Math/Physics Lab 2b: Representing Motion

- **Leave space in your notebook for the printouts of your Motion Diagrams and Motion Graphs.**
- **On completing this investigation, you will print out your various Motion Diagrams and Motion Graphs, and you will tape them in the appropriated place in your notebook.**

Part 0. Finishing Up Physics Lab 1.

- Here are the essential features from Physics Lab 1 that you should complete before continuing on with today's lab: Part 3: a) and b) Part 4: a), b), c) and d)
- If you don't have data or have problems with the data you collected, you can do video analysis to obtain data using the video One Buggy.

References:

- LoggerPro tutorials 01 Getting Started and 12 Video Analysis, available under LoggerPro, File: Open: Tutorials.
- Video Analysis for LoggerPro, available in program file share Handouts: Lab 2

Part 1. Video Analysis, Motion Diagrams, Motion Graphs

As a class, you will be introduced to video analysis. By the end of the introduction, you will be shown how to do the following. On completion of this lab, you should be able to do all the things on this list. Nearly everything on this list is covered in the References above.

- Find and launch LoggerPro, Insert a Movie, and Play the video
- Turn on the Video Analysis tools
- Set the scale to convert screen coordinates to world coordinates
- Add points to make a Motion Diagram, toggle trails to show or hide points, and delete a point
- Use Movie Options to change the frame rate for non-standard videos, set the frame advance, and set the zero time to coincide with the first measurement
- Set the Active Point to track more than one object
- Make Motion Graphs: Position vs. Time and Velocity vs. Time graphs
- Find and show best fit lines on Motion Graphs
- Copy the Motion Diagram and Motion Graphs into a separate document

All videos are available in the program file share, in Handouts: Lab 2

Part 2. Two Buggies, Same Direction (source: J.A. Bryan, Ball State University)

a) Reproduce the steps demonstrated in class to create motion diagrams for the two buggies. What do you notice about the spacing between the dots in the motion diagram? What does this indicate?
b) Reproduce the steps demonstrated in class to create **position vs. time** graphs for the two buggies.
c) Fit lines to the position vs. time graphs and obtain the slopes of the lines. Compare the slopes: which is bigger? What physical quantity does the slope of a position vs. time graph represent? Does this match your observation re: which buggy is moving faster?
d) Record the speed and velocity of each buggy (always include units). In this case, is there a difference between the numbers (with units) that correspond to speed and velocity?
e) Copy the motion diagram and position vs. time graph to your document file. Make sure to give them good labels. Save your LoggerPro file (give it a good name) and your document file in your cubbie.

Part 3. Two Buggies, Opposite Direction (source: J.A. Bryan)
Produce motion diagrams for the two buggies. What do you notice about the spacing between the dots in the motion diagram? What does this indicate?

a) Produce **position vs. time** graphs for the two buggies. Fit lines to the position vs. time graphs and obtain the slopes of the lines. Compare the slopes: which has bigger magnitude? Why do they have opposite signs? Does this match your observations re: the direction and speed of the buggies?
b) Record the speed and velocity of each buggy. In this case, is there a difference between speed and velocity?
c) Copy the motion diagram and position vs. time graph to your document file; make sure to label them. Save your LoggerPro file and your document file in your cubbie.

Part 4. Slowing Down (source: J.A. Bryan)

a) Produce a motion diagram. What do you notice about the spacing between the dots in the motion diagram? What does this indicate?
b) Produce a **velocity vs. time** graph. Does the velocity vs. time graph appear linear to your eye? If yes, fit a line to the velocity vs. time graph and obtain the slope of the line. If not, discuss with an instructor or TA.
c) What physical quantity does the slope of a velocity vs. time graph represent? What does the sign represent?
d) Record the acceleration of the car. How does LoggerPro report the units? How does this match how your book reports units for acceleration?
e) Copy the motion diagram and velocity vs. time graph to your document file. Make sure to label them.
f) Make the **position vs. time** graph, and look at its shape. Do you recognize this shape? (It's ok if you don't.) Copy it to your document file; make sure to label it.
g) Save your LoggerPro file and your document file in your cubbie.

Part 5. Speeding Up (source: J.A. Bryan)

a) Note the non-standard frame rate for this video, indicated in the first frame.
b) Reproduce the analysis as in Part 4.

Part 6. Ball Toss (source: J.A. Bryan)

a) Produce a motion diagram. What interesting and challenging thing occurs here that hasn't occurred in your previous motion diagrams?
b) Reproduce the rest of the analysis as in Part 4.
c) As you are able, make connections between Slowing Down, Speeding Up, and Ball Toss.

Part 7. Up and Down, Up and Down (source: LivePhoto Physics Series, RIT)

a) Note the non-standard frame rate as well as the reference scale in the first frame.
b) Produce a motion diagram. What interesting and challenging thing do you notice?
c) Produce a position vs. time graph. Does this look linear? Do you recognize this shape? (It's ok if you don't.)
d) Produce a velocity vs. time graph. Does this look linear? Do you recognize this shape? Compare it especially with the position vs. time graph's shape.
e) We can't do any further analysis right now. Save the LoggerPro file, etc.