



Martinsville Chase Activity

STEM Lesson for TI-Nspire™ Technology

Objective: Students will create graphs of using calculated. Students will then use the graphs to analyze the data and investigate the idea of attaching a wing to a Sprint Cup car.

About the Lesson: Martinsville Speedway is 0.526 miles around and 12 degree banking. Martinsville is a monumental test of brakes and setup. The track is partially paved in asphalt and partially (corners) paved in concrete. When brakes begin to fade a driver must simply slow down in order to keep the car on the track. Brakes and braking certainly became an issue for the 17 car as well as others in the 2011 chase race. In the old Can-Am series the cars were allowed to have moveable wings running nearly flat (low angle of attack) for down-force and minimal drag then standing the wing nearly up-right to create a huge drag and act as a brake when going into a corner. In this lesson you will investigate the idea of using a 6' x 6' moveable wing at Martinsville on a NASCAR Sprint Cup car.

Materials: Student Worksheets

Prerequisite skills: The students need to understand formulas and units. Students also need to be proficient in creating scatter plots.

Analysis:

The formula for drag is below.

$$\text{Aero Drag (force)} = \left(\frac{\rho}{2} \right) A * C_d * V^2$$

Use the following constants and fill in the table with the drag for each speed for a single square foot plate and a 36 square foot plate (6 ft x 6 ft). You will have to change miles per hour to feet per second.

$$\begin{aligned} \rho/2 &= 0.00236 \text{ slugs per ft}^3 \\ C_d \text{ (coefficient of drag)} &= 1.0 \end{aligned}$$

Speed (mph)	Speed (ft/sec)	Drag (lbf) A = 1 sq ft	Drag (lbf) A = 36 sq ft
60	88.00	9.137924	328.9653
70	102.67	12.43773	447.7583
80	117.33	16.2452	584.8271
90	132.00	20.56033	740.1719
100	146.67	25.38312	913.7924
110	161.33	30.71358	1105.689
120	176.00	36.5517	1315.861
130	190.67	42.89748	1544.309
140	205.33	49.75092	1791.033
150	220.00	57.11203	2056.033
160	234.67	64.98079	2339.309
170	249.33	73.35722	2640.86

Using TI-Nspire Technology

1. Open the file named ***Martinsville_Chase_Activity.tns***.
2. Move to page **1.2**.
3. Enter the speed in mph and drag into the appropriate columns.

	speed	drag1	drag36
1	60	9.13792	328.965
2	70	12.4377	447.758
3	80	16.2452	584.827
4	90	20.5603	740.172
5	100	25.3831	913.792

4. Move to page **1.3** to create a scatter plot of *drag* vs. *speed*.
5. What is the independent variable?

Answer: speed

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6. What is the dependent variable?

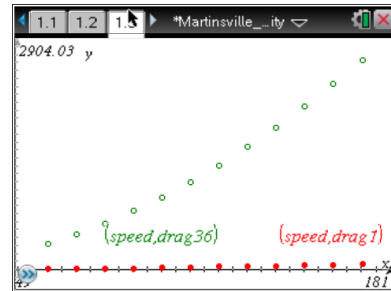
Answer: drag

Navigator Tip: Screen Capture student handhelds to make sure everyone has the right variable on the right axis.

7. Press (var) and choose your independent variable. Press \blacktriangledown then (var) and select your dependent variable. Press (enter) .

8. Press (menu) then **Window/Zoom > Zoom – Data**.

9. Press (tab) and repeat steps 7 and 8 for each driver. Adjust window to better view the data by pressing (menu) the **Window/Zoom > Window Settings** and move labels around by grabbing and dragging the text. Press (ctrl) (x) to grab an object.



10. Make a conjecture about the drag force has speed increases.

Answer: It increases.

11. Which size wing would be better to stop a 3400 lb car?

Answer: The 36 sq ft (or 6 ft x 6 ft) wing.

Navigator Tip: Quick Poll the students for their answers to #10 and #11 and show the results to start a good discussion reading graphs.

12. Move to back to page 1.2.

13. Calculate the g-force for the big wing at each speed. Move to column D and type a title in the top cell. Press (enter) . Move down to cell D1 and type the formula $=c1/3400$. Press (enter) . In the next cell type $=c2/3400$ and $=c3/3400$ in the next and so on. After the first three, you could highlight the cells the copy and paste.

	speed	drag1	drag36	gforce
1	60	9.13792	328.965	0.096755
2	70	12.4377	447.758	0.131694
3	80	16.2452	584.827	0.172008
4	90	20.5603	740.172	0.217698

$D1 = \frac{c1}{3400}$

14. Move to page 1.4 and create a scatter plot of *gforce* vs. *speed*.

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15. What is the independent variable?

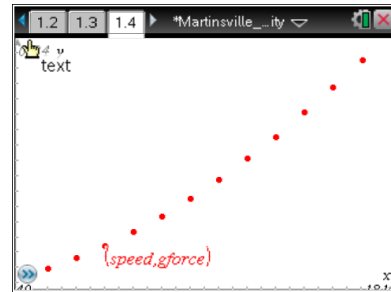
Answer: speed

16. What is the dependent variable?

Answer: gforce

17. Press **(var)** and choose your independent variable. Press **▼** then **(var)** and select your dependent variable. Press **(enter)**.

18. Press **(menu)** then **Window/Zoom > Zoom – Data**.



19. Mechanical brakes can slow a car at about 0.75 g's. Using the graph, would a wing be beneficial to a NASCAR Sprint Cup car?

Answers may vary; but since the graph shows the wing would only have a 0.80 gforce at 170 mph, it wouldn't be worth it.

Teacher Tip: Remember the point of the activity is for students to make a decision based on the graph. If a student says yes and has good reasoning based on the graph it is okay.

Navigator Tip: Quick Poll the students for the answer to #19 and discuss why students said yes or no.

For cars going over 200 mph on a road course as they do in F1 this type of wing would definitely be beneficial.

Using spreadsheet software

1. Enter the speed in mph and drag into spreadsheet software. Use 3 columns: Speed, Drag for 1 sq ft, and Drag for 36 sq ft.
2. Use the chart wizard to create a scatter plot of *drag1* vs. *speed*. Chart type will be XY(Scatter) and choose the scatter with data points connected by smooth lines. Click **Next**.
3. What is the independent variable?

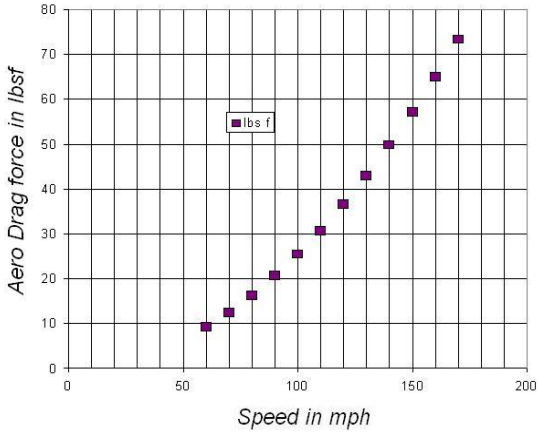
Answer: Speed

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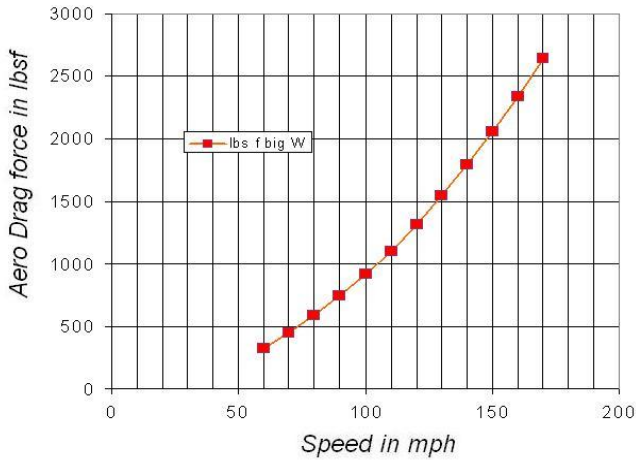
4. What is the dependent variable?

Answer: Drag1

5. You may have to click on the Series tab to select which data goes on which axis. Click in the box for the x values then highlight the data for the independent variable.
6. Click the box for the y values then highlight the data for the dependent variable. Click **Next**.
7. Create titles for the chart and each axis. You can also click the other tabs to change the appearance of your graph. Click **Next**.
8. Decide if you want the graph to appear in the same window as your table or in a new window. Click **Next** and your graph should appear.



9. Repeat steps 2-8 for the 36 sq ft wing.



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10. Make a conjecture about the drag force has speed increases.

Answer: It increases.

11. Which size wing would be better to stop a 3400 lb car?

Answer: The 36 sq ft (or 6 ft x 6 ft) wing.

20. Calculate the g-force for the big wing at each speed. Move to a new column in your spreadsheet and type a title in the cell. Move down to the next cell and type a formula to divide each of the 36 sq ft drag values by 3400 lbs. For example **=c1/3400**, **=c2/3400**, **=c3/3400**, etc.

12. Use the chart wizard to create a scatter plot of *gforce* vs. *speed*. Chart type will be XY(Scatter) and choose the scatter with data points connected by smooth lines. Click **Next**.

13. What is the independent variable?

Answer: Speed

14. What is the dependent variable?

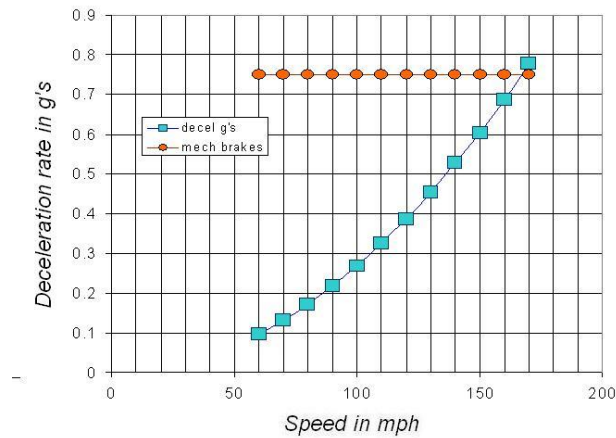
Answer: G-force

15. You will have to click on the Series tab to select which data goes on which axis. Click in the box for the x values then highlight the data for the independent variable.

16. Click the box for the y values then highlight the data for the dependent variable. Click **Next**.

17. Create titles for the chart and each axis. You can also click the other tabs to change the appearance of your graph. Click **Next**.

18. Decide if you want the graph to appear in the same window as your table or in a new window. Click **Next** and your graph should appear.

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21. Mechanical brakes can slow a car at about 0.75 g's. Using the graph, would a wing be beneficial to a NASCAR Sprint Cup car?

Answers may vary; but since the graph shows the wing would only have a 0.80 gforce at 170 mph, it wouldn't be worth it.

For cars going over 200 mph on a road course as they do in F1 this type of wing would definitely be beneficial.