Patterning the World – Winter 2014 Name:_____

Partner's Name:_____

Physics Lab 2: Measuring Motion 2

Goals: Improve communication and teamwork capacities**;** Improve ability to record notes; Improve confidence using computers; Start learning to use analysis tool LoggerPro; Start learning to perform video analysis; Apply video analysis to constant velocity motion along a straight line; Develop a mathematical model for straight line constant velocity motion and use that model to make predictions; Connect studies in pre-calculus with physics.

Equipment: Your primary tool today will be the computer. You can find a keyboard and mouse for your computer in the top drawer. These are paired with that particular computer, so take precautions not to mix them up. If the keyboard or mouse doesn't interact with the computer, make sure they are turned on. The videos for today's video analysis are located in the program share, under Handouts, and then in the Week 1 Lab folder.

Groups: For today's investigation, you will work in groups of 2; each pair will work at a computer.

References:

- LoggerPro tutorials 01 Getting Started, 07 Viewing Graphs, and 12 Video Analysis, available under LoggerPro, File: Open: Tutorials.
- Video Analysis for LoggerPro, available in the program file share, under Handouts: Week 1 Lab folder.

Part 0. Lab Notebook

o Your name and contact information should be written prominently and early.
o You should leave room for a Table of Contents. If you have already begun to write on the first page, then you can insert a separate sheet of paper for a Table of Contents; ask how if you are uncertain.
o Each new lab should begin on a new page, and start with the title of the investigation. You should also include the names and contact information of any lab partners.
o It's a good idea to leave some room at the end of each lab entry in case you need to add something later.
o For this lab, you should leave sufficient space at the end to tape in the graphs which you will print out later when you have access to a printer and then tape directly into your lab notebook.

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 set the frame advance
- Set the Active Point to track more than one object
- Make a Position vs. Time graph
- Find and show best fit lines on Motion Graphs
- Copy a Position vs. Time graph into a separate document

a) Together, we will analyze the video One Buggy (source: J.A. Bryan, Ball State University). All videos are available in the program file share, in Handouts: Week 1 Lab. You will need to make sure that you are opening the videos from within LoggerPro.
b) Leave space in your lab notebook to tape in the position vs. time graph later.
c) In your lab notebook, write down the equation for the best fit line. This is your mathematical model. Make sure to separately write down the slope, including sign, numerical value with uncertainty, and units. Make sure to separately write down the y-intercept, including sign, numerical value with uncertainty, and units.
d) Copy the position vs. time graph to your document file. Make sure to give it a good label. Save your LoggerPro file (give it a good name) and your document file in your Workspace folder.

Part 2. Two Buggies Same Direction (source: J.A. Bryan)

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 full equations for the lines for each buggy.
d) Follow steps b), c), and d) from Part 1.

Part 3. Two Buggies Opposite Direction (source: J.A. Bryan)

Reproduce the preceding steps for the video Two Buggies Opposite Direction

Analysis

1. Consider your results from Two Buggies Same Direction.

a) Which buggy moved faster?
b) How does that show up in your position vs. time graph?
c) What physical quantity is represented by the slope of the lines on the position vs. time graph (hint: look at the units)?
d) Do the numerical results match your observations as to which buggy is moving faster?

2. Consider your results from Two Buggies Opposite Direction.

a) Which buggy moved faster?
b) How does that show up in your position vs. time graph?
c) Do the numerical results match your observations as to which buggy is moving faster?
d) What does it mean that one of the slopes is a negative number? Answer both mathematically (what does a negative slope mean with respect to the graph of the line) and physically (what does a negative slope mean about the motion of the buggy).

Applications and Extensions

1. Consider your mathematical model for the One Buggy motion. Use your model to answer the following questions.

a) Where will the buggy be at 0.5 seconds? Answer in terms of world coordinates, not in terms of the meter stick. This is equivalent to asking you to evaluate your linear function at $t = 0.5$ s.
b) When will the buggy be at $x = 0.5$ m (the position is in world coordinates, not in terms of the meter stick). This is equivalent to asking you to solve the linear function for $x = 0.5$ m.
c) Use your model to predict when the buggy will be at $x = 1.0$ m (world coordinates).
d) Check with your instructor.

2. Perform video analysis on the video When Will They Pass to answer the question: when will the buggies pass each other? Then, check with your instructor.