

Name: _____

Date: _____

Lab TI-Nspire™ toys on a slope
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 DEG APPRX REAL and then RAD AUTO REAL
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The purpose of this activity is to analyze data measurements from toy vehicles rolling down a slope.

A long board was elevated 20 cm and toy vehicles were rolled down its 1.5 meter length (marked as a starting point on the board, which was actually longer than 1.5 meters). The total time of each vehicle from the 1.5 m mark to the zero point was recorded by different groups of students (as seen below) for three trials. The time for each of the three trials was added together and divided by three to find an average time, as reported below. Three vehicles were used: a large red monster truck, a medium grey car and a medium purple SUV. For comparison, I consider a small car to be a car that would fit in your pocket.

Table 1

dist (in m)	Avg time in sec, of truck	Avg time in sec, of car	Avg time in sec, of suv
0	0	0	0
1.5	2.30	1.64	2.64
1.5	2.03	1.95	2.32
1.5	2.05	2.02	1.87
1.5	1.97	1.92	1.94
1.5	2.22	1.66	2.53
1.5	2.09	1.69	2.54
1.5	1.68	1.81	1.97
List I: plotted on y-axis of each graph	List II: plotted on x-axis Of graph 1	List II: plotted on x-axis Of graph 2	List II: plotted on x-axis Of graph 3

How will this look on graphs?

	Graph 1	Graph 2	Graph 3
2m			
1.5			
1m			
.5m			
0m			
	0s 1s 2s 3s Dist (m) vs. Time (s), of truck	0s 1s 2s 3s Dist (m) vs. Time (s), of car	0s 1s 2s 3s Dist (m) vs. Time (s), of suv

Note: The intersection of 0 m and 0 s is intended to be at the x/y intersection of each of the graphs above.

In the graphs above, we drew the slope through the middle of each data pack so that we would choose the median score; the score above half the data is above and below.

The average time for each vehicle and average speed for each vehicle can be determined mathematically as follows:

Home

New Document

Calculator

For determination of the average time for the truck, car and suv, add all of the times for each vehicle (excluding the zero) and divide by 7.

Avg time of truck (in sec) _____

Avg time of car (in sec) _____

Avg time of suv (in sec) _____

Next, determine the speed/velocity of each vehicle by dividing the distance, 1.5 m, by the average time of each vehicle.

speed of truck (in meters/sec) _____

speed of car (in meters/sec) _____

speed of suv (in meters/sec) _____

PLEASE CHANGE THE CALCULATOR MODE TO **RAD AUTO REAL** BY GOING HOME, SYSTEM INFO AND SYSTEM SETTINGS. TAB AND CLICK TO CHOOSE **RAD AUTO REAL** IN THEIR RESPECTIVE PULL-DOWNS AND TAB TO OK AND CLICK. APPLY TO SYSTEM SETTINGS.

Step 1: We will enter the data into a list.

Home

Use the down arrow on the navpad to Add Lists and Spreadsheet

Click

Use the navpad to move to the A cell in the top left corner

Type **dist** in the A cell

Hit tab to go to the B cell

Type **truck**

Hit tab to go to the C cell

Type **car**

Hit tab to go to the B cell

Type **suv**

Use navpad to go to cell 1 under **dist** to enter the data in that list from Table 1 above. Push down on navpad after each entry.

Hints:

To fill down, place the number in the first cell desired (in this case, for **dist**, data cell 2), and then navpad down and back up to the cell. Control and menu, select fill down. Move the dark cell to the last cell you want (in this case 8) to fill and click. Escape.

To clear an entire column, move the navpad to the top of the column until it turns black. Control and menu, then select Clear data and click.

Use navpad to go to cell 1 under **truck** and enter data in that list from the table above. Push down on navpad after each entry.

Use navpad to go to cell 1 under **car** and enter data in that list from the table above. Push down on navpad after each entry.

Use navpad to go to cell 1 under **suv** and enter data in that list from the table above. Push down on navpad after each entry.

Step 2: Plotting the data on graphs.

Home
Data and Statistics
Click
Notice plot of data

At the bottom of the view box, use your arrow to click on the click to add variable box, use your navpad to select **truck** and use the click button in the center of the navpad to click on **truck**. We have just defined the X-axis.

At the left side of the view box, use your arrow to click on the click to add variable box, use your navpad to select **dist** and use the click button in the center of the navpad to click on **dist**. We have just defined the Y-axis.

Home
Data and Statistics
Click
Notice plot of data

At the bottom of the view box, use your arrow to click on the click to add variable box, use your navpad to select **car** and use the click button in the center of the navpad to click on **car**. We have just defined the X-axis.

At the left side of the view box, use your arrow to click on the click to add variable box, use your navpad to select **dist** and use the click button in the center of the navpad to click on **dist**. We have just defined the Y-axis.

Home
Data and Statistics

Click
Notice plot of data

At the bottom of the view box, use your arrow to click on the click to add variable box, use your navpad to select **suv** and use the click button in the center of the navpad to click on **suv**. We have just defined the X-axis.

At the left side of the view box, use your arrow to click on the click to add variable box, use your navpad to select **dist** and use the click button in the center of the navpad to click on **dist**. We have just defined the Y-axis.

Hint: If your screensaver blacks out your view box, touch the on button once.

Step 3: Analysis and Conclusion

We will now analyze each graph by adding a movable line.

Navpad back to the truck graph by hitting ctrl and left navpad.

Menu
Analyze
Click
Add movable line
Click middle button on navpad
Escape

Move the arrow until you are near the top of the movable line and a cycle sign appears. Hold control and click on the line to grab it. Use the navpad to move the top of the line until it is in the middle of the data points. Escape and grab the bottom of the movable line and place it through the origin of the x/y axis. You may have to grab and alternate between ends to accomplish this task, pressing escape to let go and move to a new location.

Repeat this process with each of the two other graphs, now following with the car graph and then the SUV graph.

Slope is rise over run. In this activity, it is distance over time, which is speed or velocity.

If m in the $y = mx + b$ equation indicates slope, look in the equation by the line and tell me the speed in m/s of each vehicle (at the end of the slope) in each graph.

Truck speed _____
Car speed _____
SUV speed _____

Does this match our earlier calculations? Is this what you expected for the speed/velocity of the vehicle?

Why not?

How can we fix this?

If the graph is not $y = 0$ and $x = 0$, navpad back to the first (**truck**) graph and we will tweak it a bit. We need to make sure that the scale on the bottom (x) is at zero at the origin. If it is not, we must control and click on the x axis and move it to make sure zero shows at the origin on the x axis. We may need to alternate back and forth moving the movable line to keep it on the page during the process. We must also ensure that all of the data remains in the screen.

Once the zero of the x axis is at the origin, again move the line until the line bisects the origin on the lower end and the data on the upper end. Now write down the speed of the truck.

Repeat the process for the car and suv graphs.

Truck speed after adjustments _____
Car speed after adjustments _____
SUV speed after adjustments _____

Does the steepness of the lines reflect the slope (speed of the vehicle)?

Is this different than the average speed of the vehicle? How?

Next, write down the formulas for each movable line so that we can place them together on a larger graph.

Or

transcribe your own:

$m1(x) := 0.747 \cdot x + 0.00625$
 $m2(x) := 0.836 \cdot x - 0.00791$
 $m3(x) := 0.639 \cdot X - 0.0075$

$m1(x) :=$ _____
 $m2(x) :=$ _____
 $m3(x) :=$ _____

Step 4: Further analysis-placing all of the movable lines on one graph together.

Home

Graphs and Geometry

Click

Escape to get a blank screen

Customizing the graph

First, we will customize the x and y values of the graph to fit the earlier data.

Use the navpad and go to the number at the top of the screen near the + y axis. Double click on it and enter 2.0 for the + y value. The + y axis represents distance. (Remember the distance traveled was 1.5 m. The value of 2.0 allows for a bit of room on the graph.

Next, go the number on the right by the + x axis and enter 3. The + x axis represents time. This exceeds the maximum time on Table 1.

Change the - y and the - x each to -1.

This will create a graph that is similar to the three hand-drawn graphs earlier.

Plotting the lines

If the formula line is not open at the bottom, move the arrow to the double arrow at the bottom left and click it to open it.

In the f1(x): entry, enter the formula you wrote in the m1 (x) : = statement above. Hit enter.

If the formula line is not open at the bottom, move the arrow to the double arrow at the bottom left and click it to open it.

In the f2(x): entry, enter the formula you wrote in the m2 (x) : = statement above. Hit enter.

If the formula line is not open at the bottom, move the arrow to the double arrow at the bottom left and click it to open it.

In the f3(x): entry, enter the formula you wrote in the m3 (x) : = statement above. Hit enter.

Do the three slopes differ dramatically?

If so, which one has the steepest slope? (Use your navpad to roll the arrow over each slope to reveal its value).

Which has the flattest slope?

What could account for the differences?

What is the over-arching lesson to be learned in this activity? How does the mass or size of a vehicle affect its speed down a slope?

Adding text on the screen

Menu

Action

Text

Move the I pointer to an open space and

Click on an open space

Type toys on a slope and click enter. (Use the bracket key to the bottom left of the enter button to add spaces between words).

Menu

Action

Text

Move the I pointer to an open space and

Click on an open space

Type car and 0.836 m/s

Click enter, escape.

Menu

Action

Text

Move the I pointer to an open space and

Click on an open space

Type truck and 0.747 m/s

Click enter, escape.

Menu

Action

Text

Move the I pointer to an open space and

Click on an open space

Type suv and 0.639 m/s

Click enter, escape.

Next, use control and click to grab the navpad the descriptions to favorable locations on the screen.

Save the document on the handheld and then download it to your computer using your TI software. Print the graphs for your lab report.

That's a very nice dress-up of the hard work you completed. Nice!

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