Lab #1 **Superposition and Reflection**
Physics 112 **of Pulses** Name: _____

I. Two types of waves: transverse and longitudinal

Send several ***transverse*** pulses along the spring and observe what happens.

[3 pts] Compared to the direction of the wave, which way does one coil of the spring move?

Send several ***longitudinal*** pulses along the spring and observe what happens.

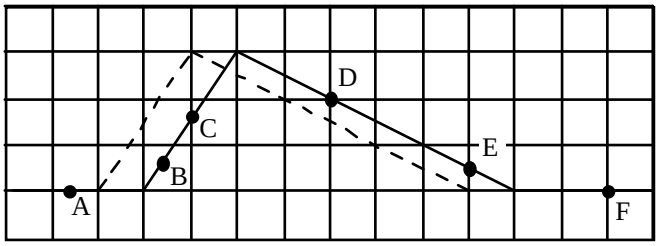
[3 pts] Compared to the direction of the wave, which way does one coil of the spring move?

[3 pts] You are floating on a raft in the ocean. You stay a fixed distance from the shore. What type of waves—transverse or longitudinal—move you up and down?

scale: 1 square = 5.0 cm

The **solid** line at right shows the position of a transverse pulse at an initial time t_i.

The **dashed** line shows the location of the transverse pulse 0.10 s later, after the pulse has moved to the ***left***.



Determine the following:

- [4 pts] the horizontal velocity of the entire **pulse**

- [12 pts] the vertical velocity of ***<u>each</u> piece*** of the spring labeled A, B, C, D, E, F in this 0.10 sec. Include (+) or (-) signs as appropriate (let upward be "+")

  v_A= _____ v_B= _____ v_C= _____

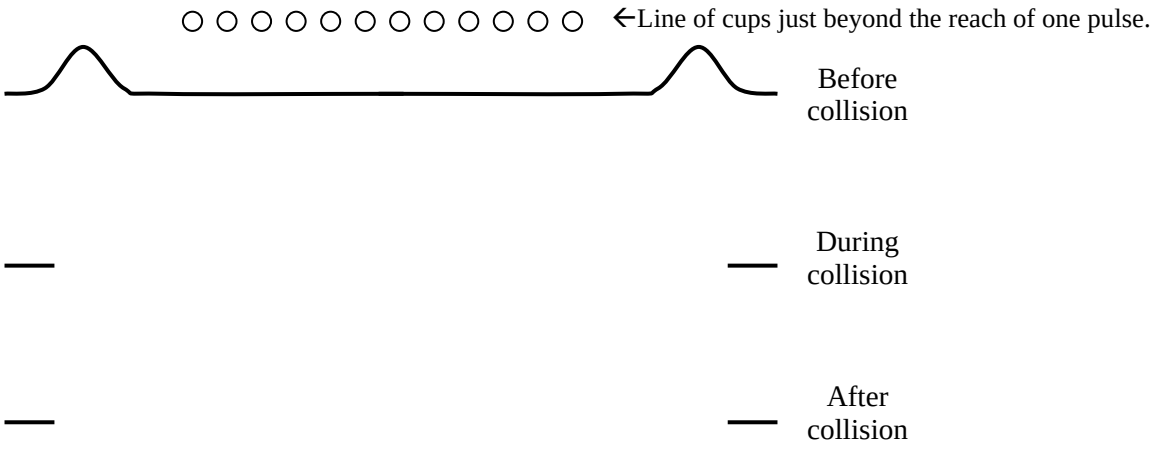
  v_D= _____ v_E= _____ v_F= _____

[6 pts] Draw ***vectors*** on the diagram to represent the instantaneous ***transverse*** velocity of the individual pieces of spring labeled A-F at time t_0.

II. Principle of Superposition

A. Send two pulses towards each other on the spring. Start the pulses are on the same side of the spring as shown below. Ignore what happens once the two pulses reach the ends of the spring.

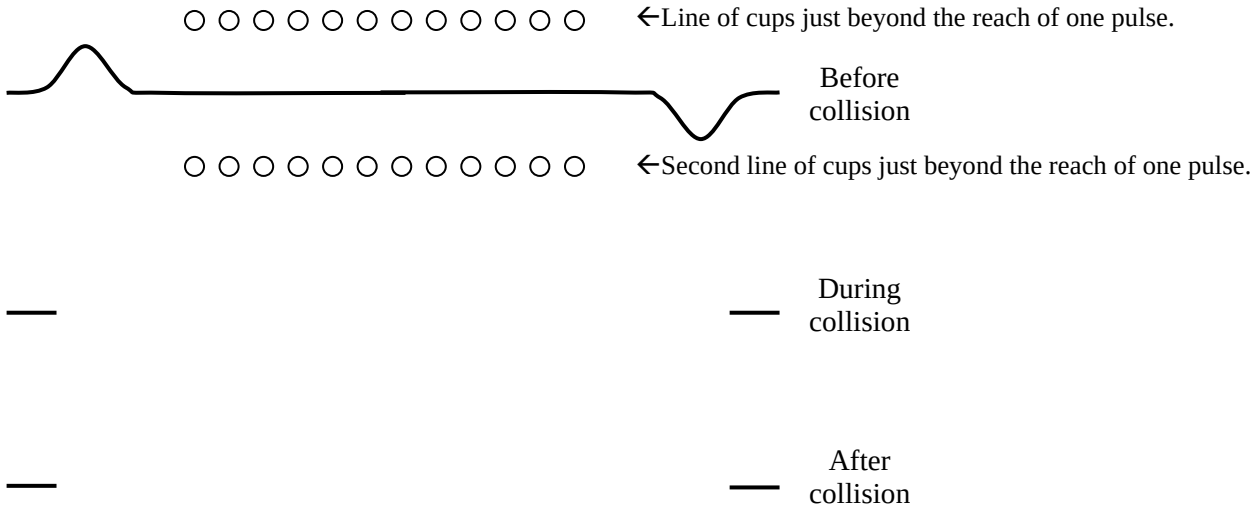
[6 pts] Draw the spring before, during, and after the pulses meet in the middle of the spring.



[3 pts] When the pulses contact each other, do they (circle one letter)
(a) collide and bounce back off of each other, or
(b) pass through each other and continue in their original direction?

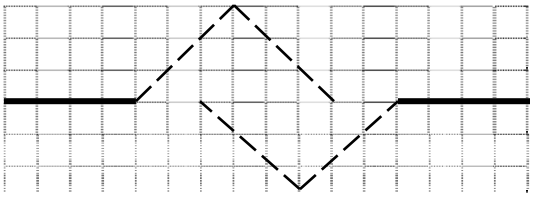
[3 pts] Explain to a staff member how you can ***prove*** this.

B. [6 pts] Send two pulses towards each other from *opposite sides* of the spring. Draw what you observed in the space below.



The principle of superposition allows you to determine the shape of a spring when two (or more) pulses are in the same place at once. To do this, you simply add the displacements of each spring at every point where they collide.

The dashed lines in the diagram at right shows two separate pulses sent towards each other on one spring meeting each other.



[5 pts] Use the principle of superposition to sketch the **resultant** shape of the spring on the diagram at the instant shown.

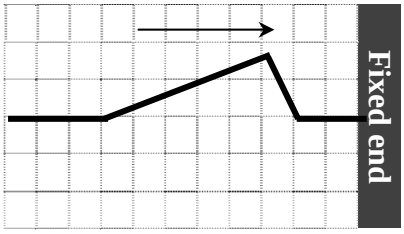
II. Reflection

A. Send a pulse so it is reflected from the ***fixed*** end of a spring.

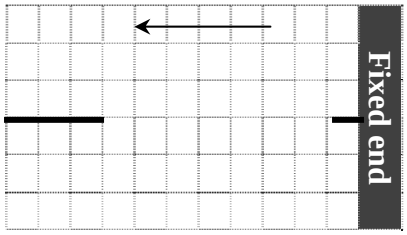
Use cups to measure the amplitude of the pulses.

[5 pts] On the diagram to the right, draw how the pulse looks after reflection.

Incident pulse



Reflected pulse



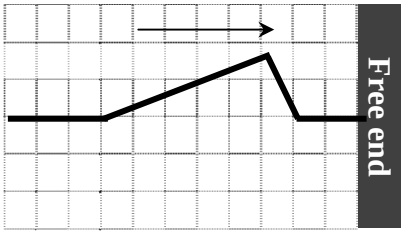
[5 pts] List the things that stay the same, and those that are different upon reflection.

Same Different

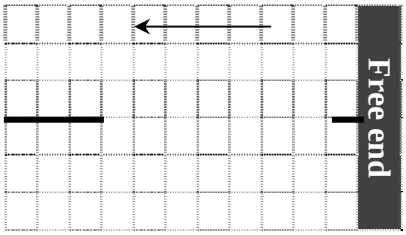
B. Send a pulse so it is reflected from the ***free*** end of a spring. Use cups to measure the amplitude of the pulses.

[5 pts] On the diagram to the right, draw how the pulse looks after reflection.

Incident pulse



Reflected pulse



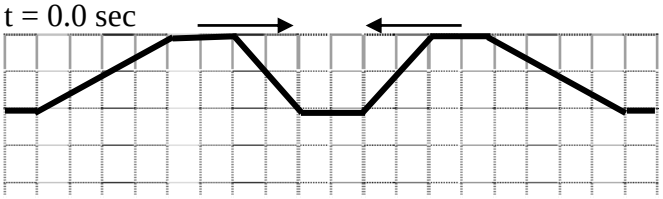
[5 pts] List the things that stay the same, and those that are different upon reflection.

Same Different

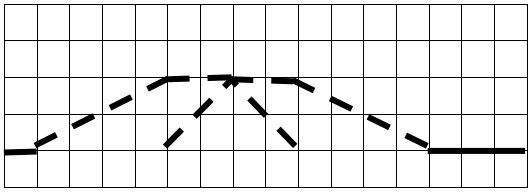
[12pts] Two pulses on the same side of a spring are moving toward each other.

The diagrams below show the pulse locations at four successive instants. On each diagram, sketch the ***resultant*** shape of the spring for the instant shown.

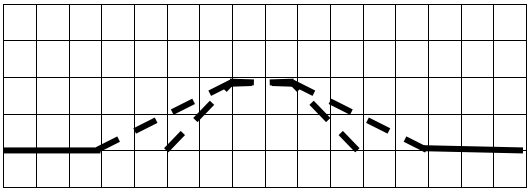
t = 0.0 sec



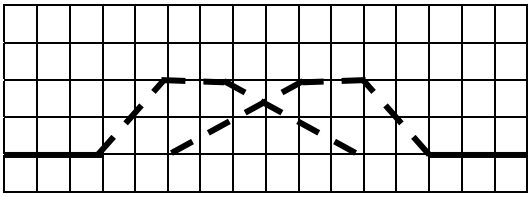
t = 0.1 sec



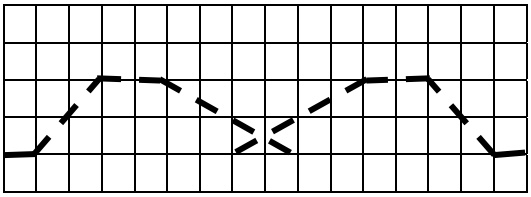
t = 0.2 sec



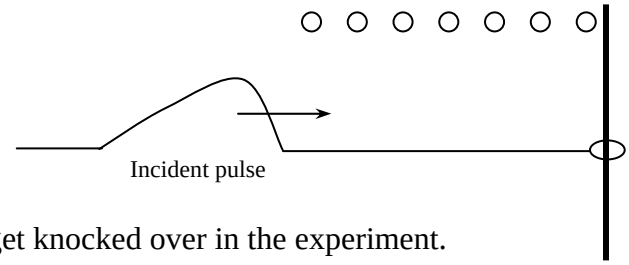
t = 0.3 sec



t = 0.4 sec



In the lab, paper cups were lined up a distance away from the spring that was *just* larger than the amplitude of the incident pulse, as shown in the diagram at right.



[4 pts] Indicate on the diagram which cups did get knocked over in the experiment.

[3 pts] Based on this observation, did the free end of spring have a maximum displacement that was *greater than*, *less than*, or *equal to* the amplitude of the incident pulse?

The vast majority of earthquakes originate (the location of their "focus") well below Earth's surface, typically several kilometers deep. The "epicenter" is the surface location where the earthquakes emerge from below.

[4 pts] Where would you expect the amplitude of the seismic waves to be greater—just below Earth's surface (i.e., several meters down) or right at the surface (at the epicenter) ?