

The Need for Speed

ID: 11271

 Time Required
 45 minutes

Activity Overview

Nowadays, any adventure-seeking person can learn to drive a real race car. Racing schools allow people to drive with professional drivers who teach racing skills and tactics, as well as safety. Modern car races are won by hundredths of a second, requiring cameras to determine which car actually crossed the finish line first. In this adventure, students will run a radio-controlled car at several different weights, recording the time of each run. They will calculate the speed for each run and use graphs to determine the relationship between speed, time, and weight.

Topic: Momentum

- *create and interpret scatter plots*
- *determine relationships between variables*
- *calculate velocity*
- *represent motion graphically*

Teacher Preparation and Notes

- *The measurements shown are suggested measurements, and can be adjusted to meet size constraints of your classroom or hallway.*
- *To complete this activity, students will need:*
 - *Stop Watches (3)*
 - *Radio controlled car*
 - *Tape measure*
 - *Scale*
- ***To download the student worksheet and TI-Navigator files, go to education.ti.com/exchange and enter "11271" in the quick search box.***

Associated Materials

- *SciAct02_NeedforSpeed_Worksheet_TI-73.doc*
- *SciAct02_Plot1.act*
- *SciAct02_Plot2.act*
- *SciAct02_Plot3.act*

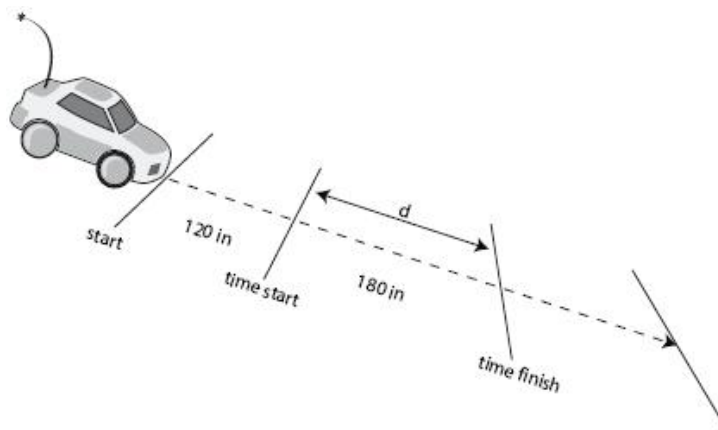
Suggested Related Activities

To download any activity listed, go to education.ti.com/exchange and enter the number in the quick search box.

- *The Science of Racing (TI-73 Explorer) — 7157*
- *Walk the Line (TI-73 Explorer) — 3877*

Setup

1. For each test run, there needs to be a driver, three timers, and a data recorder.
2. From START, measure approximately 120 inches and mark with tape. This is the line at which timers start their watches (the time Start Line). The car should be “up to speed” by this point.
3. Mark the Finish Line approximately 180 inches from the time Start Line. Instruct drivers to not slow the car until they are past the Finish Line.
4. Find weights to add to the car. The weights can be washers taped to the car or bottles with water.



Data Collection

1. Have three timers time each test run.
2. Increase the weight of the vehicle for each run.
3. Record the weights and times for each run in the table on your worksheet.

Data Analysis

Calculate and Store Average Times for Each Run

1. Press [LIST]. Under L1, enter the three times for run 1. Under L2 enter the three times for run 2. Repeat this step until all three times for each run are entered.

| L1 | L2 | L3 | 3 |
|----------------|------|-------|---|
| 2.5 | 3.1 | 3.59 | |
| 2.47 | 3.08 | 3.64 | |
| 2.42 | 3.14 | 3.69 | |
| --- | --- | ----- | |
| L3(4) = | | | |

- Press **2nd** **[QUIT]** to return to the home screen.
- Find the average time for run 1. Press **2nd** **[STAT]** **▶** **▶** **[3]** to choose the mean function. Then press **2nd** **[STAT]** **[ENTER]** **[ENTER]** to choose list L1. Enter the average time on your worksheet.
- Repeat these steps to find the average times for Runs 2 through 6.
- On the home screen, press **▲** to scroll up to previous entries and highlight the average for L1. Press **[ENTER]** to place that number at the bottom of the home screen.
- Press **[STO▶]** **2nd** **[TEXT]** **[ENTER]** **▲** **[ENTER]** **[ENTER]**. This makes the variable A equal to the average for L1. Repeat to store the averages for L2 through L6 selecting B, C, D, E, and F respectively.

```
mean(L1
2.463333333
```

```
mean(L4      4.12
mean(L5      4.37
mean(L6
5.466666667
2.463333333→A
2.463333333
```

Calculate the Speed of Each Car

- Press **2nd** **[MEM]** **[6]** **[ENTER]** to clear all the lists.
- Enter the six weights in L1.
- Enter the stored average times in L2. To enter A, press **2nd** **[TEXT]** **[ENTER]** **▲** **[ENTER]** **[ENTER]**. To enter B, press **2nd** **[TEXT]** **▶** **[ENTER]** **▲** **[ENTER]** **[ENTER]**. Continue these steps to enter C, D, E, and F.

| L1 | L2 | L3 | 2 |
|----------|--------|-------|---|
| 22 | 2.4633 | ----- | |
| 37.7 | 3.1067 | | |
| 55.4 | 3.64 | | |
| 79 | 4.12 | | |
| 93.4 | 4.37 | | |
| 109.8 | 5.4667 | | |
| ----- | | | |
| L2(6) =F | | | |

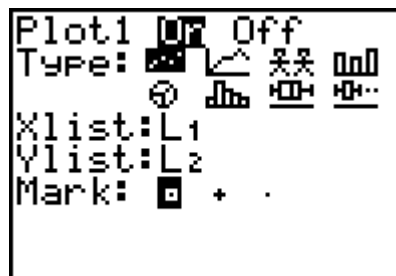
NOTE Remind students that speed (or rate) is distance divided by time. The suggested distance in this activity was 180 inches. If you used a different distance, be sure students use that value in step 4.

- Highlight the title of L3 and press **180** **[÷]** **2nd** **[STAT]** **▼** **[ENTER]** **[ENTER]**. The speed of the car for each run is now in L3.

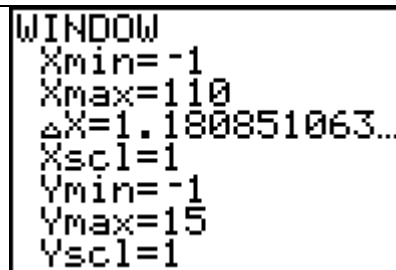
| L1 | L2 | ■ | 3 |
|-------------|--------|----------|---|
| 22 | 2.4633 | ----- | |
| 37.7 | 3.1067 | | |
| 55.4 | 3.64 | | |
| 79 | 4.12 | | |
| 93.4 | 4.37 | | |
| 109.8 | 5.4667 | | |
| ----- | ----- | | |
| L3 = 180/L2 | | | |

Find a Relationship Between Time and Weight

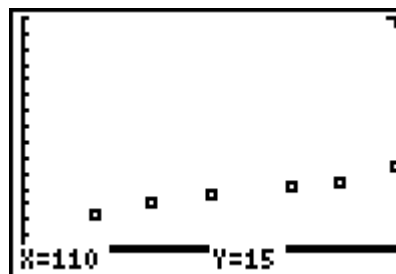
1. Press 2nd [PLOT] and select Plot 1 by pressing ENTER . Turn Plot 1 On.
2. Press \blacktriangledown and select the scatter plot. Press ENTER . Select L1 for XList and L2 for YList.



3. Have students determine an appropriate scale for the axes. Press WINDOW and adjust the values. The sample data uses $X_{\min} = -1$, $X_{\max} = 110$, $Y_{\min} = -1$, $Y_{\max} = 15$.

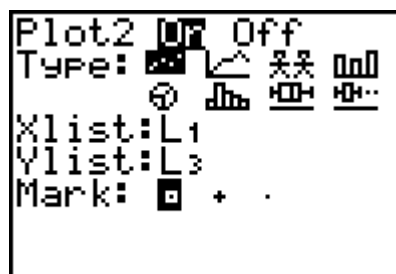


4. Press GRAPH . You will see a graph of time with respect to weight. Sketch this plot on the axes on your worksheet.

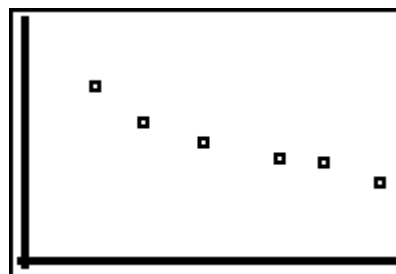


Find a Relationship Between Speed and Weight

1. Press 2nd [PLOT]. Turn Plot 1 Off. Select Plot 2 and turn it On.
2. Press \blacktriangledown and select the scatter plot. Press ENTER . Select L1 for XList and L3 for YList. (To insert L3, press 2nd [STAT] [3].)



3. Have students determine an appropriate scale for the axes. Press WINDOW and adjust the values. The sample data uses $X_{\min} = -1$, $X_{\max} = 115$, $Y_{\min} = -1$, $Y_{\max} = 100$.
4. Press GRAPH . You will see a plot of speed with respect to weight. Sketch this plot on the axes on your worksheet.

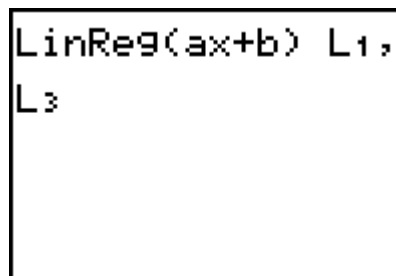


Extension Activity

1. Test a point on the graph to see if it matches reality. Start by adding a trend line to the speed and weight graph.

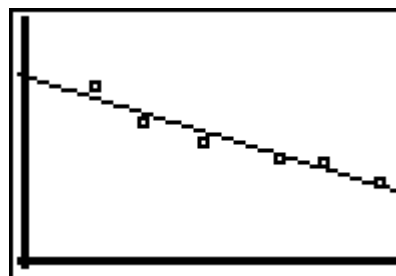
Press 2nd [STAT] \leftarrow [5] 2nd [STAT] [1] , 2nd [STAT] [3] ENTER to see the equation of the trend line.

Then press Y= 2nd [VARS] [3] $\blacktriangleright\blacktriangleright$ ENTER to paste the equation into the Y= editor. Press GRAPH to see the trend line on the scatter plot.



NOTE You can have students first manually draw a trend line. See instructions below for help with Manual Fit.

2. Press TRACE to see values on the line. Pick a weight you have not tried and test it to see if it attains the speed you predicted with your model.



Help with Manual Fit

With Manual-Fit, students can fit a line to plotted data on the screen manually. This is an alternative to having the calculator draw the line automatically.

1. After the data is plotted, go to the calculator home screen by pressing 2nd [QUIT].
2. Press 2nd [STAT] \leftarrow **Manual Fit**. This pastes the command on the home screen. Press 2nd [VARS], then select **Y-Vars**, and then **Y1**. This will store the equation of your line in Y1 after you draw it. Press ENTER .
3. Press GRAPH . Position the cursor at the beginning of the line segment that you want to draw and press ENTER .
4. Continue to press the arrow keys to draw the line. When you have matched the plotted points, press ENTER . The line is drawn and the equation appears at the top of the screen. You can continue to change the position of the line by using the arrow keys. The equation will update as the line is moved.
5. Press ENTER when you are satisfied with the fit of the line. The equation will be stored in Y1.

Discussion Notes

Discuss independent and dependent variables. The independent variable is what changes on each run (the weight). Independent variables are always represented on a graph on the *x*-axis. The dependent variables (time and speed) are shown on the *y*-axis. Stress the relationship by saying “The time/speed depended on the weight of the car.”

After each scatter plot is drawn, have students discuss its shape. On their worksheets, it may help them if they label the *x*- and *y*-axes with the words *time*, *weight*, and *speed*. To help them understand their plot, have them pick a point and explain what it represents.

For students who performed the extension, explain that trend lines are models that help predict what should occur in real life. The more data they collect, and the better they control the variables, the better their model will become.

Worksheet Answers

Data in the chart will vary.

1. Plots will vary.
2. Weight is on the *x*-axis and time is on the *y*-axis.
3. As weight increased, time increased.
4. Plots will vary.
5. Weight is on the *x*-axis and speed is on the *y*-axis.
6. As weight increased, speed decreased.
7. The speed would be 0. (The car would not move.)

TI-Navigator™ Extension Activity

1. Load the **SciAct02_Plot1.act** activity settings file. A scatter plot, and a red and green X on the *x*-axis, will appear in Activity Center. The activity settings files can be downloaded from the Texas Instruments Activity Exchange Website.
2. Ask students to imagine a trend line going through the blue points. Have one student move their cursor to the position where they think the trend line will be above the red X. Repeat with another student for the green X. See if the rest of the class agrees. Clear the data and have other students mark the points if they think they should be elsewhere.
3. Repeat with **SciActPlot2.act** and **SciAct02_Plot3.act**.
4. For any of the scatter plots, you can also have the entire class move their cursors to form the trend line.