# Sorting out the speeds

The person holding the right end of this flexible rope creates a wave pulse by flicking her hand up, then down, then back up to the hand’s original position. This figure shows a snapshot of the rope a tenth of a second after the person first started flicking her hand. Three small black dots on the rope are labeled for later reference.

C

B

A

## As the pulse travels to the left, does it speed up, slow down, or stay at the same speed? Explain why.

## Approximately how much time after the person starts flicking her hand will she feel that pulse reach her hand from the other end of the rope? Explain your reasoning.

## Draw arrows showing the direction of the velocity (if any) of points A, B, and C. Explain your reasoning.

## What is the direction of the acceleration of point A, if any? Explain.

# What affects the speed?

One end of a long, thin, flexible rope is tied to a doorknob. A student holds the other end, pulling it tight. The student creates a wave pulse by moving her hand up and down. The pulse takes 1.0 second to travel from her hand to the doorknob. For each of the following modifications to how the student creates a new wave pulse, say whether the pulse take more than 1 second, less than 1 second, or almost exactly 1 second to reach the doorknob. When you explain your answer in each case, please be sure to discuss the physical mechanism (rather than, for example, just a formula).

## The student moves her hand up and down much faster than before (but her hand covers the same distance).

## The student moves her hand twice as high as before, but at the same speed as she did originally.

## The student stretches the rope tighter. (This lengthens the rope a negligible amount.)

## The student soaks the rope in alcohol. (This doesn’t affects its tension significantly.)

# Audio dust

A tiny piece of dust is floating in the air a meter in front of an audio speaker. Suddenly, as part of a test of its electronics, the speaker is turned on and starts emitting a single note. The speaker is left on for a long time.

## Ten minutes later, is the dust particle greater than, less than, or approximately equal to a meter away from the speaker? Explain.

## Let *x* denote the dust particle’s distance from the speaker. Sketch a rough, non-numerical graph of *x* vs. time.

## Back in part A, suppose the speaker was been playing a radio station instead of a single note. Does that affect the answer to part A? Explain.

## Does playing a radio station rather than a single note affect the answer to part B? Explain.

# Changing the speed of sound

Ophelia the opera singer stands at one end of a soccer field, and you stand at the other end. When Ophelia sings a high C, the sound takes time *t*0 to travel from her mouth to your ears. For each of the following modifications to this scenario, say whether the sound’s travel time is greater than, less than, or equal to *t*0.

## The soccer field is now at high altitude where air pressure is lower.

## At the original altitude, Ophelia sings the note one octave below high C.

## Ophelia sings the high C louder than before.

## Ophelia exhales really fast while singing, “blowing” the sound toward you.

# Messages about medium

Physicists love to say *the speed of waves depends on the medium, not on the source*. In terms a 12-year-old could understand,

## “Translate” the italicized rule into plain English.

## Explain why that rule is true.