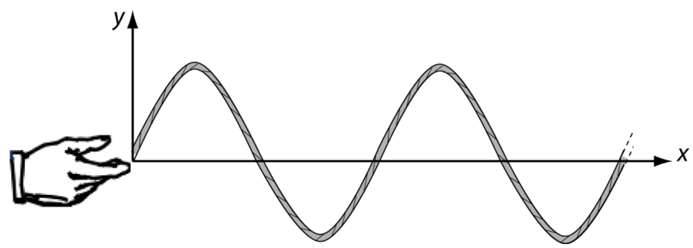
Introduction

In this activity, you will learn about different types of waves. As you work though the activity, think about how the word "wave" can be applied to these different phenomena.

Waves on a String

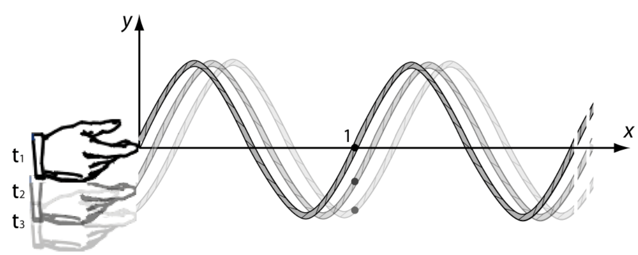
A. The representation below shows a wave on a string at one instant in time.

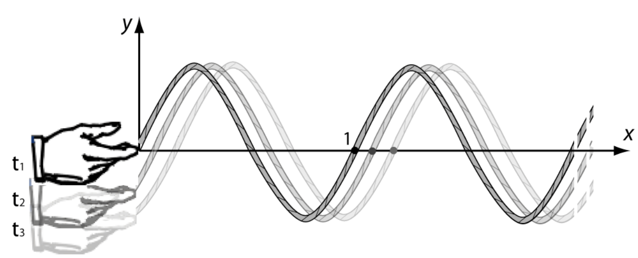
What do the peaks and troughs of the wave tell you about the positions of the string segments?



B. A hand wiggles the left end of a string up and down. The figure below shows snapshots of the wave on the string at *three* instants in time (t_1, t_2, t_3) as the wave travels in the $+x$-direction. There is a dot painted on the string at point 1.

The pictures to the right show two possible ways the dot might move as the wave travels on the string. Which picture shows the correct motion of the dot? If you think the dot does not move, state that explicitly. Explain.

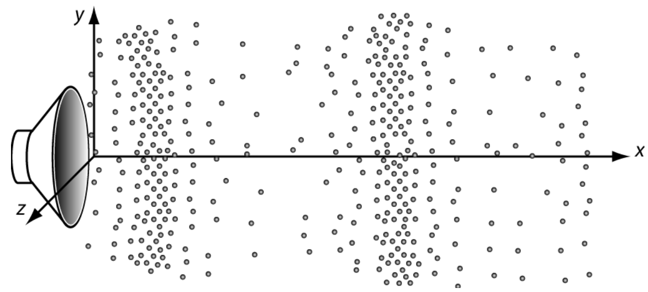




Sound Waves

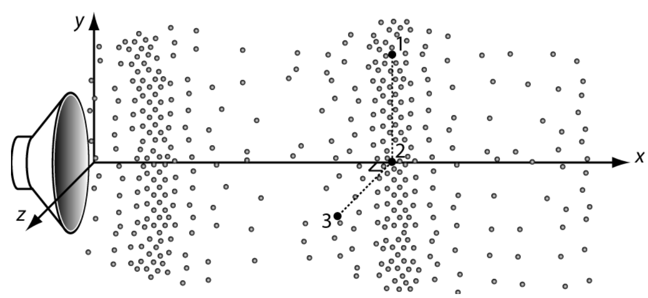
A. The representation below shows the arrangement of air particles at one instant in time.

A sound wave is made up of moving air particles. What does this representation of the wave tell you about the density of the air particles?



B. The figure below shows a sound wave at one instant in time. Three points in space are labeled 1,2, and 3. Points 1 and 2 lie in the x-y plane; point 3 lies in the x-z plane (coming out of the page in the z-direction). All three points have the same x-coordinate, and are separated by a small distance.

Compare the sound *pressure* at each of the three points at this instant in time. (The *pressure* is proportional to the *density* of air particles.)

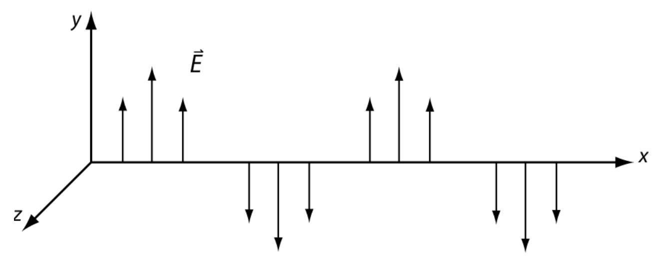


Electromagnetic Waves

I. Representations of electromagnetic waves

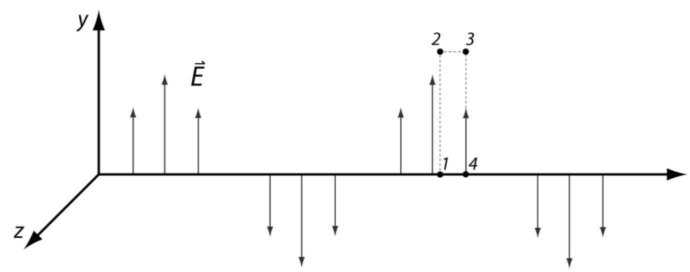
A. The figure below uses *vectors* to represent the electromagnetic wave at one instant in time.

1. What does this representation of the wave tell you about the strength of the electric field?



B. The figure below shows an electromagnetic wave at one instant in time. The wave is *traveling* to the right. Four points in space (labeled 1,2, 3 and 4) lie in the *x-y* plane.

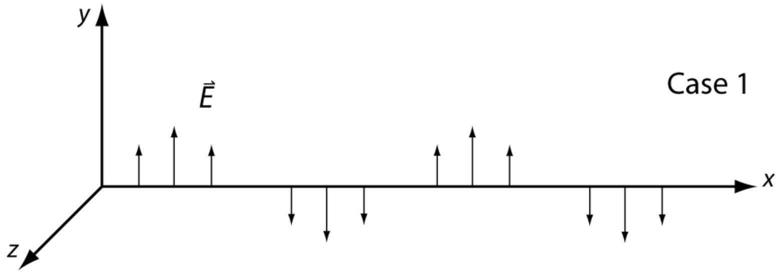
1. For the instant shown, rank these points according to the magnitude of the *electric field* at each of the four points. (*Hint: if this was a* sound wave*, what would the pressure be at the four points?*)



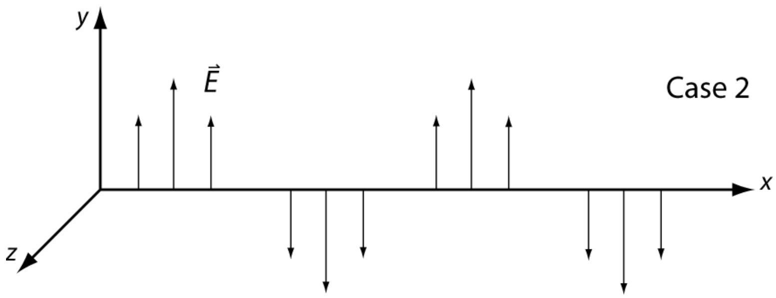
2. How, if at all, will the magnitude of the electric field change at points 1-4 as the wave travels to the right? (*Hint: what happens as a wave travels on a* string*?*)

C. Three electromagnetic waves are represented at right. The diagrams are drawn to the same scale.

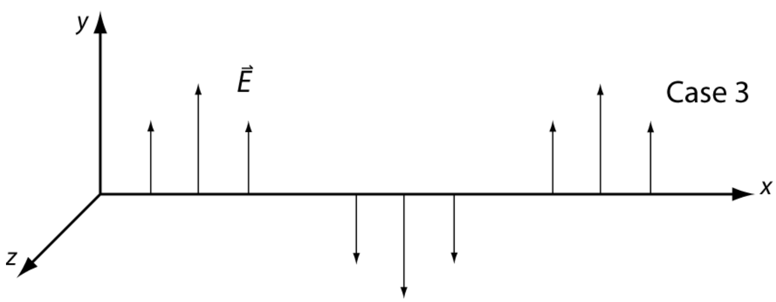
1. Is the *amplitude* of the wave greater in Case 1 or Case 2? Explain how you can tell.



2. Is the *wavelength* of the wave greater in Case 2 or Case 3? Explain how you can tell.

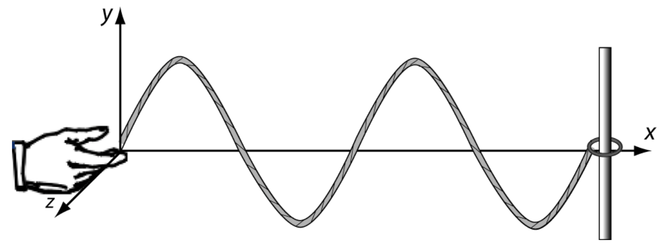


3. Is the *frequency* of the wave greater in Case 2 or Case 3? Explain how you can tell.



II. Detecting electromagnetic waves

A. The figure on the right shows a string with one end attached to a ring. The ring is free to move along the length of the metal rod.

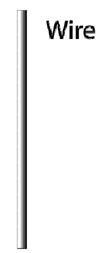


1. Will wiggling the left end of the string up and down cause the ring to move up and down on the rod?

2. Suppose you turned the rod so that it was parallel to the *z*-axis (coming out of the page). If you wiggle the string up and down (along the *y*-axis), will this cause the ring move along the length of the rod?

B. Write an expression for the force exerted on a charge, *q*, by an electric field, ***E***.

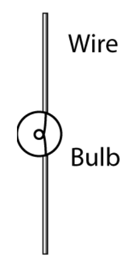
C. Imagine that the electromagnetic wave in section I, part B, is a radio wave. A long, thin conducting wire (see figure at right) is placed in the path of the wave.



Suppose that the wire is oriented parallel to the *y*-axis.

1. As the wave propagates past the wire, would the *electric field* due to the radio wave cause the electrons in the wire to move? If so, would the electrons move in a direction along the length of the wire? Explain.

2. Imagine that the thin conducting wire is cut in half and that each half is connected to a different terminal of a light bulb. (See diagram at right.)



If the wire were placed in the path of the radio wave and oriented parallel to the *y*-axis, would the bulb ever glow? Explain. (*Hint:* Under what conditions can a bulb glow even if it is not part of a closed circuit?)

How, if at all, would your answers to 1 and 2 change if the wire were oriented:

- parallel to the *x*-axis? Explain.

- parallel to the *z*-axis? Explain.