Name: ________________________

Handout 7.1.1.1: Pendulum PhET Activity

Part 1: Making Connections with Pendulums

1. On the 'Lab' tab what can you change and control?

2. Pull the pendulum to a height. Use the Energy Graph to describe how the energy changes through the pendulum's swing. Remember descriptions can and should include words and pictures.

Name: ________________________

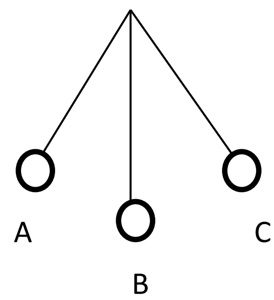
3. Predict and sketch the velocity and acceleration vectors when the pendulum is at its left highest point, in the middle, and at its right highest point.

4. Turn on the velocity and acceleration vectors. Were your predictions correct? Explain why or why not.

5. Describe the forces acting on the pendulum at both high points and in the middle. What forces are acting on the pendulum?

Name: ________________________

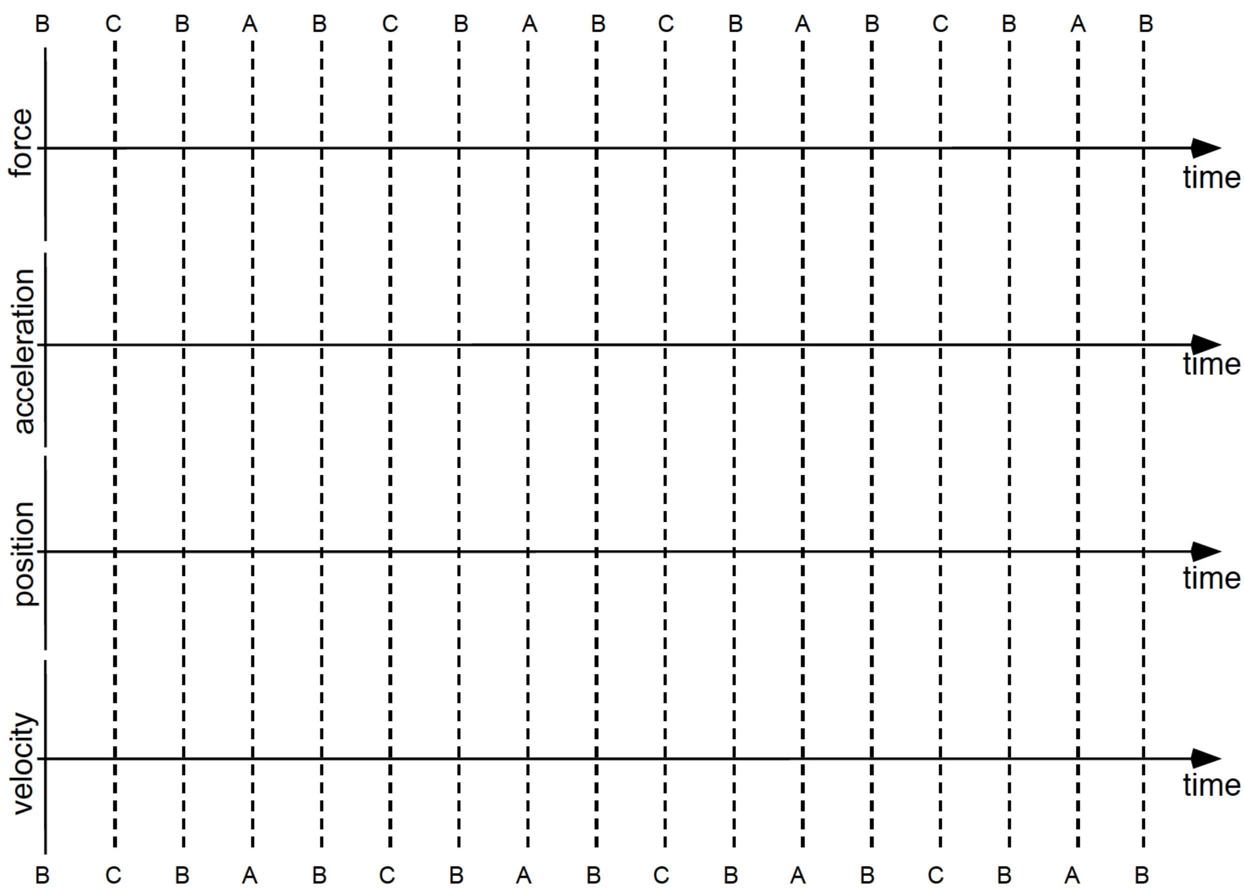
Part 2: Properties of an Oscillating System



Consider the pendulum shown. The pendulum is pulled to the left to point A and is released. There is no friction involved. Complete the following.

1. On the force vs. time graph below sketch what you think reflects the restoring force applied to the pendulum changes as a function of time. Begin your graph at time = 0 which will represent the pendulum as it passes point B moving to the right after being released.

2. With your force vs. time graph complete, sketch the acceleration vs. time, position vs. time, and velocity vs. time graphs.



Name: ________________________

Part 3: Applications of Oscillating System Properties

1. How do you know when your pendulum has completed 1 oscillation? Does it matter where you observe the oscillation and does it affect the time for the period?

2. What is the frequency of your pendulum from Part 1?

3. Explain what you would expect the pendulum to do if friction was involved.

4. Would the graphs you created in Part 2 be different if friction was active. Explain your reasoning.

5. Consider a horizontal spring system as shown. Explain what differences and/or similarities you anticipate in your graphs, if any.

Name: ______________________________

Handout 7.1.2.1: Slinky Investigation with PhET Simulation

Part I: Slinky Investigation

You will work in pairs for this investigation. One student will be the generator and the other student will be the stabilizer. It is important to hold each end firmly.

1. Describe what the slinky looks like in words and with a picture.

2. What can you change about the way you create a disturbance with the slinky? Develop two ideas and record your observations below.

Name: ______________________________

Part II: PhET Wave Simulation: PhET Simulations → Wave on a String

1. Open *Waves on a String,* **investigate** wave behavior using the simulation for a few minutes.

2. **Write** a list of characteristics that you will use in this activity to describe the waves. **Describe** each characteristic in words that any person could understand.

3. With the *Oscillate* button on and with *No End* checked, **investigate** waves more carefully using the *Amplitude* slider. **Write** answers to the following after your group has talked about each and agreed.

a) Define *Amplitude* in everyday language.

b) Explain how the wave behaves as the *Amplitude* changes using the characteristics you described in #2

c) Use your slinky on the floor for some investigations and explain how you could change the *Amplitude* of a wave.

4. Repeat step number 3, for *Frequency, Tension* and *Damping*.

5. **Investigate** how waves behave when the string end is *Fixed* and *Loose* with *Manual* settings. **Write** a summary.

Name: ______________________________

Handout 7.1.2.2: Wave speed, Wavelength, and Frequency

1. Two students, 5.0 m apart, each hold an end of a long spring. It takes 1.2 seconds for a pulse to travel from the student generating the pulse to the lab partner at the opposite end of the spring.

a. How long will it take for the pulse to return to the "generator"?

b. Explain the motion of the pulse passing through the spring. Calculate the speed of the pulse.

2. The "generator" in Problem 1 repeats the experiment with a pulse of twice the original amplitude. Will the pulse take more time, less time, or the same time to reach the far end of the spring? Explain your answer.

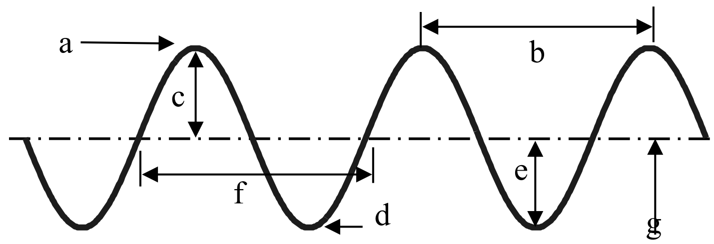
3. The students move so that they are now twice as far apart but use the same spring. How will the speed of the pulse sent now compare to the speed of the pulse sent when they were 5.0 m apart? Explain your answer.

Name: ______________________________

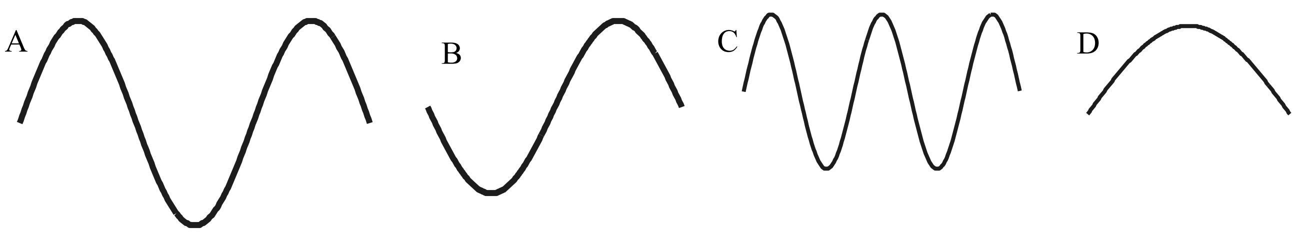
Characteristics of Waves

1. The illustration below shows a series of transverse waves. Label each part in the space provided.

a. ____________________
b. ____________________
c. ____________________
d. ____________________
e. ____________________
f. ____________________
g. ____________________



2. Below are a number of series waves. Underneath each diagram write the number of waves in the series.



a. Which of the above has the largest amplitude?

b. Which of the above has the shortest wavelength?

c. Which of the above has the longest wavelength?

Name: ______________________________

3. Sally Sue, an enthusiastic physics student enjoyed the opportunity to collect data from standing waves in a spring. She and her partner held the ends of their spring 4.00 meters apart. There were 5 nodes in the standing wave produced. Sally moved her hand from the rest position back and forth along the floor 20 times in 4.00 s. Sketch the situation and determine the following:

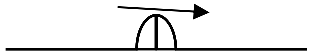
a. the wavelength of the wave Sally Sue sent

b. the frequency of the wave produced

c. the speed of the wave

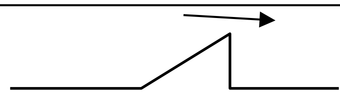
Name: ______________________________

Handout 7.1.2.3.1: Wave Interactions (Part 1: Reflection/Transmission of Waves)

1. 

a. In the box below, draw the pulse as it returns after reflecting from a fixed end.

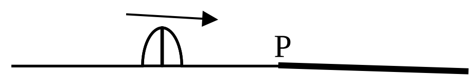
b. Draw the pulse as it returns after reflecting from a free end.

2. 

a. Draw the pulse as it returns after reflecting from a fixed end.

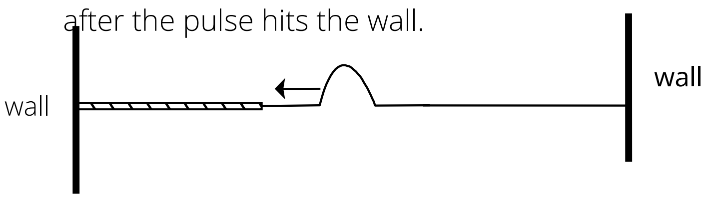
b. Draw the pulse as it returns after reflecting from a free end.

3. The diagram to the right shows a pulse traveling from a "light" string to a "heavy" string. In the box below, draw the reflected and transmitted pulses after the original pulse has reached point P.

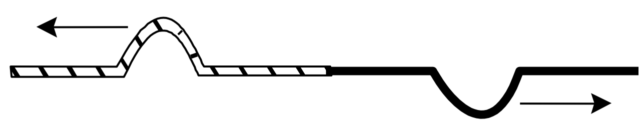


4. The diagram to the right shows a pulse traveling from a "heavy" string to a "light" string. Draw the reflected and transmitted pulses after the original pulse has reached point P.

5. Below is a pulse in a light rope approaching a heavy rope. Sketch the two rope system just after the pulse hits the wall.



6. To the right is a two-rope system soon after a pulse arrived at the center.



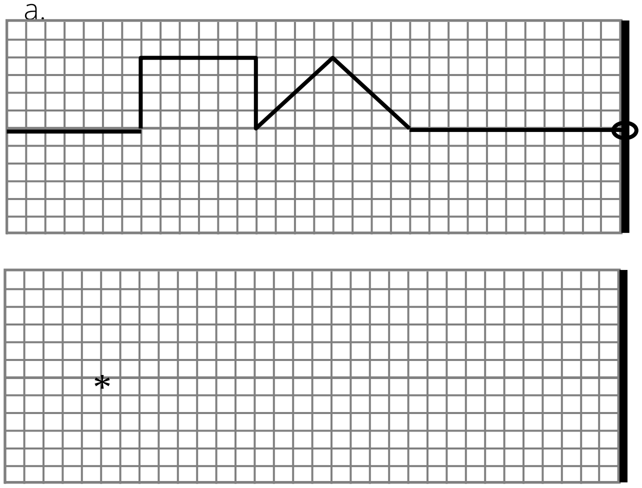
a) If the right rope is the heavy rope, what did the system look like just after the system was shaken? In other words, show with a sketch which end was shaken and if the shake was up or down.

b) If the left rope is the heavy rope, what did the system look like just after the system was shaken?

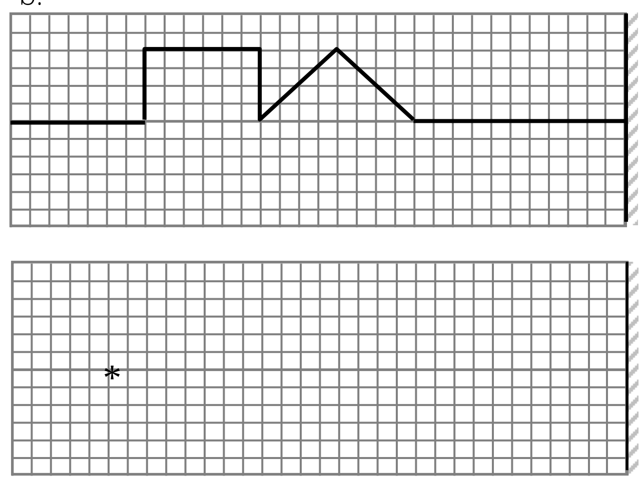
Name: ________________________________

7. On the lines below draw the pulses as they would appear after they have completed their reflection from the end. Slanted lines, (//), following the barrier line represent a fixed end. A O at the barrier indicates the barrier is a "free end." Use the grid below to show the reflected pulse, using the right edge as the boundary. Make your drawing at the time the leading point of the pulse reflects to the 5th box from the left. (Where the * is on the grid.)

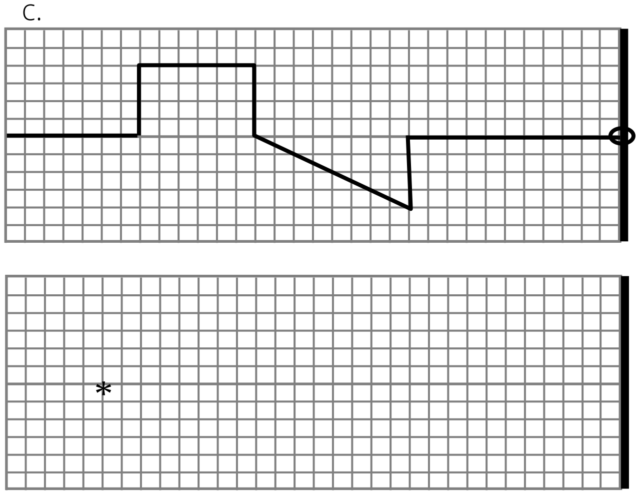
a.



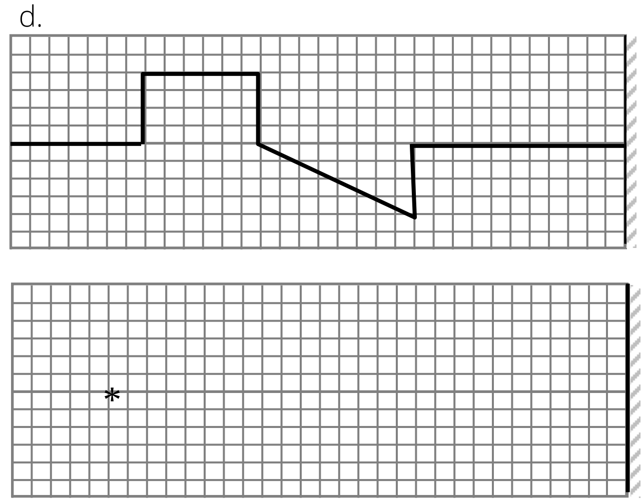
b.



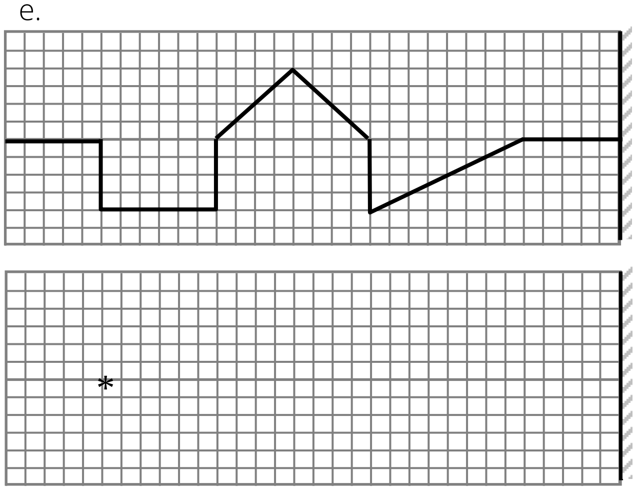
c.



d.



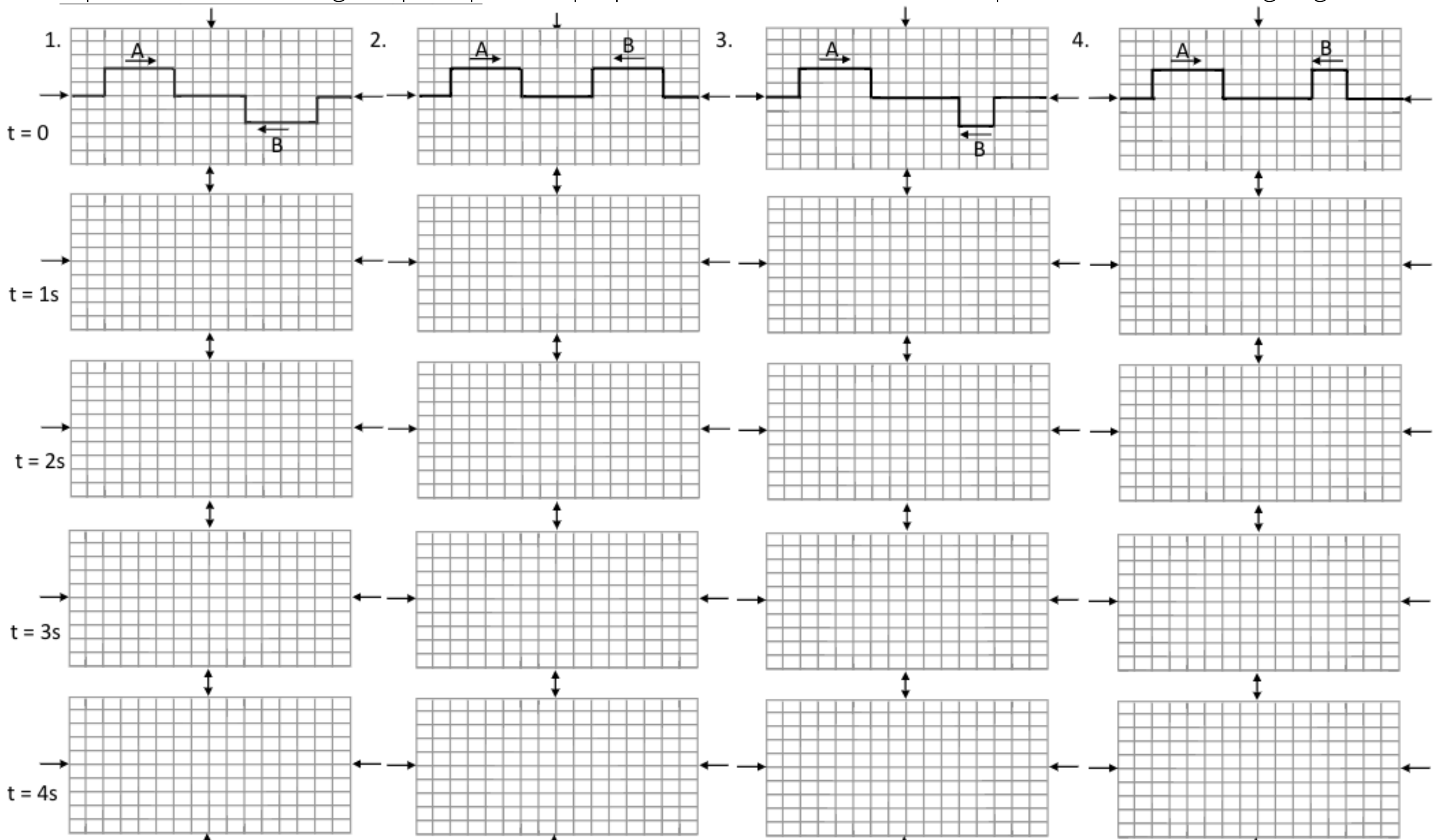
e.



Name: ________________________

Handout 7.1.2.3.2: Wave Interactions (Part 2: Wave Superposition)

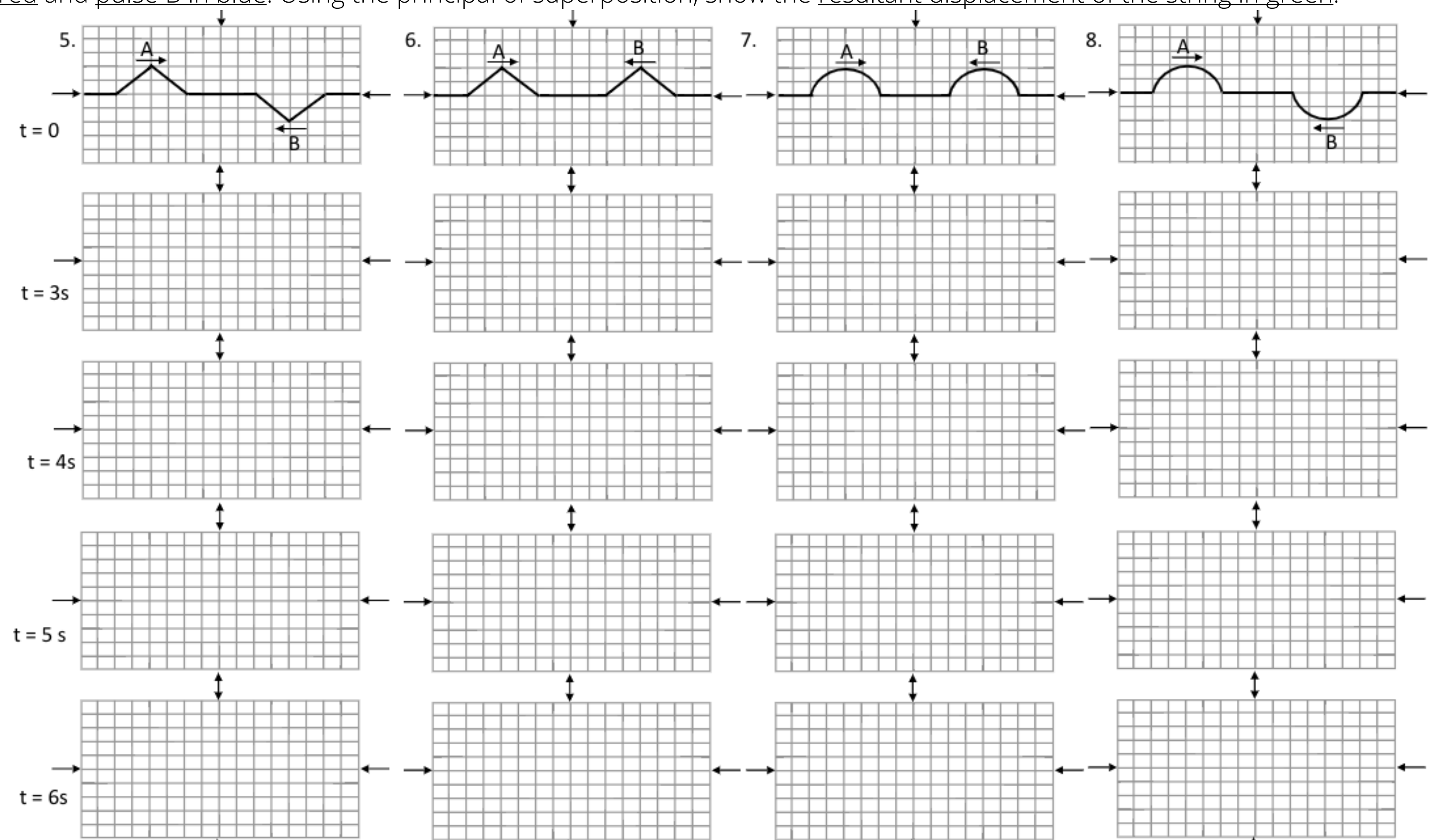
Questions 1 – 4 show pulses A and B at time = 0 as they head toward each other. Each pulse travels at a constant speed of 2 squares per second on a string which is 16 squares long. For questions 1 – 4, at t = 1 s, 2 s, 3 s, and 4 s, show the position of <u>pulse A in red</u> and <u>pulse B in blue</u>. Using the principal of superposition, show the <u>resultant displacement of the string in green</u>.



W2, Mechanical Waves in 1D, WS 3, v4.0

Name: ________________________

Questions 5 – 8 show pulses A and B at time = 0 as they head toward each other. Each pulse travels at a constant speed of 1 square per second on a string which is 16 squares long. For questions 5 – 8, at t = 3 s, 4 s, 5 s, and 6 s, show the position of <u>pulse A in red</u> and <u>pulse B in blue</u>. Using the principal of superposition, show the <u>resultant displacement of the string in green</u>.

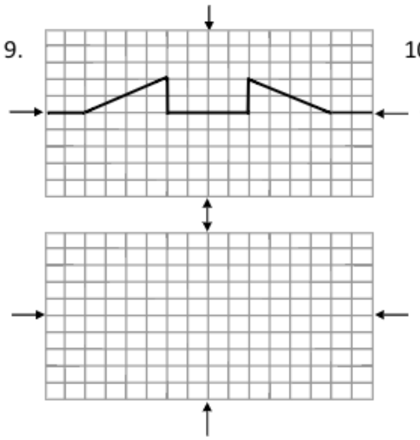


W2, Mechanical Waves in 1D, WS 3, v4.0

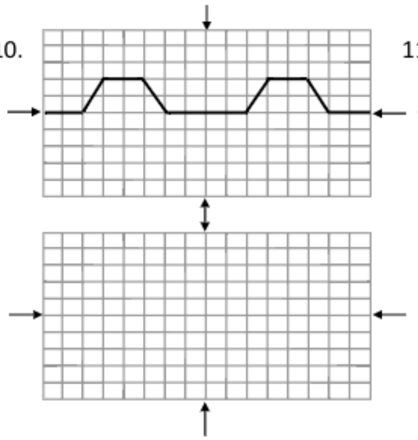
Name: ________________________

Questions 9 – 16 show pulses A and B as they head toward each other. On The graph below each situation, show the position of pulse A (in red) and pulse B (in blue) at the instant the centers of the pulses overlap. Using the principal of superposition, show the resultant displacement of the string in green.

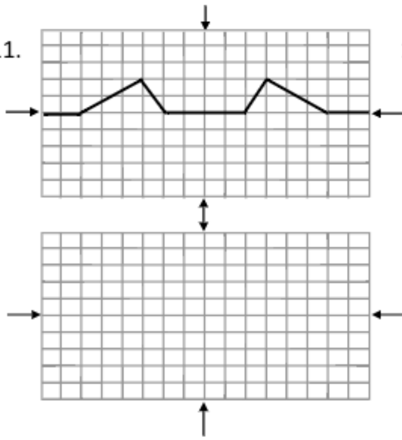
9.



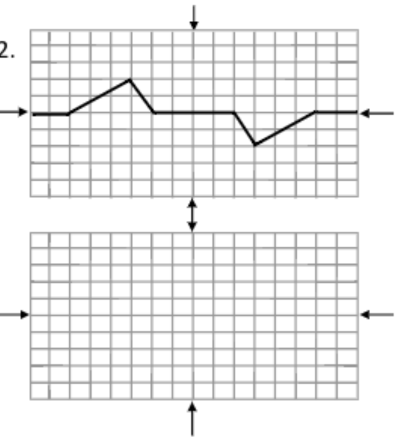
10.



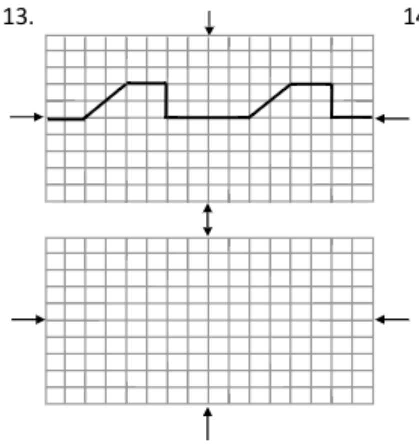
11.



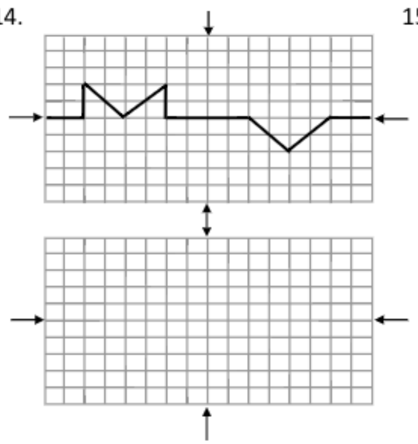
12.



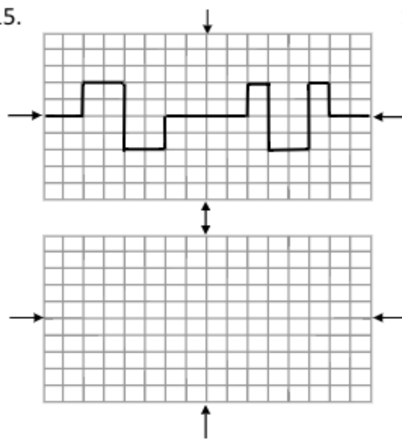
13.



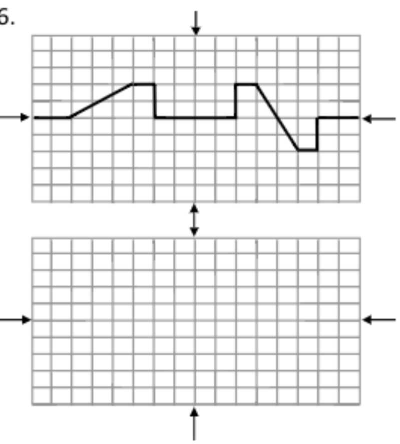
14.



15.



16.



W2, Mechanical Waves in 1D, WS 3, v4.0

Name: ______________________________

Handout 7.2.1.1: Sound Investigation

Use the Sound PhET simulation. If you have them, use headphones so you can hear the sound in the simulation.

1. Use the Listen to a Single Source tab in Sound Waves to start your investigation of sound.
   a) When you change the frequency, how does the sound change?

   b) When you change the frequency, how does the visual model change?

   c) How does changing the amplitude affect the sound and its model?

2. Sound is produced when something vibrates; this movement causes disturbances in the surrounding air pressure. Investigate how the speaker cone moves to produce different sounds. Explain the relationships between the movement of the speaker cone and the sound that is made; include drawings to support your explanation.

3. Use the tools on the Measure tab to find the speed of sound in air.
   a) Make a data table that demonstrates you have a good experiment and show sample calculations.

   b) How do your results compare to information that is published? (Include a citation)

Name: ______________________________

4. How could you find the wave length of a sound? Test your idea with several different sounds. Check to see if the results for wavelength make sense. (Include a citation)

5. Describe how you might use the simulation tools to find the period of a wave without using the frequency information. Test your idea with a variety of waves. Check your method by calculating the period using the frequency. Show data and calculations for several trials. Make corrections to the original plan as necessary.

6. Describe how you would find the frequency of a wave if the frequency slider did not have a number display. Test your idea with a variety of waves. Show data and calculations for several trials. Make corrections to the original plan as necessary.

Name: ________________________________

Handout 7.2.1.3: Standing Waves

1. Minnie Sota hits the end of a bar 1.2 m long with a hammer. Sketch the standing wave on the bar for the following situations. The speed of waves in the bar is 6,500. m/s.

MODE	DIAGRAM	WAVELENGTH	FREQUENCY
Fundamental frequency (1st harmonic)	____________		
2nd overtone (3rd harmonic)	____________		
Resonating with 4 nodes	____________		
Resonating with 4 antinodes	____________		

2. Justin Credable is singing in a shower that measures 2.40 meters from floor to ceiling, and notices his voice causes the shower to resonate with a fundamental frequency of 73 Hz.

   a. Sketch the standing wave and calculate the speed of sound in the shower?

   b. Sketch the standing wave for the first overtone and calculate the frequency.

Name: ______________________________

3. Sketch the standing wave pattern on a resonating object that has a fixed boundary on one end and a free boundary on the other. The length of the resonating object is 90.0 cm.

MODE	DIAGRAM	Number of Waves	WAVELENGTH
Fundamental frequency (1st harmonic)	Fixed boundary Free boundary		
Resonating with 2 nodes	Fixed boundary Free boundary		
Resonating with 3 antinodes	Fixed boundary Free boundary		
Resonating in 5th mode	Fixed boundary Free boundary		

4. Amy Noacid performs a physics lab to determine the speed of sound inside a tube. She blocks off one end of the 120.0 cm tube with a book and places a microphone at the other end. When she snaps her finger she determines the time for the sound to get back to the microphone is 0.00695 s. What was the speed of sound that da