

Finding pi by Measuring the Circumference and the Diameter of Round Objects

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1 Purpose

The purpose of this lab was to find a value of π (pi) by measuring the circumference and the diameter of certain objects. π should be the circumference divided by the diameter.

2 Method

In order to find the diameter of an object, we used Vernier calipers, except in the case of the floppy diskette, which was too floppy for the use of calipers, so a ruler was used. Circumference was measured by wrapping a bit of string around the object and measuring with a ruler the length of string it took to go around the object once.

3 Results and Conclusions

3.1 Data Table

Data Table 1 shows, for each item: the three circumference measurements (one by each group member); the average of these circumference measurements; the three diameter measurements (again, one by each group member); the average of the diameter measurements; the value of π given by dividing the circumference by the diameter. The entries of this last column give some idea, by their proximity to the expected value of π , of the accuracy of the measurements of each object.

The software that generated the table, Microsoft Excel, does not pay attention to significant figures, so if a measurement ends in a zero, it is truncated, for instance 8.20 is truncated to 8.2. All of our measurements are precise to the second decimal.

The average of these values of π is 3.21, giving a percent error of $(3.21 - 3.14)/3.14 = 0.0223$ or 2.23 percent.

3.2 Graphs

We have produced two graphs. For each graph, each point (x, y) represents an object, or one line of the data table. Its x value is the average of the diameter measurements for that object. Its y value is, similarly, the average of the circumference measurements. We used Microsoft Excel software to do a linear regression on the data. The slope of the line produced by the regression is the ratio of y (circumference) to x (diameter), or π .

In **Graph 1** we forced the line produced to go through the point $(0, 0)$. This is valid

because it makes good intuitive sense that an object with a diameter of 0 should also have a circumference of 0. The value of π obtained from this regression was 3.21, giving a percent error of $(3.21 - 3.14)/3.14 = 0.0223$ or 2.23 percent.

In **Graph 2** we did not force the line through $(0,0)$. This more truly reflects our experimental data. The regression equation, $y = 3.177x + 0.1678$ (Excel doesn't know about significant figures), indicates that the y -intercept is 0.1678, giving a prediction that an object with a diameter of 0 will have a circumference of 0.1678. While intuitively this is silly, numerically it is close to true. The approximation of π given in this graph, 3.18, is actually closer to the expected value than either of the other values given in this report. The percent error is $(3.18 - 3.14)/3.14 = 0.0127$ or 1.27 percent.

3.3 Improvements

Various improvements could be made to the method used in this experiment. The main sources of error seemed to be the floppy disk, which was very difficult to measure because of its floppiness and lack of thick edges to wrap a string around, and all of the circumference measurements using string. The strings had a good amount of stretch in them, and one simple improvement would be to use a measuring tape or some other non-stretchable object to measure the circumferences. Another method would be to use a rubber ruler (for its friction, so the objects don't slip) and roll the items along it for one full revolution, measuring the distance they roll. Another source of error was the small size of the objects. Larger objects would probably have similar amounts of experimental error but that error would be proportionally smaller compared to the larger measurement.