# *Lab 3-0:* **Velocity Vectors**

**Names:**

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**Purpose:**
1. To learn how to use Logger Pro to analyze a movie.
2. To determine the velocity of a toy car through video analysis.
3. To become more comfortable relating the magnitude and direction of a velocity with its components.

**Procedure:**

1. Download the video assigned to you in Google Classroom. Make sure you know where you saved it.

2. Make sure there are no probes attached to the Lab Quest and start up Logger Pro.

3. Insert the movie to be analyzed as follows: under "Insert" choose "Movie..." and pick the correct movie.

4.  Enable video analysis by clicking on the box on the bottom right of the movie that looks like the button to the left.

5.  Set the scale of the movie by clicking on the "Set Scale" button (upper right corner), then clicking and dragging between the vertical black lines in the movie. The vertical black lines are 0.305 meters apart.

6.  Set the origin by clicking on the "Set Origin" button (upper right corner), and then clicking on the first position of the car. Click on the small yellow dot in the passenger seat. Now that the scale and origin is entered, you don't need to see it (and in fact they both get in the way) so click on the buttons labeled "Show Origin" and "Show Scale" to turn them off.

7.  Now to record the actual position of the car for each frame of the movie, click on the "Add Point" button (upper right corner.) Carefully center the mouse on the yellow dot in the passenger seat, and click. Logger Pro will record the x and y coordinates of the mouse click, and the movie will automatically go to the next frame. Do this for the whole movie.

8. To clean up the window, under **Page**, choose **Auto Arrange**. You should now see the position vs. time graphs on the main screen.

9. Save your Logger Pro file in case something bad happens – and remember where you saved it. Cut and paste the position graphs below.

COPY AND PASTE YOUR POSITION GRAPHS HERE

A. *Every time you clicked on the movie, Logger Pro recorded 3 things – what were they?*

B. *The position graphs should all have been straight lines. Why does that make sense?*

C. *In general, what does the slope of a position graph tell you?*

D. *Notice you have two position graphs for each trial – one called X-Position and the other called Y-Position. Specifically, what would the slopes of those graphs tell you?*

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*E. If you know the X and Y coordinates of something, how would you calculate its distance to the origin?*

10. Make a new calculated column to determine how far away from the origin the car is for each data point. Call it "Distance." (Under **Data**, choose **New Calculated Column**.)
11. Now make the graph only Distance vs time. Copy and paste it below:

COPY AND PASTE YOUR DISTANCE VS TIME GRAPHS HERE

*F. The four graphs should all have the same slope. Why is that?*

*G. The four graphs are not all the same length though. Why is that?*

12. Determine the slopes of the Distance vs Time graph for each trial and record below.

| *Trial 1* | *Trial 2* | *Trial 3* | *Trial 4* |
|---|---|---|---|
| v = | v = | v = | v = |

*H. Do those numbers make sense? Explain.*

13. Now make the graph both the X and Y Positions vs time again. Determine the 7 non-zero slopes by highlighting the straight sections and doing a linear fit for each set of graphs in each trial. Record the results in the table below. (*Recall your hopefully correct answer to letter D previously*.)

| *Trial 1* | *Trial 2* | *Trial 3* | *Trial 4* |
|---|---|---|---|
| $v_x$ = | $v_x$ = | $v_x$ = | $v_x$ = |
| $v_y$ = | $v_y$ = | $v_y$ = | $v_y$ = |

*I. The horizontal velocity ($v_x$) for the first trial should be equal to the slopes of your D vs T graphs from part 12 and the vertical velocity ($v_y$) should be 0. Why is that?*

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*J. The horizontal velocity ($v_x$) should decrease with each successive trial while the vertical velocity ($v_y$) should increase. Why is that?*

*K. If you knew the horizontal and the vertical velocity, how could you determine how fast something was going?*

14. For each trial, and based on your data in part 13, calculate the speed of the car and record your results below:

| *Trial 1* | *Trial 2* | *Trial 3* | *Trial 4* |
|---|---|---|---|
| v = | v = | v = | v = |

*L. Do those numbers make sense? Explain.*

*M. Hopefully you found (both times) that the speed of the car was the same in each trial. But were the velocities the same? Explain.*

15. Now make the graph show the X and Y velocities. Copy and past the graph below.

COPY AND PASTE YOUR X & Y VELOCITIES VS TIME GRAPHS HERE

*N. Do those graphs make sense? Explain.*

16. Make a new calculated column to determine how fast the car is going in each trial based on the X and Y velocities. Call it "Speed 1." (Under **Data**, choose **New Calculated Column**.) Then make the graph show Speed vs time and copy and paste it below.

COPY AND PASTE YOUR "SPEED 1" VS TIME GRAPHS HERE

17. There is a second way you can make the graphs of speed vs time, but this time base it on your Distance vs Time graphs. Before you do this, see how Logger Pro calculated the X and Y Velocities by double-clicking on either the X or Y velocity column heading in the data section. Then you can add a new calculated column called Speed 2. Finally, make yor graph show Speed 2 vs time and copy and paste it below.

COPY AND PASTE YOUR "SPEED 2" VS TIME GRAPHS HERE

*O. Do those graphs make sense? Explain.*