The Circumference-Diameter Ratio of a Circle

SAFETY

- Review lab safety guidelines. Always follow correct procedures in the lab.

OBJECTIVES

- Develop techniques for measuring the circumference and diameter of a cylinder.
- Use data to construct a graph.
- Determine the slope of a graph.
- Analyze error in an experiment.

MATERIALS

- ✔ cord
- ✔ masking tape
- ✔ metric rulers
- ✔ pencil
- ✔ several cylindrical objects of varying size
- ✔ white paper

Measurements of a cylinder

Procedure

1. Select one of the cylinders. Examine the cylinder to determine how many different measurements would be necessary to give a complete description of the cylinder. In this lab, you will use a cylinder's measurements to identify one cylinder from a group of cylinders, so make sure your measurements enable you to distinguish the cylinder from similar cylinders.
2. Determine at least two different methods of making the measurements. Be sure you include ways to measure the circumference of the cylinder in each method. Keep in mind that you must measure each quantity directly; no values can be found through calculations.
3. Take all the measurements for the cylinder using the first method you developed. Record all measurements in your notebook using the appropriate SI units. Make sure to include all measured digits plus one estimated digit.
4. Place the cylinder into a container with a group of other cylinders. Trade measurements with another group. Use your method of measurement to find the cylinder that matches the measurements you were given.

Analysis

A. What measurements did you make?

B. What was your method of measuring the cylinder? Describe your method in detail.

C. Did you find the cylinder that matched the measurements you were given? If not, why not?

D. Did the other group correctly identify the cylinder you measured? If not, why not?

E. Compare your measurements with the other group's measurements for the same cylinder. Are the measurements the same? Explain any differences in your methods or measurements.

Comparing methods of measurement

Procedure

5. Using the same method you used to measure the first cylinder, measure the length, diameter, and circumference of several more cylinders. Label each cylinder with an identifying name written on masking tape. Record your measurements in your notebook using the appropriate SI units.

6. Perform another trial, using a different method to take the measurements. Repeat the measurements for the length, diameter, and circumference of all cylinders. Record your measurements in your notebook using the appropriate SI units.

Analysis

F. Compare the results you obtained using two different methods of measurement. Did you get the same measurements for each cylinder regardless of which method you used? If not, explain what you think caused the difference.

G. Which method do you think was best for measuring the cylinders? What were some problems with the other methods you tried?

H. How could you determine which method of measuring the cylinders gave the best results?

Data analysis

Procedure

7. Use the data you collected to decide which method of measuring the cylinders gave the best results. For each cylinder, select the measurements taken with this method.

8. Use the data you selected in step 7. For each cylinder, find the value for the circumference of the cylinder divided by the diameter of the cylinder.

Analysis

I. Is the relationship between the circumference and the diameter the same for all cylinders, or is it different for each one?

J. Based on your results, what measurements do you think are necessary to give a complete description of a cylinder?

Graphing data

Procedure

9. Using the data you selected, make a graph of the circumference of the cylinders versus the diameter of the cylinders. For each cylinder, plot a point on the graph that represents the cylinder's circumference and diameter.

10. Draw the line or curve that best fits the points on the graph. Not all the points on the graph will actually fall directly on the line, but the line should follow the shape made by most of the points. The line should not connect each point directly to the next one. Instead, it should be drawn as a smooth line or curve connecting most of the points.

11. Select two points on the line, one at the beginning and one at the end. Make sure the points selected are points on the best fit line but are not data points. Use the scales on the axes of the graph to determine the circumference and diameter of the cylinders that would be represented by these points on the line.

12. Label the points that you selected *A* and *B*. Find the difference between the values for the circumference at these points, and use this as the *rise.* In other words, subtract the value for the circumference at *A* from the value for the circumference at *B.* Find the difference between the values for the diameter at these points, and use this as the *run.* Subtract the value for the diameter at *A* from the value for the diameter at *B.*

13. Find the slope of the line, using the equation $slope \frac{rise}{run}$.

Analysis

K. On your graph, which quantity is the independent variable?

L. On your graph, which quantity is the dependent variable?

M. Describe the shape of the curve in your graph.

N. What is the value that you calculated for the slope of the curve in your graph? Compare this to the relationship between the circumference and the diameter that you calculated in step 8.

O. Based on your data and your graph, do you think it is better to find the relationship between the circumference and the diameter by using the slope of the graph or by calculating individual values? Explain your answer.