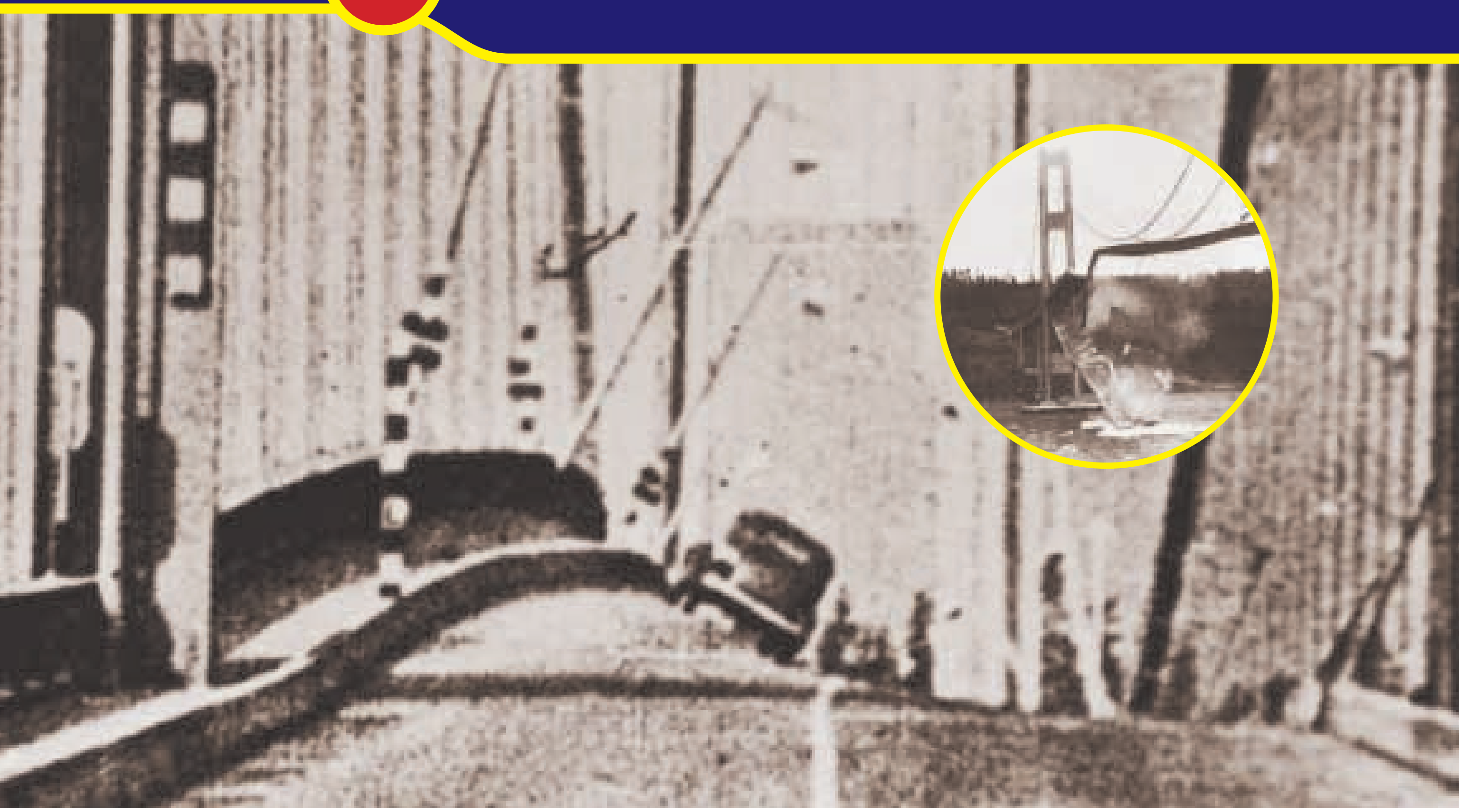
# CHAPTER 8 Waves Transferring Energy



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People living in coastal areas are very aware of the energy carried by tsunamis (large ocean waves) and the destruction that they can bring. The effects of small waves combining together can also lead to destruction. On November 5, 1940, many relatively small waves combined to produce such huge vibrations in the Tacoma Narrows Bridge (as shown in the large photograph) that the bridge was torn apart. The engineers who designed the suspension bridge, located near Tacoma, Washington, had no idea that the relatively moderate winds that blew through the Narrows could produce such destructive vibrations. Today, models of bridges such as this one are routinely tested in specially designed wind tunnels to ensure that small waves cannot combine to produce disasters like the Tacoma Narrows Bridge collapse.

The transfer of energy by waves can also be beneficial. Physiotherapists commonly use high frequency sound waves to reduce the pain and swelling of athletic injuries. High frequency sound waves (ultrasound) are also used for routine monitoring of the developing fetus in expectant mothers. Ultrasound does not present the dangers associated with X-ray imaging.

# INVESTIGATION 8-A

## Waves in a Spring

**TARGET SKILLS**
- Predicting
- Identifying variables
- Analyzing and interpreting

You have probably been observing waves of some sort all of your life. As a child, you might have dropped a pebble in water and watched the waves spread over the surface. Children often develop ideas about the nature of what they observe. These ideas can be helpful but, if they are incorrect, they can stand in the way of new learning. To see if your ideas about waves are correct, test them in this investigation.

### Problem

What affects the nature of a wave as it travels along a spring? What influences the speed of the wave?

### Prediction

Make predictions about the factors affecting the nature of a wave pulse as it travels down a spring. For example, predict whether such factors as the tension in the spring, the height of the pulse, and the distance travelled affect the speed of a wave pulse. How might these factors do so? In each case, explain your reasoning.

### Equipment

- large-diameter spring (such as a Slinky™)
- small-diameter spring
- stopwatch
- metre stick

### Procedure

1. Stretch the large spring out on the floor until you and your lab partner are about 8 m apart.
2. Move your hand rapidly to one side and back in order to send a single pulse down the spring.
3. Observe its speed, size, and anything else that you find significant.
4. Find a second way to produce a wave pulse. Experiment with different motions of the end of the spring.
5. Establish a method for measuring the speed of the wave pulse. Test the effect, if any, of the following on the speed of the wave pulse.
   - **(a)** pulse size
   - **(b)** distance travelled
   - **(c)** tension in the spring
   - **(d)** use of the small spring

(Hint: Be careful when you are testing one factor to control all of the other factors. When stretching the springs, be sure to use the same distance for timing the pulse.)

**CAUTION** Releasing one end of a stretched spring usually results in a tangled mess! When you are finished experimenting, do not *release either end*. Instead, walk toward your partner with your end of the spring.

### Analyze and Conclude

1. Compare your results with the predictions you made earlier about the factors that affect the speed of a wave pulse in a spring.
2. In each case, try to explain any discrepancies between your results and your predictions.
3. Describe any misconceptions you might have had about waves and how they travel.