3.2 Grade 8

CONCEPT 3

The wave model of light explains that light has wave-like properties.

Activity

Can Waves Carry Energy?

You can observe that water waves carry energy when you see a photo like this. But how can you demonstrate that waves actually do carry energy? And does this apply to more than water waves? To start to investigate these questions, you will need a pan of water and a rope.

1. With a partner or in small groups, decide what is necessary to produce a wave using
   a) water **b)** rope
2. Is energy always needed to produce a wave? Explain your thinking.
3. How does a wave move energy from one place to another?
4. How can you change the size of the wave?
5. How can you change the speed of the wave?

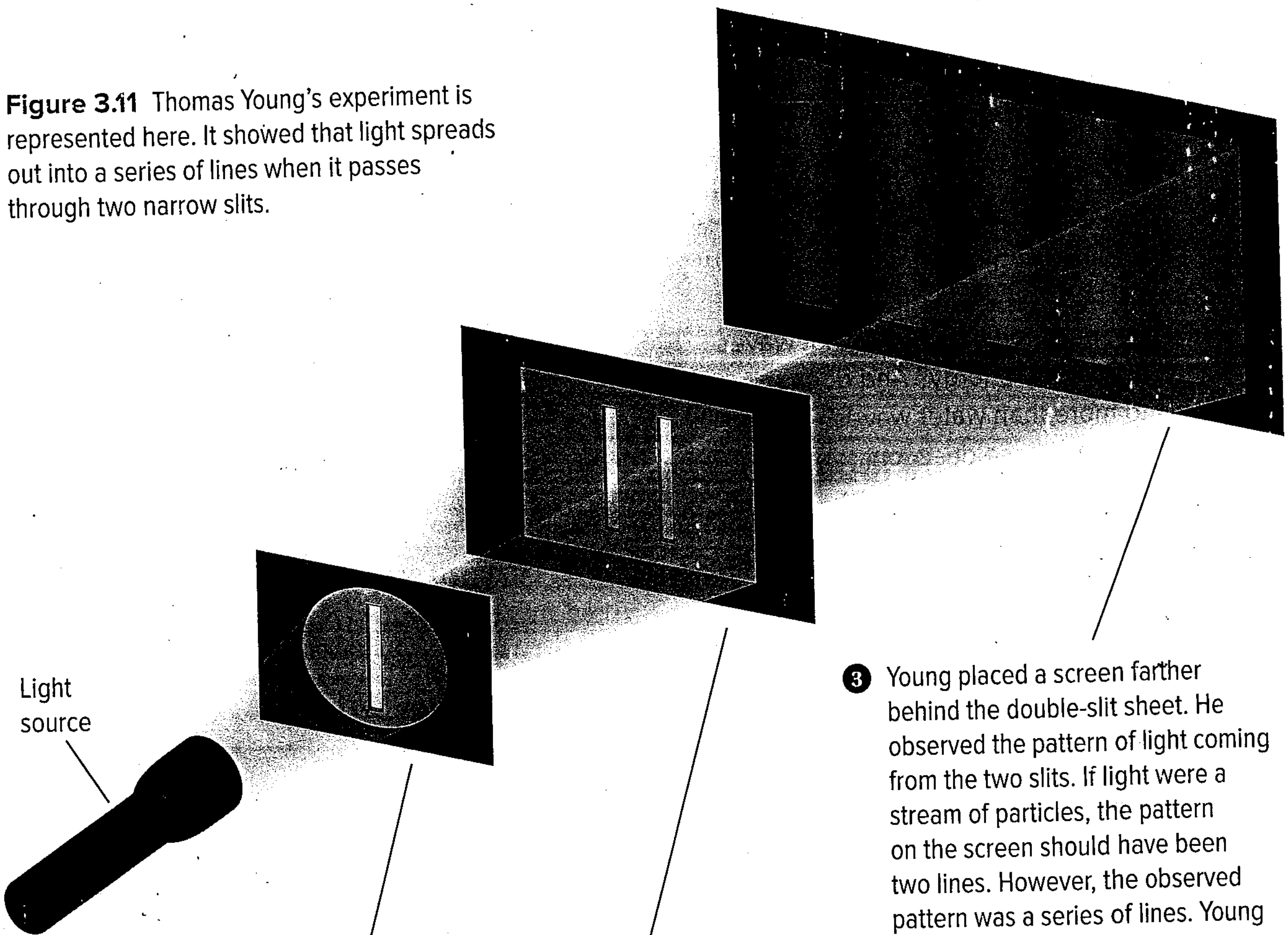
Observations of shadows enabled scientists to infer that light travels in a straight line. But there was still much about the properties of light to understand. Many scientists thought that light was made of streams of particles. The idea that light has particle-like properties is known as the **particle model of light**. A scientist named Isaac Newton was one of the first people to propose that light has these properties. However, he could not demonstrate this in an experiment.

particle model of light the idea that light has particle-like properties

As other scientists continued to study light, they realized that some properties could not be possible if light was simply a stream of particles. Some scientists argued that light has wave-like properties. In the early 1800s, a scientist named Thomas Young designed an experiment to test the hypothesis that light has the properties of a wave. His experiment supported the idea of a **wave model of light**. Young's experiment is explained in **Figure 3.11** on the next page.

wave model of light the idea that light has wave-like properties

Figure 3.11 Thomas Young's experiment is represented here. It showed that light spreads out into a series of lines when it passes through two narrow slits.



Extending the Connections

How Do Waves Interact?

What do you think Thomas Young knew about waves that helped him interpret his experimental results? Investigate your own questions and ideas about waves. Find out what Young knew, and compare your own ideas to his.

Properties of Light Waves

Light waves have some things in common with water waves. Both types of waves move energy from one place to another. In water waves, the energy causes water molecules to vibrate up and down. This motion produces the shape shown in **Figure 3.12**. Scientists use the shape of a water wave to model light waves. Like a water wave, light waves have a wavelength. They also have amplitude and frequency. These terms are explained in **Figure 3.12** and **3.13**.

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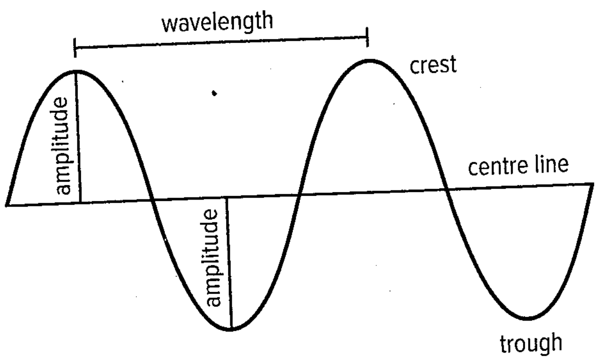
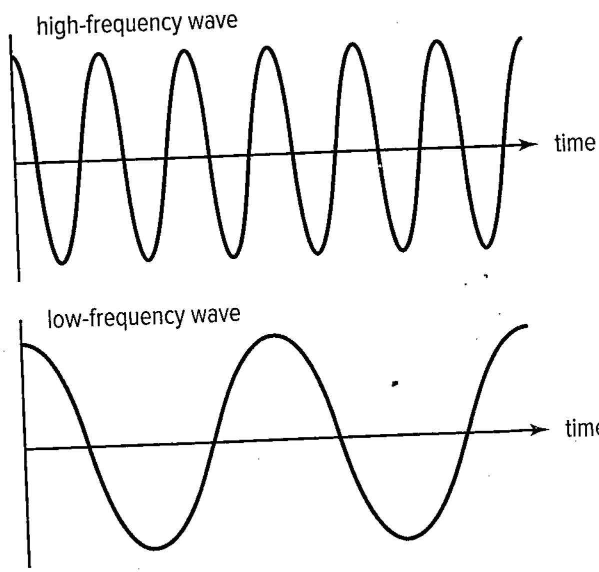
Figure 3.12 This wave illustrates wavelength and amplitude.



The crest of a wave is the highest point, and the trough of a wave is the lowest point. The distance from the centre line to the crest is the same as from the centre line to the trough. **Wavelength** refers to the distance from one crest (or trough) of a wave to the next crest (or trough). **Amplitude** is the distance from the centre line to the crest or trough of the wave.

Figure 3.13 This wave illustrates frequency.



This diagram shows two waves with different frequencies. **Frequency** refers to the number of complete wavelengths that pass a point in one second as the wave goes by. As the wavelength decreases, the frequency increases. And as the wavelength increases, the frequency decreases.

Extending the Connections

Light Waves Are More Complicated Than Water Waves

Even though scientists use a water wave as a model for a light wave, light waves are more complicated. This is because light waves have electrical and magnetic properties. Find out how electromagnetic waves are different from the simpler model used for water waves.

wavelength the distance from one crest (or trough) of a wave to the next crest (or trough)

amplitude the distance from the centre line to the crest or trough of a wave

frequency the number of complete wavelengths that pass a point in one second as the wave goes by

Light, Wavelength, and Colour

In the 1600s, Isaac Newton used a prism to separate visible light into the colours of the rainbow (**Figure 3.14**). He hypothesized that if light were a mixture of colours, the colours would recombine to form white light if they passed through another prism. He set up an experiment to test this idea and observed that they did. In this way, Newton was the first scientist to show that sunlight was actually a mixture of light of different colours.

Connect to Investigation 3-E on page 218

The colours of light are actually different wavelengths of visible light. Together, they are referred to as the *visible light spectrum*. The colour red has the longest wavelength of visible light. Violet has the shortest.

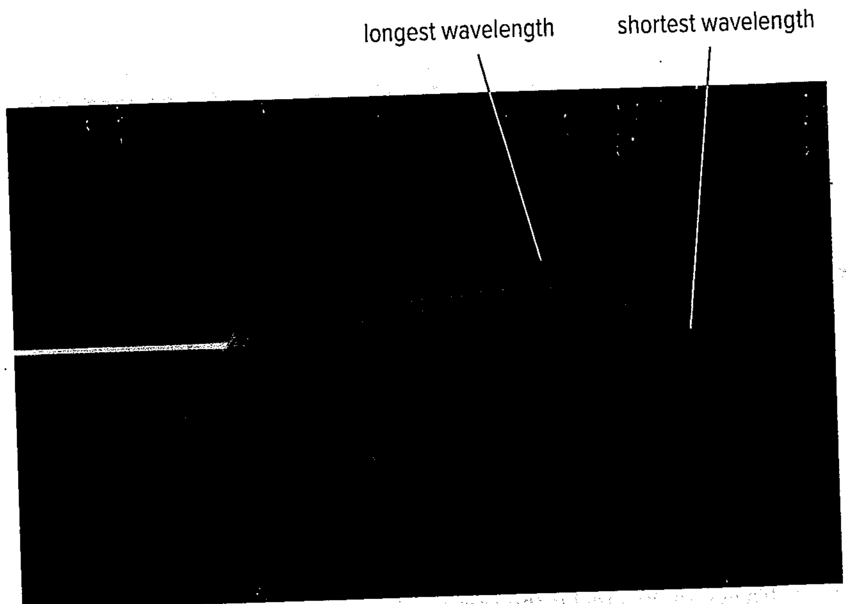


Figure 3.14 Newton separated visible light into colours. At the time, he did not know that the colours are actually different wavelengths of light. **The colours of the spectrum fall in a certain order. You can remember the colours and their order using the mnemonic ROY G BIV. Use this figure to determine what each letter in the mnemonic stands for.**

Before you leave this page . . .

1. Describe one way that a light wave is like a water wave. Describe one way that it is different.
2. One wave has a higher frequency than another wave. Which wave would have the longer wavelength? Explain your reasoning.