ES 104 Lab 5 Additional Activity

Part C - Seismometers

Seismometers are instruments designed to measure and record ground motion during an earthquake. The record kept by the seismometer is called a seismogram. Examine the seismometer at Lab Station C. The heart of the seismometer is a mass (the washers and magnets on the eye bolt in the bottle) suspended on a spring. During an earthquake, the housing of the seismometer (bottle, PVC pipe, and base) move, but the mass remains roughly stationary due to its inertia. To record the motion of the bottle relative to the mass on the spring, a coil of wire is wrapped around the bottle. The magnet on the bolt produces a changing magnetic field as it moves inside the wire coil. The changing magnetic field produces an electrical voltage in the coil. The computer measures the voltage and creates a plot of voltage vs. time; the larger the voltage, the larger the velocity of the mass.

1. Given that the purpose of the seismometer is to measure motion during an earthquake, why is the mass on the spring suspended in oil? (Hint: think about how long the mass would vibrate after an earthquake if no oil were present.)

2. This seismometer is set up to measure vertical ground motions. Draw a picture of a seismometer that could measure horizontal ground motions. (You only need to draw the mass and whatever is attaching the mass to the seismometer housing).

Making Earthquakes

You are going to simulate earthquakes and record them on this seismometer. To simulate the earthquakes, you will drop 1 kg and 0.2 kg masses onto the wooden squares attached to the plywood base. The differing masses correspond to earthquakes of different size. Energy from the mass hitting the table will travel down the plywood base as an elastic wave where the wave will move the seismometer. The seismometer will then make a record of its motions. During a real earthquake, energy released at the focus of the earthquake travels to distant seismometers through seismic waves.

Directions

1. Do not mess with any of the electronics attached to the seismometer!!!
2. Delete all previous data runs on the computer (Use the menu command *Experiment>Delete ALL data runs*).
3. Press *Start* to begin recording data from the seismometer.
4. Carefully drop the 1 kg mass from a height of 2.5 inches above the wooden block labeled 1. Use a ruler to measure the height precisely.
5. Carefully drop the 1 kg mass from a height of 2.5 inches above the wooden block labeled 2.
6. Now repeat the drops at the two wooden blocks using the 0.2 kg mass. Be sure to keep the drop height at 2.5 inches.
7. Press *Stop* on the computer to stop recording data.
8. Adjust the horizontal and vertical scales on your seismogram so that all four earthquakes fit on the graph. Print your seismogram and label the 4 earthquakes with the mass dropped and the location of the earthquake. Measure the distances of earthquake locations 1 and 2 from the seismometer in cm. and record the distances on your seismogram.

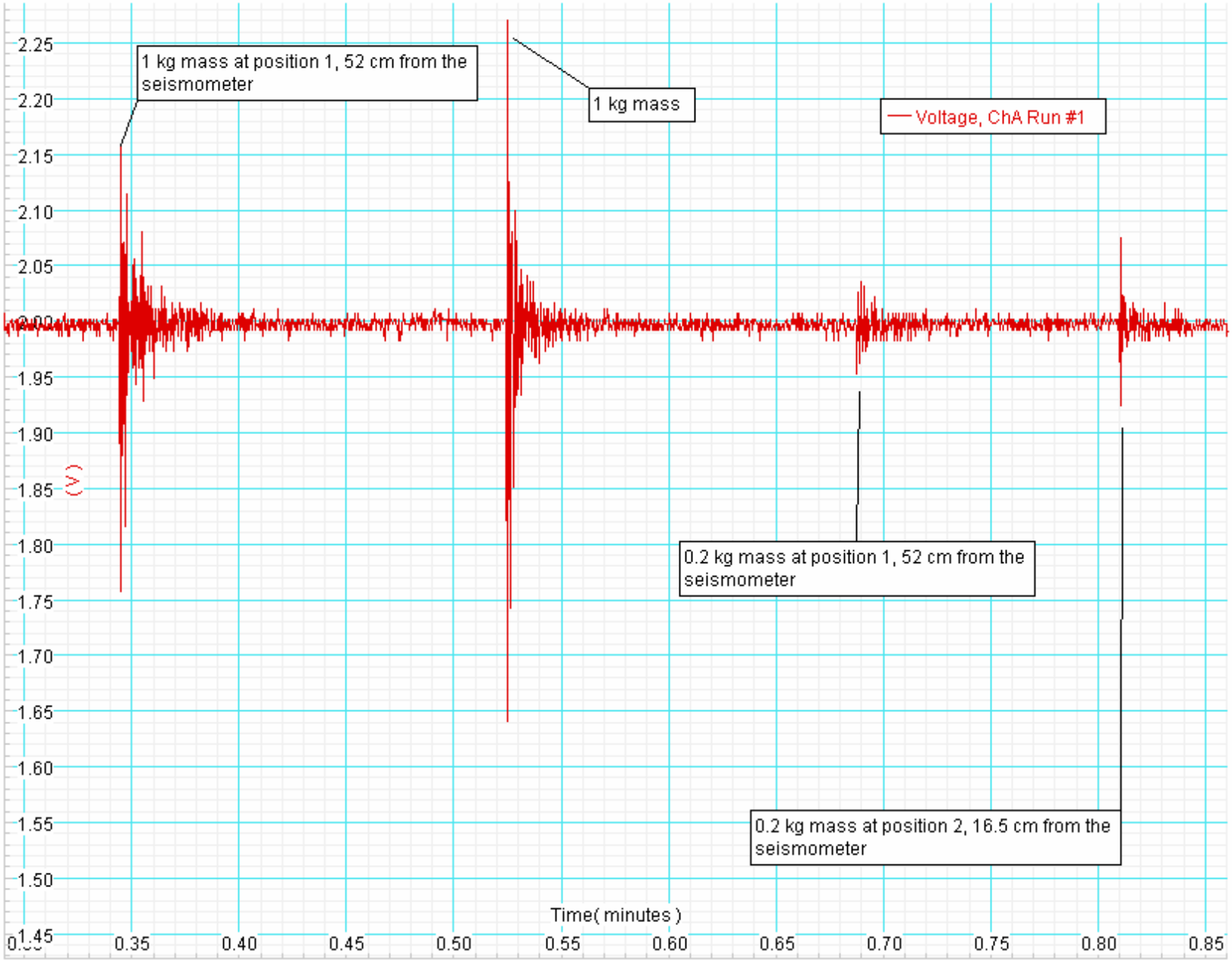
Questions

1. Notice that before and after the earthquakes that you created, the seismogram shows some small amplitude squiggles. In our seismometer, most of this noise is coming from the electronics that record the motion of the seismometer. Real seismometers are extremely sensitive to ground motion and therefore record ground motion due to sources other than earthquakes. What sorts of natural and human-caused ground motions might show up as noise on a seismogram?

2. Look at the seismogram that you made. How does the amplitude of the ground motion recorded by the seismometer relate to the magnitude of the earthquake (or in this case, the size of the mass dropped)?

3. How does the amplitude of the ground motion recorded by the seismometer depend on the distance to the location of the earthquake for a given earthquake magnitude? Use this observation to explain why earthquake magnitude scales must use both the amplitude of the wave recorded on the seismogram and the distance to the earthquake epicenter to assign a magnitude to an earthquake.

4. Compare the duration of strong shaking between the 1 kg earthquake and the 0.25 kg earthquake. How does the duration of shaking relate to the earthquake magnitude? How do you think this affects the amount of damage that occurs to buildings during an earthquake?


1 kg mass at position 1, 52 cm from the seismometer
1 kg mass
Voltage, ChA Run #1
0.2 kg mass at position 1, 52 cm from the seismometer
0.2 kg mass at position 2, 16.5 cm from the seismometer
(V)
Time(minutes)
2.25
2.20
2.15
2.10
2.05
2.00
1.95
1.90
1.85
1.80
1.75
1.70
1.65
1.60
1.55
1.50
1.45
0.35
0.40
0.45
0.50
0.55
0.60
0.65
0.70
0.75
0.80
0.85