LAB 2. GRAPHS OF MOTION

Supplies: computer with Logger Pro installed; Lab Quest Mini interface; USB to interface cable; Motion Detector with cable; flat panel; dynamics cart; grooved aluminum track; brick, boxes or blocks to elevate one end of the track.

Configuring the system

1. Take a lab laptop from the cabinet. Disconnect its charging cable from the laptop and put the cable neatly back into the cabinet.
2. Connect the data cable from the Lab Quest Mini interface to a USB port on the computer. Connect the cable from the motion sensor to the "Dig1" or "Dig2" port on the interface. Then turn on the computer.
3. Find the Logger Pro program by clicking on the search icon (magnifying glass) in the task bar near the bottom of the screen. Search for "Logger Pro;" it should come up pretty quickly after you type "l." If it doesn't, consult your instructor. Launch Logger pro. The default display when Logger Pro detects the motion sensor should be a data table and two graphs. If you don't see that, consult your instructor.
3. To take measurements, first point the transceiver (the perforated metal circle) at the moving target. Then collect data by clicking on the "collect/stop" button on the screen, or by pressing the spacebar on the keyboard. As you take data, Logger Pro populates the cells in the data table and creates the graphs. To change the duration of data collection or other experimental parameters, select "Experiment > Data Collection" from the menu bar.

Practice

Have someone (the "target") stand in front of the transmitter, holding the flat panel in front of the detector to give a flat reflecting surface. Start data collection. The target should practice moving toward and away from the detector at different speeds, speeding up, and slowing down. Logger Pro will generate a position-time graph during collection.

Practice positioning the motion sensor and moving the target so that the plot is smooth and truly represents the target's position at all times, without jumps or spikes. Jumps and spikes are the bane of data taken with these motion sensors. This lab is a great time to wrestle with them, understand them, and learn to minimize them. Common sources of error include the target moving out of the ultrasound beam and nearby objects reflecting the beam back at the detector.

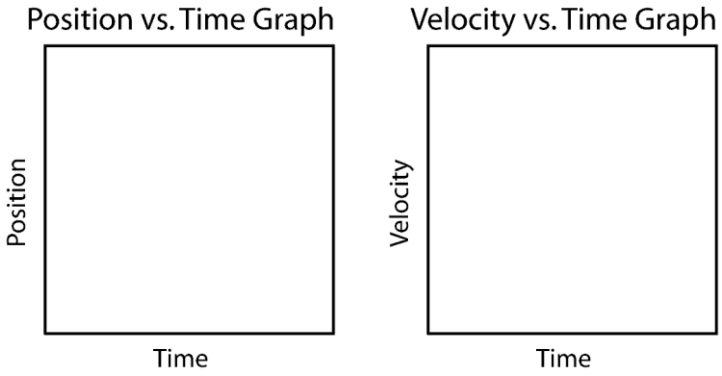
Practice using all of your group members as targets.

Taking Data

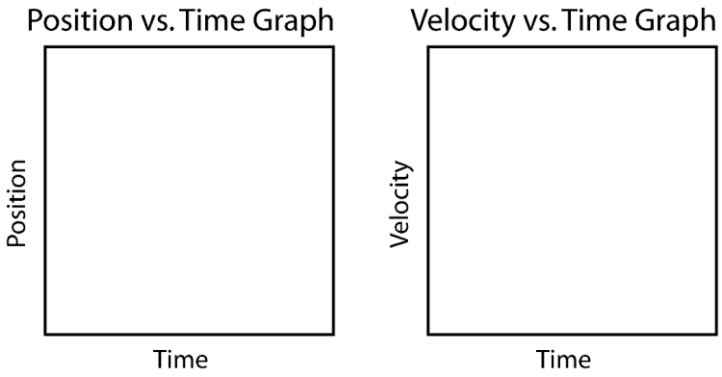
Position-time and velocity-time graphs from verbal descriptions

Here, you are given written descriptions of motion. Act out the motion in front of the probe while collecting data, and see what graphs result. Sketch the position-time graphs on the left, and the velocity-time graphs on the right.

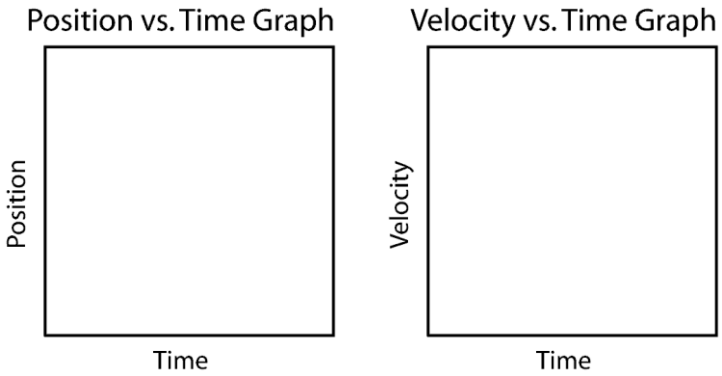
Walk steadily toward the probe, stop and wait a little while, and then walk steadily away from the probe.



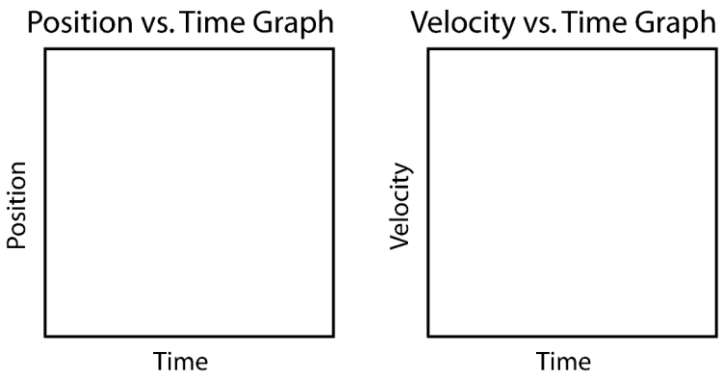
Walk slowly away from the probe, then immediately reverse direction and walk quickly toward it.



Walk away from the probe with increasing speed.



Alternate stepping toward the probe and stopping to rest.



Study each written description and the resulting graphs. Make sure you understand how and why they describe the motion.

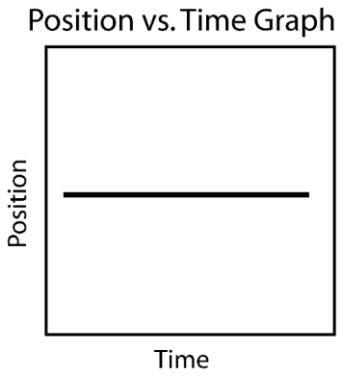
Match the position-time graphs

Look at the graphs below. Interpret what each graph means. Plan the motion of a target that corresponds to each graph.

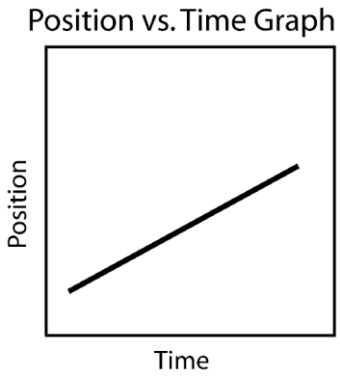
When you are ready, have the target move to duplicate each graph . Keep trying until the position-time graph you produce really looks like the model. Repeat with each person in your group as the target so that everyone gets a kinesthetic feel for what the graphs mean.

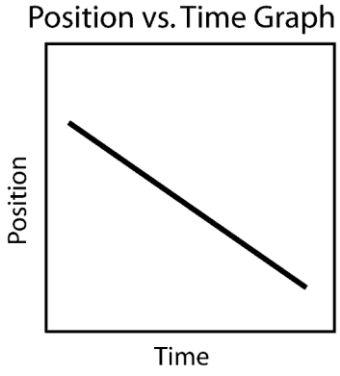
In the space to the right of each graph, describe the target's motion in words. Do not use the words "velocity," "acceleration," "positive," or "negative." Instead, use phrases like "speed up," "slow down," "hold still," "faster," "slower," "toward the detector," and "away from the detector."

When you finish with each position-time graph, go to the "Velocity Plots" activity (the next activity) to sketch the velocity-time graph that corresponds to each position-time graph.

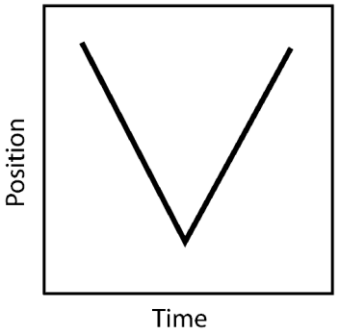


Description of Motion



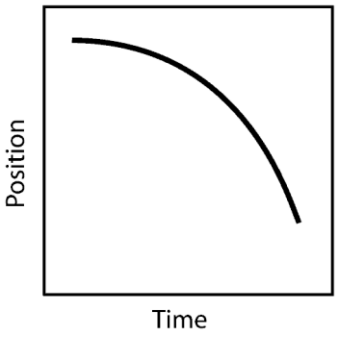


Position vs. Time Graph

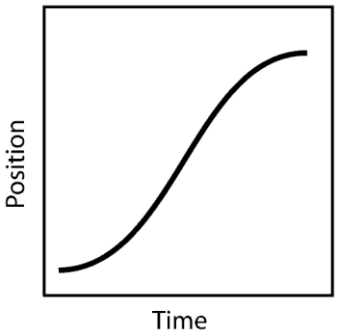


Description of Motion

Position vs. Time Graph



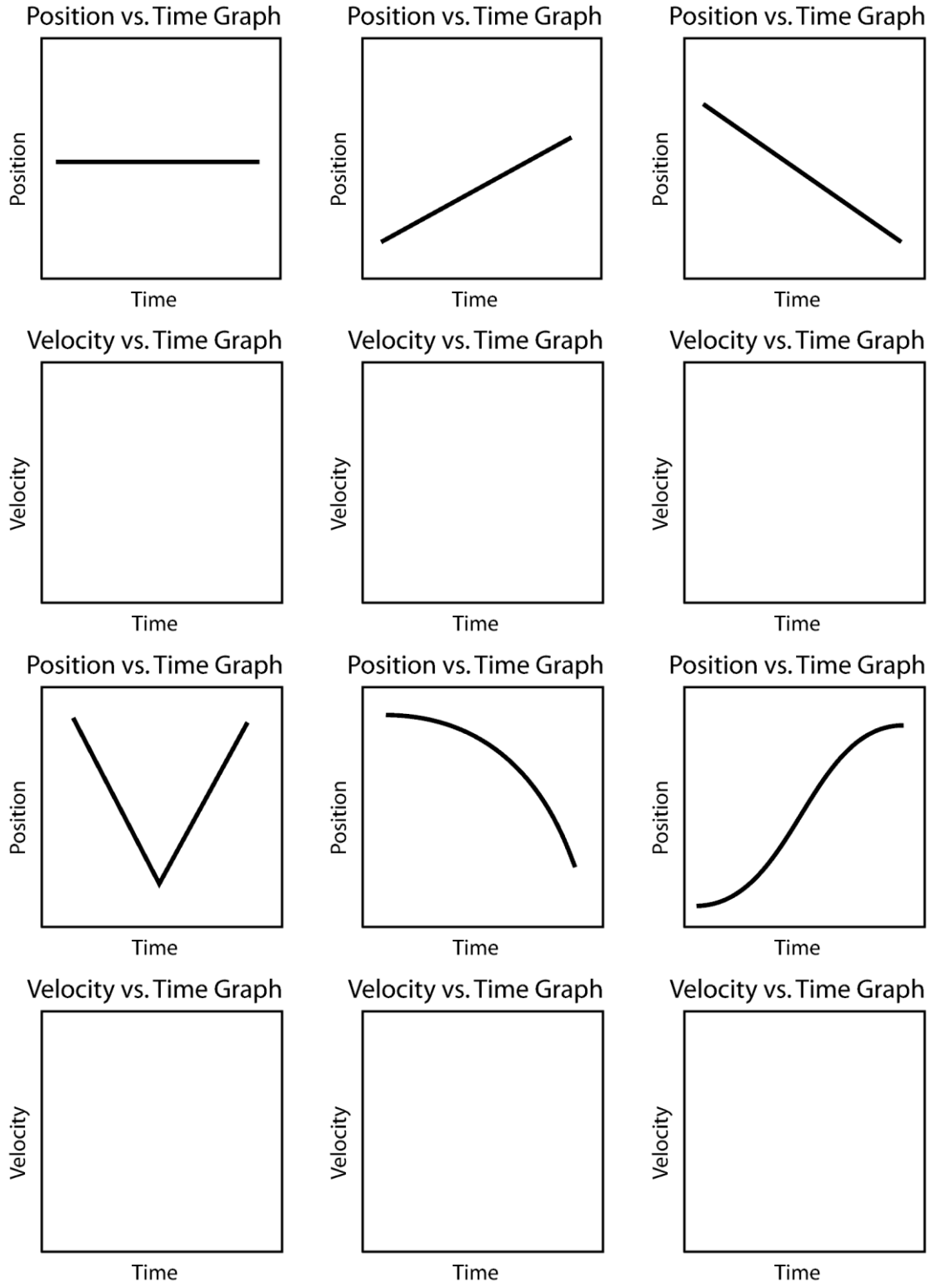
Position vs. Time Graph



Study each graph and the description of the motion that produced it. Make sure you understand how and why the graphs describe the motion.

Velocity Plots

Below each position-time graph, sketch a velocity-time graph corresponding to it.



Study each graph and consider the motion that produced it. Make sure you understand how and why each graph describes the motion.

Rail cart

Obtain an aluminum track and a cart. Elevate the far end of the track and position the motion sensor at the top of the slope. Practice pushing the cart so that it coasts almost to the top of the track and then back down. Don't let the cart run into the detector, and catch the cart when it returns to the bottom. Once you can make a satisfactory push reliably, collect data on the process. Inspect the position-time, velocity-time, and acceleration-time plots that result.

Sketch the graphs with their axes below, showing the essential features. Show them, along with all your other records from this lab, to your instructor before you leave the lab. Your *instructor must sign off on your data* for it to be accepted.

Break-down and clean up

Return all the apparatus to their proper places. Connect the charging cables to the laptops when you return them to their storage cabinet, so that they will be fully charged the next time they are used.