Physics 200 Name(s) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Motion Video Scavenger Hunt

**Overview**: In groups of 2-3, capture video clips meeting each of the motion requirements below. Care must be taken to capture videos that may be analyzed using frame-by-frame analysis. You will be using these videos to create graphs of position vs. time and velocity vs. time (and possibly acceleration vs. time).

1. Constant Velocity (or nearly constant)
2. Acceleration (increasing speed)
3. Deceleration (decreasing speed)
4. Velocity that changes sign – positive to negative or vice versa.

**Steps**:

1. Get a video camera and a meter stick. Then, in the school, the classroom, or just outside one of the school entrances, find or create an object that demonstrates the required motion.
2. Capture a video of the object’s motion. Use each of the methods below for two of your videos.
3. Confirm that the video is satisfactory. Then trim it to be as short as possible.
4. Find a way to transfer the video so that you and your partner(s) can access it on the school computers. To preserve high resolution and Iphone slow motion frame rate, uploading via a cable is recommended. The easiest method of sharing may be to upload the video to your Google Drive and share it.
5. Next class-- Use the video footage to create graphs of position vs. time and velocity vs. time.
6. You will be conducting video analysis individually. Make sure that each of the videos you created is analyzed by someone in your group. Everyone is analyzing two videos, so some students will probably be analyzing the same video.

**Two methods of capturing useful video**:

1. **The object moves along a motionless “ruler” (camera can be moving).** For example, you could follow an object that is moving along a tiled floor, in the same direction as the floor tiles. If the floor tiles are even in size, you can measure them and use them as your video *ruler*. Another ruler could be bricks on the side of the building. The ruler could also, literally, be a ruler or meter stick.
   1. For best results:
      1. **The ruler and the object should be the same approximate distance from the camera**. Otherwise perspective issues will distort your data.
      2. **Brighter lighting is best, especially for fast subjects.** This increases the camera’s shutter speed and decreases blurring.
2. **The camera is kept motionless as the object moves near an object of known length.** For this method to work well there must be an object of known length situated in the field of view at the same distance from the camera as the moving object. Again, this could be an actual ruler or meter stick. The analysis is easy to do using the Logger Pro software we used with the motion sensors.
   1. For best results:
      1. **The camera must be kept still.** During video capture, try to prevent the camera from being rotated, tilted or moved in any way.
      2. **The moving object that is being measured should remain a constant distance from the camera.** It should not be approaching or moving away from the camera. If the object approaches or moves away from the camera, the size scale will change and you’re your position data. If it’s feasible, moving farther away from the object can minimize this problem.
      3. **The moving object and the ruler should be the same distance from the camera.**
      4. **Brighter lighting is best, especially for fast subjects**

Video Analysis Directions – Save for Future Reference

**Method 1 (Logger Pro Method): CAMERA MUST REMAIN MOTIONLESS. There must be a “ruler” in the field of view, at the same distance as the moving object.**

1. Upload, share, and download the video to your computer.
2. Navigate to your downloads folder and find the video. Right click on the video and select *properties.* Then select the *details* tab. Find the frame rate of the video and remember it or write it down for later use.
3. Open Logger Pro
4. Under the *insert* tab, choose *movie.* Select the movie that you just downloaded from your *downloads* folder.
5. Right click somewhere in the movie frame and select *movie options*. Check out the line that says “override frame rate to 29.98fps.” If that’s not the approximate frame rate of your video, then click the check box and enter your video’s correct frame rate.
6. In the bottom right corner of the movie frame, click the button with three little red dots. This makes tools appear on the right side of the movie frame.
7. Expand your movie frame so that it is as large as you can reasonably manage. This will increase the precision of your measurements.
8. Click the sideways ruler to *set scale*. Then find the object in your video that will serve as your size reference. Click/Drag from one end of the object to the other, and release the mouse button. Then enter the object’s length, in meters.
9. Use the slider to advance the video to the point where you want to begin analyzing motion.
10. Click the crosshairs with a red dot in the middle. This is the *add point* tool. Choose a location on your object where you will be clicking every time. Then click on that point. When you do this, a dot appears where you clicked, and the video advances one frame.
11. Now you can either click again on the object’s new position, or you can use the double arrow button to advance the video multiple frames before you mark the new position. Sometimes this is helpful because the object is moving so slowly that the last dot obscures the object so that you can’t place the new dot. Skipping frames is okay in terms of calculations, but you will have fewer data points. Usually, that’s okay.
12. Continue to use the crosshairs to add new positions until the motion is almost finished. If you go one click too far, *Ctrl+Z* works to undo your last click. Don’t count on it working for a whole bunch of clicks.
13. You can save your work at this point, but unless you’re tech savvy it can be difficult to find later on.
14. Open the [provided Google spreadsheet](https://docs.google.com/spreadsheets/d/1WZYPesNy5ECDjOgRbAzYqrXNBr7aZOHVpd6diD3L-Ho/edit#gid=0) (recommended) or create a new Google Sheet. Make a copy of the spreadsheet and rename it with your name and a brief description.
15. Take brief look at the spreadsheet to get an idea of how your final product will look.
16. Delete the data that are currently entered into the spreadsheet (cells A2:E12).
17. Return to Logger Pro. Find the data table on the left and expand it so that you can see all of the cells. Select all of the data and copy. Alternatively, click on the data and then *Ctrl+A* to *select all*, then copy.
18. Return to the spreadsheet and paste your data into cell A2.
19. At this point, the graphs are likely messed up. It’s time to fix them.
20. Right click on the position vs time graph and select *data range.*
21. In the new window, locate “x axis.” Click the three dots to the right of those words and select *edit*.
22. In the *what data* window, delete the current data range, then select the correct data range for your x axis (time) by click/dragging down your entire column of times. Click okay.
23. Now think about your position vs time graph. Is your motion in the X dimension or the Y dimension? [The example graph is set up for the x dimension.]
24. Right click the graph again and select *data range.* This time choose *series*. “Series” is what the y axis data are called. Delete the current series data and then select (click drag) your correct y axis data. If your object’s motion is horizontal, you will select data under the “X(m)” data column. If your motion is vertical, the series data are those under the “Y(m)” data column.
25. Now repeat steps 19-23 for the velocity graph. The x-axis data will still be your data points for time. The *series* data will be either the “Vx(m/s)” column or the “Vy(m/s)” column, depending on your object’s axis of motion.
26. Share your spreadsheet so that I ([jstapleton@ewsd.org](mailto:jstapleton@ewsd.org)) **can edit it**. Then paste a link to your spreadsheet in the appropriate cell of the class spreadsheet ([A5/6](https://docs.google.com/spreadsheets/d/1ZdIhtso1S-SldRMjkBXWvsWZcVZEqVwyhISerhXRKyo/edit#gid=0),  [A7/8](https://docs.google.com/spreadsheets/d/1iovhfODgPwXJiH2KbYKG-jXgzM1rvlQOrMbwAUzDNlI/edit" \l "gid=0)).

**Method 2: Motion along a “ruler” – Camera may move**

1. Download the video
2. Navigate to your downloads folder and find the video. Right click on the video and select *properties.* Then select the *details* tab. Find the frame rate of the video and remember it or write it down for later use.
3. Right click on the movie, and select *open with*. Then select *default program* and choose *Quicktime Player.* After this, you might get a question about restoring stuff. I usually click no. Sometimes I click yes. I’ve never noticed a difference.
4. When the video opens in Quicktime, click the button in the top right of the video frame that helps you resize the movie most effectively.
5. Find the counter (00:00:00) in the bottom left of the frame. Click that counter, and then choose *frame number*.
6. Again, you will need a spreadsheet. Either create your own or use this [provided example](https://docs.google.com/spreadsheets/d/1DicNNYXNZ5_T6ydTnO2sMe8vesGcrla3KGcllFS0KZc/edit#gid=0) and replace my data with yours. In my example, I used floor tiles as my ruler. My video frame rate was 111fps. If necessary replace the contents of the green cells with appropriate descriptions and numbers.
7. Delete the data in the yellow cells.
8. Now go back to the video in Quicktime Player. Advance the video to the motion’s starting point. If the object is not on one of your “ruler” marks, advance until it reaches one. Then note the frame number in the bottom left, and enter that frame number into the top yellow cell in column A of the spreadsheet.
9. Return to the video and click or hold the forward arrow until your object reaches the next mark on your “ruler.” I clicked until mine reached the next floor tile. If you want, you can advance multiple marks on your “ruler.” Note the current frame number and the total number of ruler marks passed so far, and those numbers in the left and right yellow columns, respectively.
10. Continue collecting new data points. For each point, you will need the frame number and the total number of marks passed up to that point.
11. Now you will probably need to adjust your graph data ranges to match the size of your data set. The position vs time graph should have “elapsed time” for its x axis and “Position(m)” for its *series.* The velocity vs time graph should have “elapsed time” for the x axis and “Speed (m/s)” for its series.
12. Share your spreadsheet so that I ([jstapleton@ewsd.org](mailto:jstapleton@ewsd.org)) can edit it. Then paste a link to your spreadsheet in the appropriate cell of the class spreadsheet ([A5/6](https://docs.google.com/spreadsheets/d/1ZdIhtso1S-SldRMjkBXWvsWZcVZEqVwyhISerhXRKyo/edit#gid=0),  [A7/8](https://docs.google.com/spreadsheets/d/1iovhfODgPwXJiH2KbYKG-jXgzM1rvlQOrMbwAUzDNlI/edit#gid=0))