Least Time Principle Activity Sheet

Purpose:

The purpose is to study the relationship between the angles which a light ray makes with the normal as it crosses the boundary between two media and the speed of light in the two media.

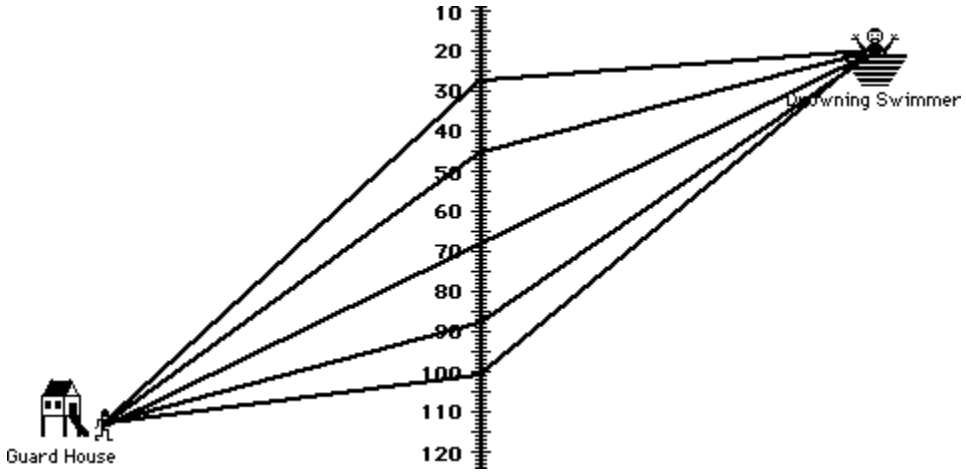
Use: https://www.physicsclassroom.com/shwave/leasttime.html

Overview:

It has already been learned that a light wave will refract (i.e., bend) as it passes from one medium into another medium. The tendency of a light wave to do this is often explained by the Least Time Principle. This principle states that

Of all the possible paths that light might take to get from one point to another, it always takes the path that requires the least amount of time.

In this activity, you will examine this principle by way of an analogy. The analogy involves a life guard who has become aware of a drowning swimmer in the water. The guard must reach the swimmer in as little time as possible. Since the guard can run faster on sand than she can swim in water, it would make sense that the guard cover more distance in the sand than she does in the water. In other words, she will not run directly at the drowning swimmer. Your task involves determining the optimal entry point into the water in order to reach the drowning swimmer in the least amount of time.



Procedure:

1. Open the web page titled Least Time Principle. Click the on-screen buttons to read the directions and eventually begin the activity.

2. The computer randomly selects a speed for the guard running across sand and for the guard swimming through water. Record these speeds in the data tables.

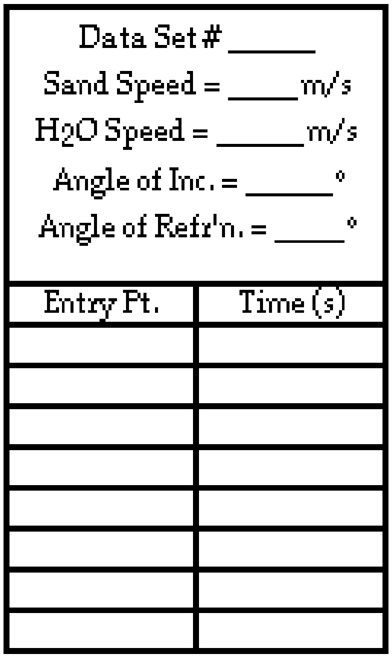
3. Follow on-screen directions to determine the optimal entry point of the guard in order to rescue the drowning swimmer in the least amount of time. Use a trial-and-error method to find the entry point. Document your efforts by recording all the guessed entry points and their corresponding times.

4. When you have successfully found the optimal entry point, the computer will construct some angles and ask you to conduct an analysis. Record the angle of approach or incidence and the angle of departure or refraction of the life guard (measured relative to a normal drawn to the sand/water interface).

5. Repeat the procedure above for at least one other data set. Use the New Data Set button at the bottom of the animation to find a new data set.

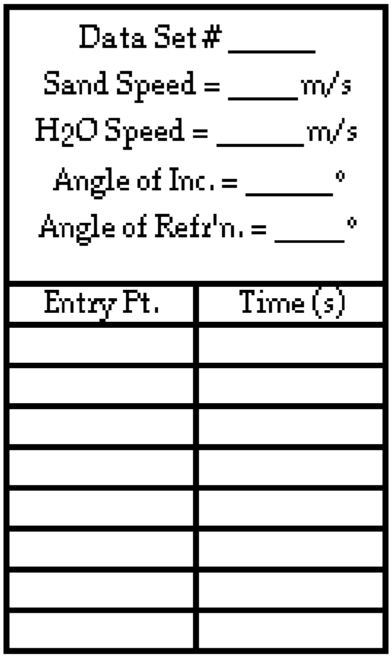
6. Answer the Analysis questions below and draw appropriate conclusions.

Data:



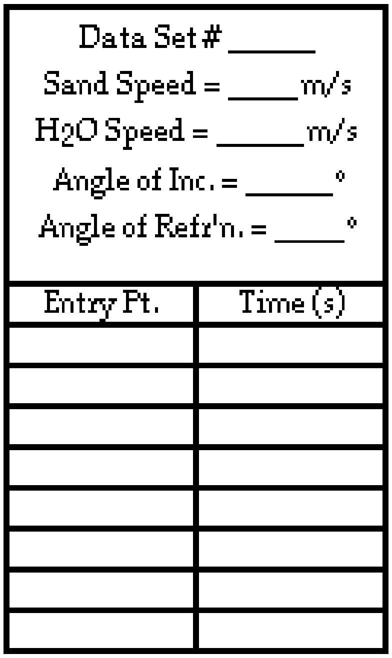
Data Set # ______
Sand Speed = _____m/s
H_2O Speed = ______m/s
Angle of Inc. = ______°
Angle of Refr'n. = _____°

Entry Pt.	Time (s)



Data Set # ______
Sand Speed = _____m/s
H_2O Speed = ______m/s
Angle of Inc. = ______°
Angle of Refr'n. = _____°

Entry Pt.	Time (s)



Data Set # ______
Sand Speed = _____m/s
H_2O Speed = ______m/s
Angle of Inc. = ______°
Angle of Refr'n. = _____°

Entry Pt.	Time (s)

Analysis:

1. In which medium is the angle between the path taken and the normal the smallest - the medium with the greatest speed or the smallest speed? ______________

2. As the guard crossed from sand (where she was moving fast) into water (where she moved slow), did she turn towards or away from the normal? ______________

3. Calculate the ratio of the sines of the angles and the ratio of the speeds of the guard.

	Data Set #_____	**Data Set #_____**	**Data Set #_____**
v_{sand} / v_{water}			
sine θ_{sand} / sine θ_{water}			

Conclusions:

1. Using an equation, state the mathematical relationship between the angles of incidence and refraction and the speeds of a light wave in the two media on both sides of the boundary.