Mathematics:

A Christian Perspective

STUDENT VERSION

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Materials prepared on behalf of the Kuyers Institute of Calvin College, March 2006

The Indian Ocean Tsunami: December 26, 2004

What is a tsunami? A tsunami is an ocean wave that is generated by a sudden displacement of the sea floor. This displacement can occur as a result of earthquakes. Tsunami is a Japanese word for “harbor wave.” The December 26, 2004, Indian Ocean tsunami was a natural disaster that caused unimaginable grief and sorrow to millions of people. The mathematics of logarithmic scales will help us understand how earthquakes are measured. By graphing trigonometric

Trigonometric functions

1) Create a tsunami in a cake pan

Materials:

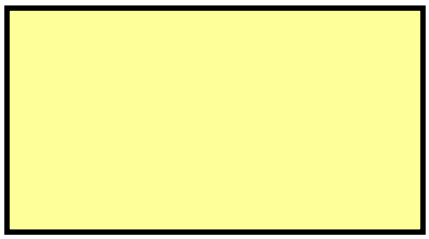
plastic cake pan
16 oz water
scissors
sturdy plastic wrap
tape

Directions: Cut a hole in the bottom of the plastic cake pan approximately 4 inches in diameter. Tape the plastic wrap on the outside of the pan, covering the hole and making sure it is water-tight. Fill the pan with water. Gently tap on the plastic wrap and observe what happens. Why? What happens if you alter the strength of your tap?

2) Graphs of cosine functions

The graphs of the cosine and sine functions are important for understanding applications to physical situations. A simple wave closely resembles that of a cosine function that moves regularly in time. These graphs are beautiful and interesting in their own right.

a. *Example 1:* Sketch the graph of each function.



c. A cosine graph may be shifted horizontally in the plane by an amount *b*. It is shifted to the right if $b > 0$ or to the left if $b < 0$. The amount of that shift is known as the "phase shift."

For $y = a\cos k(x - b)$,

Amplitude = $|a|$

Period = $\frac{2\pi}{k}$

Phase shift = b

Example 3: Find the amplitude, period, and phase shift of the function; then sketch its graph:

$$y = \frac{3}{4}\cos\left(2x + \frac{2\pi}{3}\right)$$

3) Practice Problems

a. Find the amplitude and period of the function and sketch its graph.

$y = \cos 4x$ $y = 3 \cos (3x)$

$y = - \cos (1/3\ x)$ $y = 10 \cos (1/2\ x)$

b. Find the amplitude, period, and phase shift of the function; then graph one complete period.

$y = \cos (x - \frac{\pi}{2})$ $y = 5 \cos (3x - \frac{\pi}{4})$

4) Application Problems

a. As a wave passes by an offshore piling, the height of the water is modeled by the function

$$h(t) = 3 \cos ($$

where *h(t)*

Discussion Questions

God is not only Creator and Sustainer but, through the Incarnation, Sufferer and Savior. Do you think God suffers when natural disasters bring tragedy to the lives of humans? Would God suffer differently if God did not become human?

In the midst of terrible natural tragedies, people are tempted to doubt God's mercy. What tools, skills, or resources do we have to find God in the midst of trouble and sorrow?

1. Intensity of earthquakes

In order to find the difference in intensity of earthquakes, divide the larger energy release by the smaller.

Example 1: How many times more intense is an earthquake with a Richter magnitude of 6.3 than one with magnitude 4.7?

2. Intensity of Sounds

Watts/Square meter	Description	Decibels
10^{2}	jet plane 30 m away	140
10^{1}	pain level	130
10^{0}	amplified rock music	120
10^{-1}		110
10^{-2}	noisy kitchen	100
10^{-3}	heavy traffic	90
10^{-4}	ordinary traffic	80
10^{-5}		70
10^{-6}	normal conversation	60
10^{-7}	average home	50
10^{-8}		40
10^{-9}	soft whisper	30
10^{-10}	rustling leaves	20
10^{-11}		10
10^{-12}	barely audible	0

As the decibel values increase by adding 10, the intensities multiply by 10. For example, if you increase the sound intensity by 40dB, you multiply the watts/square meter by $10^4 = 10{,}000$.

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Example 2: The sound of the tsunami was likened to the roar of a jet. The roar of a jet engine 30 m away is 140 dB. How many times more intense than heavy traffic was the sound of the tsunami?

3. Practice Problems

For a-b, use the Richter scale values given in this lesson.

a. Great earthquakes such as the Good Friday Earthquake in Alaska in 1964 had a Richter magnitude of 8.3. How many times more intense was the Indian Ocean tsunami earthquake that was recorded as a Richter magnitude of 9.0?

b. How many times more intense was the motion caused by the 1906 San Francisco earthquake that measured 8.3 on the Richter scale as that caused by the 2001 Bhuj, India earthquake that measured 6.9?

For c-d, refer to the chart of sound intensity levels given in this lesson.

c. A city will make it illegal to create sound in a residential area that exceeds 72 decibels during the day and 55 decibels during the night. How many times more intense is the noise level allowed during the day than at night?

d. For humans, the threshold of pain due to sound averages 130 dB. What is the intensity of such a sound in watts/meter^2?

Discussion Questions

Is it accidental that developing countries do not have a warning system in

The whole creation has fallen, but hope remains for it

2) Newton's formula for falling objects

In the 17th century, Isaac Newton discovered that an object thrown into the air or moving in space can be modeled by a quadratic function. The quadratic equation that involves

3) Applications of quadratics

The Indian Ocean tsunami destroyed thousands of miles of coastlines. It submerged islands, and destroyed roads and airports. Many thousands of people were stranded in areas that were inaccessible. The following problems deal with the dropping of relief supplies.

Practice Problems

a. A rescue helicopter hovering 68 feet above a fishing boat in trouble drops a life raft.

   i) Write an equation to model this situation where h(t) is the height of the raft at time, t, in seconds.

   ii) How many seconds after the raft is dropped will it hit the water?

b. A crate of blankets and food is dropped without a parachute from a helicopter

Discussion Questions

Investigate:

You may feel called to bring compassion to a hurting world, with the help of God's Holy Spirit. What should a Christian's response be when others are in trouble?

In the past few years, the world has seen several natural disasters that have caused immense damage and loss of lives. Charitable giving in many countries has reached an all time high. What is your response when local authorities note that charitable giving is being depleted in your community as a result of charity being dispersed to other countries?