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Lab Performed On: 3/14/15

Unit 0: Circles Lab

Purpose: To find a graphical and mathematical relationship between the radius of a circle and its circumference for any circular objects.

Apparatus:

Procedures:

Independent Variable: *radius*, r, measured in centimeters (calculated from *diameter*, d, measured in cm)
Dependent Variable: *circumference*, c, measured in centimeters

1. Put one of the cans on top of the meter stick.
2. Adjust the can so that the meter stick is across the center of the can. Adjust the position until the distance measured across is at a maximum value. Record this as the diameter of the can.
3. Stretch a piece of string around the edge of the can; mark this length.
4. Stretch the string across the meter stick to measure the length of the string to the mark that was made. Record this as the circumference of the can.
5. Repeat steps 1-4 for 7 other cans, making sure that the radius of the largest object is at least 10 times larger than that of the smallest object.

Data:

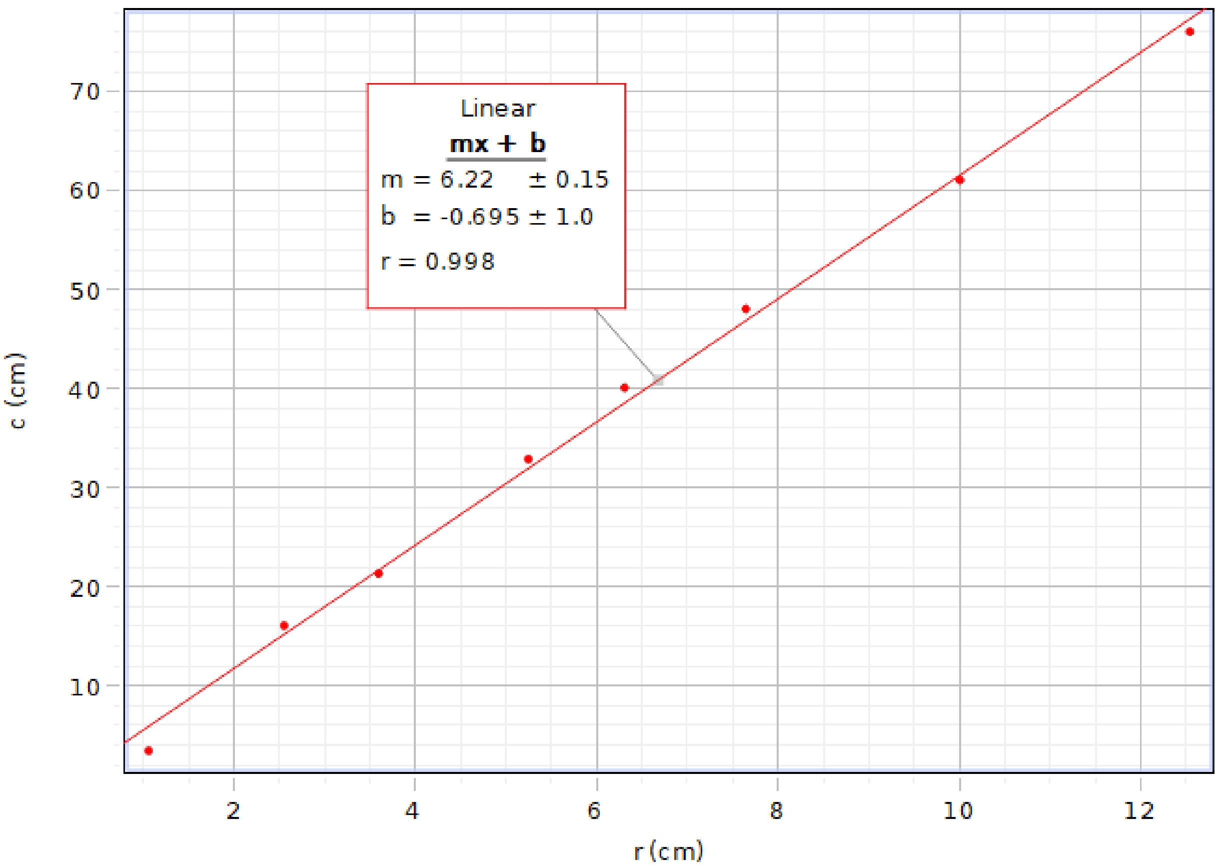
Radius: $radius = \frac{diameter}{2}$

$$radius = \frac{2.1\ cm}{2} = 1.05\ cm$$

Can Number	d / cm	r / cm	c / cm
1	2.1	1.05	3.5
2	5.1	2.55	16.0
3	7.2	3.60	21.4
4	10.5	5.25	32.9
5	12.6	6.30	40.1
6	15.3	7.65	48.1
7	20.0	10.00	61.0
8	25.1	12.55	76.0

Evaluation of Data:

Circumference vs. Radius



Mathematical model: $c = 6.22 \left[\frac{cm}{cm}\right] \cdot r - 0.695\ [cm]$

Variable notations: c = circumference, measured in cm
r = radius, measured in cm

Conclusion:

The purpose of this lab was to find a graphical and mathematical relationship between radius and circumference of a circle for any circular object. Radius is defined as the distance from the center of the circle to its outer edge. The circumference of a circle is defined as the circle's perimeter.

The relationship that was discovered in this lab was a linear relationship. The mathematical model in this lab was $c = 6.22 \left[\frac{cm}{cm}\right] \cdot r - 0.695\ [cm]$ which can be simplified to $c = 6.22\, r - 0.695\ [cm]$. This tells us that circumference is proportional to the radius of a circle. This means that as the radius of a circle increases, its circumference increases as well.

In this equation r, measured in cm, is the radius of the circle that gives a specific circumference, also measured in cm. The slope, 6.22 cm/cm, physically represents that for each additional cm of radius, the circumference increases by 6.22 cm. This means that if the slope was larger, the circumference would increase more for the same 1 cm increase in radius. Our slope was 6.22 cm/cm. Since our slope was positive, an increase in radius also gives an increase in the circumference. If the slope had been negative, that would mean that for an increase in radius the circumference would be decreasing. When comparing this slope value with other groups, it was discovered that its very close to 2π, which has a value of 6.28. When comparing these two values, our percent difference was as follows:

$$percent\ difference = \frac{|experimental - theoretical|}{theoretical} \times 100\%$$

$$percent\ difference = \frac{|6.22 - 6.28|}{6.28} \times 100\%$$

$$percent\ difference = 0.96\%$$

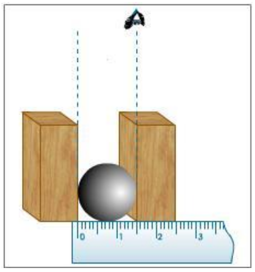
The vertical-intercept of our graph was -0.695 cm. This physically represents the circumference of a circle (-0.695cm) when the radius of that circle is zero. This was not expected, because a circle of zero radius would mean there is no circle and therefore should not have a circumference. When comparing our vertical intercept to the vertical coordinate of the largest data point we had (which was 76.0 cm), our vertical intercept was actually comparatively very small (only 0.91%). This very small percent along with the conceptual meaning of the vertical intercept discussed previously, it was decided that the vertical intercept should be zero.

This gives the general equation for the circumference of a circle as:

$$c = 2\pi \cdot r$$

A possible source of error for this lab was that the yarn that was used stretched slightly as it was pulled. This meant that in order to get an accurate circumference, we needed to stretch the yarn by the same amount around the can as we did against the ruler. To correct this, we could have used a different string, such as braided fishing line, that does not stretch as it is pulled tight.

Another possible source of error was that it was very hard to read the exact diameter of the cans. To measure this value with higher accuracy, we could have used a device such as a caliper to measure the diameter of very small objects. For larger objects, we could have laid the can on its side and use perpendicular blocks to see where the edge of the can would be. We would also have had to look directly at the blocks to avoid parallax error. See diagram below:



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