

Catching mistakes: The case of motion graphs

I. Why think about your mistakes?

In fifty minutes, even the best physics student doesn't have time to totally master a complex physics topic such as motion graphs. So, a major purpose of this tutorial is to help you learn strategies for avoiding and/or catching mistakes, strategies you can use throughout the course.

Since reflecting on the purpose of an activity can help you get more out of it, let's start with this:

- A. (*Answer individually*) What do you see as potential benefits of explicitly thinking and talking about the mistakes you make while working through these activities? If you think dwelling on your mistakes won't be particularly helpful, explain why not.
- B. Discuss your answers with your group. If anyone gave part of an answer significantly different from yours, write a one-sentence-summary of that opinion here.

II. Distance graphs

In order for this section to be effective, you must rotate who controls the computer and who does the walking. Change after *every* trial.

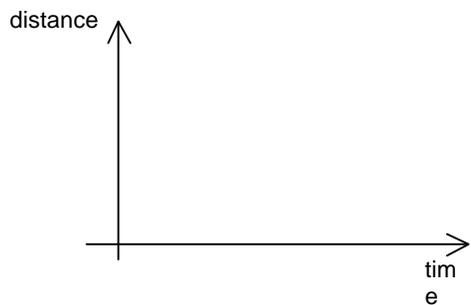
A. *Slow and steady, away.*

1. (*Work individually*) **Predict** what the distance vs. time graph will look like if you start 1/2 meter from the ranger and walk away from it slowly and steadily. Sketch your prediction with a dotted line.

2. Now compare your predictions. After discussion, sketch your consensus prediction with a dashed line.

3. Carry out the **experiment**. Sketch the result with a solid line.

4. *Mistake-catching lesson:* If each student in the group made a correct prediction while working individually, skip this question. If someone made a mistake, try to figure out what went wrong. Specifically, if you made a mistake, write what you were thinking and how you can modify that thinking to avoid the mistake in the future. We've found that your group can often help you with this process! If someone else made a mistake, it's your job to help them sort it out; and exam questions will reward you for being able to understand other students' thinking.

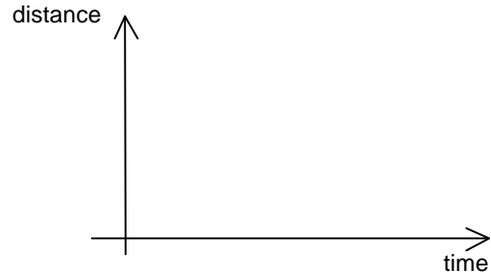


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Sample answer: Here's a good response to this question from someone who drew a flat line instead of a sloped line: "I was thinking the graph shouldn't go up or down since the motion is *steady*; but even for steady motion, your distance from the clicker is increasing, so the graph should go up—at a steady rate! The upward trend is what's steady."

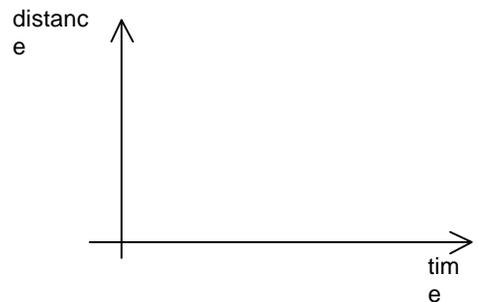
B. Medium fast, away

- (Work individually) **Predict** the distance vs. time graph if you start 1 meter from the ranger and walk away from the detector *medium fast and steadily*. Sketch with a dotted line.
- Compare/discuss. Sketch consensus with dashed line.
- Carry out the **experiment**. Remember to rotate who controls the computer and who does the walking. Sketch result with a solid line.
- Mistake-catching lesson:* If someone made a mistake while working individually, try to figure out what went wrong. Specifically, if you made a mistake, write what you were thinking and how you can modify that thinking to avoid the mistake in the future. If someone else made a mistake, help them sort out why.



C. Slow and steady, towards.

- (Work individually) **Predict:** distance vs. time graph if you start a few meters from the ranger and walk toward it *slowly and steadily*. Dotted line.
- Compare/discuss. Sketch consensus with dashed line.
- Carry out the **experiment**. Rotate who does what. Sketch result with a solid line.
- Mistake-catching lesson:* If someone made a mistake while working individually, try to figure out what went wrong. Specifically, if you made a mistake, write what you were thinking and how you can modify that thinking to avoid the mistake in the future. If someone else made a mistake, help them sort out why.



III. Working with distance graphs

- Briefly describe the difference between the graphs you made by walking slowly and the graphs you made by walking quickly. What feature of the distance vs. time graphs indicates your *speed*?

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★1: [Consult an instructor before you proceed.](#)

IV. Velocity graphs

In this section, you will plot your *velocity* rather than your *position*.

In order to plot velocity, double-click anywhere on the distance graph. A dialog box should appear. Left-click and hold on the *Distance* label and select *Velocity* from the resulting pop-up menu. Then set the velocity axis to range from -1 m/s to $+1$ m/s, and the time axis to range from 0 seconds to 4 seconds.

A. Slowly & steadily away

1. (Work individually) **Predict** the velocity vs. time graph if you walk away from the detector *slowly and steadily*. (Dotted line)
2. Compare/discuss. Sketch consensus with dashed line.
3. Do the **experiment**. Rotate who does what. It works best if you're already walking when the detector starts clicking. When sketching the result of this and other velocity graphs, smooth out the “bumps” that result from your stepping. Use a solid line.
4. *Mistake-catching lesson*: If each student in the group made a correct prediction while working individually, skip this question. If someone made a mistake, try to figure out what went wrong. Specifically, if you made a mistake, write what you were thinking and how you can modify that thinking to avoid the mistake in the future. We've found that your group can often help you with this process! If someone else made a mistake, it's your job to help them sort it out; and exam questions will reward you for being able to understand other students' thinking.

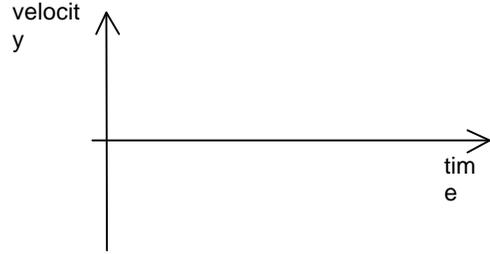


To give you a flavor of what we're asking, here's a good answer to this question from someone who drew a sloped line instead of a flat line: “I was thinking the graph should go up since the person gets farther from the clicker. But that reasoning applies to *position*. The *velocity* graph doesn't go up or down because the walker didn't speed up or slow down. In general, I need to make sure I'm not drawing position instead of velocity.”

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B. *Medium fast towards*

1. (Work individually) **Predict** the velocity vs. time graph if you walk *towards* the detector *medium fast and steadily*. (Dotted line)
2. Compare/discuss. Sketch consensus with dashed line.
3. Do the **experiment**. Sketch result with a solid line.
4. *Mistake-catching lesson*: If someone made a mistake while working individually, try to figure out what went wrong. Specifically, if you made a mistake, write what you were thinking and how you can modify that thinking to avoid the mistake in the future. If someone else made a mistake, help them sort out why.



V. Working with velocity graphs

- A. Describe the difference between the graph you made by walking toward the detector and the graph you made by walking away from the detector. What feature of the velocity vs. time graphs indicates your direction of motion?
- B. Suppose two students both walk away from the detector at a steady pace, but one student is faster than the other. Will their two velocity vs. time graphs be different? If so, how? (If your group is deadlocked, you can do experiments to help you decide!)
- C. To make a velocity graph, a student starts 1 meter from the detector and walks away at a steady pace. Then, to make a second graph, she starts 2 meters from the detector and walks away at the same pace as before. Will her two velocity graphs be the same or different? Explain.

