Experiment 11

View Tubes

Teaching Notes

In this experiment, the viewable vertical distance is a linear function of the distance from the wall. The distance from the wall is the *independent variable*, and the viewable vertical distance is the *dependent variable*. In Experiment 12, View Tubes Extension, the independent variable is changed to the diameter of the tube.

Equipment

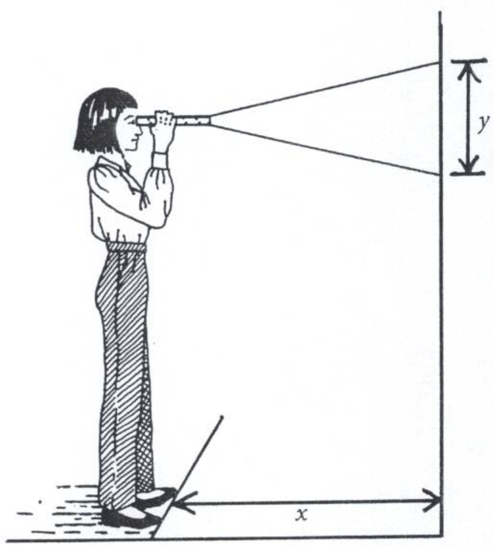
assorted tubes, 1 per group

Number the tubes. Try to have several tubes of the same length but different diameters, and some of the same diameter but different lengths. Tubes from kitchen wraps (plastic, wax paper, foil) work well. Sawed-off lengths from the core of a carpet or fabric bolt add variety. Cut them long enough so that rolling the eye doesn't distort the measurements.

yardsticks, 2 per group

graph paper, 1 sheet per student

Procedure



Students work in groups of two or three. Students wearing glasses should not be paired with students who do not.

All students should record their viewable vertical distance for each value of x and average the measured values for plotting.

Reasonable accuracy is obtained if students measure the distance from the toes. In theory, the intercept is the diameter of the tube; rough measurement may lead to a straight line with a negative intercept.

Students will have to decide on units. (Measuring the distance from the wall in feet and the viewable vertical distance in inches works well. Some students, however, will not want to use different units for the two variables.)

Have students obtain all their points first, then decide how to scale their graphs. If their x-measurements are 4, 5, 6, and 7 (that is, close together), they should allow 5 squares to a unit on the graph.

Organizing and Analyzing Class Results

Collect the students' results. Record length and diameter of tube as well as the equation. Post several graphs. Investigate the relationship between the dimensions of the tubes and the slopes and intercepts. Then, ask the class to identify which tube produced each graph.

Post several slopes and ask which of the tubes might have been used for each equation.

See Experiment 12 for a mathematical explanation of the function.

Experiment 11

View Tubes

Name ______________________________

Partner ______________________________

Collect the Data

Draw a diagram of the experiment, indicating variables.

Describe the procedure for the experiment.

The independent variable, x, is ______________________ Units ________

The dependent variable, y, is ______________________ Units ________

Equipment (labels and measurements)

Tube number __________ Length __________ Diameter __________

Data Collection

Independent ________	Dependent ________		
	Trial 1	Trial 2	Trial 3

Points to Be Graphed

x	y

Experiment 11

View Tubes

Name ____

Find the Equation

After plotting your data on graph paper, draw a straight line through two of your points. Choose the line that best fits your data. Circle the points on your graph and copy their coordinates below.

Your points: (____, _____) and (____, _____)

Use these points to find the equation of your line. Show your work.

Find the slope of the line.

Find the y-intercept of the line.

Write the equation of the line.

$y =$ __________ $x +$ __________
rational form

$y =$ __________ $x +$ __________
decimal form

Rewrite the decimal form of the equation, using the names of the variables instead of x and y.

________________ = ________ __________________ + _______

Experiment 11

View Tubes

Name ____

Interpret the Data
Metric Measures

Write the decimal form of your equation here. $y =$ ________ $x +$ ________
Use this equation to answer the questions. Show your work.

1. How much would you see if the distance from the wall were 3.5 meters?

   ____

2. How far from the wall would you have to be to see exactly 57 cm?

   ____

3. How far from the wall would you have to be to see exactly 68 cm?

   ____

4. How would your graph be different if you used a longer tube? ________

   ____

5. How would your graph be different if you used a wider tube? ________

   ____

6. Find some tall object, such as the hall clock, the school flagpole, or the gym door. Measure how far from the object you have to be to see the entire object. Use your equation to estimate the object's height. If possible, verify your measurement.

   Object ____________________

   Height ____________________

Experiment 11

View Tubes

Name ____

Interpret the Data
Standard Measures

Write the decimal form of your equation here. $y =$ __________ $x +$ __________

Use this equation to answer the questions. Show your work.

1. How much would you see if the distance from the wall were 10.5 feet?

   ____

2. How far from the wall would you have to be to see exactly 25 inches?

   ____

3. How far from the wall would you have to be to see exactly 33 inches?

   ____

4. How would your graph be different if you used a longer tube? __________

   ____

5. How would your graph be different if you used a wider tube? __________

   ____

6. Find some tall object, such as the hall clock, the school flagpole, or the gym door. Measure how far from the object you have to be to see the entire object. Use your equation to estimate the object's height. If possible, verify your measurement.

   Object ______________________

   Height ______________________

Experiment 12

View Tubes Extension

Teaching Notes

In this experiment, the vertical viewing distance is a linear function of the diameter of the tube. The diameter of the tube is the *independent variable*, and the measure of the viewable vertical distance is the *dependent variable*. The students now hold the distance from the wall and the tube length fixed.

Equipment

assorted tubes, 1 per group

Number the tubes. Try to have several tubes of the same length but different diameters, and some of the same diameter but different lengths. Tubes from kitchen wraps (plastic, wax paper, foil) work well. Sawed-off lengths from the core of a carpet or fabric bolt add variety. Cut them long enough so that rolling the eye doesn't distort the measurements.

metersticks or tape measures, 2 per group

centimeter rulers

Used to measure diameters more precisely.

graph paper, 1 sheet per student

Procedure

Students should use assorted tubes of the same length. Students work in groups of two. Students wearing glasses should not be paired with students who do not.

Reasonable accuracy is obtained if students measure the distance from the toes to the wall.

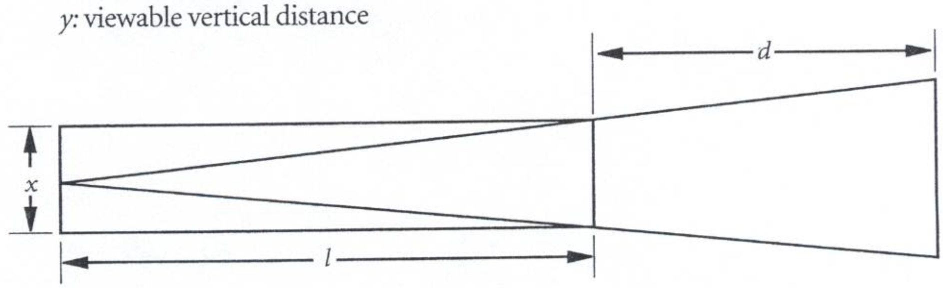
The vertical viewing distance is a linear function of the independent variable (the diameter). What does the intercept correspond to? For a geometric analysis, see the illustration below.

d: distance to the wall

l: length of the tube

x: diameter of the tube

y: viewable vertical distance



By similar triangles, $\dfrac{\frac{y}{2}}{d+l} = \dfrac{\frac{x}{2}}{l}$, or $y = x + \dfrac{xd}{l} = x\left(1 + \dfrac{d}{l}\right)$

Thus, y is a linear function of x, where d and l are fixed values.

Experiment 12

View Tubes Extension

Name ____________________

Partner ____________________

Collect the Data

Draw a diagram of the experiment, indicating variables.

Describe the procedure for the experiment.

The independent variable, *x*, is ____________________ Units __________

The dependent variable, *y*, is ____________________ Units __________

Equipment (labels and measurements)

Fixed distance from wall __________

Fixed length of tube __________

Data Collection

Independent ________	Dependent ________		
	Trial 1	Trial 2	Trial 3

Points to Be Graphed

x	*y*

Experiment 12

View Tubes Extension

Name ____

Find the Equation

After plotting your data on graph paper, draw a straight line through two of your points. Choose the line that best fits your data. Circle the points on your graph and copy their coordinates below.

Your points: (_____, ______) and (_____, ______)

Use these points to find the equation of your line. Show your work.

Find the slope of the line.

Find the y-intercept of the line.

Write the equation of the line.

$y =$ __________ $x +$ __________ (*rational form*)

$y =$ __________ $x +$ __________ (*decimal form*)

Rewrite the decimal form of the equation, using the names of the variables instead of x and y.

________________ = ________ ________________ + ________

Experiment 12

View Tubes Extension

Name ______________________________

Interpret the Data

Write the decimal form of your equation here. $y =$ ________ $x +$ ________

Use this equation to answer the questions. Show your work.

1. Using the same length of tube and the same distance from the wall, what would the vertical viewing distance be if the diameter were 4 cm?

   ____

2. What would the diameter be if you could see exactly 25 cm? ________

3. What would the diameter be if you could see exactly 45 cm? ________

4. What is the maximum diameter that makes sense for this experiment? ________

   Why? ______________________________

   ____

5. Geoff did the same experiment with a view tube that had a smaller diameter. How would the graph of Geoff's line differ from yours?

   ____

   ____