

Challenge Worksheet



Geophysics of Earthquakes

Lab 2: Seismic Waves and Travel-Time Curves

- Your Mission:** (1) Simulate velocities of different materials and how earthquake waves travel through the Earth at different speeds.
(2) Construct and utilize a graph to characterize the relationship between distance and time of travel of seismic waves (a Travel-Time curve).

Your Supplies:

- (1) A team of 4
- (2) Pencils: regular, red, and green
- (3) Ruler
- (4) Calculator
- (5) Stopwatches (three per group)

Your Task:

- (1) Choose a team of 4 and decide who will be the “*seismic wave*” person (1) and who will be the “*different layers of the Earth*” people (3). The *seismic wave* person will have the job of walking and running along a 30-meter distance. The *layers* people will stand at 10-meter, 20-meter, and 30-meter distances and use a stopwatch to time the *seismic wave* person.
- (2) On a field outside, your teacher will measure a 30-meter distance and mark 10-meter, 20-meter, and 30-meter distances. Have your 3 *layers* team members stand at the 10, 20, and 30-meter distances with stopwatches in hand.

-- Experiment #1 --

- (3) The *seismic wave* member of your group will be the designated “walker” or “runner” (or the designated S-wave and P-wave). This person will perform two time-trials. For the first, he/she will **walk** (representing the S-wave) the entire 30-meter length and the timers will time how long it takes the walker to pass. Coordinate with your team (and stopwatches) and perform this time trial.
- (4) Record your time measurements in the box on the following page titled “**Walk Times (S-wave)**”. Share your recordings with the rest of your team members.

- (5) Repeat this experiment 2 more times and record your times.
- (6) Next, perform the same experiment, but this time the *seismic wave* member will **run** (representing the P-wave). Record these times in the table below in the boxes titled “**Run Times (P-wave)**”. Repeat the experiment 2 more times and record your times.

Distance	Walk Times (S-wave)				Run Times (P-wave)			
Trial 1	0 s				0 s			
Trial 2	0 s				0 s			
Trial 3	0 s				0 s			
Average	0 s				0 s			
	0-m	10-m	20-m	30-m	0-m	10-m	20-m	30-m

- (7) Once all of the run/walk data has been collected, average the times for both walking and running trials at each distance and write this information in the table above.
- (8) Now plot the **average** times of your data at each distance (10, 20, 30-m) on **Graph Sheet 1** provided. This is called a Travel-Time curve.
- Use a **red** pencil to represent your S-wave (walking) data.
 - Use a **green** pencil to represent your P-wave (running) data.
- (9) Draw a straight line to connect your data points that approximately fits the data for your running (P-wave) and walking (S-wave) curves.

-- Experiment #2 --

- (10) Next you will repeat the entire experiment, but this time you will do this by simulating an Earth of different layers of materials (like the crust, mantle, core). The different materials of the Earth cause seismic waves to travel at different speeds as they pass through the Earth.

When you are ready to begin this phase of the Lab, let your teacher know and they will provide you with a set of plastic cups that you will place along the path that your *seismic wave* person will travel. You will set these cups up as an obstacle course with the most cups lined up between the 0-10 meter distance (layer 1), fewer between the 10-20 meter distance (layer 2), and no cups between the 20-30 meter distance (layer 3).

- (11) Repeat the experiment (both walking and running) and measure the times of your *seismic wave* person as you did in the previous experiment and fill in the table below.
- (12) As before, average the times for both walking and running trials and write this in the table below.

Distance	Walk Times (S-wave)				Run Times (P-wave)			
Trial 1	0 s				0 s			
Trial 2	0 s				0 s			
Trial 3	0 s				0 s			
Average	0 s				0 s			
	0-m	10-m	20-m	30-m	0-m	10-m	20-m	30-m

- (13) Now plot the **average** times of your data at each distance (10, 20, 30-m) on **Graph Sheet 2** provided. This will be your Travel-Time curve for a Layered Earth.

- (14) Draw a straight line to connect your data points.

Challenge Questions:

- (1) Why did we average the three measurements at each distance?

- (2) If you pick any point on your Travel-Time curve that you have constructed for the Walking time or Running time, what does that point represent?

- (3) What is the speed of the *Walking* student (representing S-wave speed) in m/s for Experiment #1? How does this speed vary in Experiment #2?

- (4) What is the speed of the *Running* student (representing P-wave speed) in m/s for Experiment #1? How does this speed vary in Experiment #2?

- (5) Compare these speeds to the actual speeds of P and S waves. Remember: in the Earth's crust and mantle, P-waves travel about 6000-14,000 m/s (6-14 km/s) and S-waves about 2000-8000 m/s (2-8 km/s).

- (6) The Travel-Time curves of the Walk and Run trials for Experiment #1 are approximately straight lines. How does the Travel-Time curve for Experiment #2 differ? Why is this so?

- (7) For seismic waves that travel through the Earth, the Travel-Time curves for P- and S- waves are curved (see example below). Why do you think this is?

Seismic Travel-time Curve

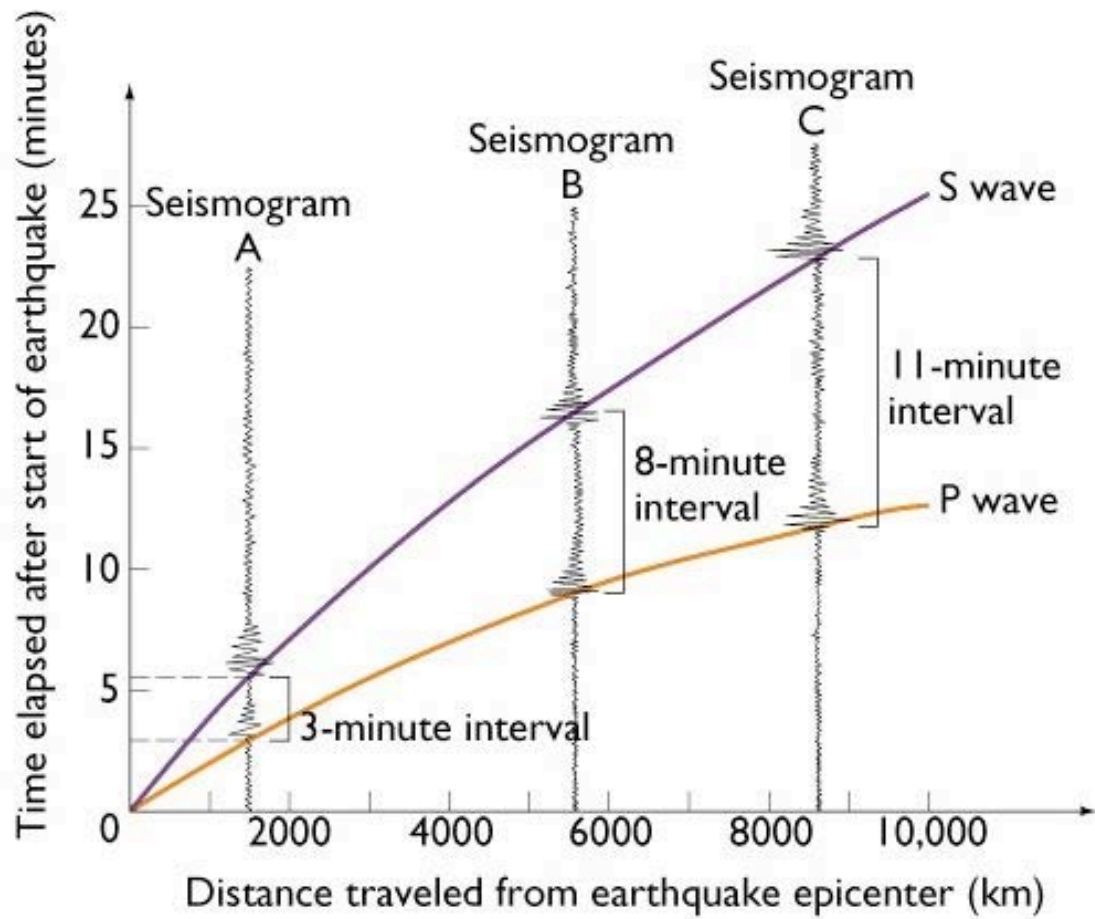


Fig.