Investigation 1
Constant Motion and the first type of graph

In this unit on motion, you will focus on your own ideas about motion by examining three types of graphs of motion and deciding what aspect of motion each type represents. Eventually you will be asked to translate between these three types of graphs and verbal descriptions of motion. We will decide what is apparently intended in these three types of graphs by investigating how the graphs respond to motions we can produce.

ACTIVITY 1.1

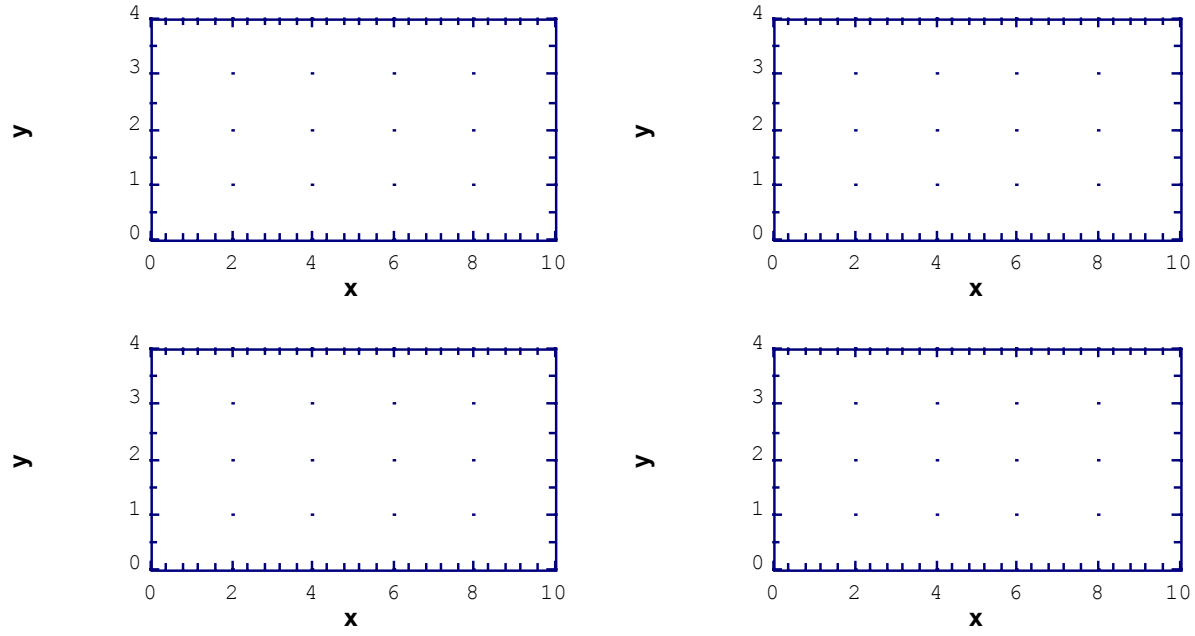
TRY THIS:

• Open the MBL file named: Act. 1.1.

The computer is now set to make the first type of graph of your motion. Note that for now the labels on the axes of the graph are generic: "x" and "y". You can make a graph by having another group member click the start button for you and then you move toward and away from the detector.

- The detector does not work well when you are closer than 1/2 meter to it. For good graphs do not go closer than 1/2 meter from the detector.
- As you move, you should always face the computer screen even if you have to make backing-up motions. This enables you to better connect your own kinesthetic experience of motion with features of the graph as they come out on the screen. Each group member should make some motions in front of the detector. Make these motions calm and steady, but do them at different speeds.
- Record the results of your efforts on the graph axes below.

Space for class notes.



WHAT DO YOU THINK? *In your own words how would you describe what is being represented on the x-axis and the y-axis of this type of graph?* Please indicate why it makes sense to you at this point in time to use these particular labels.

WHAT DOES YOUR GROUP THINK? Compare notes with your lab partners. *Were their descriptions different than yours?* If so, record them. *Can you come to a group consensus as to the descriptions for what is being represented on the x and y axes?* Record this information below.

Space for class notes.

At this point, stop and wait patiently for the other groups to participate in a discussion of how to label the axes of these graphs. DO NOT GO ON PAST THIS POINT UNTIL THE CLASS HAS GATHERED FOR DISCUSSION.

WHAT DOES YOUR LAB CLASS THINK? Be prepared to share those ideas which your group came up with. Make a record of any new ideas you hear in this full class discussion. *Can the class come to any consensus? If so, what is it? If not, what are the sticking points?*

If we were to pick single words to use as labels for each axis, what would they be? Why?

MAKING OBSERVATIONS: Find out what labels are going to be used on this type of graph by opening the file Act. 1.1a.
Collect some new data with this new file by making some of the same motions as you did earlier.

What do the labels apparently mean in everyday words? Do these labels match some of the possibilities discussed in the class?

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MAKING SENSE: Write down your answers to the following questions and then discuss your answers with your lab partners. Write down any new ideas you get from your partners.

- *Are the labels used on the axes of this type of graph the same as you would use? Are they the same as the majority of your lab class voted?* Please describe any differences you perceive between the words used on the graphs and those you and your classmates chose.

A "word" on words:
Whose labels are "right"? Whose definitions of the words are "right"? It is the meaning, what the words and labels are intended to represent, which is important. If we can take as shared the meaning, then the words we agree to use to represent it can take on this meaning. In this sense, any labels or words can be deemed "right" because we have agreed to use them to represent the meanings we take as shared. It is the meanings, the understandings, which are really important.

Alternatively, if we think we understand the meaning of things in a situation, then we have reason to guess that the words others use to describe these things also represent the meaning we think we have figured out. Meaning or understanding can be quite elusive, but with enough careful interaction and checking of the meaning we have worked out we can come to a meaning for the words which can be taken as shared.

In this activity we have attempted to decide on what the axes of this type of graph represent and we have come up with words which represent that meaning as described in the first paragraph in this section. We have also looked at the words other people have chosen to use for the axes of the graphs. Where they have used different words than we would have,

Space for class notes.

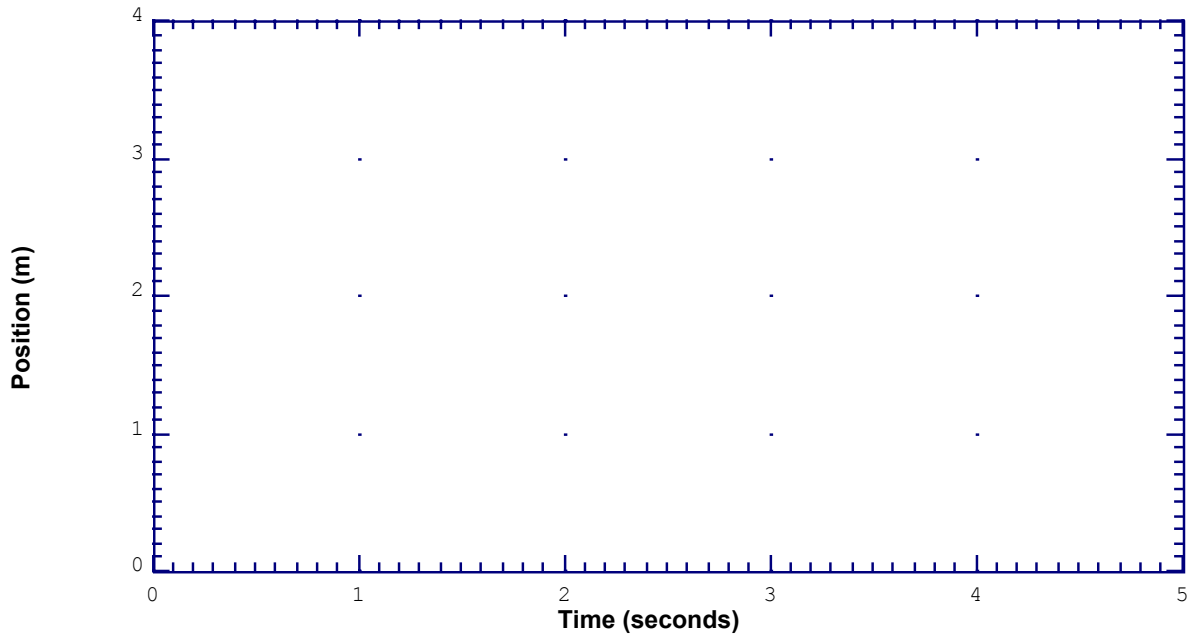
either it is just (1) a case of different words for the same meaning or (2) a case that the understanding of the aspects of motion represented in the graphs is different than we have developed so far. The rest of the activities in this investigation are designed to be a further exploration of the properties of this type of graph in order to see which case it is: (1) different words but same meaning or (2) different words having different meanings.

Begin by opening the MBL file, Act. 1.2

ACTIVITY 1.2: ***WHAT DIFFERENCE WOULD IT MAKE IF YOU WALKED SLOWLY, BUT STEADILY, AWAY FROM THE DETECTOR COMPARED TO WALKING FASTER, BUT STEADILY, AWAY FROM THE DETECTOR?***

WHAT DO YOU THINK? You have had a chance to explore this new type of graph. Using what you have seen so far, do the following: On the axes below…

1. Using a solid line draw what you think the graph will look like for a motion slowly, but steadily, away from the detector. Label this line: slowly away.mine.
2. Using a solid line draw what you think the graph will look like for a motion faster, but steadily, away from the detector. Label this line: faster away.mine.
3. Using a solid line draw what you think the graph will look like for a motion slowly, but steadily, toward the detector. Label this line: slower toward.mine.
4. Using a solid line draw what you think the graph will look like for a motion faster,



but steadily, toward the detector. Label this line: faster toward.mine.

Space for class notes.

In the space below the graph explain why you think the graphs will look like this.

Space for class notes.

•*What do you think is the essential difference between the lines for faster and slower motions on a position-time graph?*

• *What do you think is the essential difference between the lines for motions toward and away on a position-time graph?*

WHAT DOES YOUR GROUP THINK? Compare notes with your lab partners. If they have different predictions, draw them in with additional solid lines. Label these lines: slow or faster away, which ever is appropriate and indicate who made each prediction. In the space below write their reasoning behind their predictions.

• *What does your group think is the essential difference between the lines for faster and slower motions on a position-time graph?*

• *What does your group think is the essential difference between the lines for motions toward and away on a position-time graph?*

MAKING OBSERVATIONS: Have each member of the group move slowly and steadily away from the detector while facing the detector and the computer screen. Note the ways in which these graphs do and do not match the predictions you and your group have made. Using a dashed

Space for class notes.

line sketch the typical graph which results from this motion on the axes above. Label this line: slowly away.observed.

Save a good example of position-time graph of this motion by pulling down the Data menu and selecting Store Latest Run. This will move your data to another "register" so that it does not erase when you make another run and you will be able to compare this graph with a graph of subsequent motions.

Next, have each member of the group move somewhat faster than before, but still steadily away from the detector, while facing the detector and the computer screen. Again, save a good example of this second motion on screen using the Store Latest Run option under the Data menu. (*Should the two look exactly the same?*) Note the ways in which these graphs do and do not match the predictions you and your group have made. Using a dashed line sketch the typical graph which results from this motion on the axes above. Label this line: faster away.observed.

Repeat this process having each group member move slowly and steadily toward the detector. Save a good example of position-time graph of this motion by pulling down the Data menu and selecting Store Latest Run. Then, have each group member move faster but still steadily toward the detector. As you do the second of these motions, store a good example using the Store Latest Run option under the Data menu so that you can again compare the graphs of the two motions. Make sure that you draw the resulting graphs on the axes on the first page using dashed lines and label them appropriately.

- *What appears to be the difference between slower and faster motions on these position-time graphs?*

- *What appears to be the difference between toward and away motions on these position-time graphs?*

MAKING SENSE: *Did the actual graphs match your predictions?* If there were predictions which did not match the actual graphs, discuss with your group and see if you can come up with something which might explain the discrepancy. Record the ideas your group considers below as you discuss this issue.

Space for class notes.

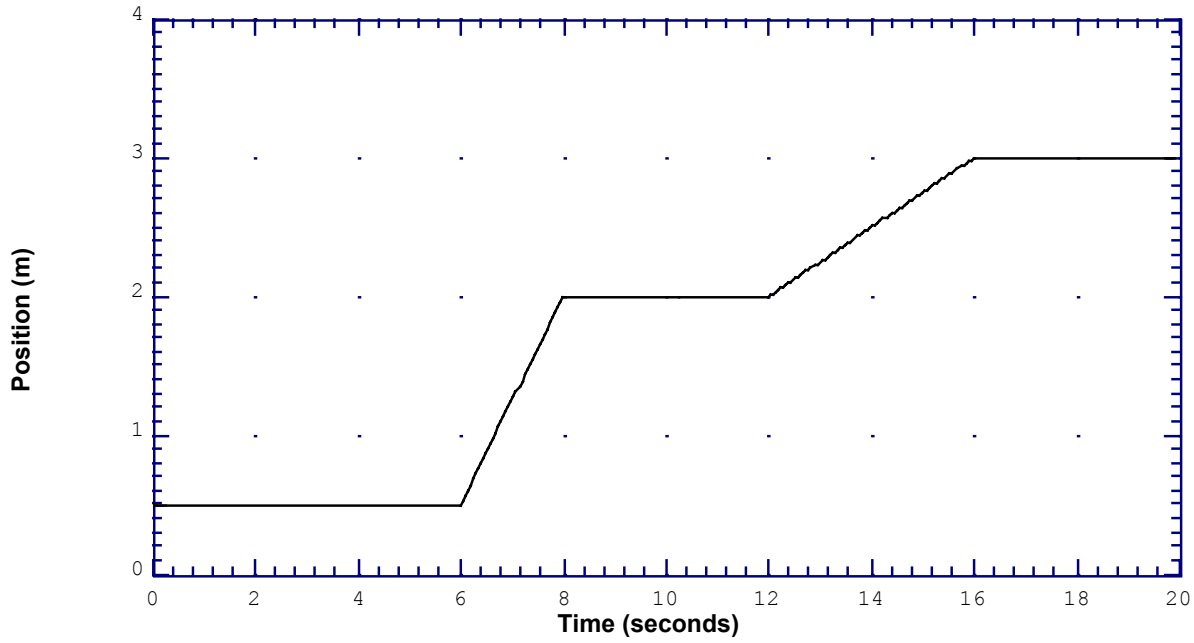
WHAT DO YOU THINK? Without discussing it with your partners, write your own answer to the following question
Any adjustments to what might be meant by the word "Position" on the vertical axis of this type of graph?

WHAT DOES YOUR GROUP THINK? Share your ideas with your group. If members of your group have additional ideas on this question make a note of them below.

With your group come to a consensus as to how one might describe what might be meant by "Position" on the vertical axis of this type of graph. Write this in the space below. Be prepared to report to the class on your group's consensus and its reasons for that consensus.

Begin by opening the MBL file, Act. 1.4.

ACTIVITY 1.4: ***HOW WOULD YOU MOVE TO EXACTLY MATCH THE GRAPH BELOW?***



Space for class notes.

WHAT DO YOU THINK? In the space below, use your understanding of your group's consensus ideas about the meaning of the word "Position" and of the graph to write a description of the motion which would result in the graph above.

WHAT DOES YOUR GROUP THINK? Share your ideas with your lab partners. If you hear different ideas than your own, make a record of them and why they seem reasonable to those who voice these ideas.

Space for class notes.

Can you come to a consensus with your group as to how to describe the motion which will make a graph which will match the graph above? Write the group's conclusions in the space below or indicate which of the predictions already written the group can agree on.

MAKING OBSERVATIONS: When the group is pretty sure of its ideas, each person should attempt to make the motion and repeat until they can make a pretty good match with the graph. The graph you are matching will not erase when you click the start button so make as many attempts as you need. It is very important that each person do this.

- Get the times right
- Get the distances right
- Every person should do it

Record whether you had to depart from the group's consensus description in order to match the graph. *What details of the motion did you have to attend to in order to get a good match with the graph?* Make a record of these.

Space for class notes.

What was the difference, if any, in the way you moved to produce the two differently sloped parts of the graph you just matched?

MAKING SENSE:
WHAT DO YOU THINK? Without discussing it with your partners, write your own answer to the following question.
What changes or adjustments, if any, would you now make to what you think the word "Position" means in this graph based on how the graph behaves? Please explain.

WHAT DOES YOUR GROUP THINK? Share your ideas with your group. If members of your group have additional ideas on this question make a note of them below.

With your group decide whether or not any changes should be made to your consensus description of the apparent meaning of the word "Position" in this type of graph as a result of what you have seen in this activity. If there are any, re-write the changed consensus in the space below.

Space for class notes.

At this point you should quit the graphing program by pulling down the File menu and selecting Quit. When it asks you, DO NOT SAVE ANY DATA.