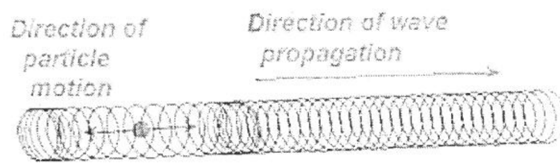
Name ____ Date _______________ Period ________

Slinky Lab- Simulating the Motion of Earthquake Waves.

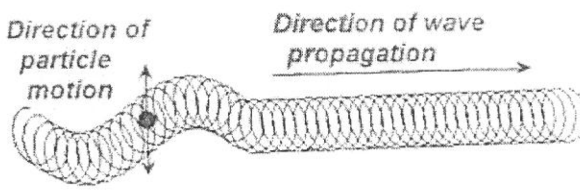
COORDINATED SCIENCE 1

Background: You will utilize a slinky to model **earthquake** waves, learn the speed, direction and behavior of different waves which tell scientists about earthquakes. Earthquakes and volcanoes are evidence for plate tectonics. Earthquakes are caused when energy is released as the lithosphere (crust and upper mantle) of the Earth moves. Energy is emitted in the form of waves. There are different types of waves, some move faster, slower, sideways, or up and down. A seismograph records these waves on a seismogram. When an earthquake is recorded it is called an earthquake "event."

There are two types of waves we will investigate, **P-waves** and **S-waves**. **P-waves** or **primary waves**, are the first waves that the seismograph records. The P-wave is the "fast" wave and can be called a push-pull wave, because it moves by contracting and ex-panding along a horizontal path.



The second major type of seismic wave is called an **S-wave**. **S-waves** are **shear waves** and move from side-to-side. S-waves are slower than P-waves. The particle motion in shear waves is perpendicular to the direction of the wave.



Proceedure:

PART 1: P-WAVES (PUSH & PULL):

1. Form groups of **3 to 4 students** each

2. Each group need to get **one slinky** (do not overstretch them!)

3. Begin by stretching the Slinky **3 meters** between your partner and yourself. One person will hold each end.

4. The other person will be **timing** the waves on the Slinky (**two** complete trip, **back and forth**). Practice first by pulling the Slinky toward you a bit and then pushing it away. Notice that a wave travels along the Slinky from you to your partner (this would make a total distance of 12 m)

5. You will do **3 trials** of the P-wave, timing the wave as it does one complete trip back and forth. Record the information in **Data Table #1** and **sketch** the movement of the Slinky in the space provided on the next page

6. Calculate the **average** (find the mean) of the 3 trial times and enter into Data Table #1. Now use this **time** and **distance** to calculate the **average speed**

$$v = \frac{d}{t}$$

PART 2: S-WAVES (SIDE TO SIDE):

1. Shake one end of the Slinky from side to side. Notice that a different type of wave travels along the Slinky. This time the sections of the Slinky move from side to side (**horizontally**), but the movement of the Slinky is at right angles to the direction of the progressing wave

2. You will do **3 trials** of the **S-wave**, timing the waves as it dos **two** complete trip back and forth. Record the information in **Data Table #2** and **sketch** the movement of the Slinky in the space provided below

3. Take the **average** (find the mean) of the 3 trial times and record it in **Data Table #2**

4. When you have completed the trials, return the slinky and answer the **Conclusion Questions**

TABLE #1: SPEED OF P-WAVES	
TRIAL	TIME (seconds)
1	
2	
3.	
AVERAGE =	
AVERAGE SPEED=	12 m/________s =____________m/s

TABLE #2: SPEED OF S-WAVES	
TRIAL	TIME (seconds)
1	
2	
3	
AVERAGE =	
AVERAGE SPEED=	12 m/________s =__________m/s

Drawing of P-wave

Drawing of S-wave

Background: When an earthquake begins the **stress** on large blocks of rock becomes greater than the strength of the rock. The rock breaks, releasing large amounts of **energy**. This energy is carried outward in all directions by various seismic waves, some of which can reach the opposite side of the earth in about twenty minutes. The further the waves travel from the focus of the earthquake, the weaker they become.

P-waves push and pull the underground rocks, causing structures on the **surface** to move back and forth. **SH-waves** move the rocks beneath the earth's surface from side to side, giving buildings on the **surface** a good shaking, often with very damaging effects. With **SV-waves**, the shaking is in a vertical direction-which sometimes can be enough to launch you out of your seat. **S-waves and P-waves** cause **high-frequency vibrations** that tend to cause low buildings to vibrate more than tall structures.

A different class of seismic waves are **surface waves**. They are long, slow waves. The **low-frequency vibrations** that they induce in buildings have more effect on tall buildings than on low ones. Love waves (also named Q-waves) are surface seismic waves that cause horizontal shifting of the earth during an earthquake and shake things from side-to-side. (A.E.H. Love predicted the existence of Love waves mathematically in 1911). The slowest seismic waves, Rayleigh waves, (predicted in 1885 by Lord Rayleigh), are rolling waves that make you feel as if you're struggling to keep your balance on a ship in the open ocean.

Conclusion Questions:

1. Which type of waves traveled the **fastest** in your experiment?

2. Does this agree with the known facts about **P-waves** and **S-waves** that cause earthquakes? (*Read Background information above*)

3. Which types of earthquake wave travels even slower than P-waves and S-waves?

4. Which type of waves cause the **most damage** during an earthquake? Why?

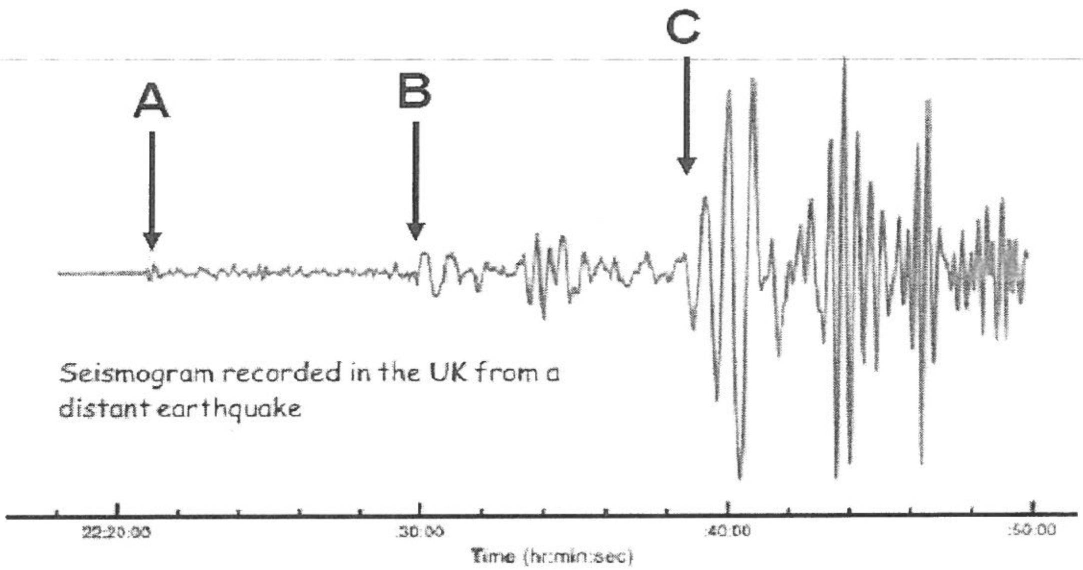
5. Which **frequency** of wave (high or low) effect **tall** buildings the most? **Low** buildings?

6. To measure the **energy** released from an earthquake and the resultant magnitude of the "shaking", scientists developed a tool called a **seismograph**. The picture below (**seismogram**) shows a typical earthquake. The arrows below indicate which types of waves were recorded first (traveled the fastest). **Identify** each type of **wave**.

A.

B.

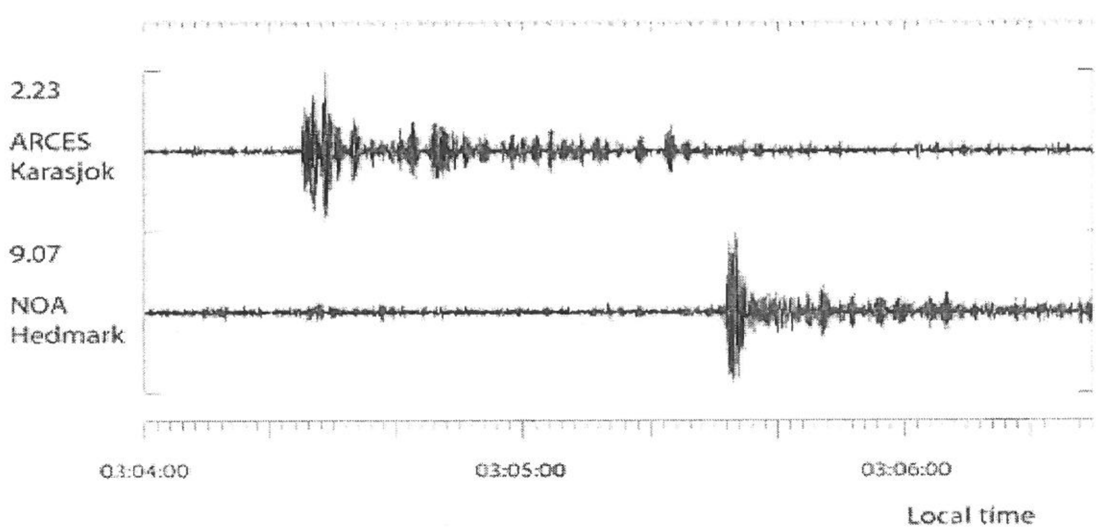
C.



Extension:

7. The **seismogram** below shows the arrival times of the seismic waves at two different cites. Using the information in the graph, and assuming the wave travels at about **5 km/s**, calculate how much **further** Hedmark is from the **epicenter**, than Karasjok.
(HINT: distance = velocity x time)

$$d = vt$$



8. Animals have keen senses that help them avoid predators or locate prey. It is thought that these senses might also help them detect an approaching earthquake before we feel the shaking. Many animals like our pet dogs and cats can hear higher frequency waves than humans can. How might this explain why they can sense and earthquake before we know about it?