of the eye consists of the cornea, iris, pupil, sclera (white part of the eye), lens, and optic nerve. Blood vessels in your eye bring food to the eye. The outside of the eye has eyelids, eyelashes, and tear ducts that protect the inside of the eye.

The light that strikes an object and reflects off of it is absorbed. The color of the object is determined by which colors are absorbed or reflected. The light travels to your cornea, a transparent material that acts as a convex lens. The light enters the interior of the eye through the pupil. The pupil is an opening in the center of the iris, which is the colored part of the eye. The iris has muscles that expand and contract the pupil. The pupil opens and closes depending on how much light is available. If there is very little light, it opens wider, and if there is a lot of light, it becomes very small. The light passes through the pupil to another convex lens. As the light passes through the cornea and the lens, it is refracted or bent. These lenses focus the light on the back of the eye, or the retina. Between the lens and the retina is the vitreous humor, a transparent jelly of salts and proteins encased in the sclera, the white part of the eye. The retina is a tissue of light-sensitive cells that absorbs light rays and changes them to electrical signals. Due to the refraction caused by the convex lenses, the image on the retina is upside-down. The retina changes the light rays into electrical signals that are sent through the optic nerve to the brain, where what you are seeing is identified.

**NAIVE CONCEPTS**

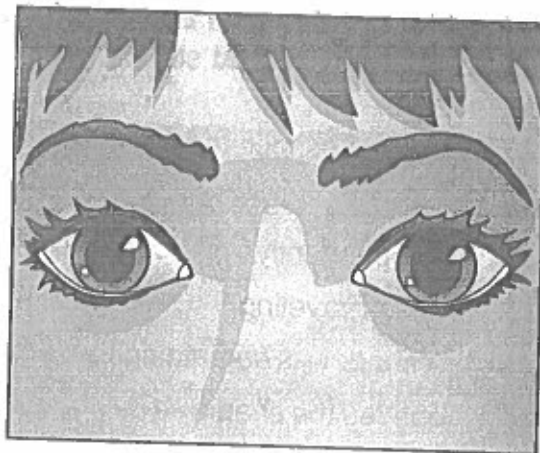
**Naive Ideas Related to Light and Color:** The naive ideas described below and on page 10 are misconceptions that students may have about light and color.

- Light is associated only with either a source or its effects. Light is not considered to exist independently in space; hence, light is not conceived of as “traveling.”
- A shadow is something that exists on its own. Light pushes the shadow away from the object to the wall or the ground, and is thought of as a “dark” reflection of the object.
- Light is not necessarily conserved. It may disappear or be intensified.
- Light from a bulb only extends outward a certain distance, and then stops. How far it extends depends on the brightness of the bulb.
- The effects of light are instantaneous. Light does not travel with a finite speed.
- A mirror reverses everything.
- The mirror image of an object is located on the surface of the mirror. The image is often thought of as a picture on a flat surface.
- Light reflects from a shiny surface in an arbitrary manner.
- Light is reflected from smooth mirror surfaces, but not from non-shiny surfaces.
- Curved mirrors make everything distorted.
- When an object is viewed through a transparent solid or liquid material, the object is seen exactly where it is located.
- When sketching a diagram to show how a lens forms an image of an object, only those light rays that leave the object in straight parallel lines are drawn.
- Blocking part of the lens surface would block the corresponding part of the image.
- An image can be seen on a screen, regardless of where the screen is placed relative to the lens. To see a larger image on a screen, the screen should be moved farther back. An image is always formed at the focal point of the lens.
- The size of the image depends on the size (diameter) of the lens.



## NAIVE CONCEPTS (CONT.)

**Naive Ideas Related to Color and Vision:** The naive ideas described below and on page 9 are misconceptions that students may have about light and color.



- The pupil of the eye is a black object or spot on the surface of the eye.
- The eye receives upright images.
- The lens is the only part of the eye responsible for focusing light.
- The lens forms an image (picture) on the retina. The brain then “looks” at this image, and that is how we see.
- The eye is the only organ for sight; the brain is only for thinking.
- A white light source produces light made up of only one color.
- Sunlight is different from other sources of light, because it contains no color.
- When white light passes through a prism, color is added to the light.
- The primary colors for mixing colored lights are red, blue, and yellow.
- A colored light striking an object produces a shadow behind it that is the same color as the light. For example, when red light strikes an object, a red shadow is formed.
- When white light passes through a colored filter, the filter adds color to the light.
- The mixing of colored paints and pigments follows the same rules as the mixing of colored lights.
- Color is a property of an object and is independent of both the illuminating light and the receiver (eye).
- White light is colorless and clear, enabling you to see the “true” color of an object.
- When a colored light illuminates a colored object, the color of the light mixes with the color of the object.
- Naive explanations of visual phenomena involving color perception usually involve only the properties of the object being observed and do not include the properties of the eye-brain system.

(American Institute of Physics, 2000)

## DEFINITION OF TERMS

**Bioluminescence:** Light given off from certain living things that have the ability to chemically excite the molecules in their bodies

**Color:** Characteristic of objects that is caused by different qualities of light being reflected or absorbed by them

**Diffraction:** Bending of a wave around a barrier

**Dispersion:** Separation of light into colors arranged according to their frequency

**Energy:** Ability to do work. The scientific definition of work is moving something over a distance.

**Infrared Rays:** Electromagnetic waves with frequencies lower than the red in the visible light spectrum

**Laser:** An optical instrument that produces a beam of coherent light, with waves of the same frequency, phase, and direction

**Law of Conservation of Energy:** Excluding nuclear energy, energy cannot be created or destroyed, only changed.

**Lens:** A piece of glass or other transparent material that can bend parallel rays of light so that they cross or appear to cross at a single point

**Light:** A form of radiant energy

**Photosynthesis:** Process of green plants using sunlight as the energy source to combine carbon dioxide and water to produce sugar and oxygen

**Shadow:** A shaded area resulting when light is blocked out by an object in its path

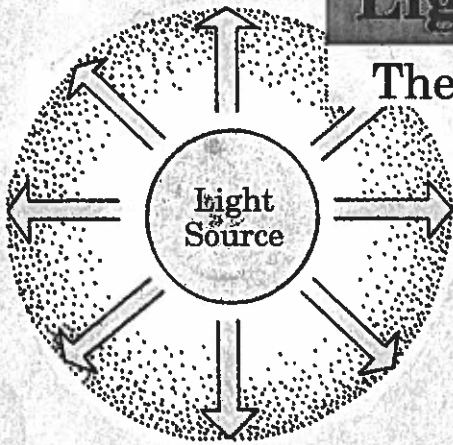
**Spectrum:** The spread of radiation by frequency

**Ultraviolet Light:** Electromagnetic waves above the frequency of violet light in the visible spectrum

**Visible Spectrum:** The spread of colors seen when light passes through a prism or diffraction grating

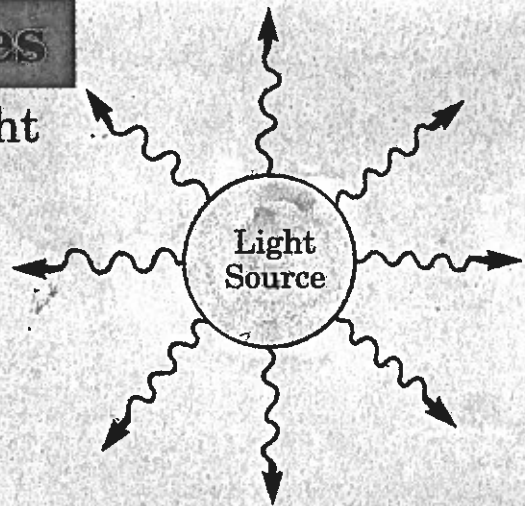
# Light Waves

## Theories of Light



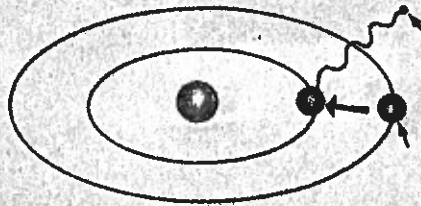
### Particle Theory of Light

Streams of tiny particles move in all directions from the source, like buckshot.



### Wave Theory of Light

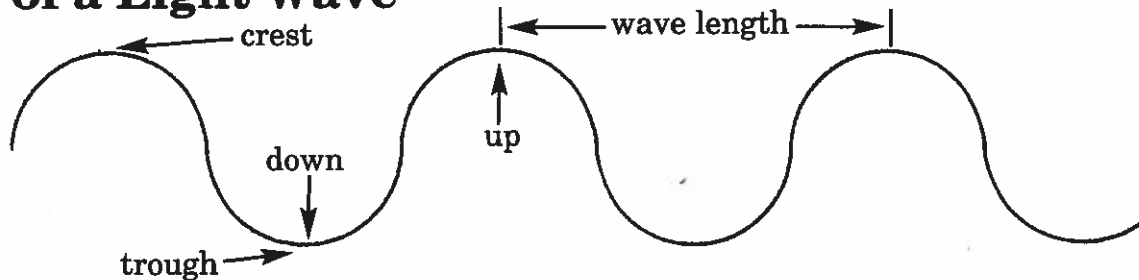
Light travels in waves in all directions from source, like waves from a disturbance in water.



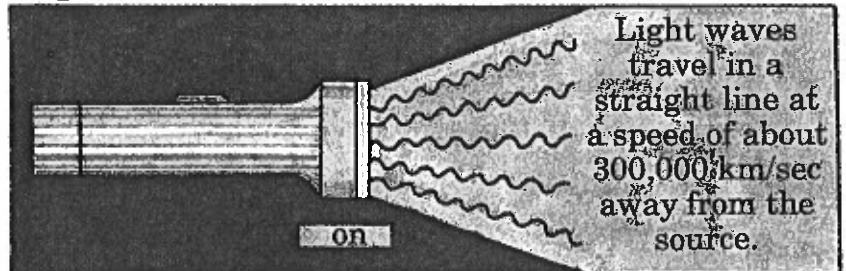
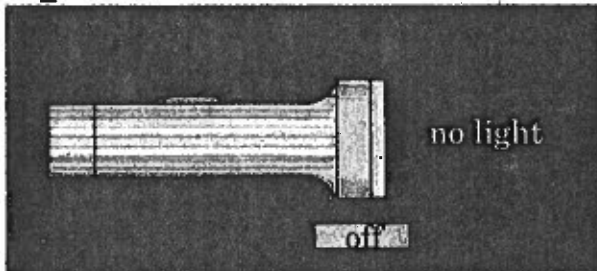
### Quantum Theory of Light

Bundles of light energy, called **quanta**, travel in waves.

## Parts of a Light Wave



## Speed and Movement of Light



1. How is the quantum theory of light a combination of the other two theories?

2. Describe the movement of light.

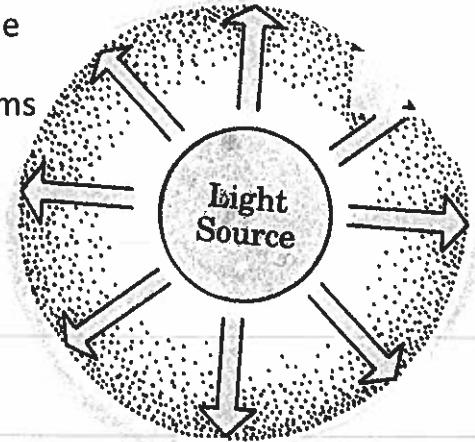
**STUDY QUESTION:** Research the visible portion of the electromagnetic spectrum.

## How Does Light Travel

Name: \_\_\_\_\_

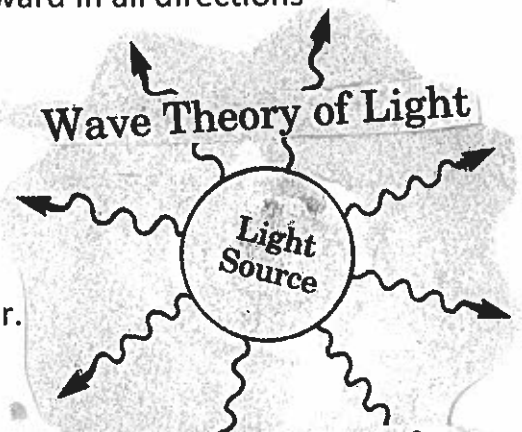
***Light travels away from its source in all directions in a straight line. Light travels at a speed of about 300, 000 kilometers (186, 300 miles) per second.***

Throughout history, scientists have proposed several theories in attempt to explain the nature of light. Sir Isaac Newton proposed the ***particle theory of light*** which considers light to be streams of particles moving out in all directions. It was thought that the more particles striking the human eye per second, the brighter the light would appear. The fewer the particles that reach the eye, the dimmer the light would appear.



**Particle Theory of Light**  
Streams of tiny particles move in all directions from the source, like buckshot.

Scientists also theorize that light is waves moving outward in all directions like waves on water. The closer one is to the source, the larger and stronger the waves would be. This would then cause the light to appear bright. As the waves move farther from the source, they spread out and grow smaller. And the light appears dim. This theory is called the ***wave theory of light***.

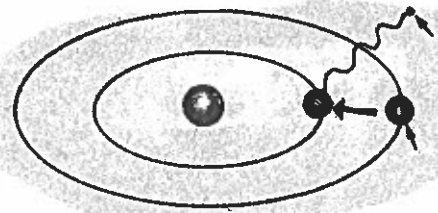


**Wave Theory of Light**  
Light travels in waves in all directions from source, like waves from a disturbance in water.

The present theory of light, developed by Niels Bohr and other scientists, assumes that electrons in atoms may move from a higher

## Quantum Theory of Light

energy level orbit to a lower energy level orbit. In doing so, small bundles (quanta) of energy, called photons, are released. The bundles move in waves, which move in straight lines. This is known as the **quantum theory of light**.

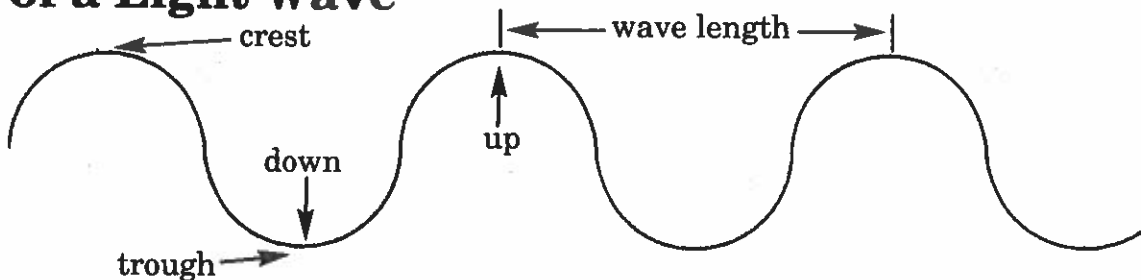


Bundles of light energy, called **quanta**, travel in waves.

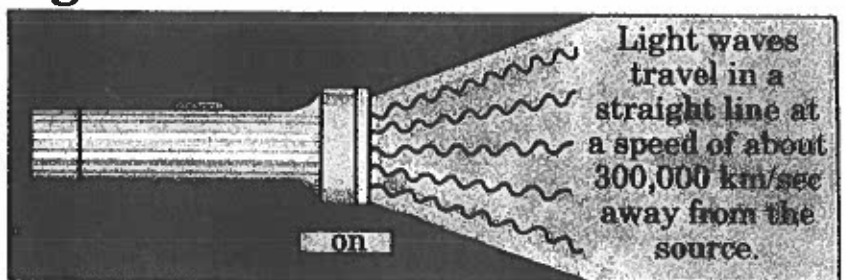
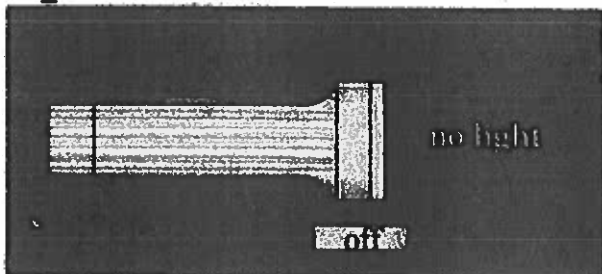
Electromagnetic waves move up and down at the same time that they move forward in straight lines. Therefore, each wave has a length and frequency.

**Wavelength** is the distance between two waves, and **frequency** is the number of waves that pass a given point in one second. A **crest** is when the wavelength reaches the height of its movement. A **trough** is when the wavelength reaches the depth of its movement. Light is not instantaneous, but it is extremely fast, moving about 300,000 kilometers (186, 300 miles) per second.

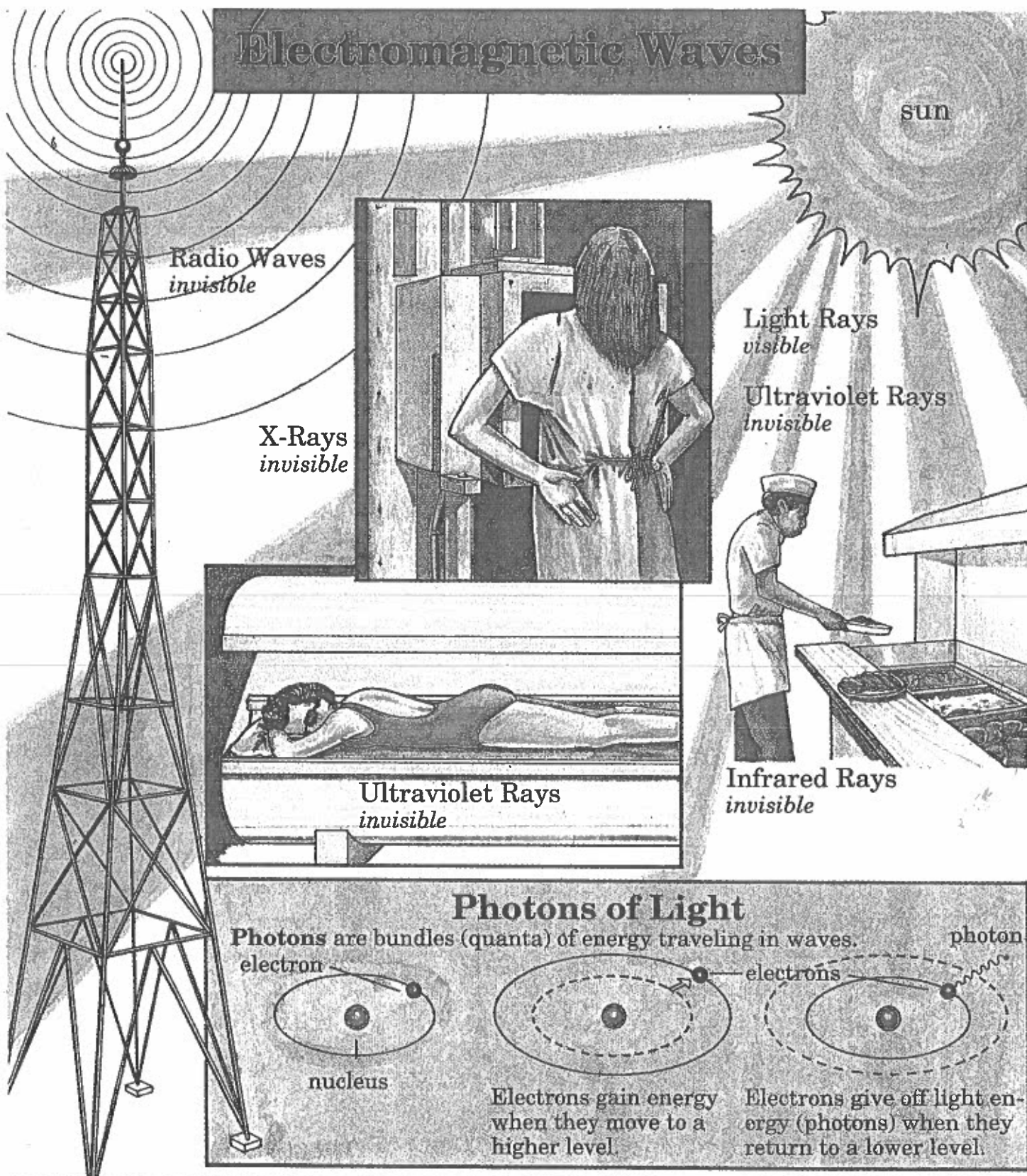
### Parts of a Light Wave



### Speed and Movement of Light



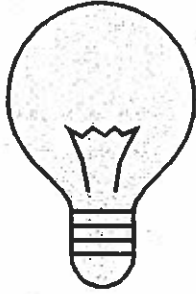
# Electromagnetic Waves



1. Which form of electromagnetic wave is visible to the human eye?

2. What causes an atom to give off light?

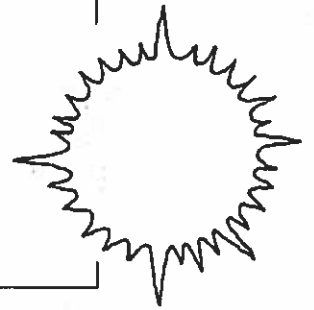
**STUDY QUESTION:** Find out about the electromagnetic spectrum.



## Sources of Light

***Luminous** objects produce light*

***Illuminated** objects reflect light*

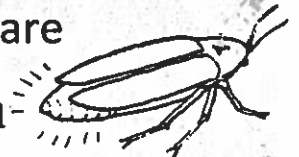


sun—nuclear fusion

Light sources are luminous or illuminated. **Luminous objects** produce their own light and can be **natural** or **artificial**. Our most important source of natural light is the sun. This tremendous mass of incandescent gas, produced by nuclear fusion, provides the earth with light and other types of energy.

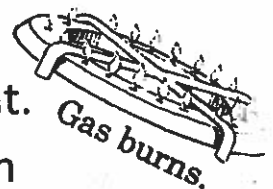
**Illuminated** objects do not produce light, but are seen because they reflect light from another object. The moon and planets receive light from the sun and reflect it; they are illuminated objects.

firefly—chemical

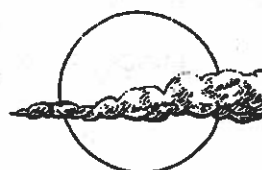


Fireflies produce light through chemical reaction. Artificial light is made by people. Common sources of this light are candles, kerosene lamps, oil lamps, natural gas lamps, incandescent lamps, fluorescent lights, and neon lights.

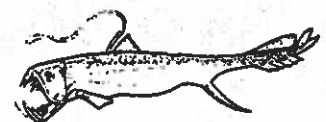
Electricity is most often used to produce artificial light. However, electricity is generated by water power or steam power from coal. Both power sources can be traced back to the sun.



lightning—burning



moon—reflected

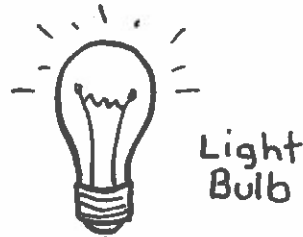
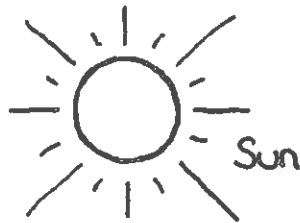


deep-sea fish—chemical

## Light

Light is a kind of energy and does not have any mass.

Some objects, like the sun, make their own light. They are called luminous.



Things that are lit up by another object and do not have their own source of light are said to be illuminated.

Traffic Signs

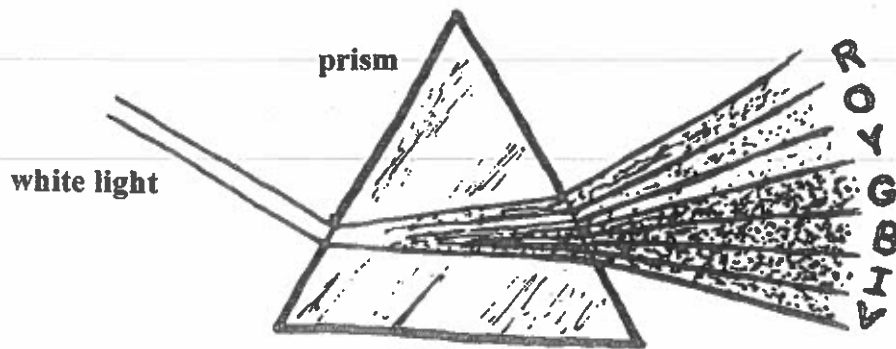


Questions (Answer In Full Sentences - A.I.F.S.)

- 1) In the summer, a firefly will make its own light to try and attract other fireflies. Is a firefly luminous or illuminated? (explain)
- 2) When there is a full moon, it is almost bright enough outside to read by. Is the moon luminous or illuminated? (explain)
- 3) A firefly gives off natural light while a lightbulb gives off artificial light. What is the difference between natural and artificial light?

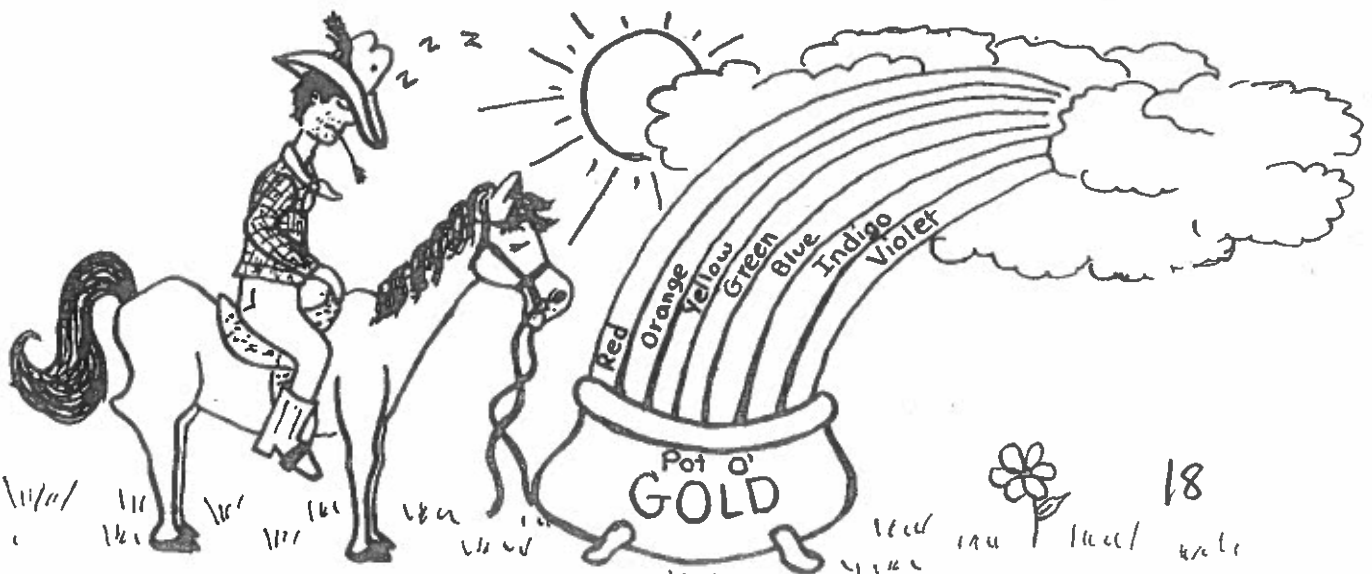
## White Light

Sunlight and light from electric lightbulbs is called white light. However, when a narrow beam of sunlight (or white light) is passed through a triangle-shaped piece of glass called a prism, the white light will be split into the colors of the rainbow. If these colors are then combined again using a second prism, the result is white light. This tells us that white light is made up of all the colors of the rainbow.

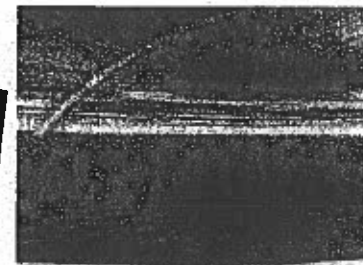


## The Spectrum

The name for the colors of the rainbow is the spectrum. Remember the colors by using the name "ROY G. BIV".



## Light and Colour



***A beam of white light passing through a prism forms a spectrum of colour. The order of the colours of the spectrum from the longest wavelength to the shortest is red, orange, yellow, green blue, indigo, and violet.***

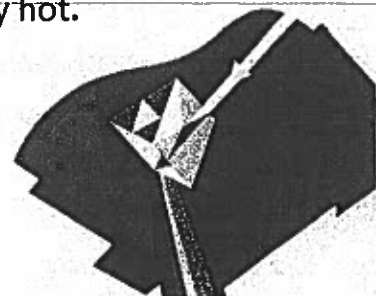
White light is really a mixture of many colours. These colours can be seen when a beam of sunlight passes at a slant through a glass **prism**. The prism breaks up the white light into bands of coloured light called the **spectrum**.

Seven coloured light in the spectrum are: **violet, indigo, blue, green, yellow, orange and red**. Colours of the spectrum are seen in that order because our eyes see each wave length as a different colour. The prism refracts (or bends) the coloured lights in varying amounts; short waves are bent more than long waves. **Violet** light, with the shortest wavelength, is bent the most. **Red** light is the longest wavelength is bent the least.

**Blue**-colour material looks blue because of the chemical structure of that material absorbs all the coloured waves except blue, which is reflected and seen by the eye. **White**- coloured material appears white because it reflects all the coloured waves. **Black**-coloured material appears black because it absorbs all the colour waves and reflects none.

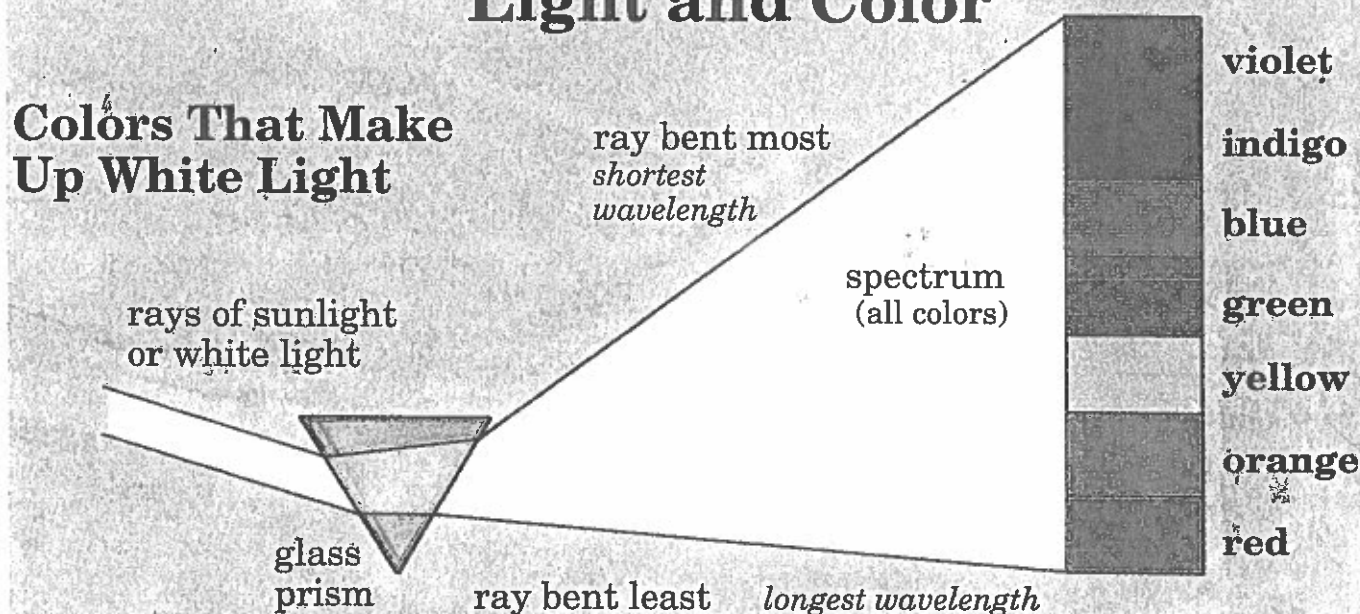
Dark colours absorb light energy and change it into heat. Therefore, darker clothes worn in winter help keep us warmer by holding or absorbing heat. Light colours worn in the summer help to keep us cooler because these colours reflect more light and absorb less energy.

Just think when you wear light white or black cotton t-shirts on a hot summer day for example. Why does it feel as though the white one is light and breathes? Light and heat reflect off the white surface almost repelling heat from the surface. Whereas black would absorb the heat and make a person feel really hot.

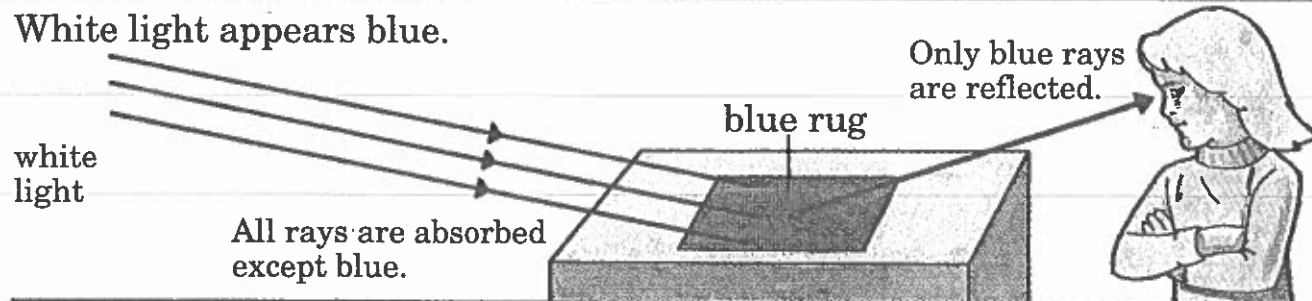


# Light and Color

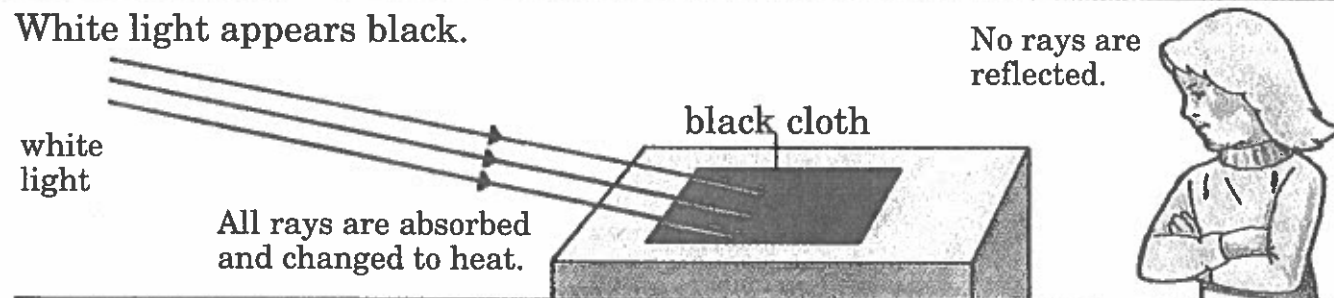
## Colors That Make Up White Light



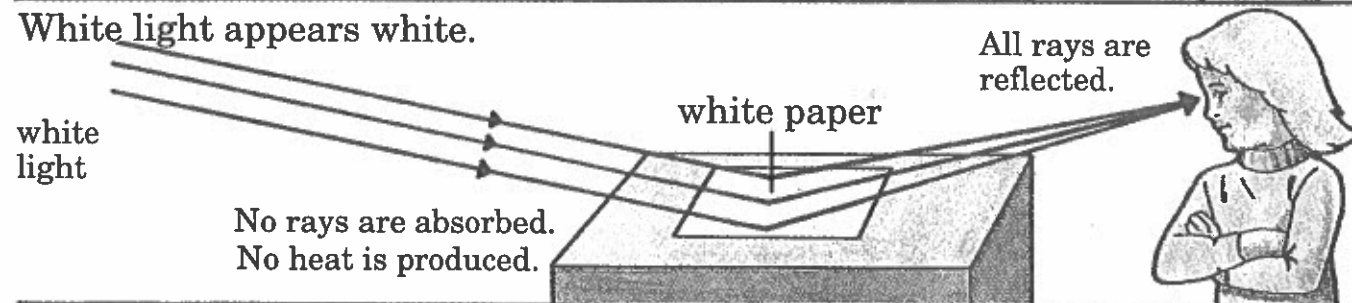
White light appears blue.



White light appears black.



White light appears white.



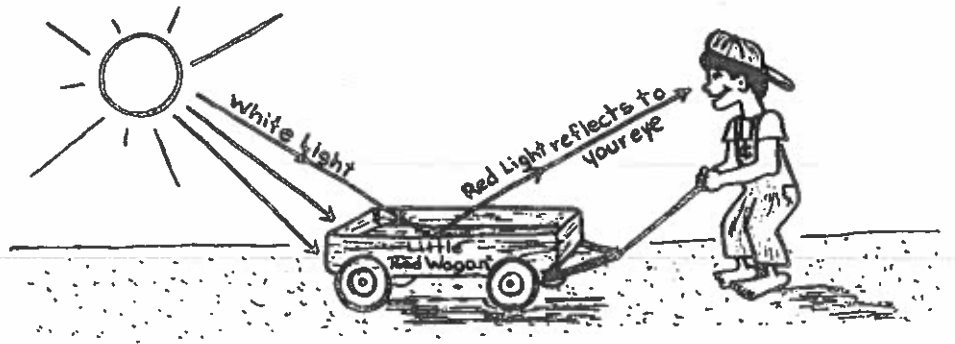
1. Name the colors of the spectrum, starting with the color that has the longest wavelength and ending with the color that has the shortest wavelength.

2. Why does a rose appear red to our eyes?

**STUDY QUESTION:** Why is outer space black?

## Color and Pigments

Mixing colored paints or crayon is *not* the same as mixing colored light. Paint contains pigments which are substances that absorb certain colors of light. For example, a red wagon has red pigment which absorbs all the colors of the spectrum - except red. The red light is reflected back to your eye.



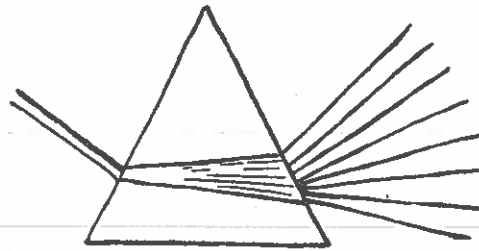
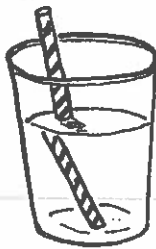
Black pigment absorbs all the colors and no light is reflected back to the eye. For this reason, objects that contain black pigment will heat up fast on sunny days since they absorb all the colors of white light.



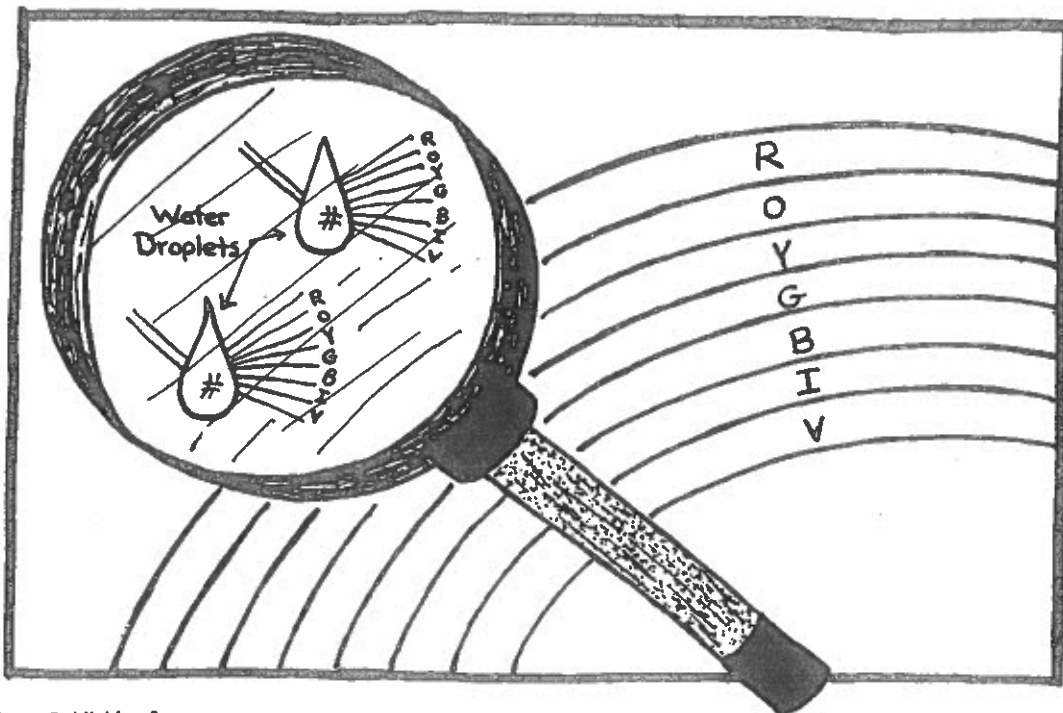
White objects absorb little light and all the colors of the spectrum are reflected back to the eye.

## Refraction (Bending of Light)

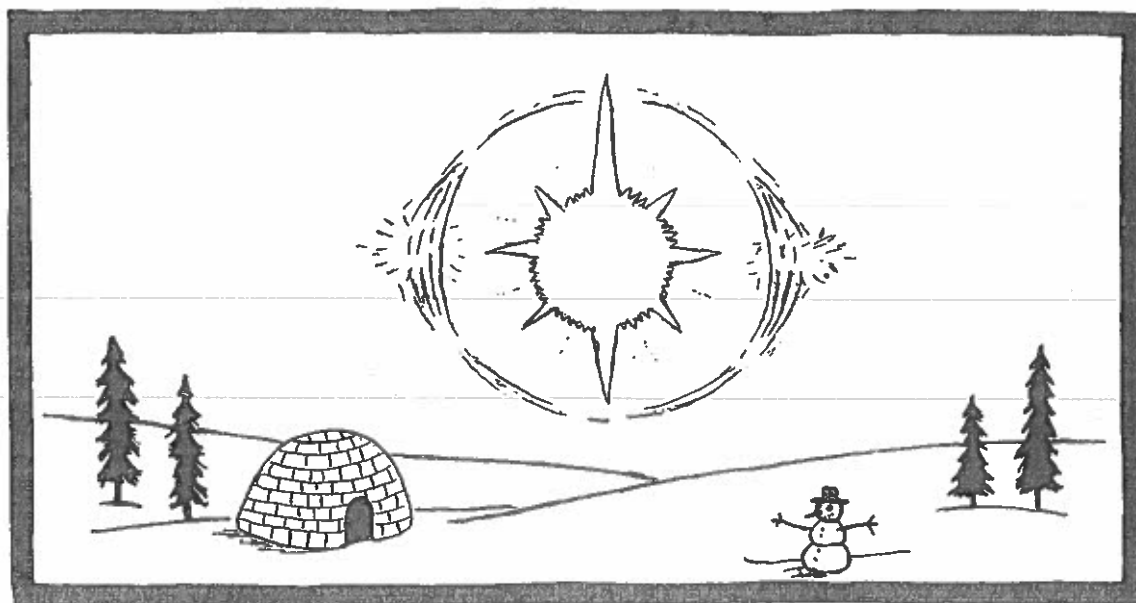
Light travels in straight lines but it can be bent. When light passes from one transparent material to another type of transparent material, the light rays are bent. Bending of light rays is called refraction. A prism is a good example of refraction as light rays are bent when they go from air to glass.



A rainbow is another example of refraction and the bending of light. White light from the sun passes through droplets of water in the air. This white light is bent (refracted) by the water droplets and separates into the colors of the rainbow, just like a prism.



**“Sundogs” are small rainbows found on either side of the sun that sometimes form during the winter in extremely northern climates. Ice crystals can act like water droplets separating the light into the colors of the spectrum. Instead of a rainbow, you could call a sundog an “icebow”.**

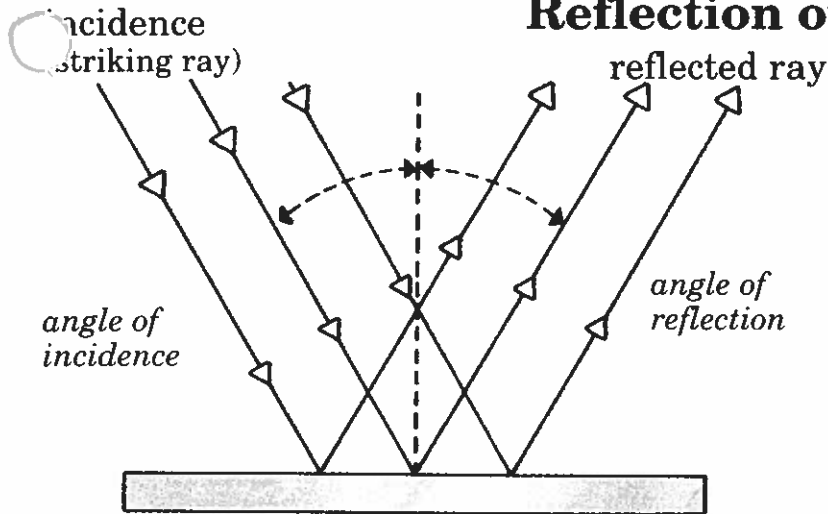


**Questions (Answer In Full Sentences - A.I.F.S.)**

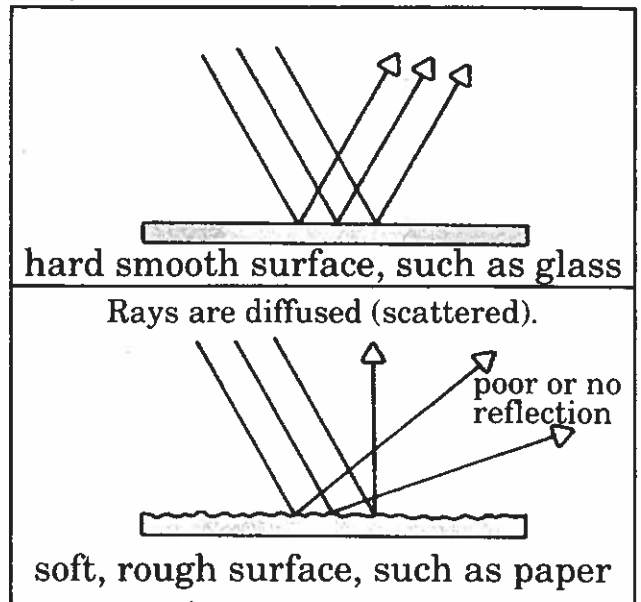
- 1) How is a rainbow similar to a prism?**
- 2) Why are there not usually rainbows on overcast days?**

# Reflection and Refraction

## Reflection of Light

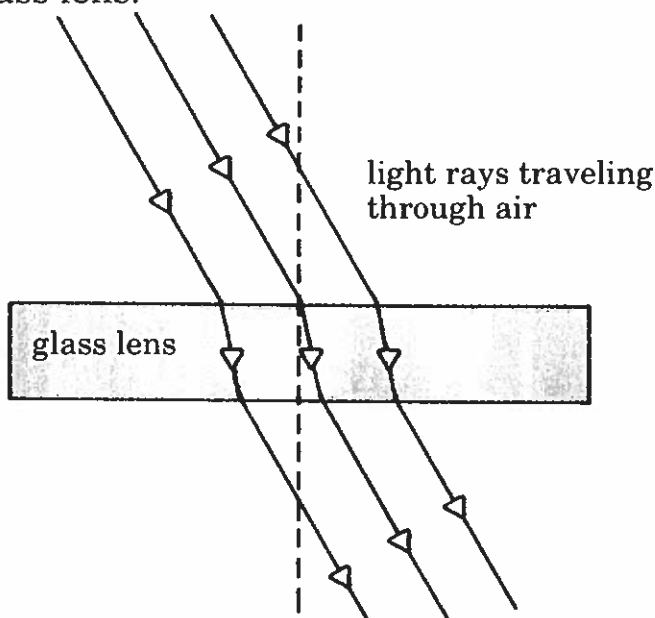


The **Law of Reflection** says that the angle of incidence is equal to the angle of reflection.



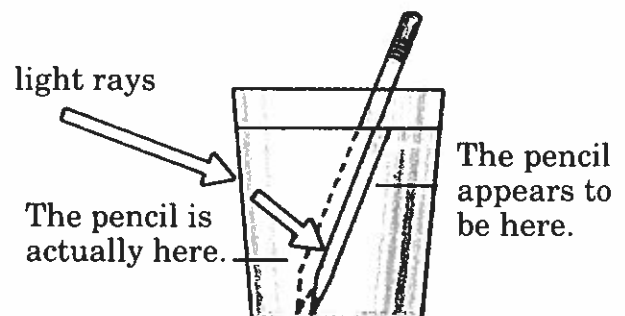
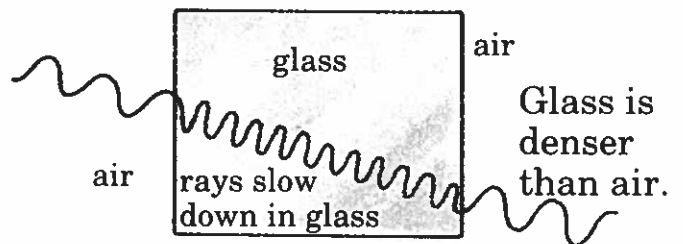
## Refraction of Light

Light rays bend as they pass through a glass lens.



**Refraction** is the bending of light rays.

Depending on the density of the transparent material, the speed of light will change, causing refraction.



An Example of Refraction

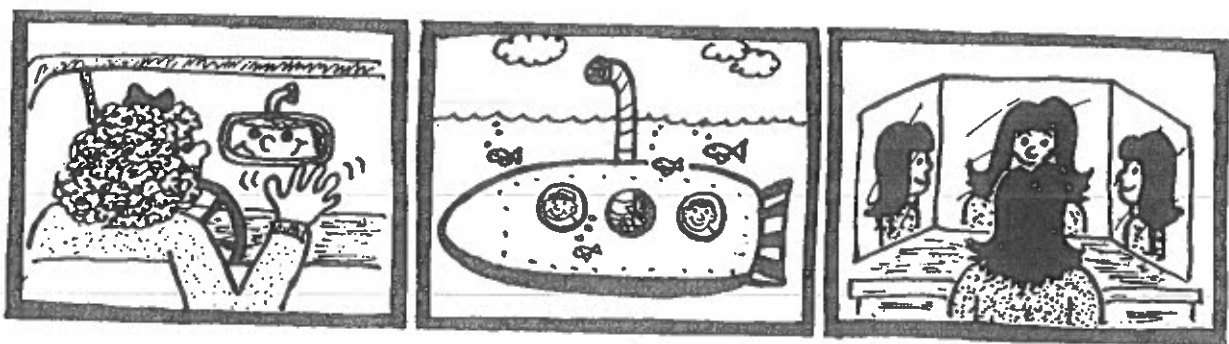
1. Why might there be no reflection from a rough surface?

2. What causes refraction?

**STUDY QUESTION:** What causes mirages?

## Reflection

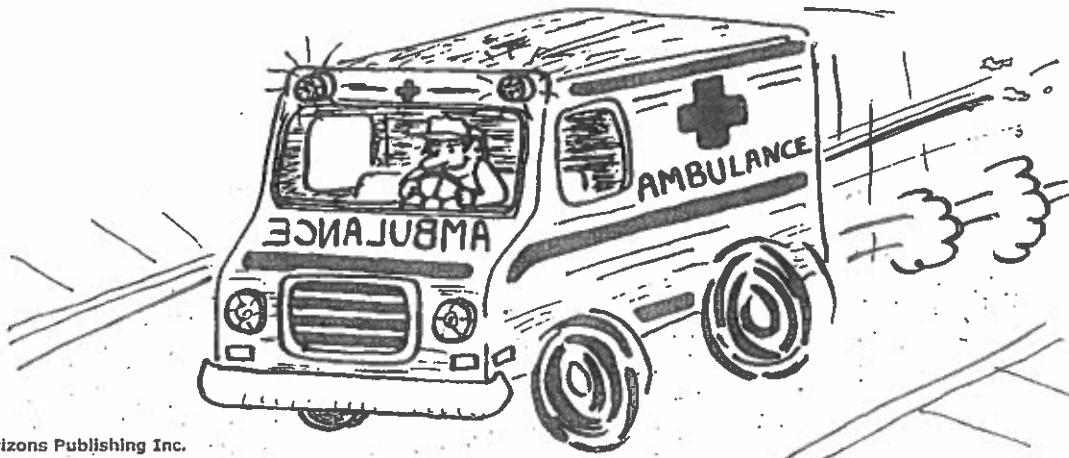
Light travels in straight lines but it can be made to turn a corner - reflection. Special types of materials that are shiny will cause light to change its direction and reflect. Mirrors are made by painting a piece of glass on one side with a shiny coating that reflects. Reflection of light is used for rearview mirrors in cars, periscopes in submarines and bathroom mirrors to help comb your hair in the morning.



## Reversed Images

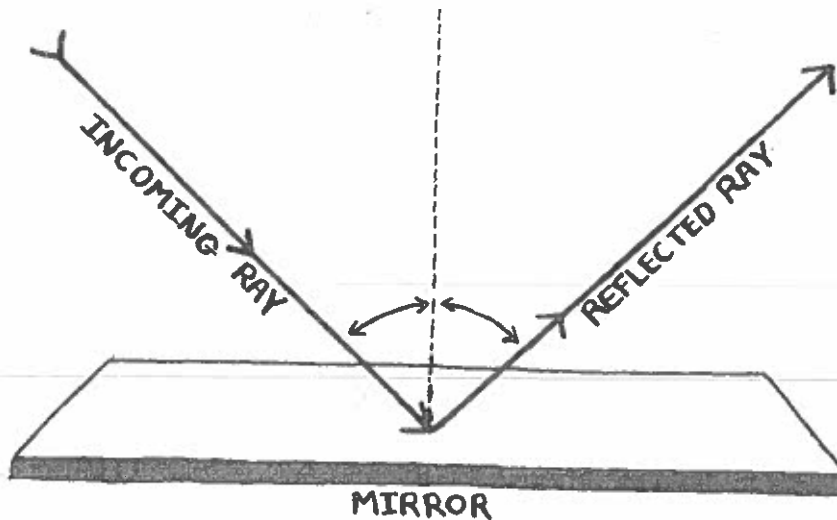
When light reflects, everything is the same except for one thing - right and left are reversed. This reversal of right and left makes it very hard to read handwriting that is held in front of a mirror.

An ambulance will often have reversed writing on the front so that drivers will be able to see the word "ambulance" correctly when they look in their rearview mirrors.

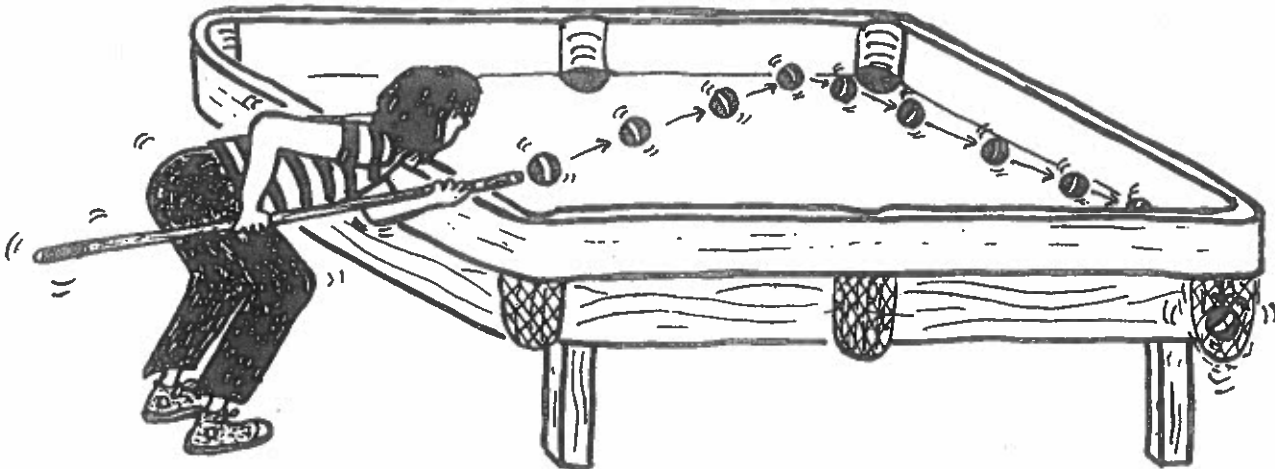


## Law of Reflection

The law of reflection says that light will reflect off a mirror at the same angle that it came to the mirror.



The law of reflection is not just for light. This also holds true for other things like bank shots in pool.

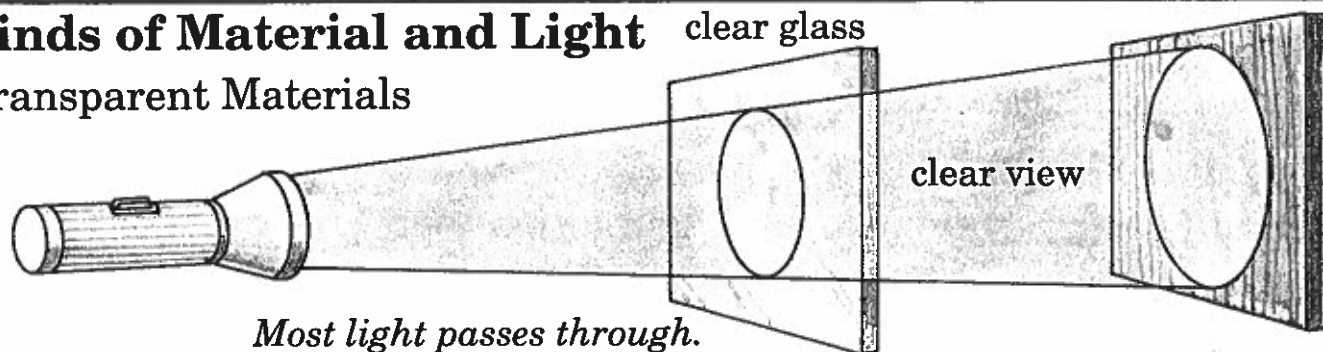


# Light and Materials

## Kinds of Material and Light

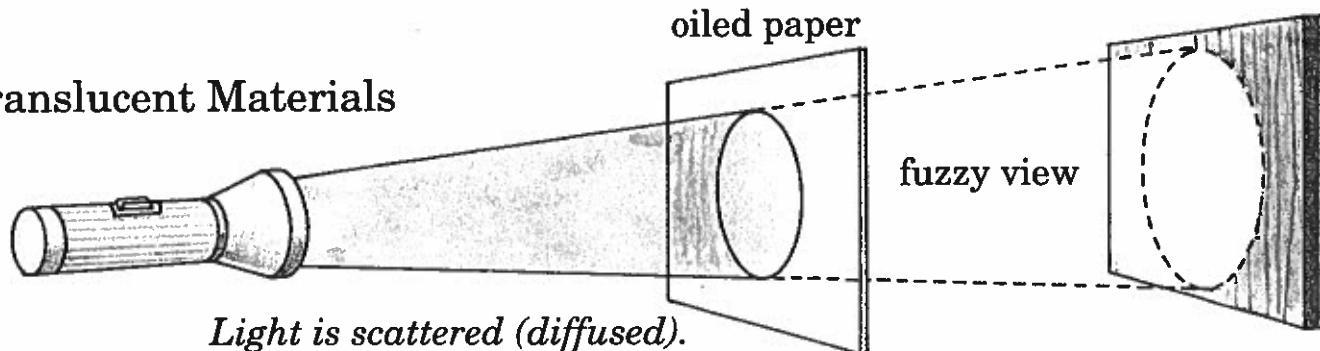
clear glass

### Transparent Materials



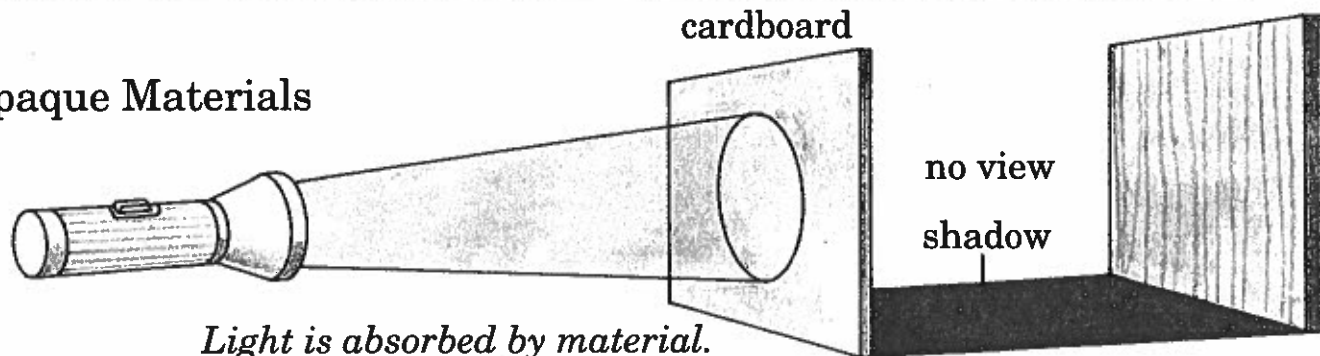
oiled paper

### Translucent Materials

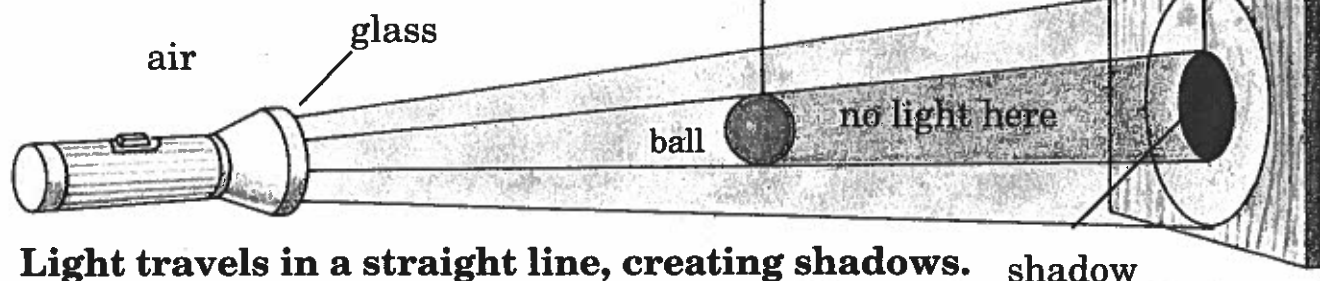


cardboard

### Opaque Materials



## Light and Shadows



**Light travels in a straight line, creating shadows.**

1. Which type of material allows a person looking through to see objects on the other side most clearly?

2. What causes a shadow?

**STUDY QUESTION:** Find out about the umbra and penumbra parts of a shadow.

## Properties of Light

Light is invisible when it travels. A person will not see light until it hits something. Light also travels in straight lines. It can go through objects or it can be stopped but it will not go around. If light is blocked, a shadow will form behind the object where there is no light.



### Transparent

Objects that let all the light through are transparent. (see-through)

Examples include:

- 1) \_\_\_\_\_
- 2) \_\_\_\_\_
- 3) \_\_\_\_\_

### Translucent

Objects that let only some of the light through are translucent.

Examples include:

- 1) \_\_\_\_\_
- 2) \_\_\_\_\_
- 3) \_\_\_\_\_

### Opaque

Objects that do not let any light through are opaque.

Examples include:

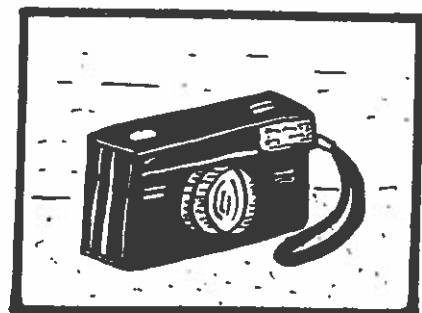
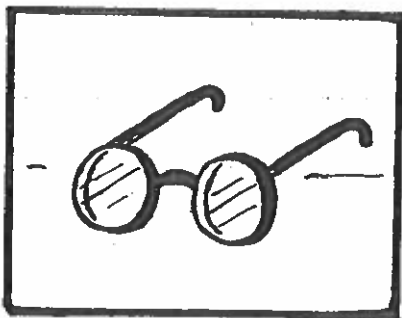
- 1) \_\_\_\_\_
- 2) \_\_\_\_\_
- 3) \_\_\_\_\_

Put each under the correct heading above: glass, cardboard, wax paper, plexiglass, aluminum foil, dirty water, air, frosted glass.

## Lenses

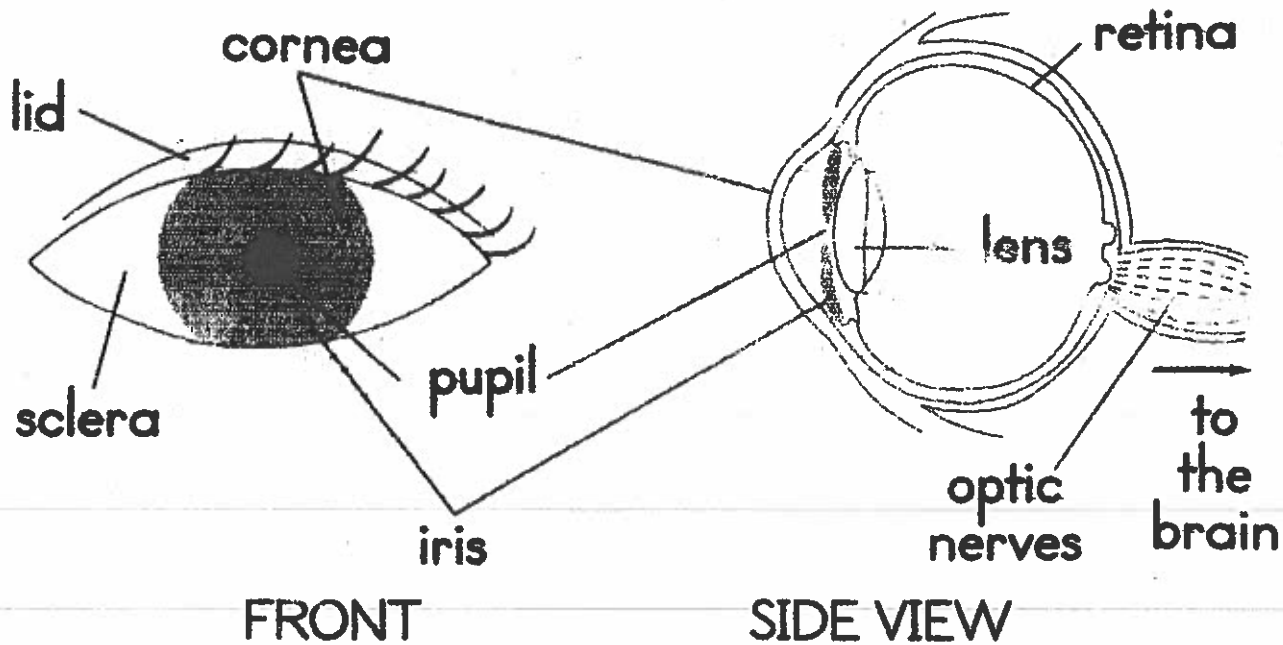
A lens is a curved pieces of glass that bends light in ways that help us. A magnifying glass bends light to make small objects look larger.

Lenses are also used in microscopes, cameras, telescopes, contact lenses and glasses. (glasses to help people see better, not for holding pop or Kool-Aid)



Name \_\_\_\_\_

# Sense of Sight



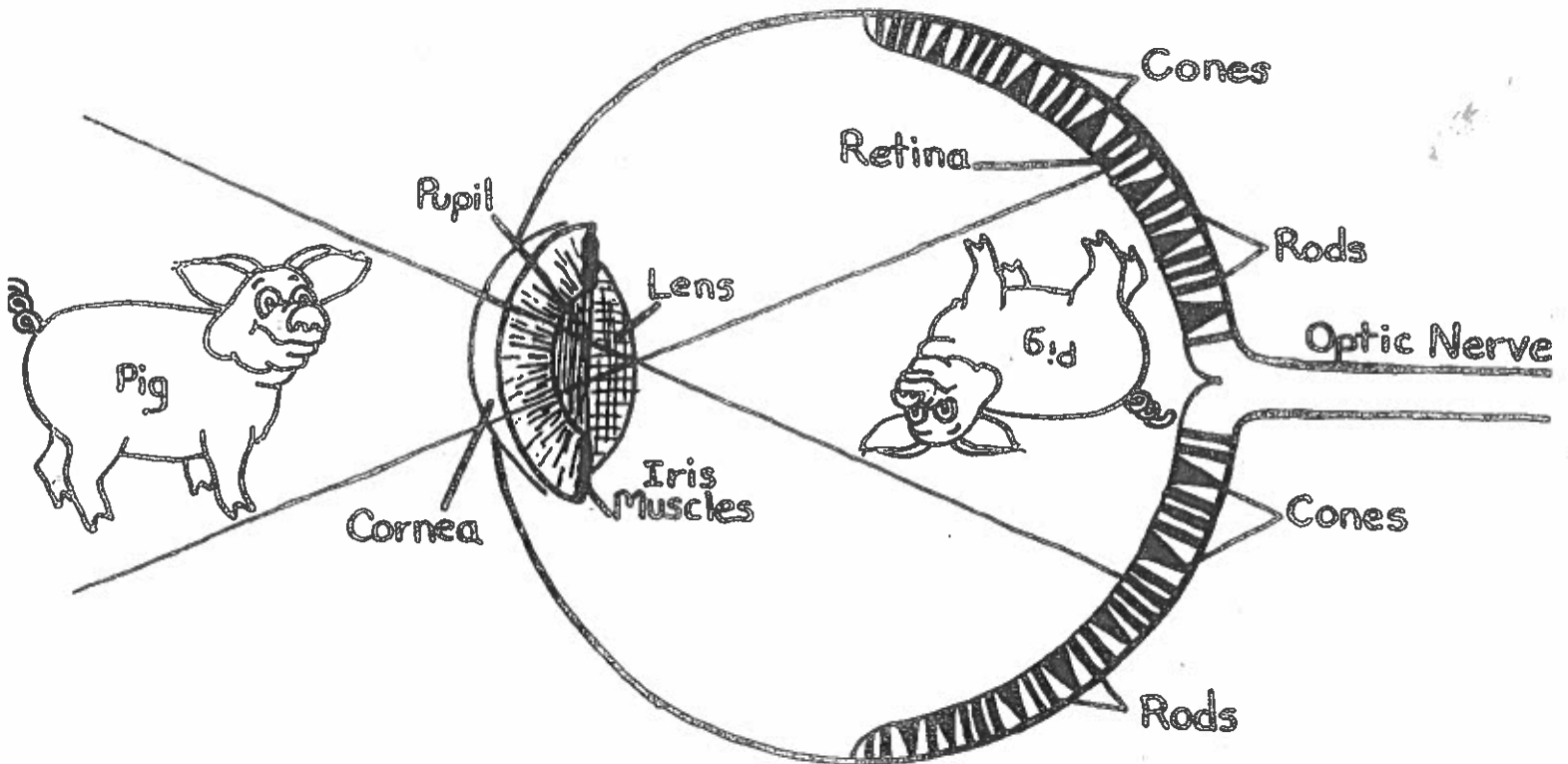
THE FIVE SENSES SHEETS • 002

The sense of sight is the most complex of the five senses. When we see an object, we are actually seeing beams of light that are bouncing off the object. The light enters the eye through the cornea (the transparent covering) and goes through the pupil (the dark circle in the center of the eye). It then passes through the lens and is projected onto the retina. From there the information is sent to the brain, which tells us what we are seeing.

SKILL: SIGHT/DIAGRAM OF THE EYE

## The Eye

Light passes through the protective cornea and enters the eye through the pupil. The iris is a set of muscles that controls the size of the pupil and how much light to let in. Then, light goes through the lens which bends the light and focuses it upside-down on the retina which acts like a screen. Special cells on the retina called rods and cones send out signals when they are hit by light. These signals are sent from the eye to the brain along the optic nerve. Every eye has a blind spot where the optic nerve connects to the retina. This happens because there are no rods or cones where the optic nerve joins to the retina.



- cornea - a transparent (see-through) cover that protects the eye
- pupil - a "hole" in the eye that lets light into the eye (the black part at the center of the eye)  
- gets smaller in bright light and gets bigger (dilates) in the dark to let more light in
- iris - a set of muscles on the edge of the pupil that control the size of the pupil
- lens - bends the light and focuses light on the retina at the back of the eye
- 
- retina - acts like a screen and contains many cells which react to light (cones and rods)
- optic nerve - sends messages from the cells in the retina to the brain
- cones - cells in the retina that can see color  
- cones are used mainly in the day
- rods - cells in the retina that see light and dark but not color  
- rods are used mainly at night

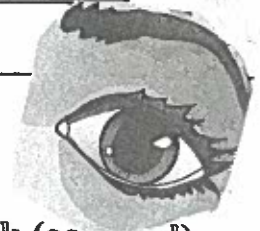
## ACTIVITY #9 - MAKE YOUR HOMEWORK DISAPPEAR

Question:

Name: \_\_\_\_\_

### Instructions

what is an optical  
illusion



- 1) This student is sad because there is too much homework (as usual). You can help by making the homework disappear.

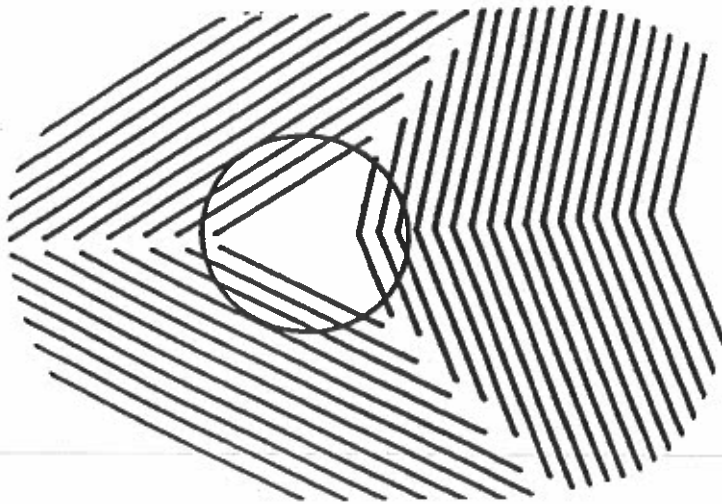


- 2) Hold this paper in front of you at arm's length and close your left eye.
- 3) Stare at the student and slowly bring the page closer to your face. (*Keep staring at the student*)
- 4) The homework should disappear when the paper is about 8 inches from your face. You have found your "blind spot".

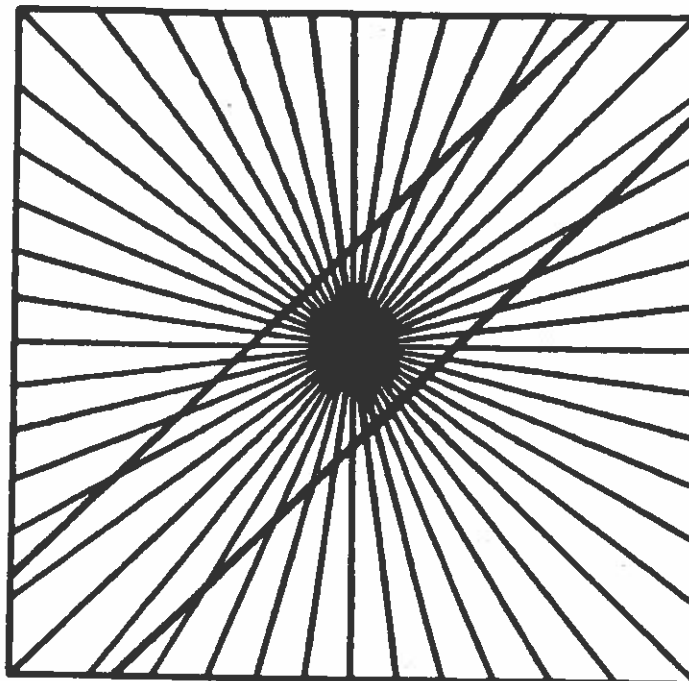
### Explanation of Blindspots

At the back of each eye there is a nerve called the optic nerve that carries signals from the eye to your brain - sort of like a T.V. cable. The only problem is that where the optic nerve connects to the eye, the eye can't see. This is the blind spot.

**IS THIS CIRCLE ROUND?**



**ARE THESE RAILWAY TRACKS PARALLEL OR  
WILL THERE BE A TRAIN DERAILMENT?**



HOW OLD IS THE WOMAN IN THIS PICTURE?

21

40

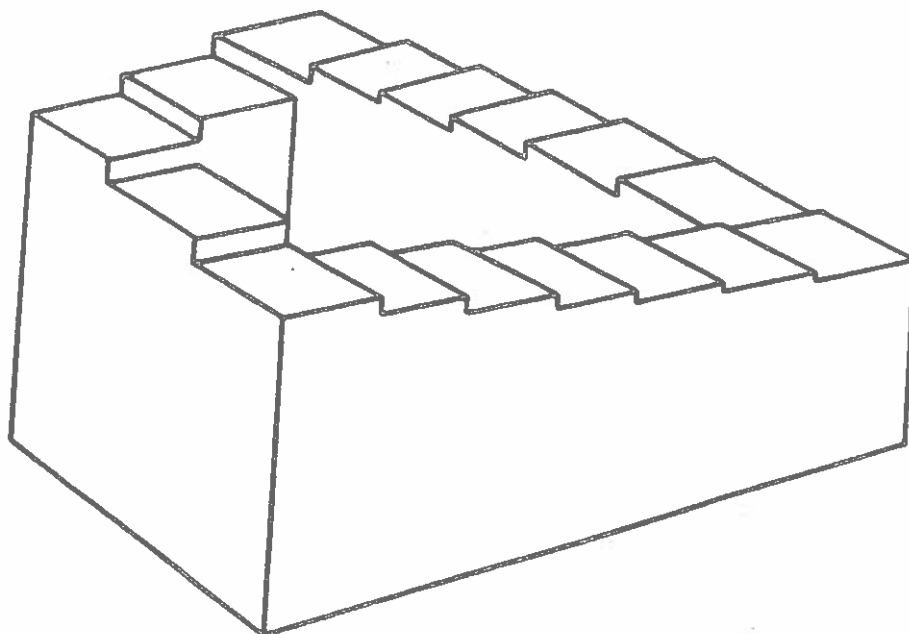
83



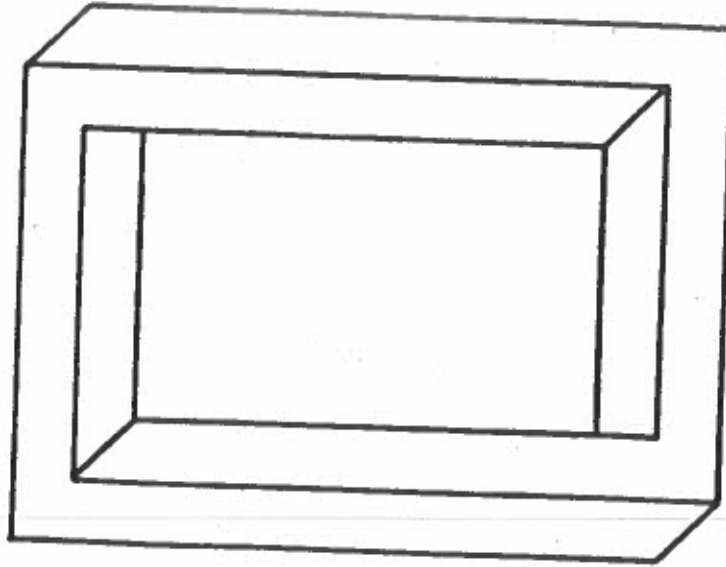
**A FANCY LAMP OR TWO CATS ABOUT TO RUB NOSES?**



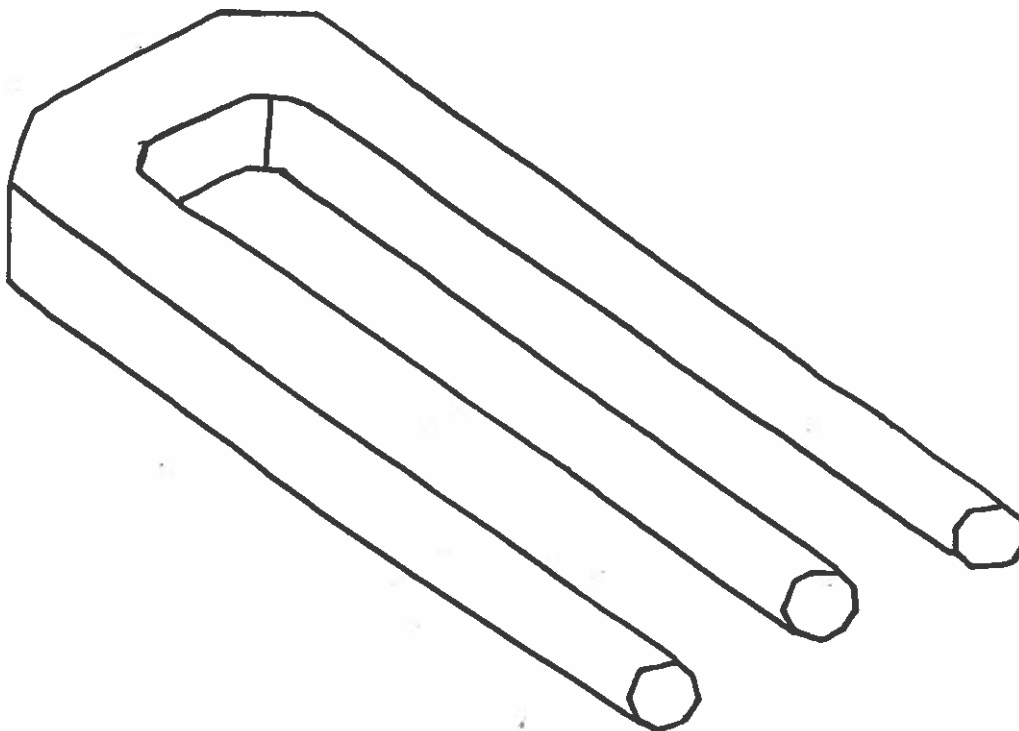
**THE IMPOSSIBLE STAIRCASE - IT JUST KEEPS  
GOING AND GOING AND GOING...**



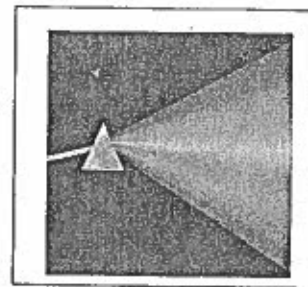
## THE IMPOSSIBLE BOX



## FIGURE THIS OUT!



# Light Glossary



**Ray:** is a straight line of light.

**Natural light:** is a source of light that occurs naturally without human intervention or creation like fire or lightening.

**Artificial light:** are light sources that are created by people like fireworks or light bulbs.

**Visible light:** a rainbow contains all the colours that can be seen with the human eye.

**Infrared light:** electromagnetic radiation from the sun is felt as heat.

**Ultra violet light:** : electromagnetic radiation from the sun that causes change of pigment colour such as tanning.

**Reflect:** light sources are grouped by how light is made or reacts. When light bounces from another source it is called reflecting.

**Emit:** light sources are grouped by how light is made or reacts. When sources create their own light source it is called emitting.

**Optical device:** any tool that uses or makes or reflects light like kaleidoscopes, mirrors or periscopes.

**Luminous:** an object that makes it's own light is a luminous source (like the sun).

**Illuminated:** when an object is lit up by another source (like the moon reflecting the sun's light).

**Translucent:** is when most of the light is scattered bouncing off in all directions. Translucent materials that allow some light to pass through but not clearly. Example tissue paper.

**Transparent:** are materials that allow light to pass through. you can see through transparent objects because they do not scatter the light or stop it. AN example would be a glass window.

**Opaque:** are materials that block light from passing through. Opaque objects absorb all the light or cause it to bounce off. Opaque objects also cause shadows such as blinds.

**Prism:** is a clear, smooth block with ends that are triangular shaped. Usually a prism is used to bend or changes the direction of light enabling to see the colour spectrum.

**Spectrum:** the name for the colours of the rainbow.

**ROY G. BIV:** a device for helping us remember the colours of the spectrum. Red Orange Yellow Green Blue Indigo Violet.

**Light waves:** a theory of how light travels likes waves farther from the source.

**Electromagnetic waves:** is a radiant energy that is a kind of energy that travels outward from a central source. Some examples are cosmic rays, gamma rays, X-rays, ultraviolet rays, and radio waves.

**Electromagnetic radiation:** this term is used to describe all the energy that comes from the sun. Some can be seen, others affect our body, some used for technology. Examples are radio waves, gamma rays and ultraviolet rays.

**Reflection:** what happens when light hits a mirror and turns a corner.

**Refraction:** when light is "bent" going from one material to another.

**Blind spot:** this part of the eye that has no cones or rods and "can't see".

**Rainbow:** refraction of sunlight causes this after a rainstorm.

**White light:** sunlight and light from electric lightbulbs is seen as white light.

**Cornea:** a transparent (see through) cover that protects the eye.

**Pupil:** a "hole" in the eye that lets light into the eye(the black part at the center of the eye) It dilates or makes the pupil smaller the more light that gets in.

**Iris:** a set of muscles on the edge of the pupil that control the size of the pupil. (the colour part).

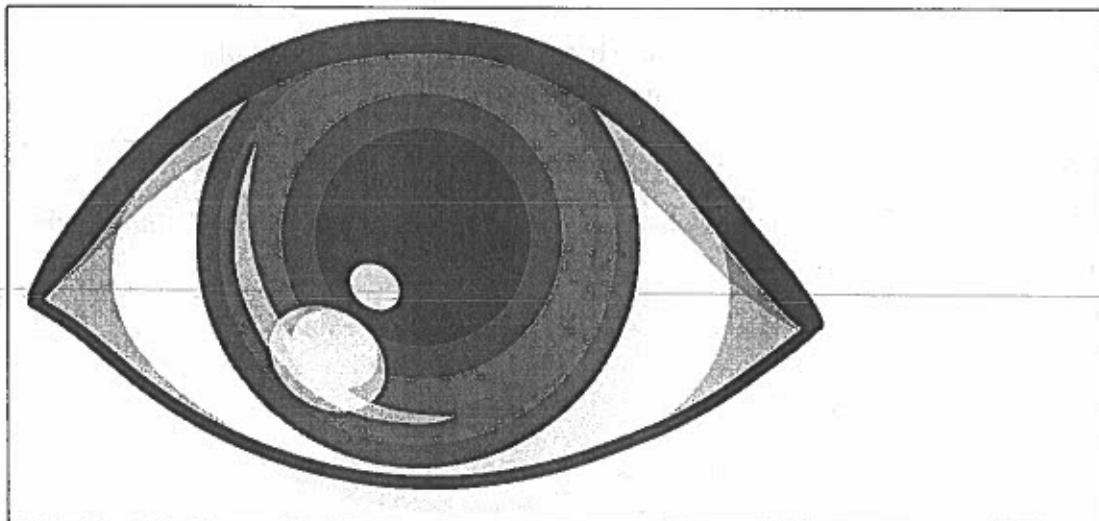
**Retina:** acts like a screen and contains many cells which react to light(cones and rods).

**Lens:** bends the light and focuses light on the retina at the back of the eye.

**Rods:** cells in the retina that see light and dark but not colour.

**Cones:** cells in the retina that can see colour.

**Optic nerve:** sends messages from the eye to the brain.



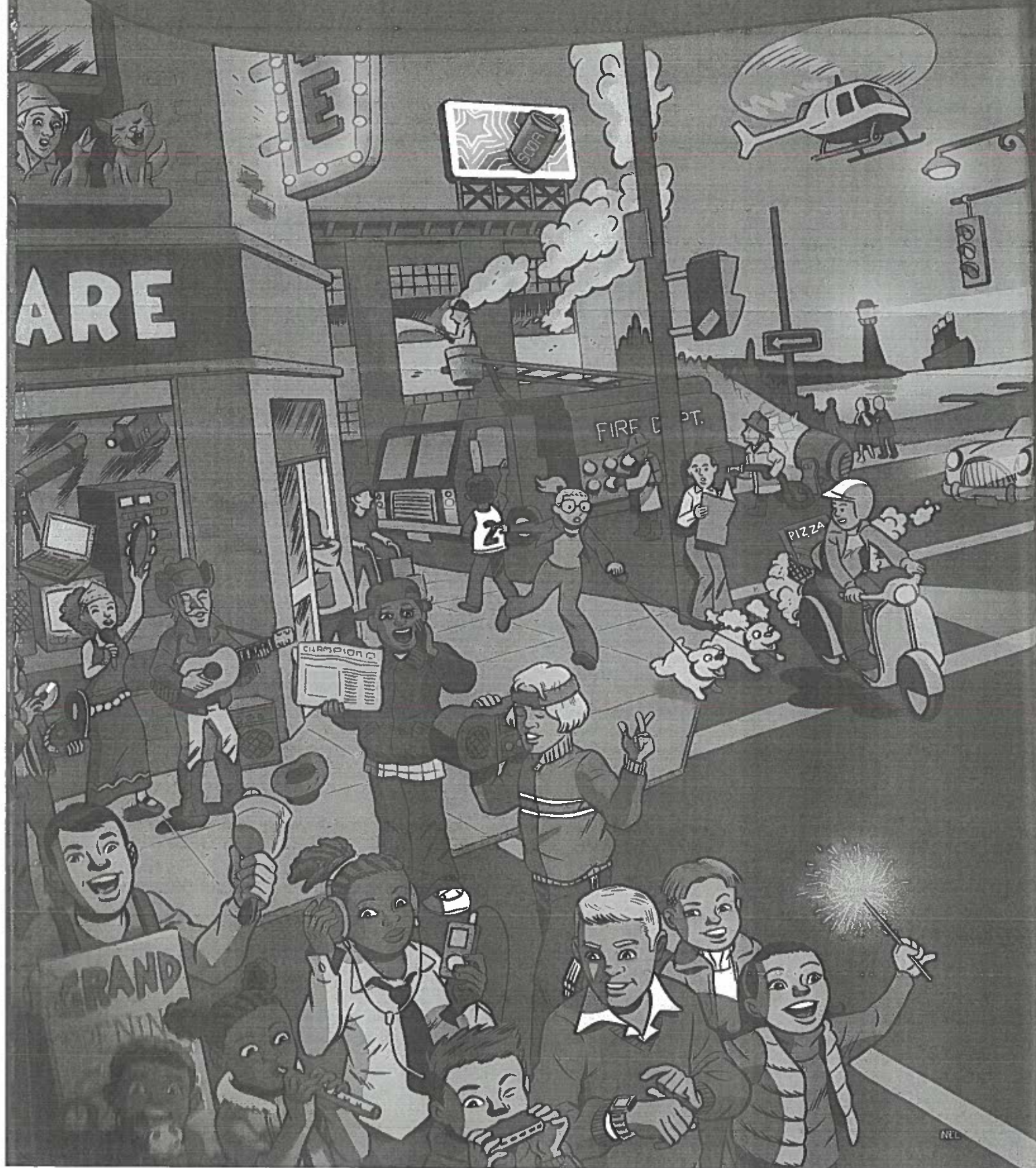
# LIGHT

The background of the page is a dark, atmospheric night scene. A bright, jagged lightning bolt strikes from the top center, illuminating the sky and casting a glow on the city below. The city skyline is visible in the distance, with numerous lights from buildings and streets. The word 'LIGHT' is superimposed in large, bold, 3D-style letters across the middle of the image. The letters have a metallic or reflective texture and are outlined in black. The overall mood is dramatic and powerful.

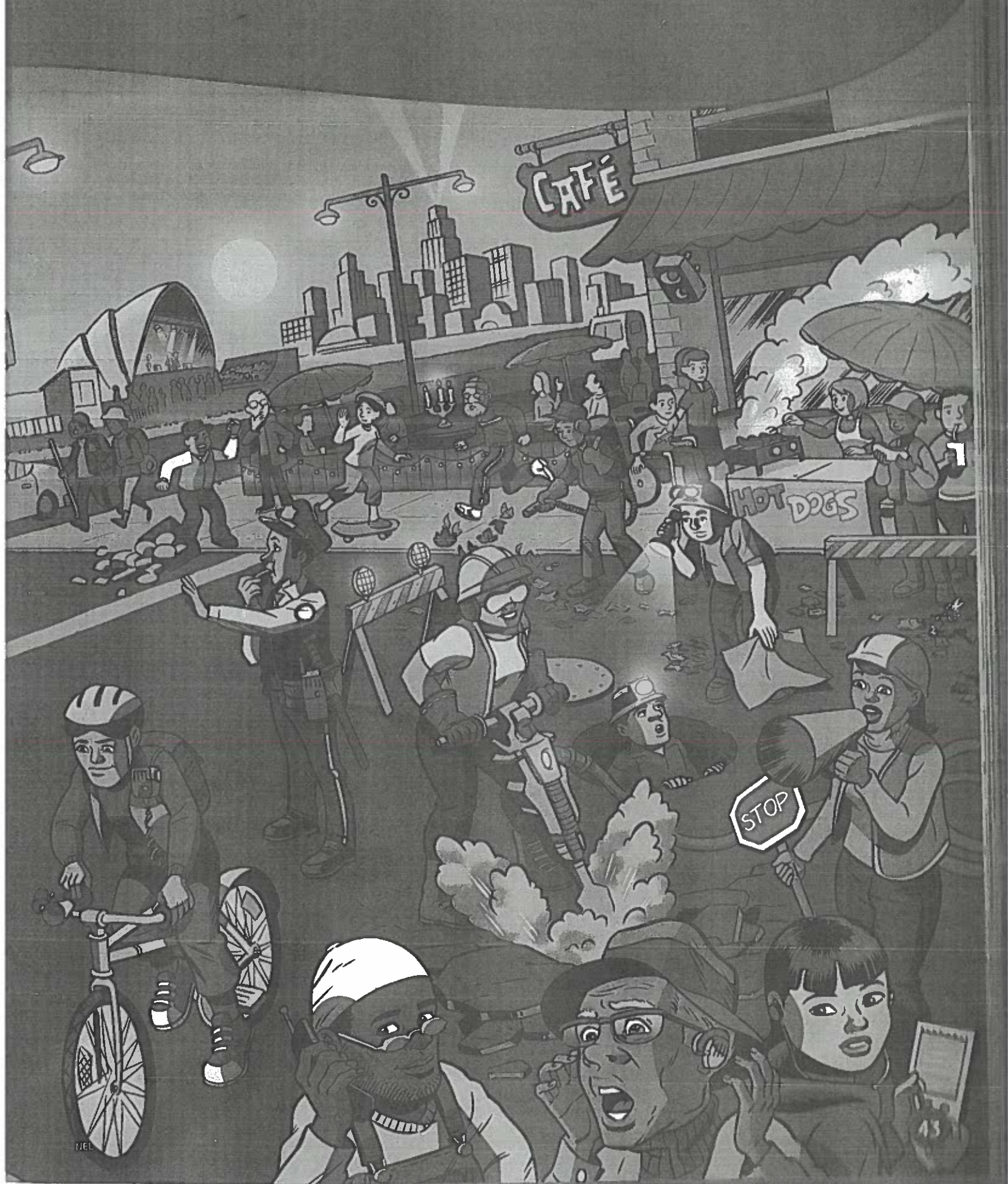
## In this unit, you will

- ask yourself questions while you read
- ask questions to gather information when you listen
- use formal and informal voice in your writing
- identify characteristics of PowerPoint presentations
- read charts and diagrams
- learn about light

# Open Your Eyes to Light!



Find at least 15 sources of light in this picture.



### Questioning

Asking questions makes you an active reader and helps you understand what you are reading.

# Where Does Light Come From?

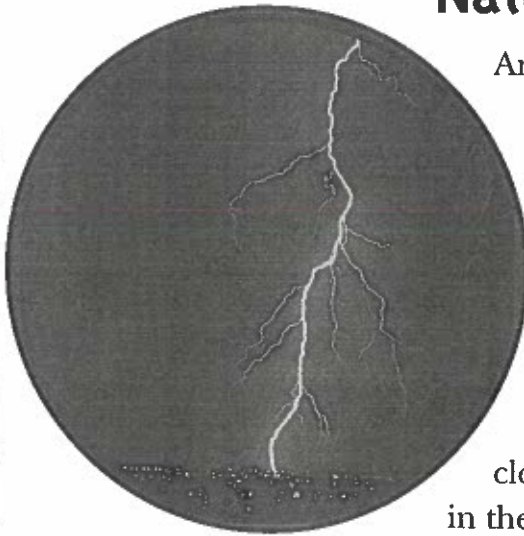
Shut your eyes tight—all you can see is darkness. Now, open your eyes again. If it is daytime, you will see that light is all around you.

## Natural Light

Anything that gives off a light that we can see is called a light source.

The light sources that are not created by people are called natural light sources.

They include the sun, the stars, and lightning. During the day, the rays of the sun light up the earth. At night, if there are no clouds, you can see the stars twinkling in the sky. During thunderstorms, you might see different kinds of lightning.



→  
Ask questions to check your understanding. What is a natural light source?

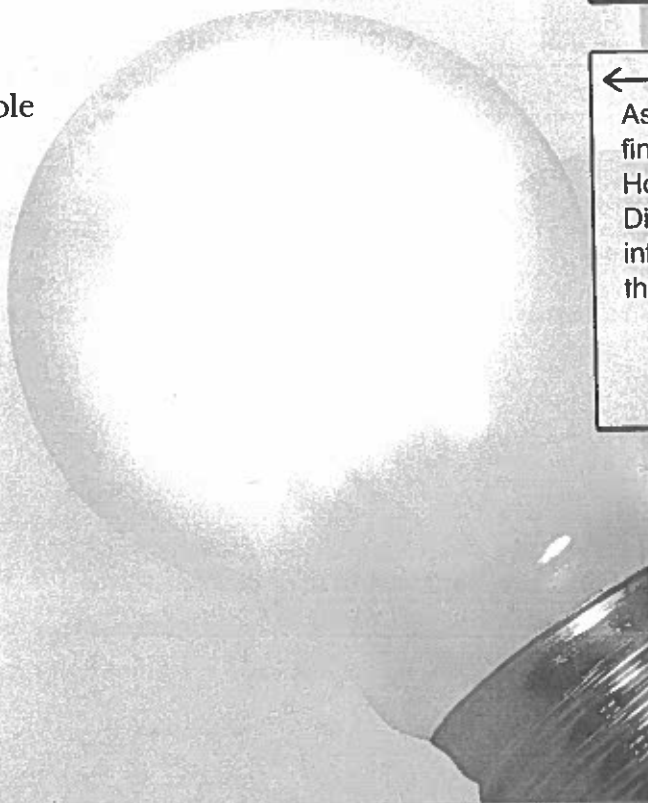
There are other sources of natural light, too. Fireflies are insects that give off a pale, greenish-yellow light that flashes or glows in the dark. Deep down in the sea, some fish are able to produce flashes of light in the darkness. And, if you live in the northern or southern regions of the world, you can see the aurora, a dazzling display of coloured lights that flicker in the sky at night.

## Artificial Light

There are also many light sources that don't occur naturally but are created by people. These are called artificial sources of light. Electric lights, oil lamps, and even candles are all artificial light sources. You can find your way in the dark by using a flashlight powered by batteries. Without artificial light, there would be no television or movies. And city streets are full of artificial lights—vehicle headlights, brightly coloured advertisements, streetlights, and neon lights.

## Uses of Light

Light does more than just enable us to see. We use beams of light to cut metals into complicated shapes or to perform surgery. Light even helps us to stay healthy. When sunlight shines on our skin, our body makes a vitamin called vitamin D, which helps our teeth and bones to grow healthy.



Ask questions about things you wonder about. How do some deep-sea fish produce light? Sometimes the answer is not in the text.



Make a personal connection. Where else have I heard the word *artificial* used?



Ask questions to find information. How is light used? Did you find the information in the text?

# WHAT DOES LIGHT

by Sally Nankivell-Aston and Dorothy Jackson

## Applying Strategies

### Questioning

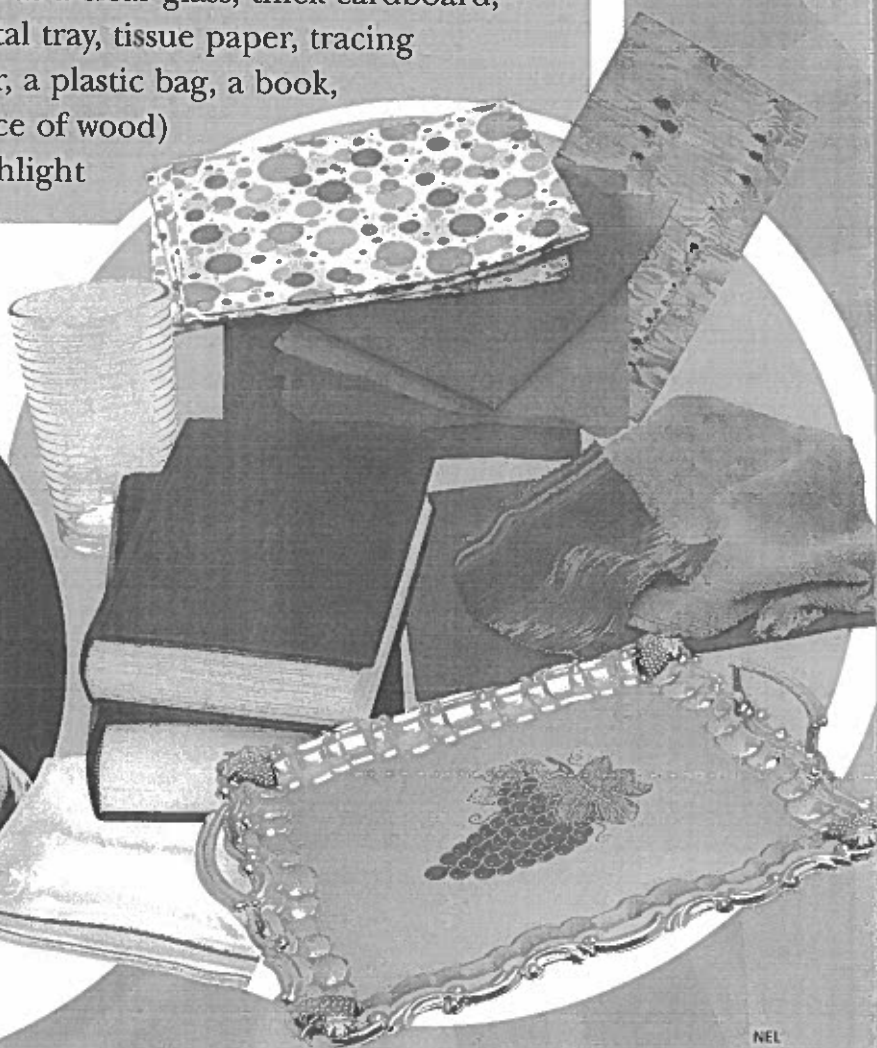
As you read, ask questions to:

- check your understanding
- find out about things you wonder about
- make personal connections
- find information

Light travels better through some materials than others. Clear materials that let all light through are called transparent. Materials that let some light through, but not all, are called translucent. Materials that light cannot travel through at all are called opaque. Find out more in this activity.

### You will need

- assorted pieces of fabric
- a selection of other materials (such as a clear glass, thick cardboard, a metal tray, tissue paper, tracing paper, a plastic bag, a book, a piece of wood)
- a flashlight



# TRAVEL THROUGH?

1. Look closely at the fabric and other types of materials. Predict what will happen when you shine a flashlight at each one. Which will let all the light through, which will let just some light through, and which will not let any light through at all?

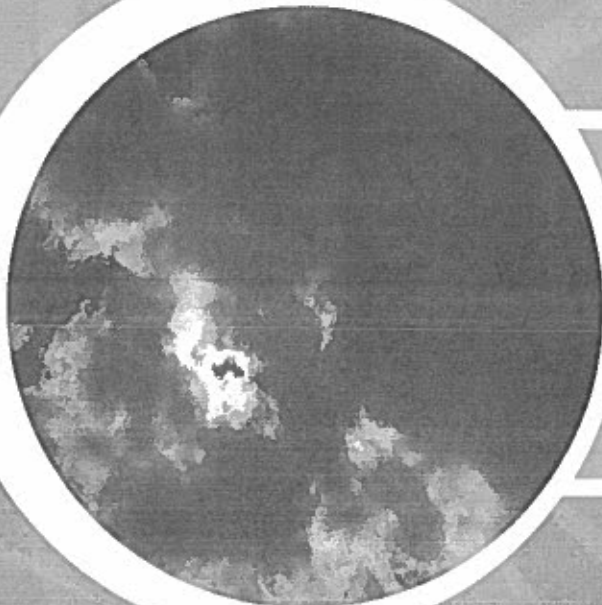
2. Make a chart like this one and record your predictions on it.

Material	Prediction			Result
	transparent	translucent	opaque	

3. Now shine the flashlight at each material. Make sure you keep the distance between the flashlight and each material short (about 10 centimetres). Ask a friend to look at the other side of the material. Can your friend see the light shining through?

4. Record the results in the chart.

5. Now sort your materials into three groups: transparent, translucent, and opaque.

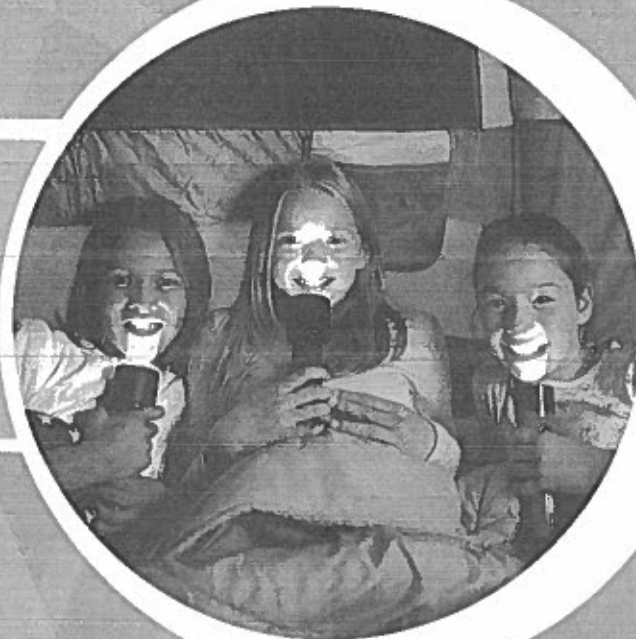


## KEEP THINKING

Have you noticed that the clouds in the sky sometimes get in the way of the sun's rays? Do you think clouds are transparent, translucent, or opaque?

## DON'T STOP THERE

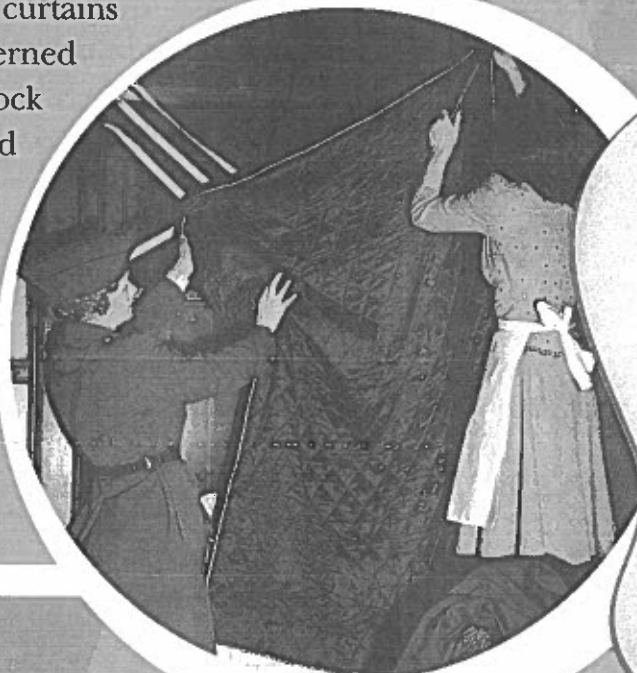
Take the flashlight around your home or school and test some other items to find materials that are transparent, translucent, or opaque.



## IN ACTION

Sometimes we need to use translucent or opaque materials to block out some or all of the light. Net curtains and frosted or patterned glass are used to block out some light—and also to stop people from looking in!

Blackout curtains were used in World War II to make sure no light showed outside.



## Reflect on

**Strategies:** What questions did you ask that really helped you understand what you were reading?

**Critical Literacy:** Why do you think the writers presented this information as an activity? Did the writers' presentation help you understand the information?

# Asking Questions

Asking questions is a good way to check your understanding while you're listening. Most people are very happy to answer questions because it shows that their listeners are interested in what they are talking about.

A GUEST SPEAKER  
IS VISITING CLASS.  
LISTEN IN ...



YOU'VE BEEN A GREAT AUDIENCE! YOU'VE ASKED TERRIFIC QUESTIONS! NOW I'LL SHOW YOU SOME OF MY CREATIONS, AND YOU'LL SEE HOW SCIENCE INSPIRES ART!



## How to ask questions:

- ☒ When you don't understand something, ask a question.
- ☒ When you want more information, ask a question.
- ☒ Make your question as clear as you can so the person you're questioning understands what you want to know.

# Using Formal or Informal Voice

You use different “voices” every day when you talk with people. You probably use a formal voice when you are talking with most adults and an informal voice when you are talking with your friends. Writers use different voices, too. They choose the voice they think will help them connect with their audience.

Here are two articles about light pollution. As you read, think about the audience for each article.

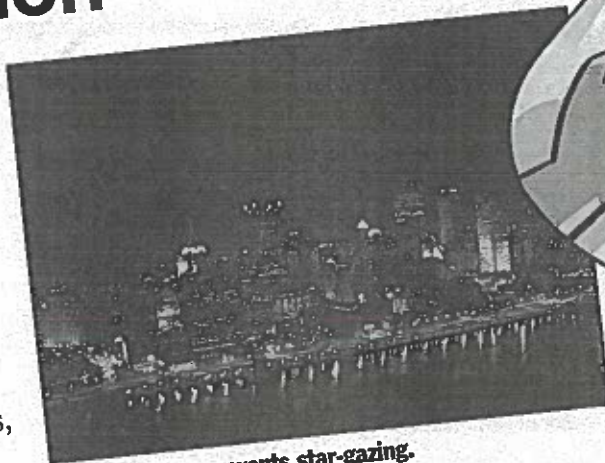
## Light Pollution

Light pollution is a problem caused by too much artificial light shining in places where it is not wanted or needed.

In cities, light from streetlights, outdoor advertising, office buildings, airports, schools, and homes creates “sky glow,” a hazy dome of light that blocks out the night sky.

More than half of the world’s population can no longer see the Milky Way, a vast stretch of stars that has fascinated humankind for thousands of years.

Today, scientists are urging



Light pollution prevents star-gazing.

people to use “sky-friendly” lights. Sky-friendly lights direct light down to the ground where it is needed.

If people plan lighting carefully, the problem of light pollution can be solved.



**Formal voice** is serious, factual, and free from personal comments. Formal writing is in complete sentences.

# HEY! TURN OUT THE LIGHTS!

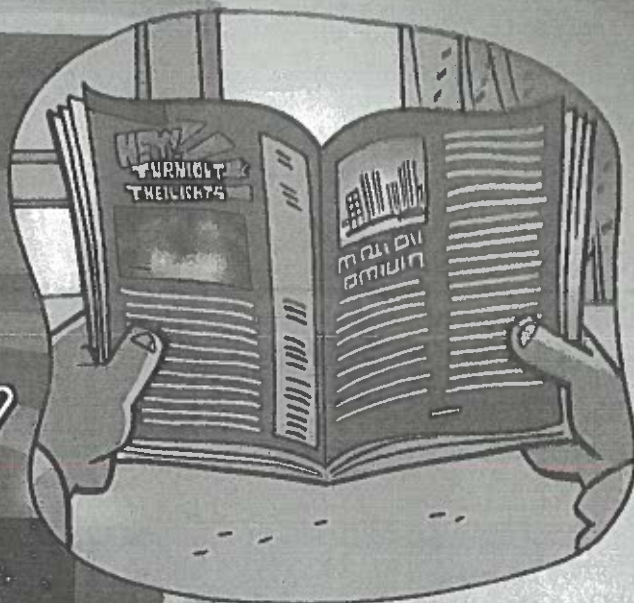


The Milky Way

You've probably never heard of light pollution, but it's a big problem for millions of kids around the world—and you're probably one of them! What's light pollution? Light where you don't want it. It's that simple.

Every night, light from office buildings, advertising, airports, schools, and homes creates an ugly haze of light called "sky glow." And sky glow blocks out all the really cool things to see in the night sky, like stars and planets and even the Milky Way.

The good news is, we can get our night sky back. Good light planning and "sky friendly" lights that send light down—not up!—will do the trick. Then kids will be able to tune into the nightly star show, the longest running entertainment on the planet.



**Informal voice** is friendly, factual, and personal. Informal writing sounds like the writer is talking directly to the reader.

## How to use formal or informal voice:

- ☒ Think about your audience. Choose the voice you think will connect with your audience.
- ☒ To write in a formal voice, be serious. Use facts. Write in complete sentences. Don't make personal comments.
- ☒ To write in an informal voice, be friendly. Use facts. Write as you would talk to a friend.

## Applying Strategies

### Reading Like a Writer

As you read, think about the voice the writer has chosen. Has the writer used a serious, factual voice or a friendly, informal voice?

# Facts of Light

by Lorraine Cameron

## Travelling Light Rays

To our human eyes, light travels in straight lines. Look at sunlight streaming through a window or shining through a group of trees. On a dark road, you can see how car headlights shine a beam of light that goes straight ahead. These narrow beams of light are called light rays.

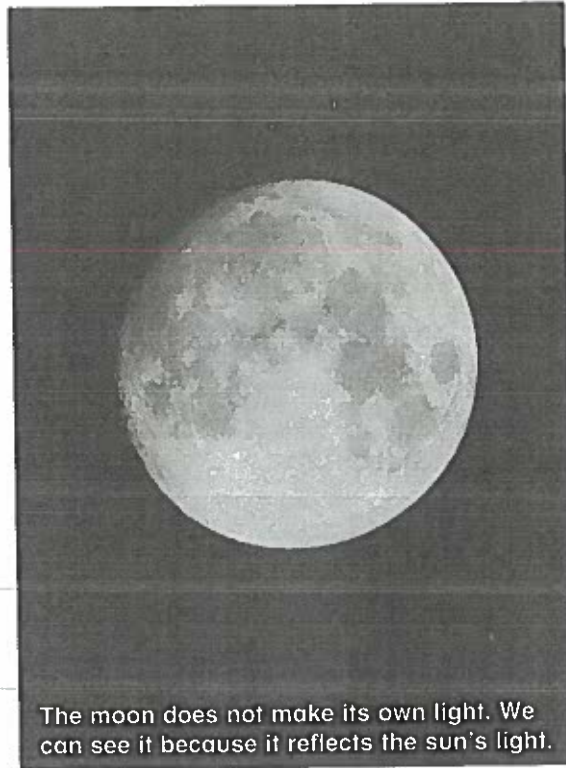


On their own, light rays can't go around corners or curve themselves around objects in their way. But things can change the direction the beams are travelling in. Anything that crosses the path of a light ray—even air, water, or dust—affects how the light behaves.

## When Light Is Reflected

Of the millions of things our eyes can see, only a few of them make their own light. The sun, stars, electric lights, fire, and fireflies are some examples. Most things that we can see do not make their own light. We can see them because they reflect light. When light rays hit something, some of them bounce off and scatter in all directions. When this reflected light enters our eyes, it allows us to see the shape and colour of the object.

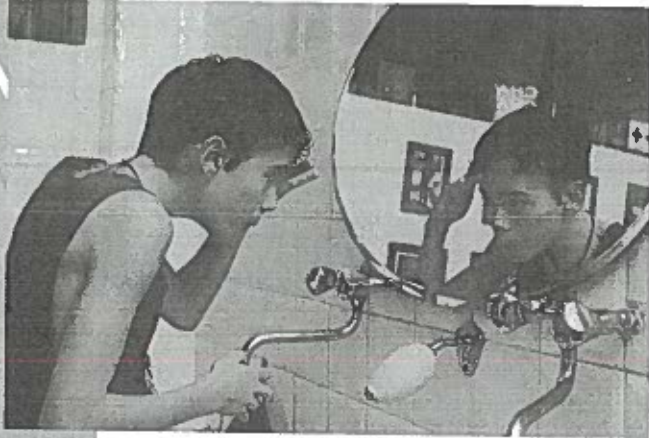
Some objects reflect light better than others. How well an object reflects light depends on its surface.



The moon does not make its own light. We can see it because it reflects the sun's light.



The smooth, shiny pot reflects much more light than the black cast-iron pot.



If you raise your left hand, your reflection will be raising its right hand!

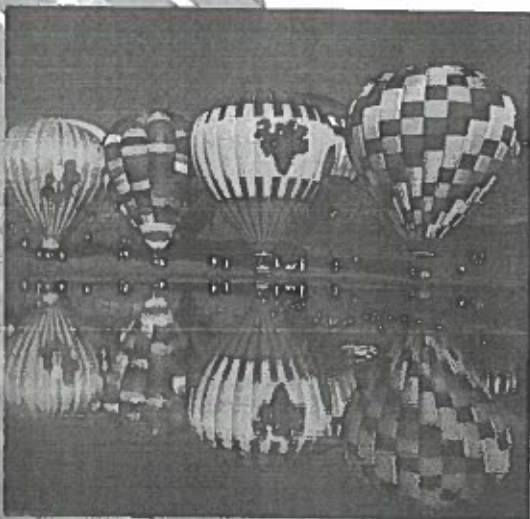
## Mirror, Mirror

What's special about a mirror? The shiny surface of a mirror reflects almost all of the light that hits it. The reflected light makes an image—a reflection—that matches the original almost perfectly. But you've probably noticed that a mirror image is actually a reversed copy of the original.

### Mirror Magic

Write something on a piece of paper and hold it up to a mirror. What do you see? Can you read it?

Try writing a message backward on a piece of paper. Hold it up to a mirror to read it. Have a friend stand behind you with another mirror. Use the mirror image in front of you to read your writing in the mirror behind you.



Sometimes, the surface of still water can produce a reflection almost as clear as a mirror. If something disturbs the surface, the light is reflected in different directions and makes the reflections blurry.

### Reflect on

**Writer's Craft:** What voice did the writer use? Find a place in the article that helped you decide what voice the writer chose for this article.

**Critical Literacy:** How did the voice the writer used affect your reaction to the article?

# Mr. Microscope's Reflections on Bike Safety

Interview by Annie Chan



## Applying Strategies

### Reading Like a Writer

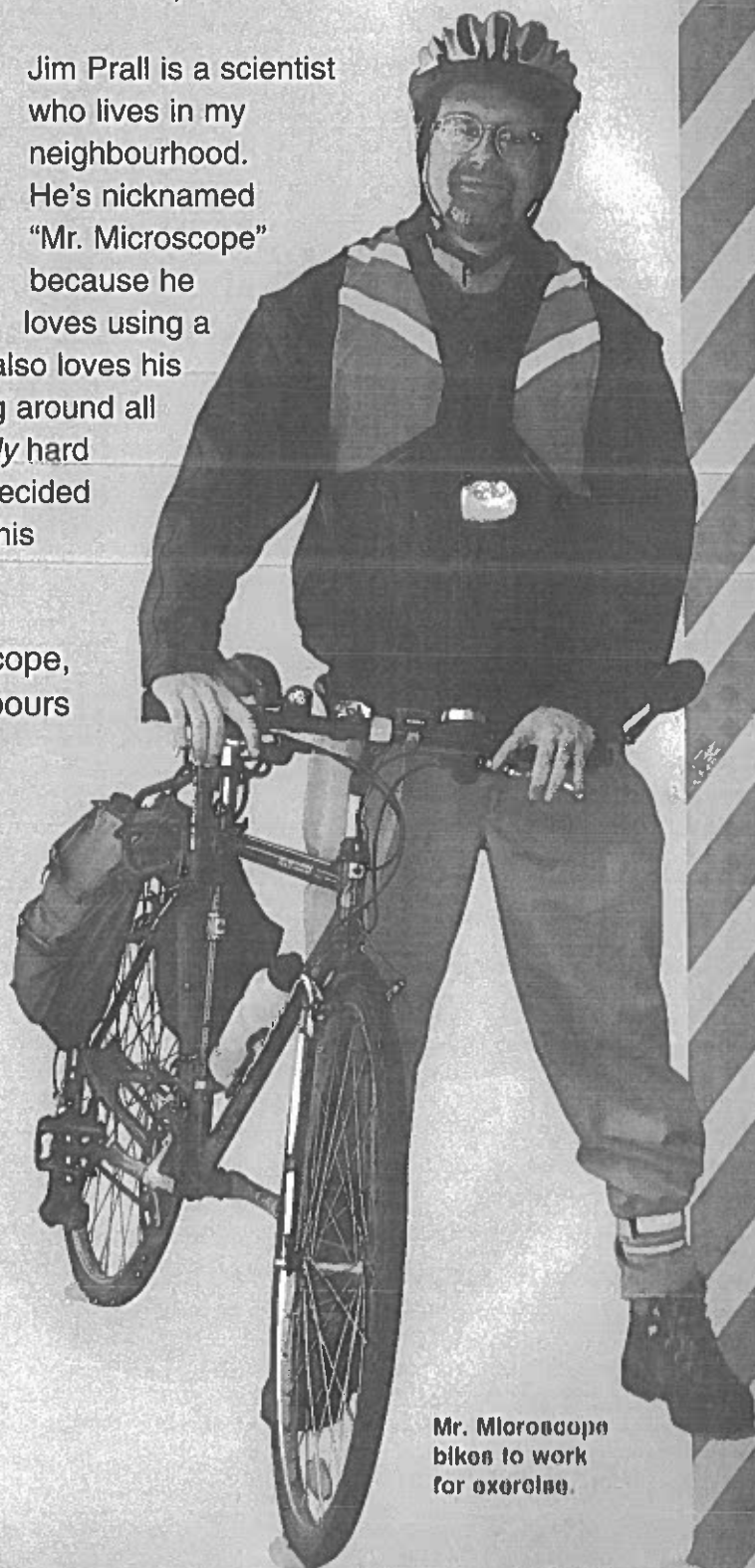
As you read, think about whether the voice of the interview is formal or informal.

Jim Prall is a scientist who lives in my neighbourhood. He's nicknamed "Mr. Microscope" because he loves using a

microscope. But he also loves his bike. I see him biking around all the time and it's really hard not to notice him! I decided to ask him about all his safety equipment.

**Annie:** Mr. Microscope, some of the neighbours say you are a bike safety nut.

**Mr. M.:** I am! I live in a big city and I share the road with drivers, pedestrians, and other cyclists. Riding my bike is fun, but I don't want to have an accident.



Mr. Microscope bikes to work for exercise.

**Annie:** Would you tell me about your vest, please? How does it keep you safe?

**Mr. M.:** My big idea is that it's important for drivers to see me. Drivers are looking at so many things on the road. But when they spot my bright orange vest with the big yellow X, they think, "Oh, there's a cyclist." Cyclists should always wear brightly coloured clothing.

**Annie:** How does your vest help you at night?

**Mr. M.:** Reflection! The yellow X works as a reflector. It's made of special reflective material. When car headlights hit the X, the light bounces right back to the driver. That way, drivers know where I am.



**Annie:** How do reflectors work?

**Mr. M.:** What's so cool about any kind of reflector is that it actually seems to shine. If you look closely at a reflector—under a microscope, maybe—you can see that it has thousands of tiny surfaces. At night, when light from a car hits a reflector, it bounces from one surface to another and then back to the car.

**Annie:** Do you have reflective material on your helmet too?

**Mr. M.:** Yep. I also have reflective tape on the back of my bicycle frame, on the front forks, and on my ankle straps. Plus all my backpacks have reflective tape on them. I attach a red flashing light on my back as well.

**Annie:** Last night I saw you with a headlight on your handlebars *and* a light strapped to your forehead! Why do you need both of them?

**Mr. M.:** Because two are better than one! They help me see where I'm going at night and they help drivers and other cyclists see me. I also have two bells on my bike, one for each hand.

**Annie:** Why do you have a mirror on your bike?

**Mr. M.:** The mirror lets me see cars and bikes coming up behind me.



**Annie:** Thanks for telling me your ideas about bike safety, Mr. Microscope.

**Mr. M.:** It was fun bouncing around ideas with you. I was happy to throw a little light on the subject.

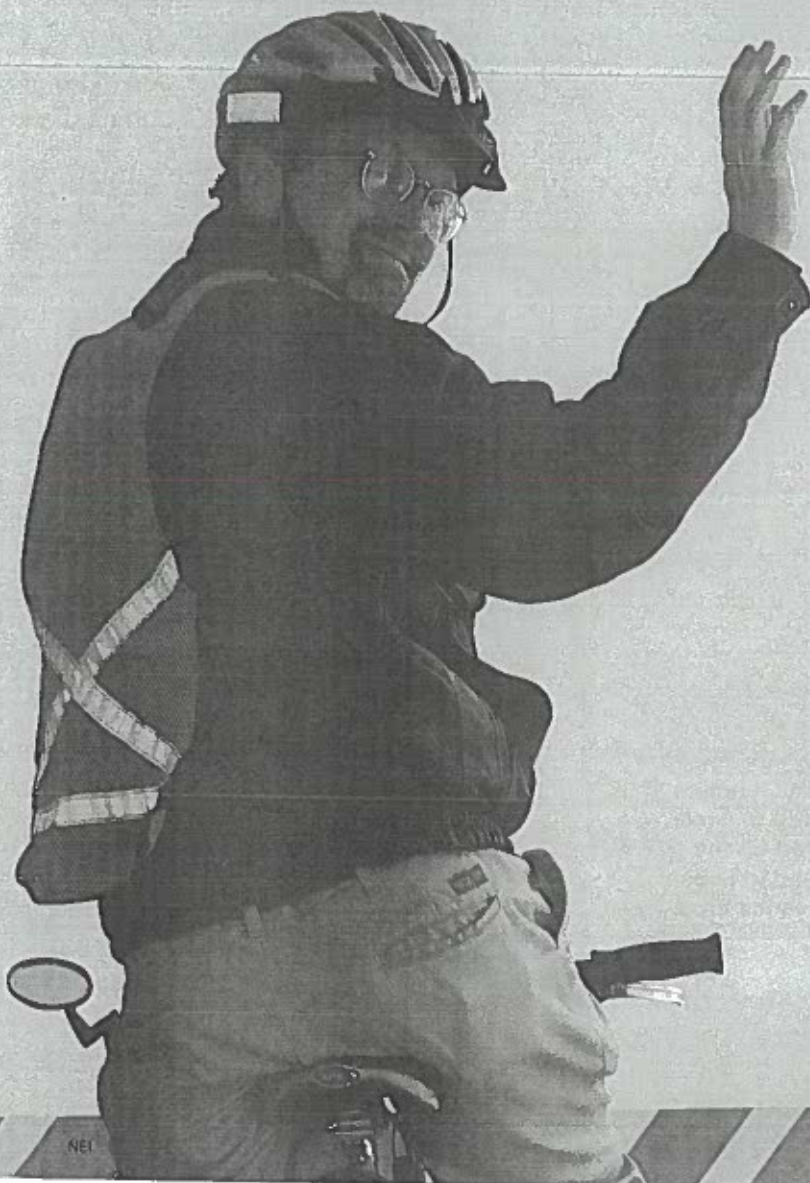
**Annie:** Those are pretty bad jokes, Mr. Microscope.

**Mr. M.:** After a bit of *reflection*, I have to agree with you.

## Reflect on

**Writer's Craft:** Find a place in the interview that helped you decide whether the voice was formal or informal.

**Critical Literacy:** How did the voice affect your enjoyment of the interview?



## Text Features: Diagrams, Captions, and Charts

Diagrams, captions, and charts are text features. They can help you understand what you are reading by giving you additional information and by giving you visual information.

A caption tells you what is important about a diagram. How does this caption help you read the diagram?



# THE COLOURS OF LIGHT

When we look at a beam of sunlight, it appears to travel through the air in a straight line. But when it enters another substance, such as water or glass, it changes direction. This bending of light is called refraction.

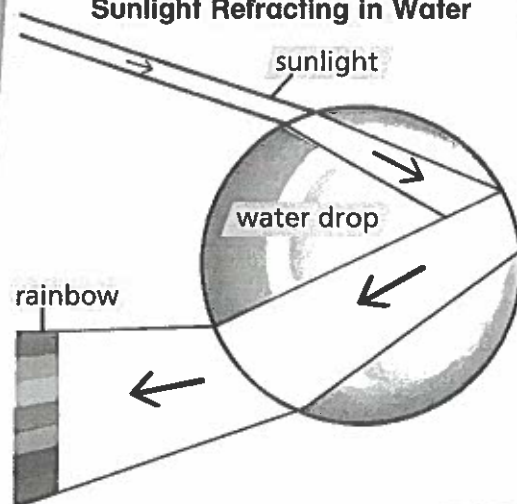
Sunlight is made up of many colours. Usually, the colours combine and look white. Sunlight bends when it passes through water droplets. The bent sunlight splits into all the colours of light—red, orange, yellow, green, blue, indigo, and violet.

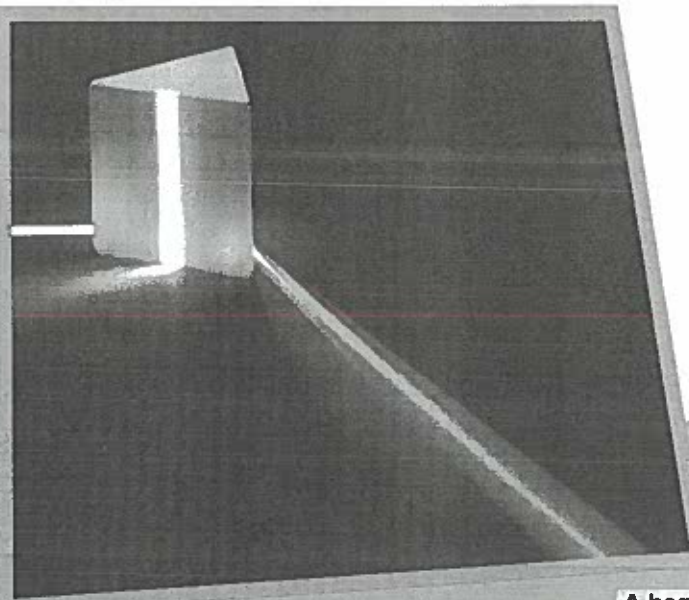
**Sunlight bends as it enters the edge of a drop of water. It is then reflected off the back of the drop and is bent again as it leaves the drop.**

A diagram shows how something works. What does this diagram show you?



**Sunlight Refracting in Water**





A beam of light bends as it passes through a glass prism. The light splits into the colours of the rainbow.

Sunlight also splits into colours when it shines through a glass object called a prism. A prism bends sunlight into its rainbow colours, just as a water droplet would do!

When the sun is shining and it is raining at the same time, the raindrops split the sunlight into different colours.

Because different colours of light bend more than others, the bent sunlight forms an arch of the colours—

a rainbow! This chart shows the order of the colours of a rainbow. Red light bends the least and is closest to being a straight line.

Violet light bends the most. The order of colours in a rainbow never changes.

**sunlight + raindrops = rainbow**

Rainbow Colours	
Order	How They Bend
red	
orange	
yellow	
green	
blue	
indigo	
violet	

A caption tells you what is important about a photograph. What does the caption tell you about this photograph?

A chart is a way to organize information. The title tells you what the chart is about. The headings show you how the information is organized.

# Rainbow Riddle

Written by Sheilah Currie  
Illustrated by Helen Flook

## Applying Strategies

### Text Features: Diagrams and Charts

As you read, use text features to help you understand what you are reading.

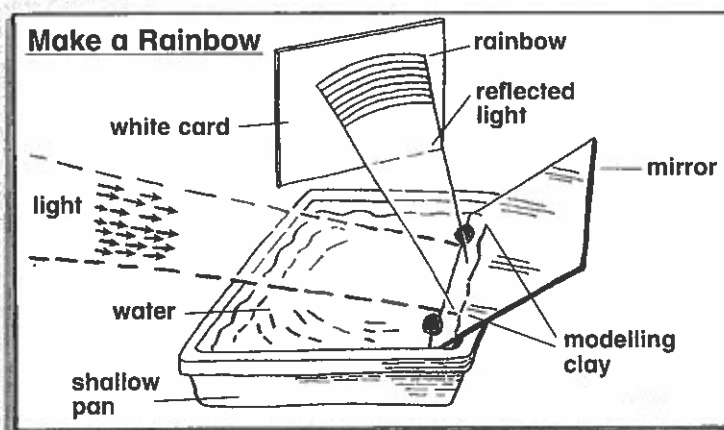
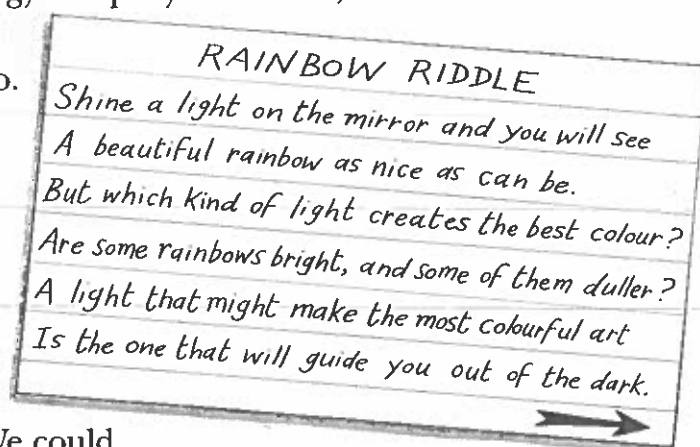
- A diagram helps you understand how something works.
- A chart's title tells you what it's about. The headings show you how the information is organized.

My Aunt Stella has a great job. She's a senior scientist for a large, alternative-energy company. Last week, she sent an experiment for my brother and me to do. She made it sound like a riddle.

"Hmm," I mused. "It's something that will guide you out of the dark."

"I KNOW!" yelled my brother. "We could use a flashlight! That's what I'd use to get out of the dark!"

It seemed like a reasonable idea, but first, we set up our materials the way Aunt Stella showed us in her diagram.



We shone a flashlight on the mirror and held up the white card, but there was only a teensy bit of colour at the edge of a white glow.

My brother was disappointed, but then he got another idea. "A candle! Let's use a candle! That's what guided people out of the dark in the old days!"

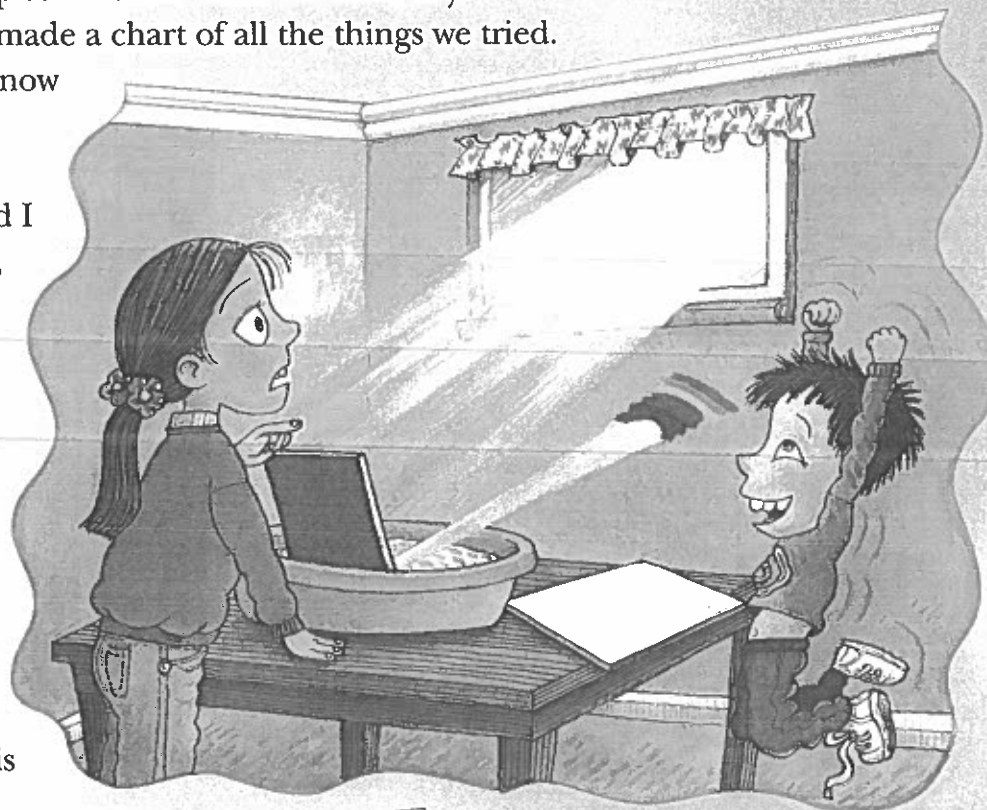
I had to admit that a candle might be the answer, so we asked our dad to help us. When we tried the candle, though, our results were almost the same as with the flashlight. “Hmm,” I wondered, “What else would ‘guide you out of the dark’?”

We tried a couple of other kinds of light, but they just made teensy patches of colour. We were stumped and it was bedtime, so we decided to think up some other ideas the next day. Before I went to sleep, I made a chart of all the things we tried. I wanted Aunt Stella to know that we were being very *scientific*.

When my brother and I woke up in the morning, we were stunned. How could we have forgotten the most important source of light?

The sun! It was shining onto our mirror, and a beautiful rainbow appeared.

I guess we were *guided* out of the dark! Groan. Our Aunt Stella is *so-o-o* clever!



Making Rainbows	
Source of Light	Results
flashlight	round white reflection: dull colours: bit of colour around one edge
candle	flickering white reflection: dull: no colour
lamp	large white reflection: dull: bit of colour around one edge
mini book light	small white reflection: no colour: dull
Sun	<b>Rainbow!</b> most colourful, order—red, orange, yellow, green, blue, indigo, violet

## Reflect on

**Strategies:** How did text features help you understand what you were reading?

**Connections:** When have you used a hands-on activity to help you solve a problem?

Identifying  
Characteristics  
of PowerPoint  
Presentations

# The Wonder of Fireflies

PowerPoint is a software program you can use to create reports. PowerPoint lets you use text, pictures, animation, and sound to share your learning with others in interesting ways.

Look at how these students used PowerPoint to tell about fireflies.

The opening slide tells the topic and the names of the creators. These students recorded themselves reading the title. They also made the fireflies blink on and off.

## Fireflies

Created by  
Mark Samuels and Sachi Kocho

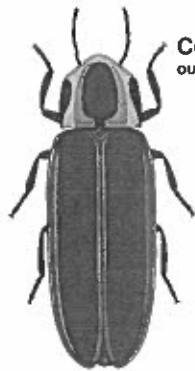
- What are fireflies?
- Where do fireflies live?
- Interesting firefly facts

The next slide lists the main sections in the report. The students used a font that is easy to read. The type is yellow and the background is dark to make viewers think of fireflies at night.

### What are fireflies?

- Fireflies are actually a kind of beetle.
- Some people call fireflies "lightning bugs."
- A firefly's body uses chemicals to make a glowing light that blinks.
- About 125 different kinds of fireflies are found in North America.

## Pyralis Firefly



Covered Head  
outlined in yellow

Thorax

Abdomen  
(under wing  
covers)

Length: 2 cm

Diagrams, maps, and photographs help the viewer understand the topic. Text explains what is important to notice in these visuals.

## Where do fireflies live?

Fireflies can be found across southern Canada, from British Columbia to Québec.



Fireflies usually like damp places, such as fields or lawns, or the edges of woods and streams.

## Interesting firefly facts

- Fireflies glow to attract a mate.
- Each kind of firefly blinks its light in a certain pattern.
- Fireflies may also glow to warn predators that they taste bad.



The last slide gives a strong ending to the report. These students added nature sounds to keep the viewer thinking about the wonder of fireflies.



# Tips for Making a VIDEO

Written by Mark Shulman and Hazlitt Krog Illustrated by Martha Newbigging

## Putting It All Together

As you read this article, remember the strategies you've learned in this unit:

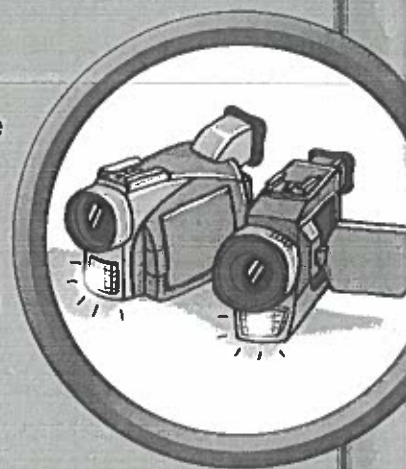
- Ask questions to help you understand what you are reading.
- Identify whether the voice is formal or informal.
- Use diagrams, captions, and charts to get additional information or visual information.

*So, you'd like to wow your friends and family by making a video? Then you'll want to learn more about light!*

## Let There Be Lighting

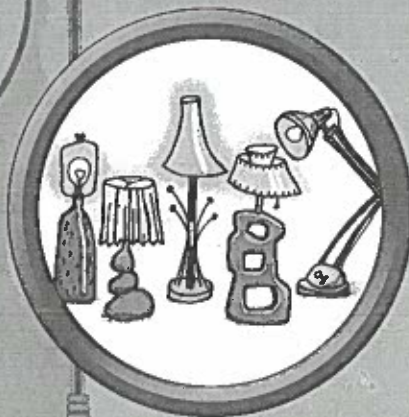
Light is very important when you are making your own video. Here are some sources of light that should be handy to you when you're ready to videotape:

**Built-in Light** Some camcorders have a small built-in light. It's good for home movies, but not really good enough for your super-professional show.

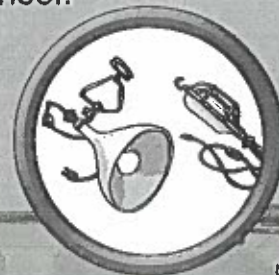


**Daylight** The sun is great for light, but it's hard to move it where you need it. And the sun decides its own schedule. Good news: it's free and plentiful. Bad news: sunlight puts deep shadows on people's faces.

**Indoor Lights** Any of the lights in your house can help your shoot.



**Work Lights** Clip-on work lights are great because they are easy to point at your actors.



## Types of Lighting

Let's take a look at some basic types of lights and their effect on videotape. Try not to mix them in a shot. And remember, consistent light is better than perfect light.

### Kind of Light

### What Is It?

### What's It Good For?

#### Daylight

A brilliant golden light from our local star.

Exterior (outdoors) shooting in daytime, shooting inside rooms with lots of windows.

#### Halogen

A brilliant white light bulb found in many desk and floor lamps.

Everything ... halogen mixes pretty well with daylight, too.

#### Tungsten

The normal everyday light bulb. These regular light bulbs have a warm, yellowish light.

Interior (indoors) shooting when that's all that can be done; tungsten makes a video look "homey."

#### Fluorescent

A blue-white light from tube bulbs.

Shooting inside schools, stores, or bathrooms, where we expect that kind of light. Usually makes people look pale or cold.

#### Neon

Tubes filled with gas that can be shaped to spell words in different colours.

Establishing a mood or setting.