LIFEPAC® Science

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SCIENCE 1204
INTRODUCTION TO WAVES

CONTENTS

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INTRODUCTION TO WAVES

A wave is a disturbance in a medium that transfers energy from one place to another without transferring matter. Nonrepetitive waves are called *pulses*, or nonrecurrent waves; whereas other waves consisting of several identical pulses in a rhythmic pattern are called *periodic waves*. In this LIFEPAC® you will observe and study waves and their characteristics, their various phenomena, and their applications in the area of sound.

OBJECTIVES

Read these objectives. The objectives tell you what you will be able to do when you have successfully completed this LIFEPAC.

When you have finished this LIFEPAC, you should be able to:

1. Identify a pulse and a periodic wave.
2. Calculate the velocity, frequency, period, and length of a wave.
3. Identify and generate transverse waves and longitudinal waves.
4. (Optional) Describe the properties of a torsional wave.
5. Identify reflection, refraction, diffraction, and interference.
6. Calculate problems that involve interference phenomena.
7. Explain standing waves.
8. Calculate problems involving beats.
9. Describe resonance.
10. Describe and explain the Doppler effect.
11. Describe and explain shock waves.
12. Calculate speed of sound problems.

Survey the LIFEPAC. Ask yourself some questions about this study. Write your questions here.

I. ENERGY TRANSFER

Energy is transferred in only two ways, by particle motion and by **wave** motion. A moving particle has kinetic energy proportional to its mass and **velocity**. The energy of a wave is not so simple to assign. Under certain conditions, energy is proportional to the wave height. Under other conditions, wave energy is proportional to the number of pulses per unit time.

Waves are periodic moving pulses of energy. The shape, or form, of a wave is to some degree determined by the medium through which the wave travels.

OBJECTIVES

Review these objectives. When you have completed this section, you should be able to:

1. Identify a pulse and a periodic wave.
2. Calculate the velocity, frequency, period, and length of a wave.
3. Identify and generate transverse waves and longitudinal waves.
4. (Optional) To describe the properties of a torsional wave.

VOCABULARY

Study these words to enhance your learning in this section.

amplitude	period	transverse wave
condensation	periodic wave	trough
crest	pulse	velocity
frequency	rarefaction	wave
longitudinal wave	torsional wave	wavelength
nonrecurrent wave		

Note: All vocabulary words in this LIFEPAC appear in **boldface** print the first time they are used. If you are unsure of the meaning when you are reading, study the definitions given.

PULSES

A **pulse** (a **nonrecurrent wave**) is a **wave** of short duration. Although it is nonrepetitive, it transfers energy. In some cases, the energy transferred is huge. Surf crashing onto a beach carries energy from a storm generated at sea. Nuclear energy released in a nuclear device transfers energy for miles as heat, light, sound, and mechanical energy (earth tremors and quakes). In A.D. 1054 Chinese astronomers reported seeing a super nova. The aftermath of this explosion can still be seen in the nebula that is continuing to expand at high velocities. A seismic sea wave, or tsunami (misnamed a "tidal wave"), caused by a typhoon, hurricane, or undersea earthquake, hit Lisbon in 1755. Traveling at 500 miles per hour, it caused tremendous damage with waves up to fifty feet high. Knocking down a row of dominoes by touching the first one is still another example of a pulse.

Two characteristics of a pulse are **amplitude** and **velocity**.

Amplitude. The maximum height of a pulse is its amplitude and is a function of the energy that created the pulse.

Try this investigation of pulses.

This item is needed:

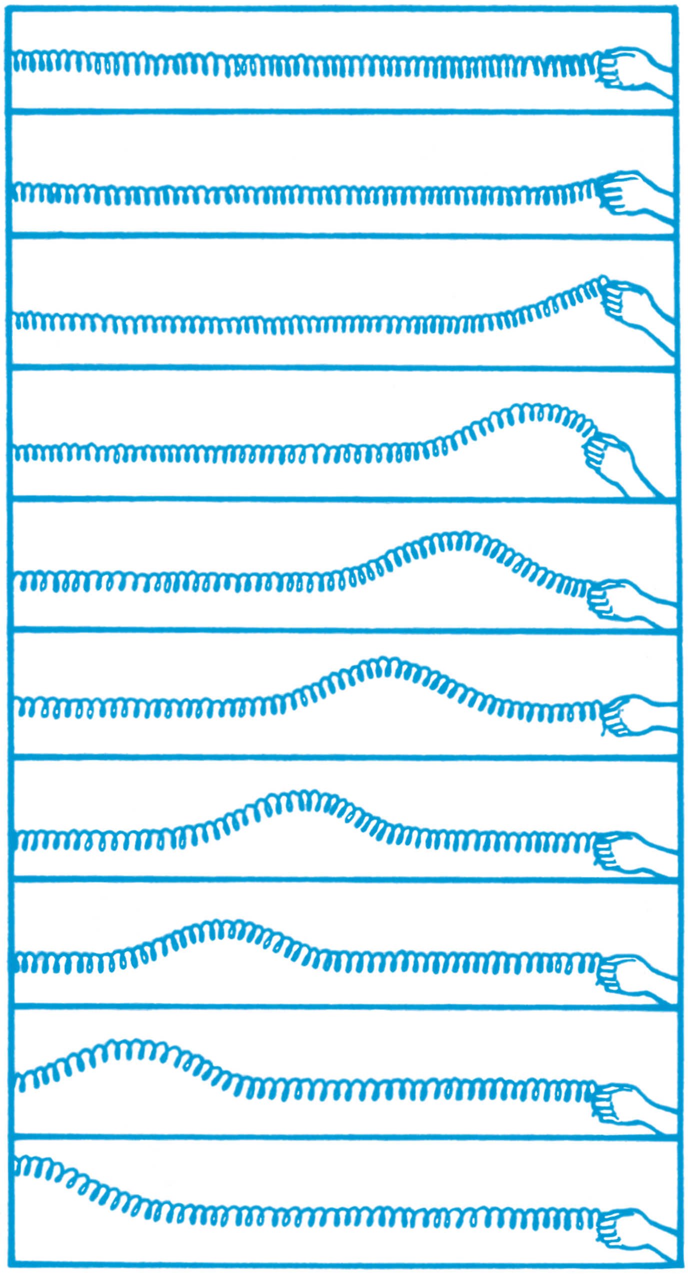
Slinky®[1]

[1]© James Industries Inc. Hollidayburg, PA. Reprinted with permission. Patent catalog #100.

Follow these directions and answer the questions. Put a check in the box when each step is completed.

❑ 1. If no partner is available, secure one end of the Slinky® to a permanent fixture at floor level so that the end cannot move.

❑ 2. Stretch the Slinky® approximately 10 meters along a smooth floor. Whip the Slinky® sideways from its equilibrium position and back again. (Do not go past this starting position.) Notice that as the pulse propagates, only the pulse moves along the Slinky® and not the coils. The coils are moved out of position as the pulse passes by and then returned to their original position.



❑ 3. Generate pulses of various sizes.

1.1 What provides the energy for this type of pulse?

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1.2 Does the slow motion of the hand produce a long pulse or a narrow pulse?

____

1.3 Does moving the hand a short distance produce a tall pulse or short pulse?

____

1.4 Does the shape of the pulse change as it travels along the Slinky®? ______________

____

1.5 Do pulses change size? _______________________________________

____

Velocity. Different waves travel at different velocities. A seismic sea wave, or tsunami, may travel at speeds up to 830 kilometers per hour. Sound waves travel at about 330 meters per second through air depending on the air's temperature. Light and other electromagnetic radiation travels at $3 \cdot 10^8$ meters per second through space, but slower through glass or water.

Try this investigation of the effect of the medium on wave speeds.

These supplies are needed:

- Slinky®
- stopwatch or sweep second hand
- meter stick

Follow these directions and answer the question. Put a check in the box when each step is completed.

❑ 1. Fix one end of the Slinky® and extend it exactly 6 meters.
❑ 2. Generate a pulse by plucking and time its travel from the pluck to the far end. Repeat several times to obtain an average time.
❑ 3. Extend the Slinky® exactly 8 meters.
❑ 4. Repeat Step 2.
❑ 5. Extend the Slinky® exactly 10 meters.
❑ 6. Repeat Step 2.
❑ 7. Calculate the velocities, using d/t .

1.6 How did the different stretches (densities) affect the velocity of the pulse?

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