Fun Projects to Liven Up the Classroom

By

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Picking a telephone calling plan

- You have a friend or family member visiting another country. You would like to keep in touch with that person by phone.
- Pick a country. Compare “World Connect Rates” with “International Standard Rates”.
### South Africa

<table>
<thead>
<tr>
<th>Country Code:</th>
<th>27</th>
</tr>
</thead>
</table>

#### AT&T World Connect Rates

<table>
<thead>
<tr>
<th></th>
<th>To Landline</th>
<th>To Wireless</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0.36</td>
<td>$0.53</td>
<td></td>
</tr>
</tbody>
</table>

#### International Dial Pay-Per-Use Rates

<table>
<thead>
<tr>
<th></th>
<th>To Landline</th>
<th>To Wireless</th>
</tr>
</thead>
<tbody>
<tr>
<td>$2.69</td>
<td>$2.86</td>
<td></td>
</tr>
</tbody>
</table>

#### Monthly Recurring Charge

<table>
<thead>
<tr>
<th>$3.99</th>
<th>Monthly Recurring Charge</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>$0.00</th>
<th>Monthly Recurring Charge</th>
</tr>
</thead>
</table>
System of Equations

- **AT&T World Connect**
  \[ C(x) = 0.36x + 3.99 \]

- **International Rate**
  \[ C(x) = 2.69x \]

\[ x = 1.71 \text{ minutes} \]
Slope

Preparation:

在京 Find a wheelchair ramp on campus. Measure the rise and the run.

在京 You may have trouble measuring the rise. Measure the “Slanted part” and use the Pythagorean Theorem to calculate the rise.

- New wheelchair ramps: Slope of at most 1:12 ratio. Maximum height of 30 inches for a single run.

- A wheelchair ramp slope of 1:10 to 1:12 ratio. Height 6 inches.

- A wheelchair ramp slope of 1:8 to 1:10 ratio. Height 3 inches.

- A wheelchair ramp with a slope more than 1:8 ratio is not permissible under any circumstances.
1. Use your data and find the ratio of rise to run.
   \[ \text{rise:run} = 14:180 = 1:12.86 \]

2. Does your ramp satisfy ADA guidelines?
   Yes

3. Find the slope of your ramp.
   \[ \text{Slope} = \frac{\text{rise}}{\text{run}} = \frac{14}{180} = 0.07778 \]
The contest:

Two volunteers write “I love math” on the blackboard 10 times. How long did it take? How much of the assignment will get done in 1 second (that is the rate). Now how long will it take if both volunteers work on the same assignment?
The change in temperature, in the atmosphere, over altitude can be described by the ISA model. For a temperature of $15^\circ C$ at sea level, the temperature decreases at a rate of $-6.5^\circ C$ per kilometer rise in altitude, up to 11 km (inside the troposphere).
a) Give a function of temperature to height, to represent this model.

\[ f(x) = -6.5x + 15, \quad 0 \leq x \leq 11 \]

(b) If a plane takes off at sea level (at \( 0^\circ C \) ) and reaches a maximum height of 10 km above sea level, find the range in temperature in Celsius.

\[ f(10) = -6.5(10) + 15 = -50 \]

\([-50, 15]\]

(c) Find the range in temperature in Fahrenheit, if \( C = \frac{5}{9}(F - 32) \).

\[-50 \leq \frac{5}{9}(F - 32) \leq 15 \]

\[-58 \leq F \leq 59\]
Consider the following set of data from the US Department of the Treasury, Bureau of the Public Debt.

Each year’s debt was taken on September 30th.
<table>
<thead>
<tr>
<th>YEAR</th>
<th>Debt in trillions of dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>5.7</td>
</tr>
<tr>
<td>2001</td>
<td>5.8</td>
</tr>
<tr>
<td>2002</td>
<td>6.2</td>
</tr>
<tr>
<td>2003</td>
<td>6.8</td>
</tr>
<tr>
<td>2004</td>
<td>7.4</td>
</tr>
<tr>
<td>2005</td>
<td>7.9</td>
</tr>
<tr>
<td>2006</td>
<td>8.5</td>
</tr>
<tr>
<td>2007</td>
<td>9.0</td>
</tr>
<tr>
<td>2008</td>
<td>10.0</td>
</tr>
<tr>
<td>2009</td>
<td>11.9</td>
</tr>
<tr>
<td>2010</td>
<td>13.6</td>
</tr>
<tr>
<td>2011</td>
<td>14.7</td>
</tr>
</tbody>
</table>
$y = 0.0724x^2 + 0.0095x + 5.853$
$R^2 = 0.9902$

$y = 5.2492e^{0.0883x}$
$R^2 = 0.9744$
Area of Circle

What is the area of a circle? About 250 B.C., Archimedes derived the area of a circle via geometric methods. We will explore a similar method.

\[ A = \pi r^2 \]
Inscribe an $n$-gon

$$A_1(n) = \pi r^2 \frac{\sin \left( \frac{2\pi}{n} \right)}{2\pi} \frac{n}{n}$$
Circumscribe an n-gon

\[ A_2(n) = \pi r^2 \frac{\tan(\frac{\pi}{n})}{\frac{\pi}{n}} \]
Let \( n \to \infty \)

What happens to \( \theta = \frac{\pi}{n} \)?

\[
A_1(\theta) = \pi r^2 \frac{\sin(2\theta)}{2\theta} \leq A \leq A_2(\theta) = \pi r^2 \frac{\tan \theta}{\theta}
\]

Where \( A = \) the area of a circle
Squeeze Theorem

\[
\lim_{\theta \to 0} A_1(\theta) = \pi r^2
\]

\[
\lim_{\theta \to 0} A_2(\theta) = \pi r^2
\]

\[\text{Hence } A = \pi r^2\]
Optimization

* Competition!!!

* Divide into groups. Get a wire of 1 meter long. The wire should be cut into two pieces in such a way that if you form a circle with the one piece and a square with the other piece, the combined areas would be a minimum. The group who can find the smallest area will win a fabulous prize. (How can we find the maximum area?)
\[ A = x^2 \]
\[ P = 4x \]
\[ A_T = x^2 + \pi r^2 \]
\[ L = 4x + 2\pi r = 2(2x + \pi r) = 100 \]
\[ 2x + \pi r = 50 \]
\[ 2x = 50 - \pi r \]
\[ r = \frac{50 - 2x}{\pi} \]
\[ A_T = x^2 + \pi \left( \frac{50 - 2x}{\pi} \right)^2 \]
\[ A_T = x^2 + \pi \left( \frac{2500 - 200x + 4x^2}{\pi^2} \right) \]
\[ A_T = x^2 + \frac{2500 - 200x + 4x^2}{\pi} \]
\[ A_T = x^2 + 795.8 - 63.7x + 1.3x^2 \]
\[ A_t = 0.3x^2 - 63.7x + 795.8 \]
\[ x = 13.8 \]
Team Penguin

143 + 2\pi r

A = \frac{1}{2} a^2
A = \frac{1}{2} \pi r^2 + \pi r h
100 = 45 + 2\pi r
45 = 2\pi r
S = \frac{1}{2} \pi r^2 - 25

A = (4.5\pi + 25) + 6.25\pi
13 = r

\sqrt{14.5}

8.16 / 8.32

100 = 45 + 2\pi r
45 = 2\pi r
S = \frac{1}{2} \pi r^2 - 25

If you solve for S, plugging it into
100, you get 5 = \frac{1}{2} \pi r - 25,
you substitute it into the height equation, which is your slope for f,
and the smallest area once you get
you go. If you plug it back into
the circumference equation to get
the length of the circumference,
subtract it from 100, as get
the length of space.

MeganPatterson
Oriya
Drew
Molly Bernardini
Luci Murphy
Austin Helinski
Length of side of square is \( x \) (radius of circle is \( r \)).

Radius of circle is \( r \).

The perimeter of circle is square is:
\[
P = 4x + 2\pi r = 1
\]

The total area of the circle + square is
\[
A = x^2 + \pi r^2
\]

Use the perimeter formula to solve for \( x \):

\[
4x + 2\pi r = 1
\]
\[
x = \frac{1 - 2\pi r}{4}
\]

Substitute this solution into the area formula:
\[
A = \left(\frac{1 - 2\pi r}{4}\right)^2 + \pi r^2
\]
\[
= \frac{1 - 4\pi r + 4\pi^2 r^2}{16} + \pi r^2
\]
\[
= \frac{1 - 4\pi r + 4\pi^2 r^2 + 16\pi r^2}{16}
\]
\[
= \frac{1 - 4\pi r + (\frac{1}{4} \pi^2 + \pi) r^2}{4}
\]

Find critical points by setting the derivative of the area with respect to \( r \) to 0.
\[
A' = -\frac{1}{4} \pi + 2(\frac{1}{4} \pi^2 + \pi) r = 0
\]
\[
A' = -\frac{1}{4} \pi + (\frac{1}{2} \pi^2 + 2\pi) r = 0
\]
\[
r = \frac{\frac{1}{2} \pi^2 + 2\pi}{\pi + 2\pi} = \frac{\frac{1}{2} \pi^2 + 2\pi}{4\pi + 16}
\]
\[
r = \frac{\frac{1}{2} \pi^2 + 2\pi}{4\pi + 16}
\]
\[
r = \frac{1}{\pi + 8} = 0.36
\]
\[
\begin{align*}
\text{Total} & \quad 121 \\
36.4 & \quad 55.5 \\
& \quad 112.9 \\
& \quad 175.3 \\
& \quad 350.2
\end{align*}
\]

\[
\begin{align*}
\text{Total} & \quad 114 \\
50.4 & \quad 47.7 \\
& \quad 100.1 \\
& \quad 190.2
\end{align*}
\]

\[
\begin{align*}
\text{Total} & \quad 115 \\
51.1 & \quad 47.3 \\
& \quad 102.4 \\
& \quad 196.8
\end{align*}
\]

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Share Ideas
Questions
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