Module 6 – Standing Waves – Instructions

LEARNING OUTCOMES (FROM SYLLABUS)

- Solve a variety of basic problems in particle kinematics (uniform motion and accelerated motion, including "free fall"), dynamics using Newton's Laws of Motion and the conservation laws of energy and momentum (e.g., collisions), fluid mechanics (including Archimedes' and Bernoulli's Principles), thermodynamics, wave motion, basic electricity (Coulomb's and Ohm's Laws), and radioactive decay.

- Interpret the results of simple experiments and demonstrations of physical principles.

EXPERIMENT SIMULATION

Use this Experiment Simulation[1] to conduct the first part of the experiment according to the instructions in Part I[2]. Use this Experiment Simulation[3] to conduct the second part of the experiment according the instructions in Part II[4]. Follow all instructions *explicitly*.

WORKSHEET

Please print the worksheet for this experiment. You will need this sheet to record your data.

PART I: STANDING WAVE – SUPERPOSITION WITH REFLECTED WAVE

Open the Standing Wave with Reflection simulation[5].

Step 1

Ensure the simulation settings are as follows:

- **Reflection: from a fixed end**

- **Animation** is selected

- **Incidenting wave**, **Reflected wave**, and **Resultant wave** boxes are all checked.

Step 2

a   Click **Start** to start the simulation. Observe the bead on the left edge of the simulation box rising from the centerline and then falling below it with a controlled, rhythmic frequency. This motion will propagate toward the right, each bead to the right of the next reflecting the transmitted energy. The incident wave, and its energy, are depicted with red lines.

---

[1]http://www.walter-fendt.de/html5/phen/standingwavereflection_en.htm

[2]manual.pdf#parti

[3]http://iwant2study.org/lookangejss/04waves_11superposition/ejss_model_wave1d01/wave1d01_Simulation.xhtml

[4]manual.pdf#partii

[5]http://www.walter-fendt.de/html5/phen/standingwavereflection_en.htm

b When the incident wave is close to the barrier—three or four beads left on the centerline— **Pause** the animation.

c Select **Single steps**. From the dropdown menu, select **T/24**.

d **Resume** the animation. The simulation will move forward by one bead.

e Repeat step d above until only the last bead on the far right is still on the centerline.

f Answer Questions 1–3 on Part I of the worksheet.

g **Resume** the animation **24** times, moving the wave forward 24 iterations. Note: The wave energy reflected back along the centerline is indicated with blue lines.

h Answer Question 4.

i **Resume** the animation 6 more times (totaling 30).

j Answer Questions 5 and 6.

k Select **Animation**, then **Resume** the animation and allow the simulation to run until the standing wave is fully formed.

l Answer question 7.

PART II: WAVE SUPERPOSITION

Open the Wave Superposition simulation[6].

The buttons along the top to the right of the red box control the simulation. They are, from left to right—**Play/Pause**, **Step Backward**, **Step Forward**, **−T/8**, **+T/8**, and **Reset**.

At the bottom right of the simulation window, in the yellow box, there are various values. We will only be concerned with "**t**", which indicates *time* in the simulation.

Step 1

At the top, in the box to the right of **f(x,t)?=**, ensure that **Show F** is selected. In the box to the right of **g(x,t)?=**, from the dropdown menu, select **Hide G**.

Step 2

Select the **Play** button to begin the simulation.

a Look at only the leftmost bead on the waveform. Observe how it oscillates up and down between $y = 1$ and $y = -1$ along the vertical line at $x = -1.000$.

b **Reset** the simulation using the following button.

Figure 1: Reset Button

[6]http://iwant2study.org/lookangejss/04waves_11superposition/ejss_model_wave1d01/wave1d01_Simulation.xhtml

c Utilizing the **Step Forward** button, select it *80 times* (counting 8 sets of 10 selections may help to keep track). This will step the leftmost bead of the wave through one full cycle of up and down movement along the vertical line at $x = -1.000$, and it will end up back at its starting point ($y = 0$) on the 80th step. Observe the wave propagating toward the right with each step.

d Answer questions 1–6 in Table 1. **NOTE: In WebAssign, the following notation indicates that there is a specific number of significant figures that must be recorded.**

Figure 2: Significant Figures Notation

Record the values to the decimal places or significant figures indicated.

Step 3

a Reset the simulation and repeat step 1 above.

b **Step Forward** in the simulation to $t = 0.25$ s. Below Table 1, enter answers for how far the wave has traveled along the x-axis, and a description of the waveform in terms of its change in phase from $t = 0$ to $t = 0.25$ s. 90 degrees out of phase means that the wave is 0.250 horizontal units from its original position, and 180 degrees out of phase means the wave is 0.500 vertical units from its original position.

Step 4

a **Reset** the simulation. Ensure both Show F and Show G are selected. The F-wave will display in green, and the G-wave will display in blue, and are initially superimposed.

b **Step Forward** in the simulation to 0.11 seconds.

c In Table 2, wave amplitudes have been provided to the nearest two decimal places for each wave (F and G) at the indicated locations along the x-axis.

d Calculate and record the resultant wave amplitude (F + G) at the indicated locations along the x-axis. Record values to the nearest **two** decimal places.

Step 5

a **Step Forward** the simulation forward to 0.25 seconds.

b In Table 2, record the wave amplitude for each wave (F and G) at the indicated locations along the x-axis. Record values to the nearest **two** decimal places.

c Calculate and record the resultant wave amplitude (F + G) at the indicated locations along the x-axis. Record values to the nearest **two** decimal places.

Step 6

a **Reset** the simulation. Ensure both Show F and Show G are selected. The F-wave will display in green, and the G-wave will display in blue, and are initially superimposed.

b Click in the grey square inside the red **+?** box to display the resultant wave.

c **Step Forward** in the simulation to 0.11 seconds.

d Based on what you observe, complete the two statements below Table 2 in the worksheet.

Step 7

Answer the four remaining questions in the worksheet, pertaining to some general concepts and applications regarding waves.