Physics Lab 3: More Measuring Motion

- **Leave space in your notebook for printouts of the graphs you will obtain in this investigation.**
- **In the program file share Workspace create a folder named Lab 3 – names of lab partners (example: Lab 3 – Hermione and Harry). Store all your data there; since it's in the Workspace, each partner can access the data.**

Part 0. Previous Labs. Do your best to complete on your own time by Monday January 20.

- Essential features from **Physics Lab 1 Measuring Motion** that you are responsible for completing: 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 (in the program file share, in Handouts: Lab 2).
- **Math Lab 2a.**
- **Math/Physics Lab 2b Representing Motion**.

Goals: Improve communication and teamwork capacities**;** Improve confidence in hands-on work with equipment; Improve ability to make, describe, and record observations; Learn to use a data logger with a motion detector to measure motion and kinematics data; Learn to use LoggerPro software to analyze kinematics data; Gain more experience with graphical representations of motion; Collect and analyze data for constant velocity, constant (non-zero) acceleration, and non-constant acceleration situations.

References for today's investigation:

- LoggerPro tutorials 01 Getting Started, 04 Motion Measurement, and 07 Viewing Graphs, available under LoggerPro, File: Open: Tutorials.

Equipment: You will be oriented to the location and proper use of the equipment for this lab. At the end of the session, return the equipment to its original configuration and location.

Part 1: Getting Started

a) Work in groups of 2, with each group on one side of a lab bench. Take out the keyboard and mouse from the top tray. Take out the LabQuest unit and connecting cables. Obtain an Ultrasonic Motion Detector and cable. Connect up the Motion Detector to the LabQuest and LabQuest to the computer, and then launch LoggerPro (if done in that order, LoggerPro will automatically detect the Motion Detector). Write down sufficient instructions in your lab notebook so that you can connect up this equipment in the future.
b) In LoggerPro, go to Experiment: Data Collection. Look at the default settings and note them down; if you change settings during a data collection run, you may need to change them back.
c) Complete the LoggerPro tutorial 04 Motion Measurement (under Open: Tutorial).

Part 2: Tumble Buggy

a) Adjust the swivel on the Motion Detector so that it will measure motion in the horizontal direction.
b) Confirm the useful measurement range for your motion detector as follows: Aim the Tumble Buggy so that it will travel directly away from the motion detector. Start it as close to the motion detector as you can. Start collecting data, and then turn on the Tumble Buggy. Adjust the Motion Detector as needed so that it detects the moving Tumble Buggy. If needed, extend the data collection time by adjusting Duration under Experiment: Data Collection. Repeat as needed (just a few times should be sufficient) to see what is the distance range over which the motion detector can collect data (closest and furthest distances). Keep track of this information.
c) Obtain a good position vs. time graph for the Tumble Buggy moving away from the motion detector. Once you've obtained good data, **store this run and rename as 'tumble buggy away'**; under Data: Data Set Options, choose the run, which puts up a dialog box; you can rename from there.
d) Obtain a good position vs. time graph for the Tumble Buggy moving towards the motion detector. **Take care so that the Tumble Buggy does not strike the motion detector**. Once you've obtained good data, **store this run and rename as 'tumble buggy towards'**.
e) **Save your LoggerPro file with a useful name** to the folder you created in the Workspace.

Part 3: Bouncing Ball Observations

a) It's important that you do this part as directed, since the key learning will come from making your hand drawn graphs first.
b) Begin with some observations. Obtain a ball. Drop the ball (release it from rest, please don't throw it) so that it bounces straight up and down. Do this several times until you have a good sense of how its position above the ground (the height) changes with time.
c) By yourself: In your lab notebook, draw the best graph you can (by hand) that represents the position above the ground (the height) vs. time. Consider just one "round trip": just after the ball hits the surface and is moving up through reaching top of its trip to just before the ball hits the surface on the way down.
d) By yourself: Similarly, draw the velocity vs. time graph that corresponds to the position vs. time graph you just drew.
e) With your partner: Share your graphs with your partner, compare them, discuss them. If needed, draw new graphs (don't cross out your old ones!). Note down any disagreements between you and your partner.
f) Show your graphs to Krishna. Obtain Krishna's initials, which just indicate that you drew the graphs and discussed them with him.

Part 4: Bouncing Ball Measurements

a) Start a new LoggerPro, using File: New.
b) Hold the motion detector in the air, and aim it straight towards the ground. Drop the ball under the motion detector so that it bounces straight up and down (as close as you can get). If you need a third person, ask Krishna, Diane, or Julian for help.
c) Obtain good position vs. time graphs for straight up and down bounces of your ball that includes four full bounces (more is preferable) in a single run, storing each acceptable run. Adjust the measurement Duration in Experiment: Data Collection as needed. Use Reverse Direction in the Experiment: Set up Sensors menu (why do you do this?). **Rename your best run as 'best ball bounce'**.
d) **Save your LoggerPro file with a useful name** to the folder you created in the Workspace.

Part 5: Pull-back Car

a) Start a new LoggerPro, using File: New.
b) Obtain a Pull-back Car. Play around until you find the right distance to pull back the car (not too far!) so that when you release it, the motion of the car is in the range of your motion detector.
c) Obtain position vs. time graphs for the motion of the Pull-back Car, storing each acceptable run. **Rename your best run as 'best pull back car'**.
d) **Save your LoggerPro file with a useful name** to the folder you created in the Workspace.

Part 6: Analysis

a) In each LoggerPro file, show each of your best position vs. time graphs. Typically, the very beginning and the very end of a run aren't very useful because you are in the way. Change the horizontal and vertical scale so that the relevant part of the motion is prominently displayed and takes up the most horizontal and vertical space (ask if you're not sure what this means).
b) For each position vs. time graph, create a corresponding velocity vs. time graph (Insert: Graph). Make sure that the horizontal (time) axis matches the position vs. time graph exactly. Make sure the vertical (velocity) axis is scaled so that the relevant data fills up the graph vertically.
c) If the position vs. time graph (or parts of it) looks linear, obtain a best fit straight line by highlighting the data and pressing the Linear Fit button (make sure the position vs. time graph is selected). If more than one region is linear, obtain separate lines for each region.
d) If the velocity vs. time graph (or parts of it) looks linear, obtain a best fit straight line; if more than one linear region, obtain separate lines for each region.
e) Discuss with Krishna either today or in the follow-up session for this investigation.