Hitting Your Marks on the Drag Strip

STEM Lesson for TI-Nspire™ Technology

Objective: Collect data, analyze the data using graphs, and use the results to determine the best driver.

Frameworks: LF.3.AI.1, LF.3.AI.2, LF.3.AI.5, LF.3.AI.8, DIP.5.AI.1, DIP.5.AI.5, DIP.5.AI.6, DIP.5.AI.9

About the Lesson: As you'll see in this investigation, not all drivers are created equal. Using data, your objective is to figure out who is the best driver and what is the best possible drive time along the drag strip.

Materials: RC Car (optional)
Straight-line drag strip that is 50-75 ft long
3 stop watches (Number depends on the number of students in the group)
Student worksheets

Prerequisite skills: The students need to know how to work the stop watch and how to read it. Some students are not familiar with the digits after the decimals being 10ths and 100ths of a second while the digits before the decimal being actual seconds which are $1/60^{th}$ of a minute. You might have to teach this first. Students should also know how to calculate averages and speed. This is a good lesson to use for reinforcement of the distance formula: $d=rt$.

Procedure:

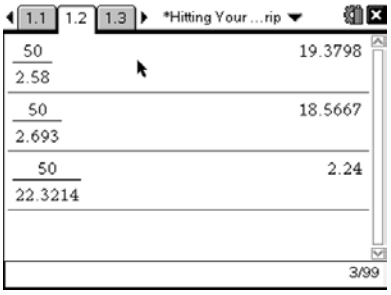
1. Record info about your car and driving conditions on the data sheet.
2. With a fully charged battery. Set the car at the start line and decide what the "GO" signal will be.
3. Make sure all time keepers are ready and have another student give the "GO" signal. Make sure all time keepers can see the start and finish line clearly.
4. Drive from the start line to the finish line. Time keepers measure the time it takes to drive the drag strip while the driver drives.
5. Record the trial number and measured drive time on your data sheet.
6. Repeat steps 2-5 for 10 trials.
7. Change drivers and repeat steps 2-6.

Teacher Tip: *Make sure each person in the group has a job and the jobs rotate with the driver change. Usually all students want to drive the car but don't force them. One student can do both a stopwatch and record times for small classes.*

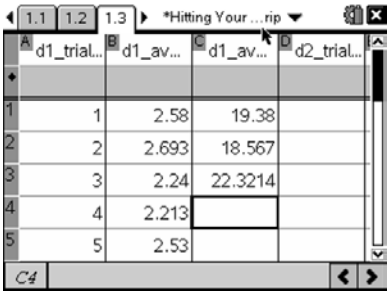
Analysis:

1. On your handheld, go to My Documents and open the file named *Hitting Your Marks_Drag Strip.tns.*

2. Use ctrl ▸ to move to page **1.2**. Calculate the average drive time and average speed for each trial and driver. Record your calculations on your data sheet.



3. Move to page **1.3** and enter the trial number, average drive time, and average speed into the table. Columns for 2 drivers (d1 for driver 1 and d2 for driver 2) are provided. If you have more than 2 drivers, enter the titles then enter the data.



4. Move to page **1.4**. You want to compare each driver's drive time using a graph of average drive time vs. trial number. Which variable (average drive time or trial number) is the independent variable x?

   _____

   Which variable is the dependent variable y?

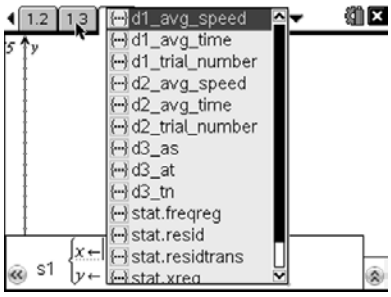
   _____

Answer: Independent variable: Trial #
Dependent variable: Average Drive Time

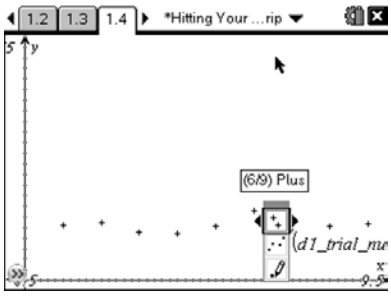
Teacher Tip: *This is a place to discuss the fact that **time** is not necessarily the independent variable.*

Navigator Tip: *Quick Poll the students for their answers to #4 and show the results to start a good discussion and to make sure the students know which variable goes on which axis.*

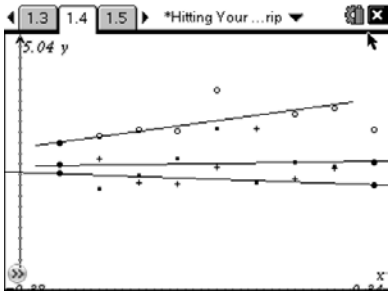
5. Graph the scatter plot of average drive time vs. trial number for driver 1. To do this first make sure the cursor is in the function bar. Then press (var) and choose the variable for driver 1. You can use the up and down arrows to go between the *x* and *y*. Press (enter) to see the graph. Move the arrow to one of the points and press (ctrl) then (menu) and select attributes to change the shape of the points.



6. Create a line of best fit for the points by pressing (menu) then Points and Lines then Line. Click where you want to start the line then where you want it to end. Draw the line from left to right as close to the most points as possible. This line can be adjusted later by grabbing and dragging one of the points of the line.



7. Press (tab) to bring the function bar back and repeat steps 5 and 6 for each driver. Give each driver a different shape so you can easily tell them apart. You can move or delete the labels as needed.



8. Move to page **1.5**. Now we want to compare speed with drive time by graphing speed vs. average drive time. Which variable (average drive time or speed) is the independent variable x?

   _____

   Which variable is the dependent variable y?

   _____

   Answer: Independent Variable: Average Drive Time
   Dependent Variable: Speed

9. Repeat steps 5-7 to make a graph of speed vs. average drive time.

Teacher Tip: *This is a place to discuss the range and why we need to adjust the graph window according to domain and range.*

10. Based on these graphs, who do you think is the best driver?

_____

Why? _____

_____

_____

_____

Answer: Answers will vary. Each group will have a different driver.

Navigator Tip: *Quick Poll the students for their answers to #10 and show the results to start a good discussion. Make sure the students back up their choice of driver based on the data and not opinion.*

11. What was his or her best drive time? _____

Answer: Answers will vary.

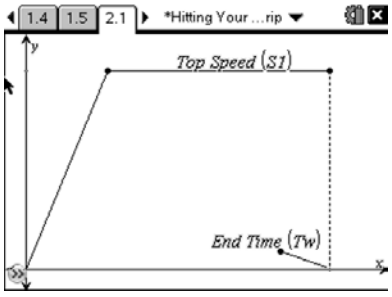
Teacher Tip: *The whole Extension part of this activity could be teacher led.*

EXTENSION

A vehicle traveling at a constant speed of S1 for a time of t1 travels a distance of d which is equal to d = S1 * t1. For example, driving at a speed of 34 mph for 2 hours gives a distance of 68 miles; or 34 feet/sec for a time of 1.5 seconds gives a distance of 51 feet.

Move to page **2.1**.

This graph is the model of a car accelerating to a constant speed (*S1*) over a certain length of time (*Tw*). Move to page **2.2**. Notice the model can be divided into a triangle and a rectangle. This splits the graph at the point the car stops accelerating and starts traveling at a constant speed. The heights of the rectangle and triangle are both *S1*. The base of the triangle is *Ta* and the width of the rectangle is *Tw-Ta*.



12. Using these variables, write equations for the area of the triangle and the area of the rectangle.

    Triangle _____

    Rectangle _____

    Answer: Triangle – ½(S1)(Ta)
    Rectangle – S1(Tw-Ta)

13. Compare these equations to the formula *d = r*t* or in this case *d = S*t*. What is similar? What is different? _____

    _____

    _____

    Answer: Answers will vary, but students should notice to find the distance traveled you just find the area under the line, or curve.

14. Write an equation for the total distance of the car using the formulas for the areas.
    _____

    Answer: Total d = ½(Ta * S1) + S1(Tw – Ta)

Navigator Tip: *Quick Poll the students for their answers to #14 and show the results to make sure everyone has the correct equation.*

15. If you ran a car on the 50 ft drag strip in 3 sec and calculated the car's top speed to be 30 ft/sec, how long did it take the car to accelerate to top speed?
    _____

    Answer: 2.67 sec