Wave Pulses

**Topic**

A coiled spring can help visualize and explain *interference* and *reflection* of a wave.

**Introduction**

There are two types of waves, longitudinal and transverse. In a *longitudinal wave* the *medium* moves parallel to the direction of the wave (see Figure 1). In a *transverse wave*, the medium moves perpendicular to the direction of the wave (see Figures 2). A wave pulse is a type of wave with only one or two crests. It is typically a sudden and short-lived disruption of a medium. Wave pulses have *velocity*, *amplitude*, and *wavelength*. Wave pulses do not have a frequency because they usually have only one or two crests. One example of a wave pulse is “the wave” often seen at sporting events. This pulse has one crest that travels through the stadium.

![Figure 1](longitudinal_wave.png)

**Figure 1**

![Figure 2](transverse_wave.png)

**Figure 2**

When two wave pulses collide, interference occurs. There are two types of interference, constructive and destructive. Constructive interference
occurs when two waves with amplitudes in the same direction collide and create a larger wave. When two waves interfere destructively, they have opposite amplitudes and create a small wave. In some cases, a wave can interfere with its own reflection. When a wave hits a change in medium, some of the wave is absorbed into the new medium and some is reflected. In the case of a transverse wave, the reflected wave is always inverted. In this experiment, you will use a spring to demonstrate wave pulses, wave interference, and reflection.

**Time Required**

30 minutes

**Materials**

- long coiled spring (or a Slinky™)
- science notebook

Please review and follow the safety guidelines.

**Procedure**

1. Work with a partner, one on each end of the spring.
2. Stretch the spring out on the floor with one person holding each end. Do not extend the coils of the spring.
3. Have one person push his or her end of the spring to send a longitudinal wave pulse down the length of the spring. Observe the wave and describe it in your science notebook.
4. Have one person push his or her end of the spring several times to create multiple wave pulses down the spring. Make sure that the other end of the spring is held very still, allowing the pulses to be reflected back down the spring. Observe the waves and describe them in your science notebook.
5. Pick the spring up and stretch it between partners so that the spring sags slightly in the middle.

6. One partner should create a transverse wave pulse down the spring by raising and lowering his or her arm (along with the spring) quickly. Observe what happens when the wave reaches the end of the spring and is reflected. Describe the wave and its behavior in your science notebook.

7. One partner should create several wave pulses down the length of the spring. Observe the interaction between initial waves and reflected waves. Describe the waves and their behavior in your science notebook.

8. Each partner should create a single wave pulse toward the opposite ends. Observe what happens when the two pulses meet. Describe your observations in your science notebook.

Analysis

1. What is carried in a wave pulse?
2. Explain what happens in step 6 of the procedure.
3. What happens when initial waves and reflected waves interact? Why?
4. How can you make a wave pulse bigger or smaller without putting more energy into the initial motion?

What’s Going On?

The spring is used as a medium to carry energy from one student’s hand to the other’s. This energy is evident in the visible wave pulse that races along the length of the spring. When creating a longitudinal wave, the pulse is an area of coils close together called a compression. Transverse wave pulses are visible because the high crest that travels the length of the medium. When either type of wave pulse hits the opposite end of the spring, some of the wave is absorbed by the student’s hand and some is reflected back. In this case, most of the wave is reflected because a student’s hand is a much more dense medium than the spring.
When both ends of the spring are moved to create two transverse waves, interference occurs. This is easy to see with single wave pulses; it becomes obvious when the pulses get bigger through constructive interference or smaller through destructive interference. When both students make upright waves or both make inverted waves, the waves get larger when they overlap. If one student makes an upright wave and the other makes an inverted wave, the waves interfere destructively and create a smaller wave when they overlap.

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OUR FINDINGS

WAVE PULSES

**Suggestion for class discussion:** Line up members of the class in an open space and have them use their arms to perform “the wave.” Ask students what kinds of waves exist in nature. Review this question after the experiment.

**Analysis**

1. Energy is carried in a pulse wave.
2. The transverse wave is reflected and becomes inverted due to the difference in mediums.
3. When the two waves interact, destructive interference occurs. This is because the two waves have opposite amplitudes.
4. Interference can make a wave bigger or smaller. Constructive interference occurs when a wave with the same type of amplitude overlaps the original wave and makes it bigger. Destructive interference occurs when a wave with opposite amplitude overlaps the original wave and makes it smaller.
SAFETY PRECAUTIONS
Review Before Starting Any Experiment

Each experiment includes special safety precautions that are relevant to that particular project. These do not include all the basic safety precautions that are necessary whenever you are working on a scientific experiment. For this reason, it is absolutely necessary that you read and remain mindful of the General Safety Precautions that follow this note. Experimental science can be dangerous, and good laboratory procedure always includes following basic safety rules. Things can happen very quickly while you are performing an experiment. Materials can spill, break, or even catch fire. There will be no time after the fact to protect yourself. Always prepare for unexpected dangers by following the basic safety guidelines during the entire experiment, whether or not something seems dangerous to you at a given moment.

We have been quite sparing in prescribing safety precautions for the individual experiments. For one reason, we want you to take very seriously every safety precaution that is printed in this book. If you see it written here, you can be sure that it is here because it is absolutely critical.

Read the safety precautions here and at the beginning of each experiment before performing each lab activity. It is difficult to remember a long set of general rules. By rereading these general precautions every time you set up an experiment, you will be reminding yourself that lab safety is critically important. In addition, use your good judgment and pay close attention when performing potentially dangerous procedures. Just because the book does not say “Be careful with hot liquids” or “Don’t cut yourself with a knife” does not mean that you can be careless when boiling water or using knives. Notes in the text are special precautions to which you must pay special attention.

GENERAL SAFETY PRECAUTIONS
Accidents caused by carelessness, haste, insufficient knowledge, or taking an unnecessary risk can be avoided by practicing safety procedures and being alert while conducting experiments. Be sure to check the individual experiments in this book for additional safety regulations and adult supervision requirements. Anytime you are working with an electrical current, it becomes possible to shock yourself on exposed wires. If you will be working in a lab, do not work alone. When
you are working off-site, keep in groups with a minimum of three students per group, and follow school rules and state legal requirements for the number of supervisors required. Ask an adult supervisor with basic training in first aid to carry a small first-aid kit. Make sure everyone knows where this person will be during the experiment.

PREPARING
- Clear all surfaces before beginning experiments.
- Read the instructions before you start.
- Know the hazards of the experiments and anticipate dangers.

PROTECTING YOURSELF
- Follow the directions step by step.
- Do only one experiment at a time.
- Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eyewash, and first-aid kit.
- Make sure there is adequate ventilation.
- Do not horseplay.
- Keep floor and workspace neat, clean, and dry.
- Clean up spills immediately.
- If glassware breaks, do not clean it up by yourself; ask for teacher assistance.
- Tie back long hair.
- Never eat, drink, or smoke in the laboratory or workspace.
- Do not eat or drink any substances tested unless expressly permitted to do so by a knowledgeable adult.

USING EQUIPMENT WITH CARE
- Set up apparatus far from the edge of the desk.
- Use knives or other sharp, pointed instruments with care.
- Pull plugs, not cards, when removing electrical plugs.
- Clean glassware before and after use.
- Check glassware for scratches, cracks, and sharp edges.
- Let your teacher know about broken glassware immediately.
- Do no use reflected sunlight to illuminate your microscope.
- Do not touch metal conductors.
- Use alcohol-filled thermometers, not mercury-filled thermometers.
SAFETY PRECAUTIONS

USING CHEMICALS
- Never taste or inhale chemicals
- Label all bottles and apparatus containing chemicals
- Read labels carefully.
- Avoid chemical contact with skin and eyes (wear safety glasses, lab apron, and gloves).
- Do not touch chemical solutions.
- Wash hands before and after using solutions.
- Wipe up spills thoroughly.

HEATING SUBSTANCES
- Wear safety glasses, apron, and gloves when boiling water.
- Keep your face away from test tubes and beakers.
- Use test tubes, beakers, and other glassware made of Pyrex™ glass.
- Never leave apparatus unattended.
- Use safety tongs and heat-resistant gloves.
- If your laboratory does not have heat-proof workbenches, put your Bunsen burner on a heat-proof mat before lighting it.
- Take care when lighting your Bunsen burner; light it with the airhole closed, and use a Bunsen burner lighter rather than wooden matches.
- Turn off hot plates, Bunsen burners, and gas when you are done.
- Keep flammable substances away from flames and other sources of heat.
- Have a fire extinguisher on hand.

FINISHING UP
- Thoroughly clean your work area and any glassware used.
- Wash your hands.
- Be careful not to return chemicals or contaminated reagents to the wrong containers.
- Do not dispose of materials in the sink unless instructed to do so.
- Clean up all residues and put in proper containers for disposal.
- Dispose of all chemicals according to all local, state, and federal laws.

BE SAFETY CONSCIOUS AT ALL TIMES!