LAB 17. GRAPHS OF MOTION

Supplies: computer with Capstone installed; Science Workshop 750 interface; USB to interface cable; interface power supply; PASCO Motion sensor II with cable; small whiteboard ; dynamics cart; grooved aluminum track; books, boxes, or blocks to elevate one end of the track.

Configuring the system

1. Connect the power supply to the wall outlet and the Science Workshop interface. Connect the USB to serial cable to a USB port in the computer and the serial port in the back of the interface. Connect the detachable cable to the socket in the motion sensor. Plug the yellow plug into socket 1 on the interface, and plug the black plug into socket 2. Make sure the interface is turned on (the switch is in the back).
2. Turn on the computer and log in (user genetics, password genetics).
3. Launch the Capstone program by double clicking on its alias icon. If necessary, do what it says to connect to the interface. To recognize the motion sensor, click on channel 1 in the picture of the interface box.
4. Set the sample rate to 40 Hz.
5. Select the display format from the options in the window. I like the data table and graph display; at least choose a display that includes the graph. Select Position for the vertical axis and Time for the horizontal axis.
6. Now you are ready to take data!

Practice

Have someone (the "target") stand in front of the transmitter, holding the whiteboard in front of the detector to give a good reflecting surface. To start data collection, click on the "Start" button. The target should practice moving toward and away from the detector at different speeds, speeding up, and slowing down. Capstone will generate a position-time graph during collection.

Practice positioning the Motion Detector, holding the reflector, and moving the target so that the plot is smooth and truly represents the target's position at all times. Sources of error include the target moving out of the ultrasound beam and other objects reflecting the beam back at the detector.

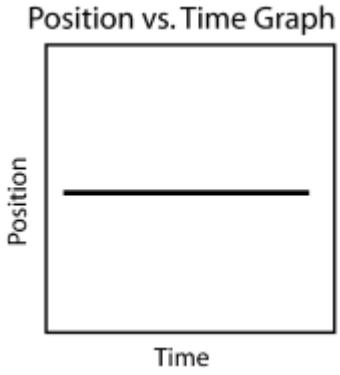
Practice using every one of your group members as the target.

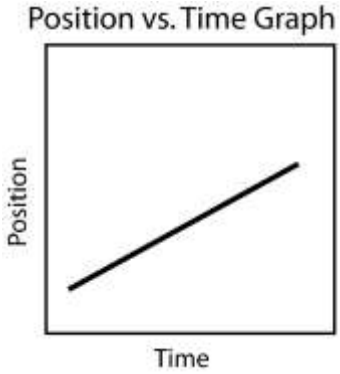
Match the graphs

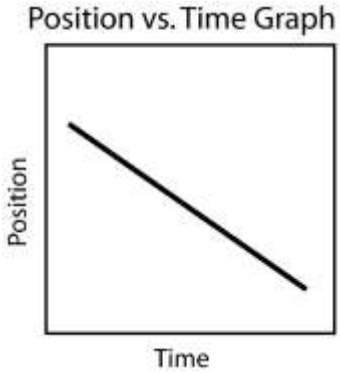
Look at the graphs below. Interpret what each graph means. Plan the motion of a target that corresponds to each graph.

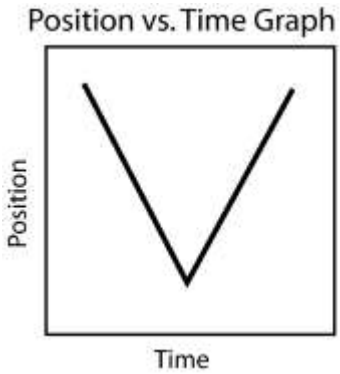
When you are ready, have the target move to duplicate each graph while collecting data.. Keep trying until the graph you produce really looks like the model. Repeat with each person in your group as the target so that everyone gets a kinesthetic feel for what the graphs mean. When you have a good matching graph, save it to use later.

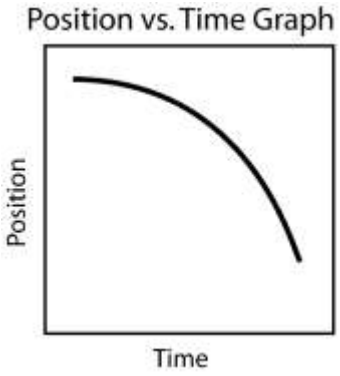
In the space to the right of each graph, describe the target's motion in words. Avoid the words "velocity," "acceleration," "positive," or "negative." Instead, use phrases like "speed up," "slow down," "hold still," "faster," "slower," "toward the detector," and "away from the detector."

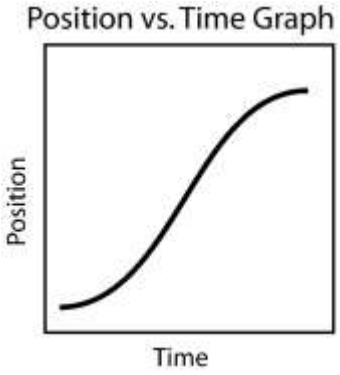










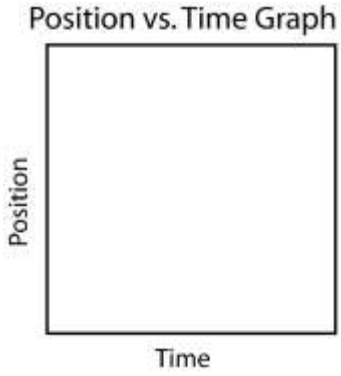


Study each graph and think of the motion that produced it. Make sure you understand how and why the graph describes the motion.

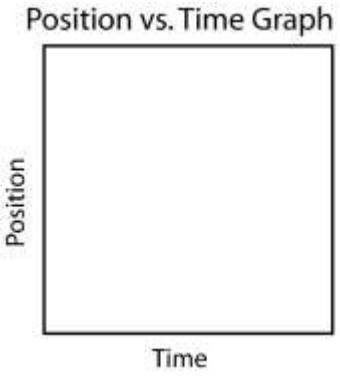
Make the graphs

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

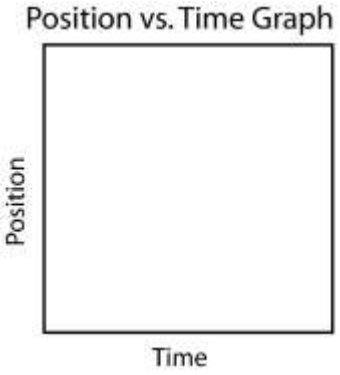
Walk steadily toward the probe, stop and wait briefly, and then walk steadily away from the probe.



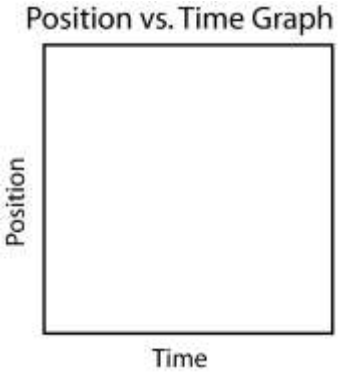
Walk slowly away from the probe, then immediately reverse direction and walk quickly toward it.



Walk away from the probe with increasing speed.



Alternate walking toward the probe and stopping.



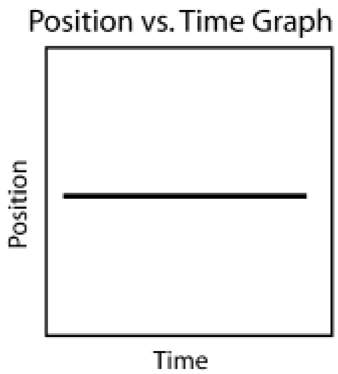
Study each written description and resulting position-time graph. Make sure you understand how and why they both describe the same motion.

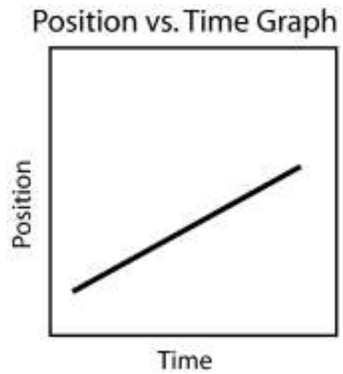
Velocity Plots

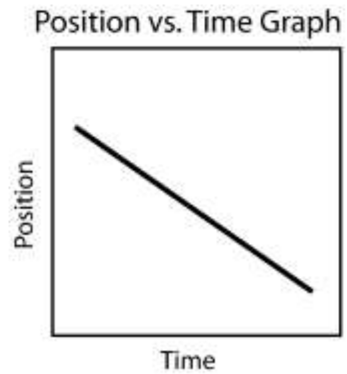
Now that you have an idea what position-time graphs look like, we'll move on to graphs of velocity and acceleration. Velocity is the rate of change of position; acceleration is the rate of change of velocity.

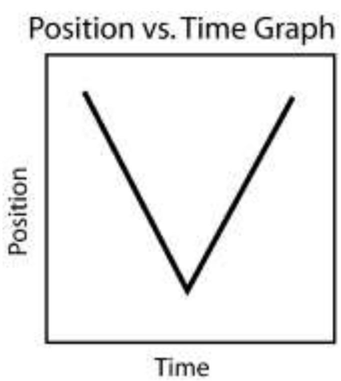
To plot a velocity graph, change the vertical axis label of the graph to "velocity." You now should have axes for a velocity-time graph.

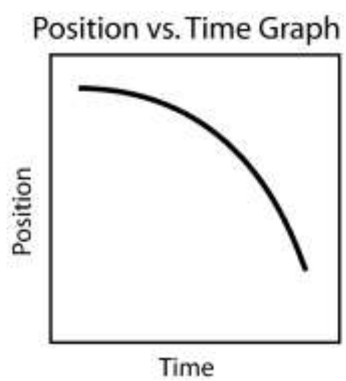
Using the data from your previous runs, plot the velocity-time graphs corresponding to the position-time graphs in the spaces directly below them.

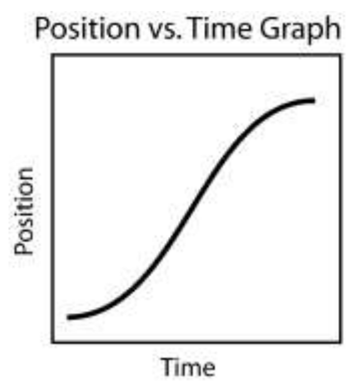










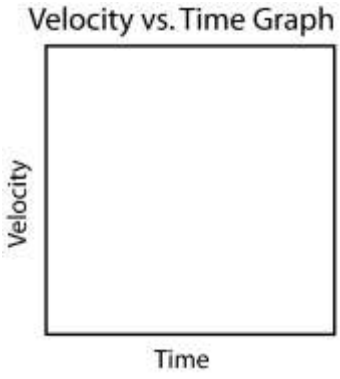


Study each graph and consider the motion that produced it. Make sure you understand how and why each graph describes the motion.

Discover velocity graphs

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

Walk steadily toward the probe, stop and wait briefly, and then walk steadily away from the probe.



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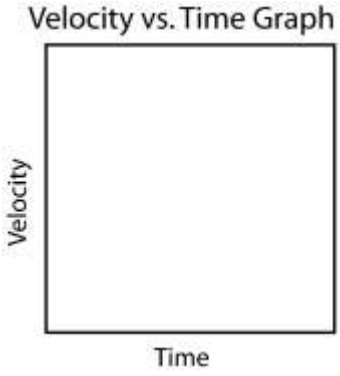

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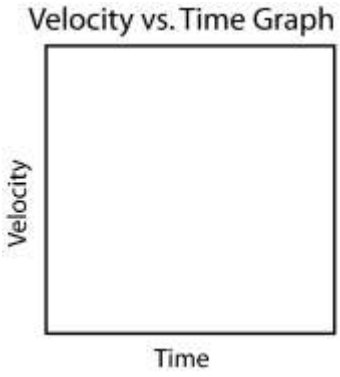
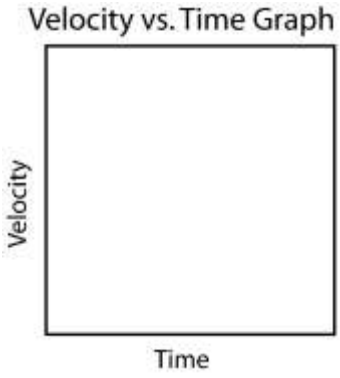


Alternate walking toward the probe and stopping.



Study each written description and resulting velocity-time graph. Make sure you understand how and why they both describe the same motion.

Rail cart

Obtain an aluminum track and a cart. Elevate the far end of the track and position the probe at the top of the slope. Practice giving the cart a quick shove so that it coasts almost to the top of the track and then back down. (Don't let the cart run into the probe!) Once you can do that reliably, collect data on the process. Sketch the position-time, velocity-time, and acceleration-time plots that result.

Getting Credit

Show this completed worksheet to your instructor for check-off.