Wave Watching

Lesson Concept Energy is transmitted through the earth in the form of seismic waves, which are classified as body waves and surface waves. Body waves (primary P and secondary S) have different movements.

Link: The first five lessons focused on describing the movement along plate boundaries. Lesson 6.6 describes energy transmitted during earthquakes in the form of different types of waves. Waves are categorized by the how the wave moves. Lesson 6.7 demonstrates how the waves travel differently through different earth materials.

Time 100 minutes (two class periods)

Materials:

Per Groups of Four

1 Spring toy (Slinky)

Individual Students

H1 Venn Diagram

Notebooks

Charts

C1 T Charts sample

Advance Preparation:

1. Copy H1 for students.
2. Prepare chart (C1) to use through out lesson.
3. Preview *http://web.ics.purdue.edu/~braile/*

Procedure

Engage: ***(15 minutes) Seismic waves (P and S) move differently through liquids and solids.***

1. Display a globe and remind students that the Earth's surface has both water and rock. Earthquakes energy moves as a wave through both rock and water.
2. Hold up a glass of water and a rock. Ask students how waves might act differently in a liquid or in a solid? Chart ideas to refer to later.
3. Explain that we are going to make a model of a wave with some of the students in the class. Ask 10 people to stand in front of the class, side by side, with their feet a shoulder width apart.
4. Ask the rest of the class to think about how this line of students could become a model for a wave? What might start the wave moving? How does the wave move?

Punchline: Students are likely to say something about being pushed or moved along. Stress that if they are modeling a wave, they will move with the force next to them but not fall over. Once moved they will return to the upright position somewhat like elastic.

5. Post **C1 (T-Chart)** and explain that the information from our model of waves will help us figure out how waves move in a liquid or solid.
6. Explain to students that we will first represent wave motions in a solid. Ask each person to put their arms over the shoulders of the person next to them ("chorus line style" providing a model where each student is a "molecule or "particles" of the solid- tightly bonded).
7. Ask the students observing and draw the wave movement in their notebooks. Push on the person at the end of the line and the deformation (leaning to the side and then straightening up) will propagate down the line of people approximating a P wave.
8. Debrief by asking observers if any of the students moved from their original position? How long did the movement take along the line? Which direction did the movement go as the wave passed? Did the students (molecules/ particles) ever move closer together? Did the people ever move farther apart?
9. Record how the model using students moved on the class T chart **C1 (T Charts)** under P wave. Explain this is how movement occurs in a solid like the rock.
10. Ask students to draw the movement of molecules (students) moving closure together and further apart in notebooks. Label the closer together area (compression) and label the further apart movement (dilation).

Teacher Note: If time. ask the ten more students to produce the wave and allow the original ten to draw in their notebooks with the help of partner students still sitting. Observe that the propagation down the line took some time (there is a velocity for the wave propagation) and that although each person was briefly subjected to a deformation or disturbance, the individuals did not move from their original locations. Also, the motion of each person as the wave passed was in the direction of propagation and that, as the wave passed, the people moved closer together temporarily (compression), and then apart (dilation) to return to their original position.

11. Explain to students that the next wave is a different movement in the same solid. Be ready to describe the difference in how the molecules propagate the wave..
12. Ask the first person at the end of the line to bend forward at the waist and then stand up straight.
13. Continue the movement down the line. Watch the wave propagate along the line of students.
14. Ask observers to compare this wave to the last wave? How is it the same? How is it different? How would you describe the movement? This is called an S wave. Chart description on the T chart.

15. Ask one of the observers to watch the human wave model of the P wave and the S wave propagation and time each. What is the difference in time? What makes that difference?

Punchline: The difference is due to the direction of the movement in the P or S wave.

16. Hold up the glass of water and explain we will model the movement in a liquid. Predict how the wave might move in water?
17. Ask students to stand shoulder to shoulder without their arms around each other. Push on the shoulder of the end person and a P wave will propagate down the line. How is the movement the same or different from the P wave in a solid? Add to the T chart observations of P wave in a liquid.

Teacher Note: The P wave in a liquid moves in a manner that moves the wave through the liquid. Contrast this with the next step after the students see the model.

18. Explain to students that the next model is a S wave in a liquid. Watch for the difference. Ask the person at the end of the line to lean forward at the waits (a transverse or shear disturbance). Ask the student at the end of the line to bend forward at the waist – a transverse or shear disturbance. What happens to the rest of the line of students (molecules)?
19. Chart observations on the T chart. Ask students to summarize differences between P and S waves in a solid and liquid. Chart summary statements at the bottom of the T chart.
20. Ask students if their earlier prediction (step 2) above waves in a solid or waves in a liquid were accurate. Cross off any inaccurate ideas and add new ideas.

Teacher Note: The "molecules" of the liquid are more loosely bound; the shearing motion will not propagate through the liquid (along the line of people). The disturbance does not propagate to the next person because the liquid does not support the shearing motion. Only the first person in the line – the one that is bent over at the waist – should move because the people are not connected. If the next person bends, "sympathetically", not because of the wave propagating, ask that person if he or she felt, rather than just saw, the wave disturbance, then repeat the demonstration for S waves in a liquid.

Explore/Explain I (25 minutes) P and S waves can be modeled using a "slinky"

21. Explain to students that the P and S waves can be modeled using a spring or slinky. Refer to the T chart(s) and explain we should see samples of similar movement as our human model.
22. Ask students to stretch a spring toy across the tables while a partner securely holds the other end. Gather together four coils of the spring toy in one hand and release them. Repeat this step switching with another person in your group describe the movement. Which wave does this resemble? How do you know? Add a picture of the moving coil in your notebook and on the class T chart.

23. Ask students to stretch the spring toy across the table again while the partner securely holds the other end. Ask one partner to jerk or snap one end of the spring from side to side once. Observe the coil's motion. Repeat this step and switch with your partner. Discuss with a partner: Which wave does this resemble on a T chart. How do you know? How would you describe the wave? How would you draw the wave?
24. Review the information on the class T –chart. Talk to your partner about the differences between P and S waves and how you know?
25. What type of wave traveled faster? How can you explain the difference? Please record your answers in your Science Notebook.

Explore/Explain II (30 minutes) P waves are body waves, which move by compression and dilation of rock. S waves shear the rock sideways at right angles.

26. Explain to students that we cannot see inside the earth but we can view an animation of the movement of body waves. Observe the animation and watch for the movement of a P wave in solids/liquids and an S wave in solids and liquids.
27. View Animation 4 Wave Type PPT from Purdue/Braille website***http://web.ics.purdue.edu/~braile.***
28. Discuss with a partner what you could add to the difference between P and S waves on the class T chart. Add suggestions.

Extend (10 minutes) P waves move fast from a seismic event through rock. S waves move more slowly than P waves and consist of elastic vibrations transverse to the direction of travel.

29. Repeat the "spring " activity at least three times for each movement. (Compression and Side to Side). Ask three members of the group of four to time the movement using a stopwatch. Average the three trials. Which movement was faster? Average the entire classes data to find if it is the same or different from your group.
30. Add class data to the class T charts.

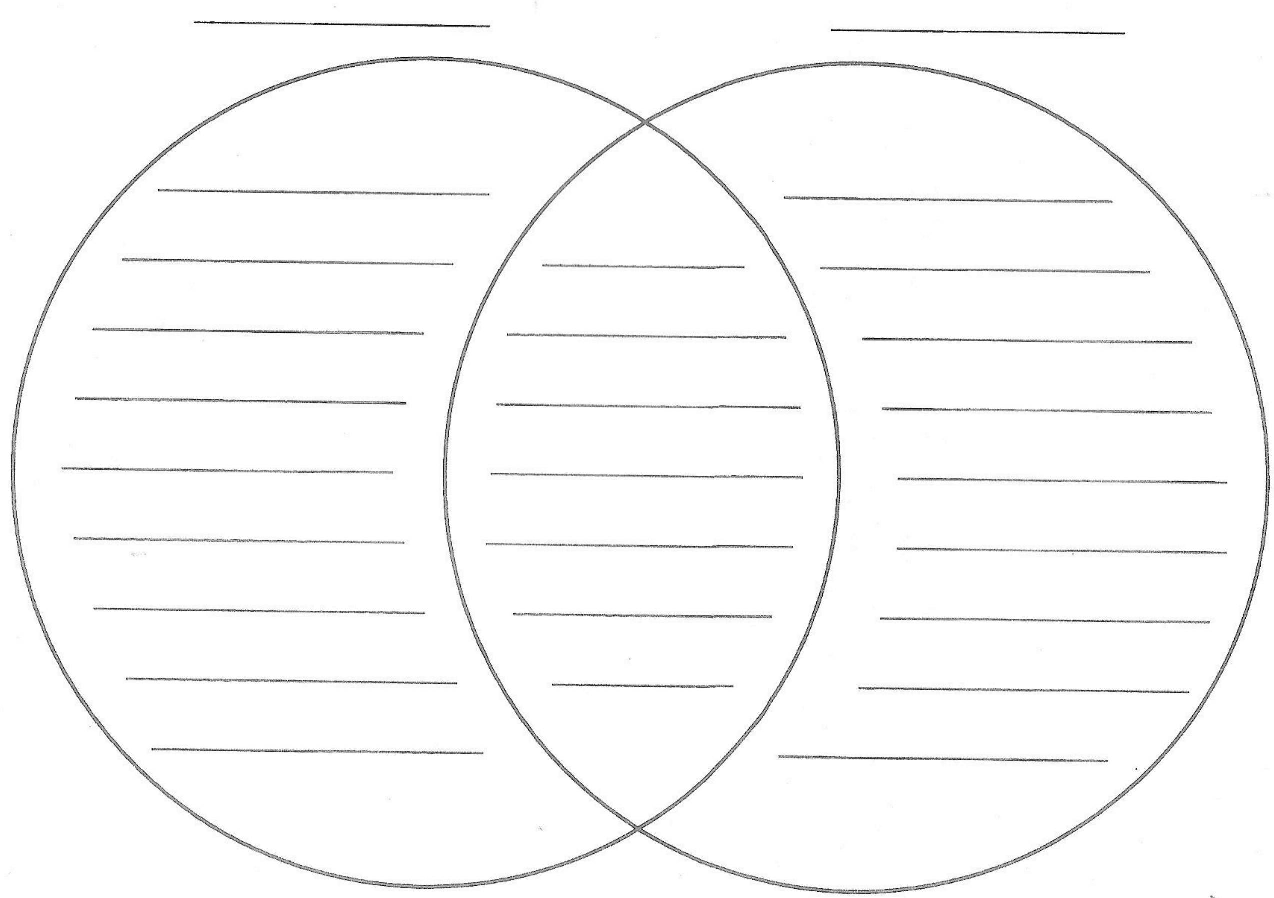
Evaluate (10 minutes) P and S waves can be compared.

31. Distribute **H1 (Venn diagram)** and ask students to individually complete the chart comparing and contrasting P and S waves in solids and liquids. Ask students to explain how they know on the back of the Venn Diagram.

Name: ______________________________

Venn Diagram

Directions: Write on the top two lines the concepts you are comparing and contrasting. List the ways in which they are similar in the center section of the Venn Diagram. Write the ways they are unique in the outer sections of the circles.



Sample T Chart

Solids		(Remove this line	Liquids	
P Wave	S wave		P Wave	S Wave
		Remove this line)		

Summary Statements about P waves:

Summary Statements about S wave