

SCIENCE 710

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“Thou, even thou, art LORD alone; thou hast made heaven, the heaven of heavens, with all their host, the earth, and all things that are therein, the seas,

and all that is therein, and thou preservest them all; and the host of heaven worshippeth thee” (Nehemiah 9:6).

SECTION OBJECTIVES

□ **Read these objectives.** When you have completed this section, you should be able:

7. To tell how light travels and to review pigments and spectral colors.
8. To review the method of producing sound and how it travels in air.
9. To tell how motion is measured with reference to work, foot-pounds, horsepower, power, kilogram-meters, and watts.
10. To locate the main divisions of the periodic table (metals, nonmetals, and so forth).
11. To explain the nature of matter, and to relate the various particles to the structure of matter.

□ **Restudy these words.**

amplitude	machine	rarefaction
compression	matter	relative weight
electromagnetic spectrum	opaque	translucent
friction	pitch	transparent
horsepower	power	work

LIGHT

Light from the sun travels by waves. It also may travel by energy packets known as photons. It can travel through space or in a vacuum, which has no air. Many forms of radiation reach the earth from the sun and other stars. Visible light is only a tiny portion of the radiations that strike the earth. Cosmic rays, X rays, and ultraviolet light are a few examples of invisible radiation. The visible and invisible radiations collectively are called the **electromagnetic spectrum**.

The speed of light. In the air, light travels at approximately 186,000 miles per second. In glass it travels at about two-thirds this

rate. Light normally travels in a straight line. Its rays are bent when passing from one substance to another. This bending of light is called refraction.

Transmission. A **transparent** material is one that is clear and allows light to pass through it. Clear glass, air, water, and clear plastics are transparent. A **translucent** material is one that allows some light to pass through it. Examples of translucence are frosted glass and parchment paper. An **opaque** material is one that does not allow any light to pass through it. Shadows are cast by opaque objects.

The spectrum. In 1672 Sir Isaac Newton found that white light could be separated into a band of colors. By passing light through a prism, he was able to separate the colors of the rainbow. The band of colors into which white light is separated is called the continuous spectrum. The colors of the spectrum are always in the same order. Red is the longest wavelength; violet the shortest. The colors in order of appearance are red, orange, yellow, green, blue, indigo, and violet. Sunlight or white light is a mixture of these colors.

The rainbow. When light is refracted in raindrops, a rainbow is formed. The raindrop acts like a prism. It is God's promise (a covenant) that He will never again flood the whole earth (Genesis 9:13). "I do set my bow in the cloud, and it shall be for a token of a covenant between me and the earth."

Colors. Colors are made only when objects reflect light. If you awaken early in the morning, just before daylight, things will be shades of gray, black, and white. No colors are seen in the dark. An object appears colored if light is reflected. A green dress reflects green. Black absorbs light. For example, a piece of black cloth will appear black, even if you look at it through

colored glass. The color of an object depends upon which color of the spectrum is reflected.

Mixing colored lights and mixing pigments do not produce the same results. The three primary colors of the light spectrum are red, green, and blue. Other colors of light are produced by mixing the primary colors. A mixture of the primary colors of light produces white light. If you were to flash red, green, and blue light on a screen and mix them together, they would produce white light. When you mix red and green light, it produces yellow light. Remember, this process is not the same as mixing pigments.

When you mix paints or crayons, you are mixing pigments. The results are quite different from those obtained by mixing light. The primary colors of pigments are red, yellow, and blue. Mixing red and yellow produces orange; yellow and blue make green; red and blue make violet. These new colors, orange, green, and violet, are the secondary colors. By mixing various combinations of pigments, an artist can achieve a desired color.

☐ **Review.** If you do not understand this discussion, review pages 9 through 28 of Science LIGHTUNIT 706.



Complete these activities.

2.1 List the colors of the spectrum, beginning with the *shortest* wavelength.

- a. _____ b. _____ c. _____
d. _____ e. _____ f. _____
g. _____

2.2 What are the primary colors of the light spectrum? a. _____

b. _____ c. _____

- 2.3 What color do you get when you mix the three primary colors of light?_____
- 2.4 What color do you get when you mix red and green light?_____
- 2.5 An object will appear the color that it reflects. A red dress reflects _____.
- 2.6 What is the speed of light in the air? a._____miles per
b._____
- 2.7 What are the primary colors of pigments? a._____,
b._____, and c._____.
- 2.8 Mixing red and yellow pigments makes a._____; yellow
and blue make b._____; and red and blue make
c._____.
- 2.9 Three general types of material may be defined according to their
transmission of light. Material that is clear and allows light to pass
through it is called a._____. Material that allows
some light to pass through it is called b._____.
Material that will not allow any light to pass through it is called
c._____.
- △2.10 What is the electromagnetic spectrum? _____

-

SOUND

All sounds are produced by vibrations. When you strike a drum or cymbal, the object vibrates. These vibrations set the air molecules into motion. Sound waves move out from the source. When the vibrating air molecules reach your ear, the eardrum also vibrates. The bones of the ear vibrate in the same manner as the object that started the sound wave. These vibrations enable you to hear different sounds. Even vibrations are musical tones. Irregular vibrations are noise.

Compression, rarefaction. Sound waves have two parts: **compression** and **rarefaction**. Compression describes the part of the waves where the molecules of air are pushed (compressed) together. Rarefaction describes the part of the waves where the molecules are far apart. Sound waves are a series of compressions and rarefactions.

The speed of sound. Sound waves can travel through liquids, solids, and gases.

They can travel through water faster than through air. They travel even faster in solids such as stone, iron, and steel. Sound travels 1,100 feet per second (one-fifth of a mile) in the air.

4,000 times per second. Middle C vibrates 256 times per second. The loudness of a sound is its **amplitude**. Striking a key harder will make it louder. It will not change the pitch.

Pitch and amplitude. **Pitch** describes the highness or lowness of sound. Pitch is determined by the number of vibrations per second. The highest key on a piano vibrates

□ **Review.** If you have difficulty with this discussion on sound, review pages 3 through 5 of Science LIGHTUNIT 706.



Match these items.

- | | | | |
|------|-------|--|----------------------------------|
| 2.11 | _____ | the loudness of a sound | a. pitch |
| 2.12 | _____ | the source of all sound | b. vacuum |
| 2.13 | _____ | describing a sound as high or low | c. $\frac{1}{5}$ mile per second |
| 2.14 | _____ | middle C on the piano | d. amplitude |
| 2.15 | _____ | the part of a sound wave where molecules of air are close together | e. rarefaction |
| 2.16 | _____ | sound travels through this medium faster than through air | f. compression |
| 2.17 | _____ | the speed of sound | g. 256 vibrations per second |
| 2.18 | _____ | the part of a sound wave where molecules of air are far apart | h. solid |
| | | | i. vibrations |

MOTION

Everything in the world is made of **matter**. All matter is in motion. The atoms and molecules that make up matter are in constant motion. The electrons move around the nucleus. The protons and neutrons within the nucleus also are in motion. A force is required for movement. Force is defined as a push or a pull action.

Work. Scientists define **work** in a special way. Work is done only when a force moves something. If you attempted to move an object and were unable to do so, you did no work. You exerted a force and spent some energy, but did not accomplish anything. Work is defined as the amount of force times the distance the force moves.

The unit for measuring work is the foot-pound. If you move 2 pounds 1 foot, you have done 2 foot-pounds of work. Also, if you have moved 10 pounds 2 feet, you have done 20 foot-pounds of work. The formula for computing work is

$$\text{WORK (foot-pounds)} = \text{FORCE (pounds)} \times \text{DISTANCE (feet)}$$

In the metric system the unit for measuring work is the kilogram-meter. When a kilogram weight is raised to a height of 1 meter, 1 kilogram-meter of work is done. Also, when 3 kilograms are lifted 2 meters, 6 kilogram-meters of work are done.

The scientific definition of **power** is the rate or speed of an energy force doing work. Suppose Sue weighs 90 pounds. Sue climbed to the top of a 10-foot stairway in 3 seconds. Mary also weighs 90 pounds, but it took her 6 seconds to climb the same stairway. Sue's power is twice that of Mary's. Notice that both girls have done the same amount of work. Only the rate (power) has changed.

One unit of measuring power is the **horsepower**. Horsepower is defined as the power required to lift a 550-pound load 1 foot in 1 second. Another unit for measuring power is the watt. Watts are much smaller units than horsepower. Watts are useful measurements for electrical power and for small engines and household items such as vacuum cleaners. One horsepower is about 746 watts.

Machines. A **machine** is a mechanical device people use to help them do work. Machines help do work with less force or in less time. They do not reduce the amount of work to be done. They can save a lot of effort. More work is needed to operate a machine because of **friction**. Friction is a force that opposes motion. It is a hindrance to work because parts rub against one another. Friction is necessary when walking on the pavement and when stopping your car. If the road is icy, friction is decreased. Without friction you could not stand up. Although friction is useful for standing and stopping and other similar things, it causes a problem in operating machines.

Scientists have found that the work output of a machine equals the work put into the machine. This principle is known as the work principle. Not all of the work from a machine is useful, some may be lost as heat or friction. Machines are very helpful to man because they can transfer a force and also change the direction of a force. Machines, such as the turbine, are used for generating power. The turbine is an example of a machine that can change the direction of a force. When you push down on your bicycle pedal, you change the direction of a force and your bicycle goes forward.

☐ **Review.** If you have difficulty with this discussion on motion and its measurement, review Science LIGHTUNIT 707.



Complete these activities.

- 2.19 Solve this problem. How much work was done when 70 pounds were moved 10 feet? _____ (indicate units)
- 2.20 Solve this problem. How much work was done when 7 kilograms were moved 2 meters? _____ (indicate units)