Airport Impact Study

ID: 9320

Time required
45 minutes

Activity Overview

This activity is based on an impact study to address the concerns of the residents of a community near an airport. Students perform a simulation to measure the sound intensity at different distances from the source of the noise, and then use the data to develop an inverse variation model. After verifying the model, students use it to map safe and unsafe zones based on sound-intensity restrictions.

Topic: Rational & Radical Functions & Equations

- *inverse variation*
- *direct variation*

Teacher Preparation and Notes

- *This activity is designed to be used in an Algebra 2 or Precalculus classroom.*
- *Prior to beginning this activity, students should have had experience with direct variation problems. This activity could be used as an introduction to indirect variation, although some experience with indirect variation is preferred.*
- *This activity requires students to graph functions, plot data in scatter plots, use simple formulas in a spreadsheet and draw and label circles. If students have not had experience with these functions of the handheld, extra time should be taken to explain them.*
- *If time considerations require, Problem 1 can be performed in class and Problem 2 assigned as homework.*
- *Notes for using the TI-Nspire™ Navigator™ System are included throughout the activity. The use of the Navigator System is not necessary for completion of this activity.*
- ***To download the student and solution TI-Nspire documents (.tns files) and student worksheet, go to education.ti.com/exchange and enter "9320" in the quick search box.***

Associated Materials

- *Airport_Impact_Study_Student.doc*
- *Airport_Impact_Study.tns*
- *Airport_Impact_Study_Soln.tns*

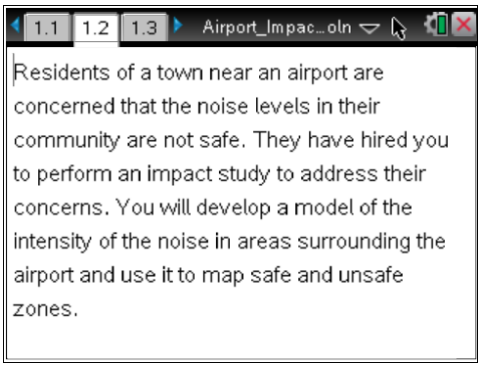
Suggested Related Activities

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

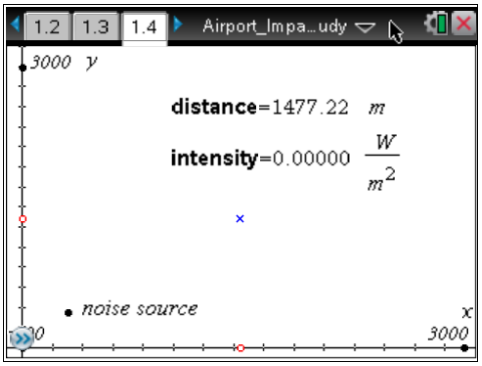
- *Inverse Variation (TI-Nspire technology) — 9480*
- *Direct, Inverse, and Joint Variation (TI-Navigator) — 1895*
- *Constant of Variation (TI-Nspire technology) — 11197*

Problem 1 – Creating the model

This problem presents a real-life situation that can be perfectly modeled by a polynomial function. Page 1.2 presents the problem: residents of a community near an airport have commissioned a study of the noise intensity in different areas surrounding the airport. The results of the study are to be used to map safe and unsafe zones.

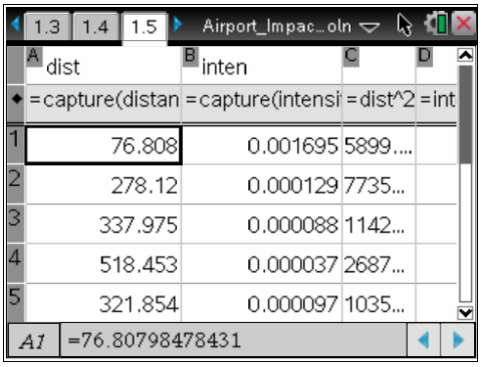


On page 1.4, students collect sound readings at various distances from the noise source. They control the location where the reading is taken by dragging the sliders at the left side and bottom of the page, and take a reading by pressing ctrl + . . The distances from the noise source and sound intensity are displayed on the right side of the screen. Students are directed to collect at least 10 sound readings.

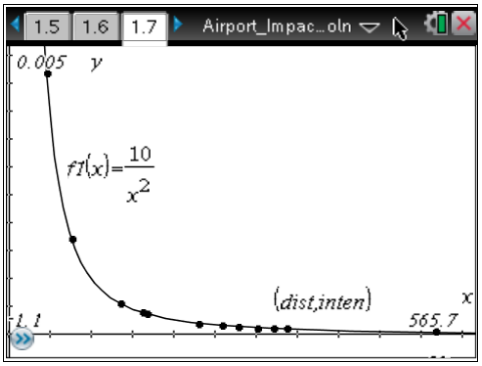


TI-Nspire Navigator Opportunity: *Screen Capture* and/or *Live Presenter*
See Note 1 at the end of this lesson.

The sound readings are recorded as (*distance*, *intensity*) pairs on page 1.5.

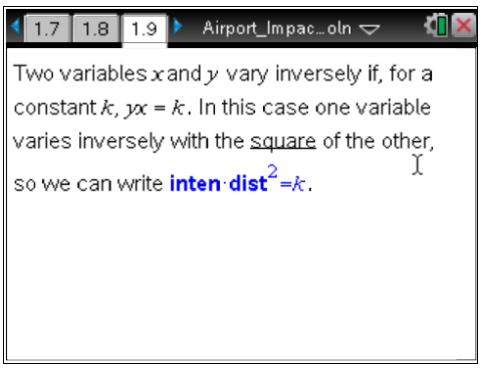


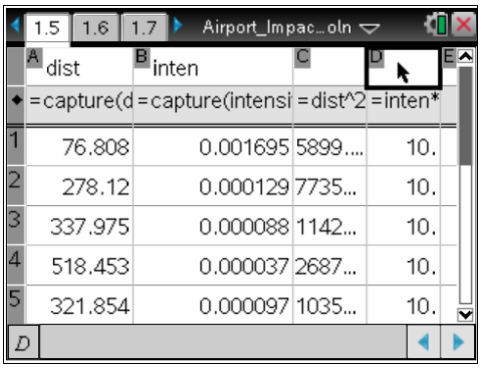
Students are directed to display this data in a scatter plot on page 1.7. Page 1.8 offers a crucial piece of information to help the student create an accurate model for this data: The laws of physics state that sound intensity varies inversely with the square of the distance from the source. If students are not already familiar with inverse variation, take time to discuss it now, asking questions like, *If x and y vary inversely, what happens to y when x increases? When x decreases?*



Pages 1.9 and 1.10 direct students to manipulate the data in the spreadsheet on page 1.5 to see if this holds for this data set. Students may need help entering the correct formulas into the formula bar.

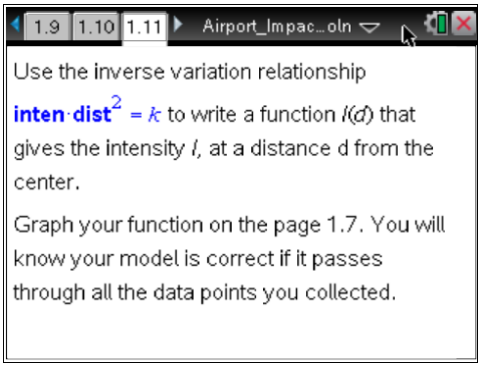
There are several different ways to manipulate the data. One is to type **=dist^2** in Column C and **=inten*dist^2** in Column D. This process reveals the constant of variation *k*, as a byproduct, since the product of the intensity and the square of the distance is 10 for every (*distance*, *intensity*) pair.





TI-Nspire Navigator Opportunity: *Screen Capture* and/or *Live Presenter*
See Note 2 at the end of this lesson.

Page 1.11 directs students to rewrite their model as a function *I*(*d*) that gives the intensity *I*, at a distance *d* from the noise source. Students should see that solving the relationship $I*d^2 = k$ for *I* will give this function. Finally, students verify their model by graphing the function *I*(*d*) along with the data they collected. They will need to use the variable *x*, instead of *d*, when graphing.



Student Worksheet Solutions

1. The square of the distance times the intensity is the same number for each row.
2. 10
3. $I(d) = \frac{10}{d^2}$

Problem 2 – Applying the model

In this problem, students are given the community association's definition of 3 noise-level zones.

Zone 1: Intensity is less than 0.000001 W/m^2

Zone 2: Intensity is between 0.000001 and 0.0001 W/m^2

Zone 3: Intensity is greater than 0.0001 W/m^2

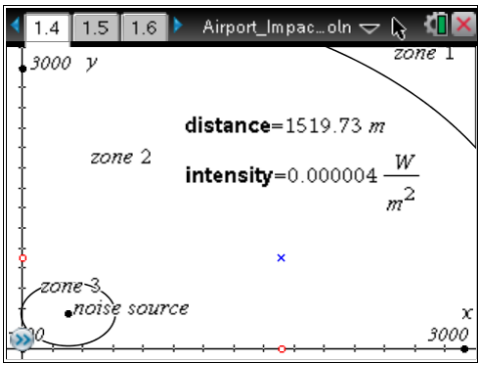
Discuss the meaning of these three zones with the class. Zone 1 is designated safe for houses; zone 2 is designated as an impacted zone, meaning that the airport will be required to advise people who live there of the risks of unsafe noise; and zone 3 is considered unsafe for houses.

Discuss what the zones will look like. Return to the simulation map on page 1.4. Where on this map is the sound intensity less than 0.000001? (All points where the distance from the noise source is greater than a certain value.) Where is it greater than 0.0001? (All points where the distance from the noise source is greater than a certain value.) What kind of shape is made by such points? Students should see that the zones will be circles centered on the noise source.

Student Worksheet Solutions

1. Unsafe zone: Zone 3; Impact zone: Zone 2; Safe zone: Zone 1
2. Each zone will be circular with a center at the noise source.
3. distance = 3,162 meters
4. $0.0001 = \frac{10}{d^2}$
5. distance = 316 meters

The worksheet provides a place for students to write and solve two equations to find the radii of these circular zones. Students should use the results to draw and label the zones on the map on page 1.4.



To draw a circle with a certain radius, students should draw a line segment with one end at the center of the circle, measure the segment's length, adjust its length by dragging an endpoint to make it equal to the desired radius, and then use the **Circle** tool. Afterwards they can hide or delete the line segments.

TI-Nspire Navigator Opportunities

Note 1

Problem 1: *Screen Capture* and/or *Live Presenter*

Screen Capture can be used here and throughout the lesson to ensure students are able to follow along and collect the data. You may choose to pick a student (or group of students) as a live presenter to demonstrate the activity to the class.

Note 2

Problem 2: *Screen Capture* and/or *Live Presenter*

This is another good place to use screen capture to make sure students are able to enter the formulas for the columns. A live presenter can be used to demonstrate how the formulas are entered.