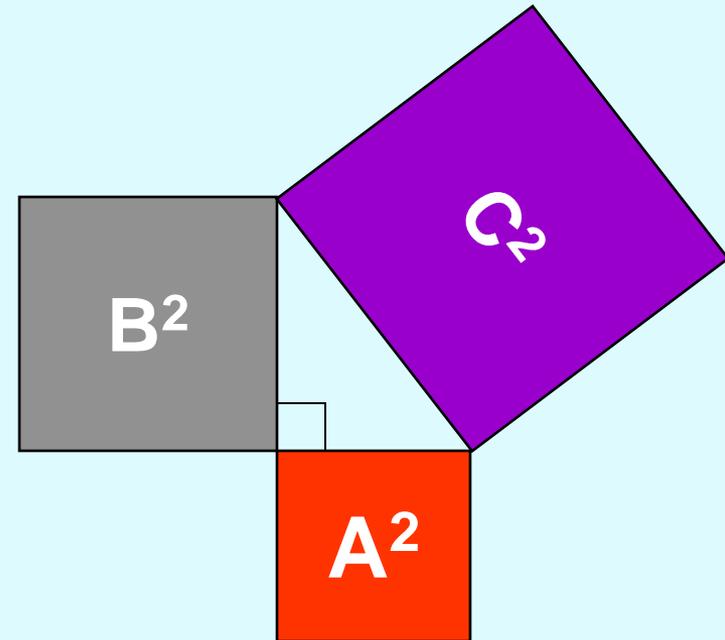


# Presentation to Clark State Community College *03 May 2006*

## *Pythagoras, Trigonometry, and The Cell Phone*



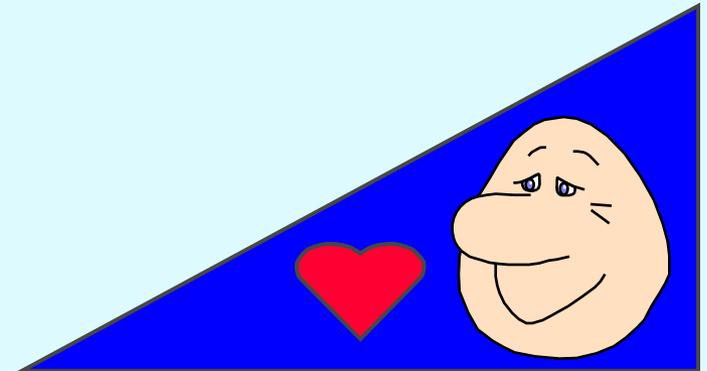
$$C^2 = A^2 + B^2$$

# Poem: “Love Triangle”

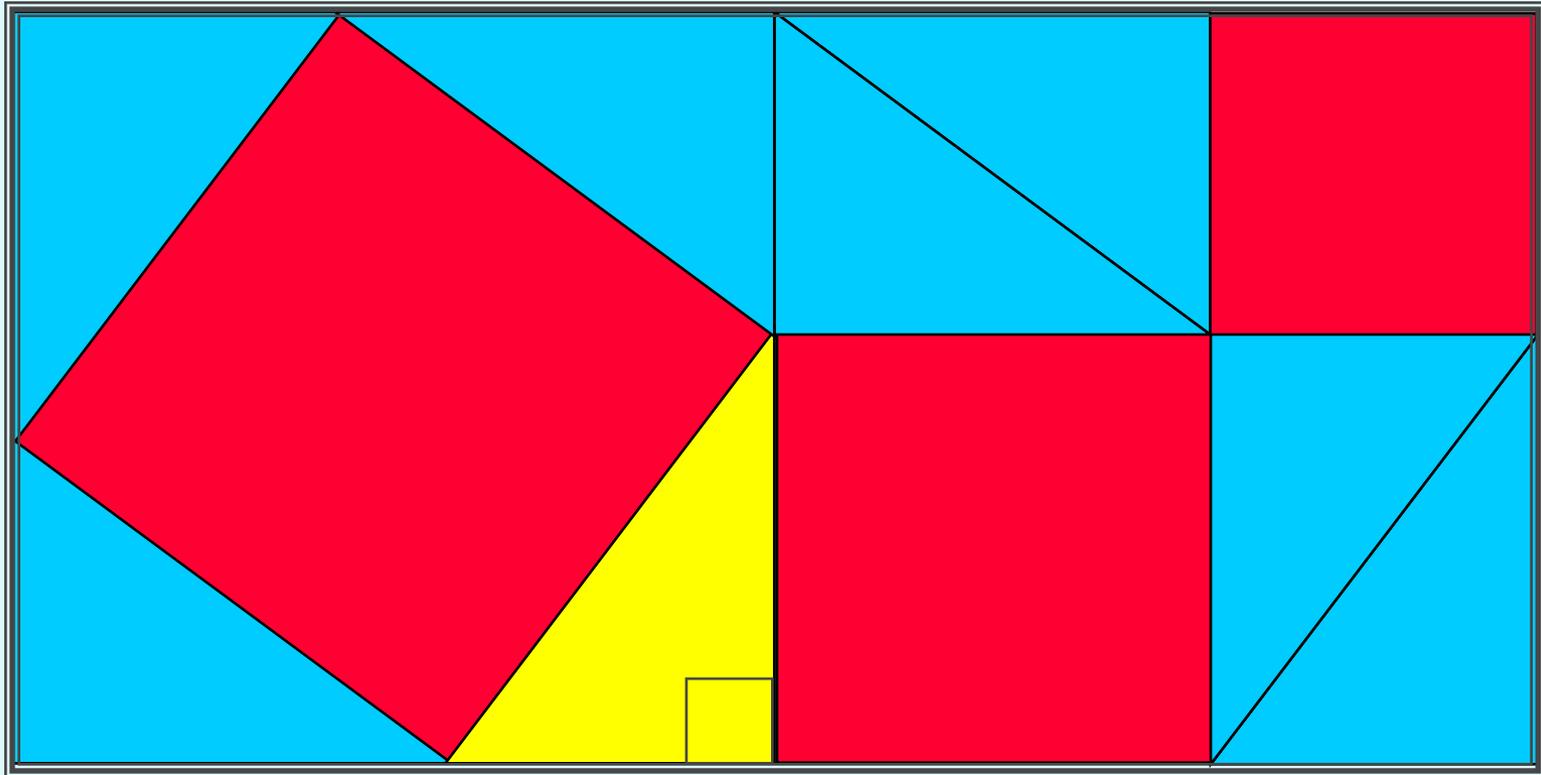
*Consider ol' Pythagorus,  
A Greek of long ago,  
And all that he did give to us,  
Three sides whose squares now show*

*In houses, fields, and highways straight;  
In buildings standing tall;  
In mighty planes that leave the gate;  
And, micro-systems small.*

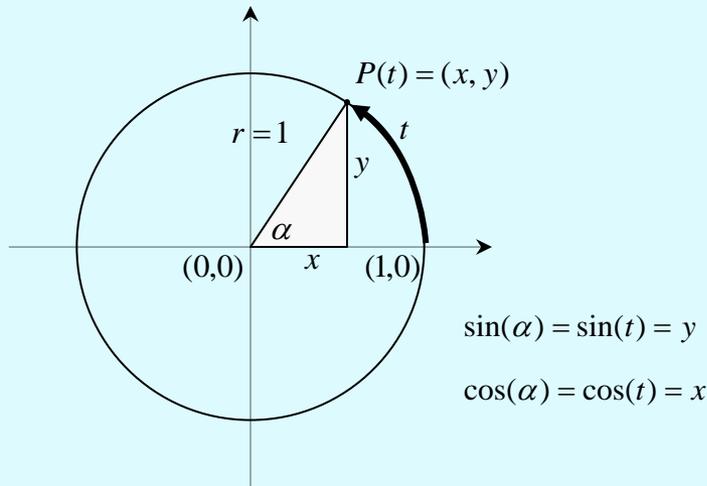
*Yes, all because he got it right  
When angles equal ninety—  
One geek (BC), his plane delight—  
One world changed aplenty!*



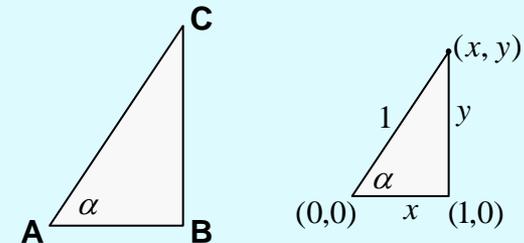
# An Early Pre-Algebraic Visual 'Proof' of the Pythagorean Theorem



# Trigonometry is *Pythagorean* Right-Triangle Geometry



**Dynamic view of trigonometry as a descriptive measurement system for right-triangular relationships that propagate through time.**



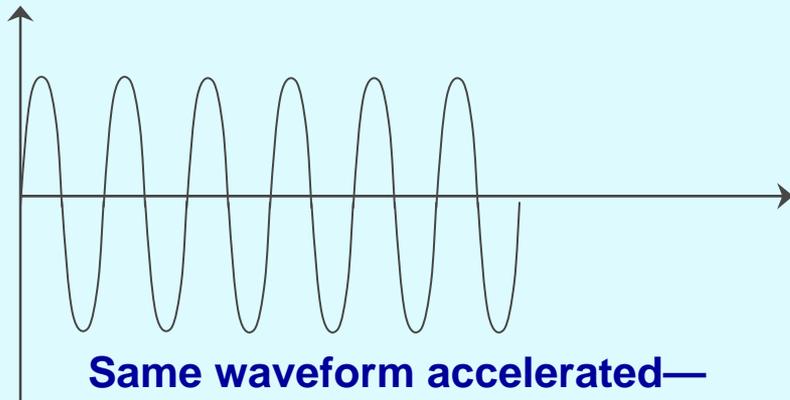
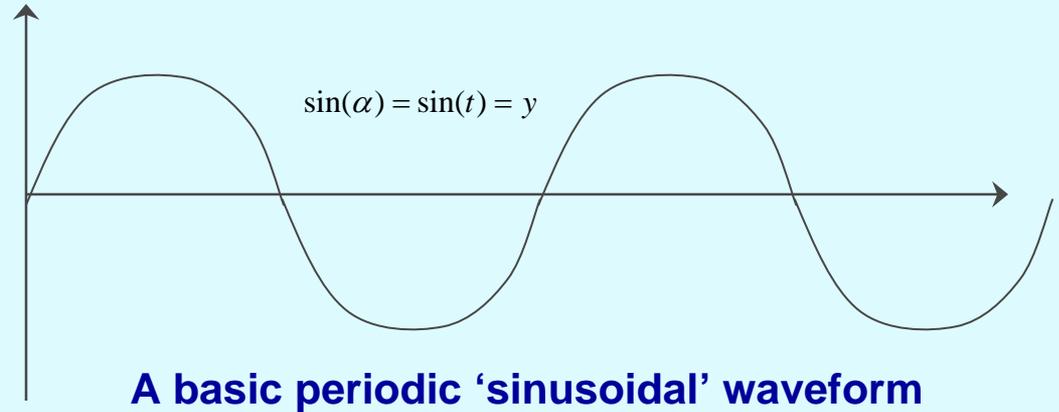
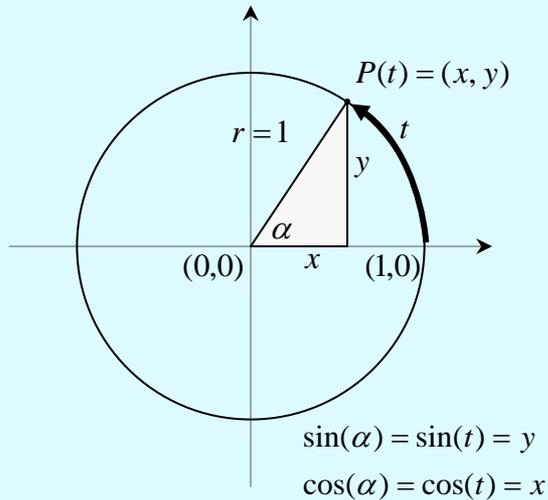
$$\sin(\alpha) = \frac{y}{1} = \frac{\overline{BC}}{\overline{AC}}$$

$$\cos(\alpha) = \frac{x}{1} = \frac{\overline{AB}}{\overline{AC}}$$

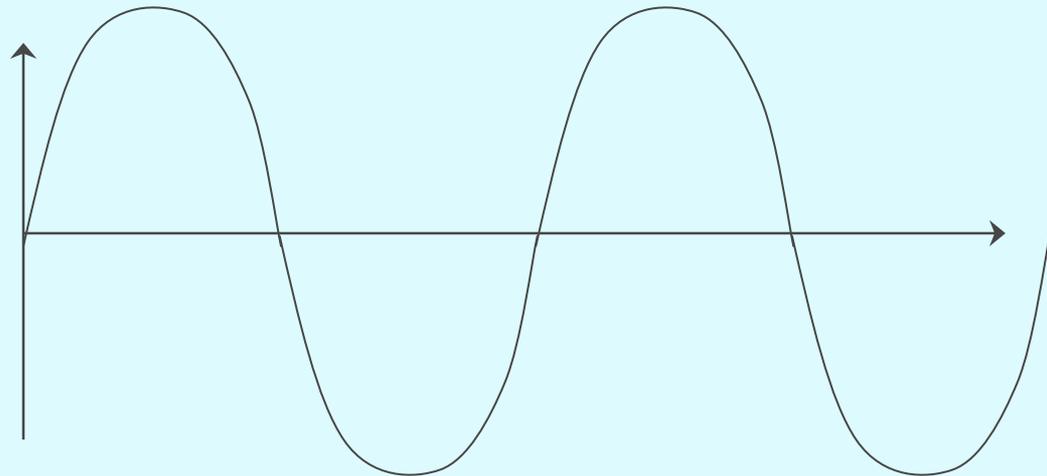
**Static view of trigonometry as a descriptive measurement system for right-triangular relationships that occur in physical space.**

**In either case, since these relationships—sin, cosine, etc—are derived using right triangles, we can say all trigonometry is Pythagorean in origin.**

# Why the Human Voice is Trigonometric Friendly (One)

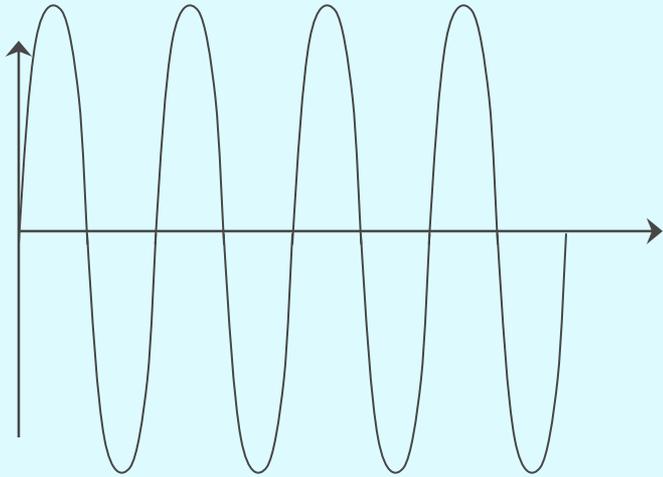


**Same waveform accelerated—  
Called a frequency change**

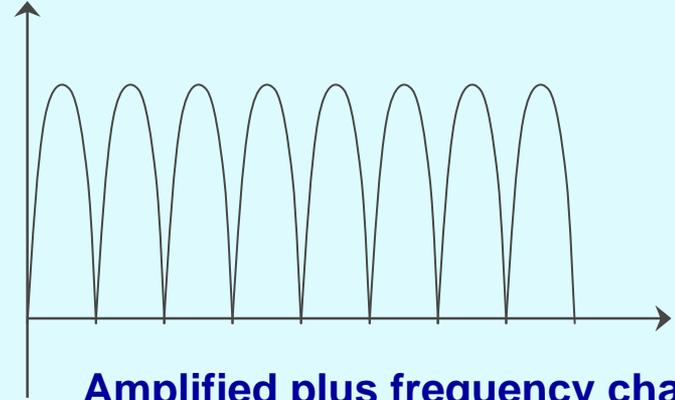


**Same waveform amplified**

# Why the Human Voice is Trigonometric Friendly (Two)

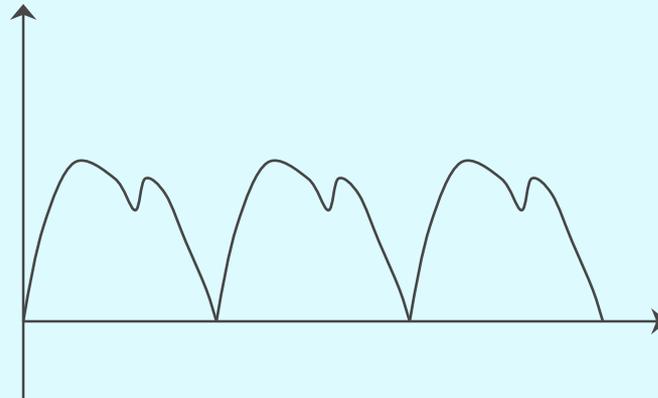


**Amplified plus frequency change**

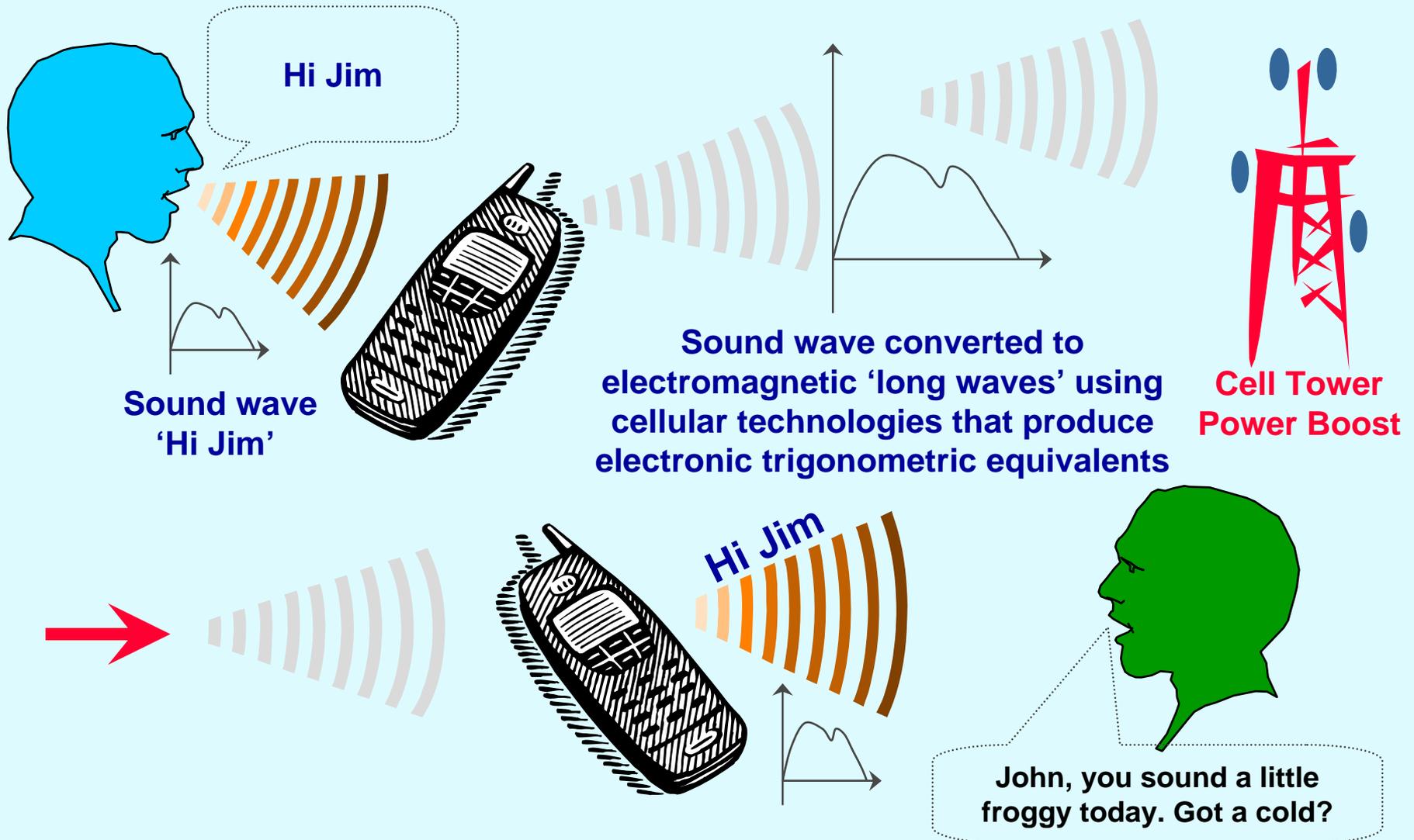


**Amplified plus frequency change  
plus sign change to always positive:  
'rectification' in electrical engineering**

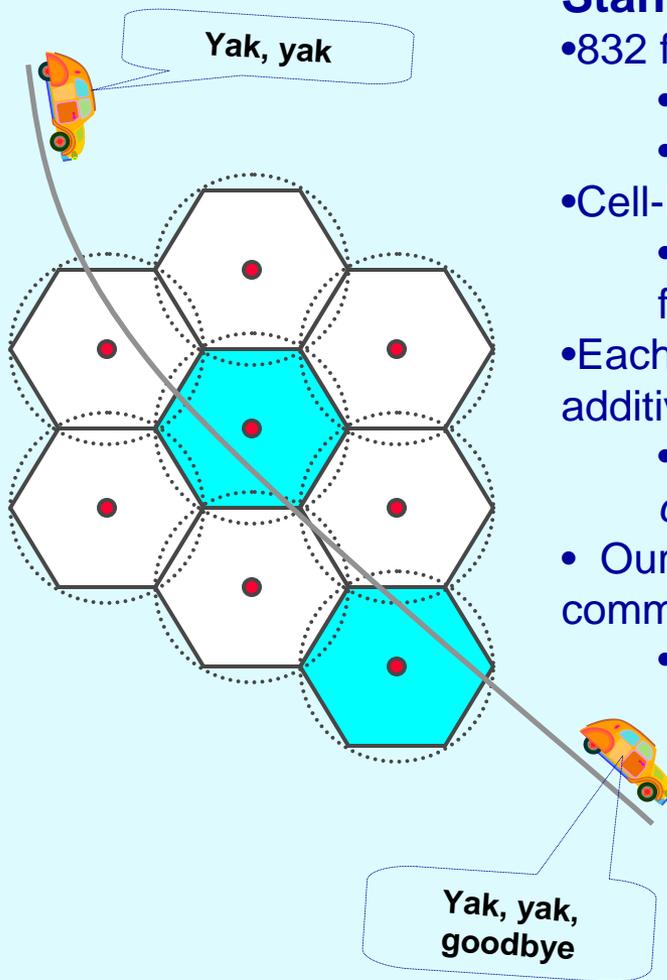
**Effect of adding or subtracting  
two or more 'rectified'  
sine and cosine waves.**



# Why the Human Voice is Trigonometric Friendly (Three)



# Meet the Cell in Cellular Phone

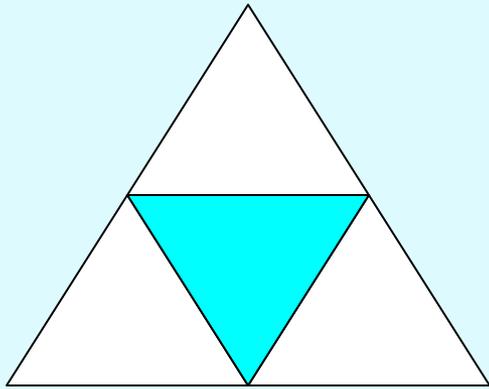


## Standard Seven-Cell Cluster

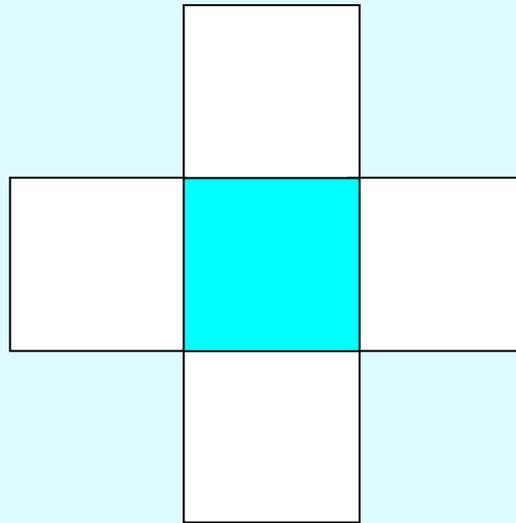
- 832 federally-assigned frequencies
  - 48 channels reserved for network control
  - 784 channels for voice communications
- Cell-Phone conversations are simultaneous and two-way
  - Each conversation requires two different electromagnetic frequencies
- Each frequency is a specific waveform patterned after a basic additive combination of *sines and cosines*
  - Mathematically *processed* per the *rules governing sines and cosines* using electronic equipment designed to do just that
- Our basic seven-cell cluster can accommodate 392 separate communications
  - 56 simultaneous communications per cell

The beauty of the cell system is that 832 frequencies can be reused throughout the provider's assigned area, since a cellular system—by design—is a low-power system

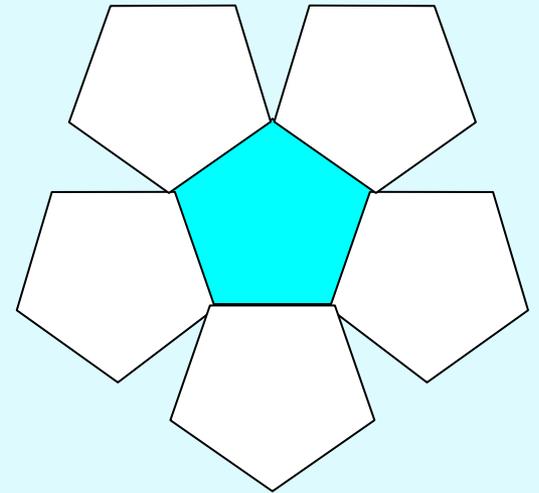
# Some Geometrically Unacceptable Cellular Clusters



**4-Cell Cluster**



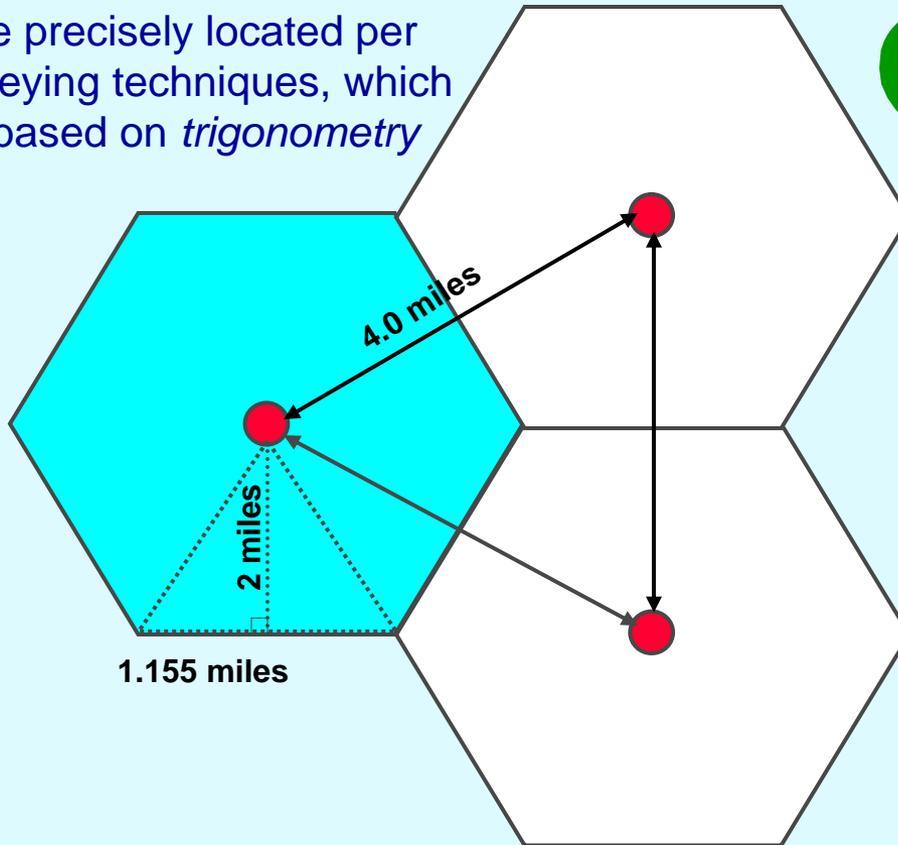
**5-Cell Cluster**



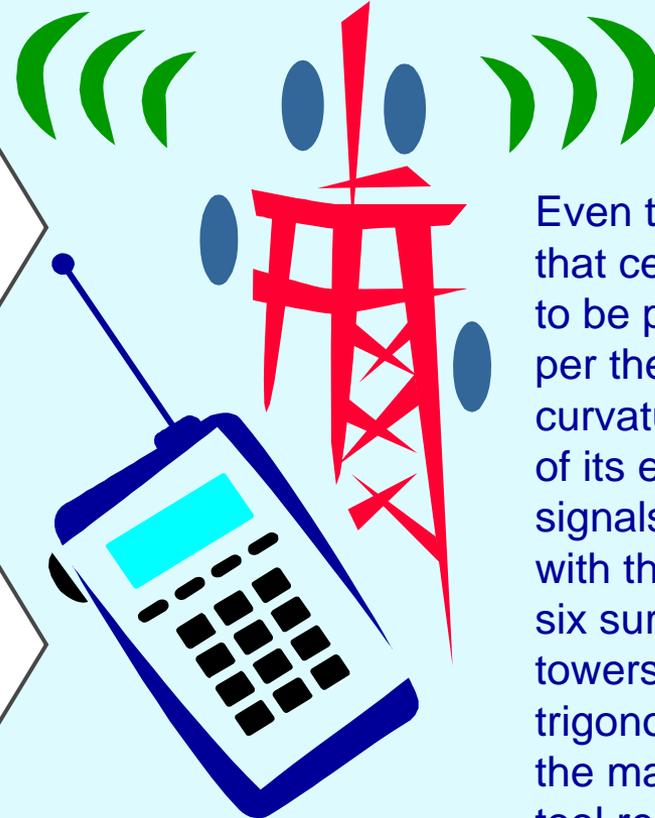
**6-Cell Cluster**

# Trigonometric Geometry of a Typical Single Cell

All Cellular Infrastructure has to be precisely located per surveying techniques, which are based on *trigonometry*



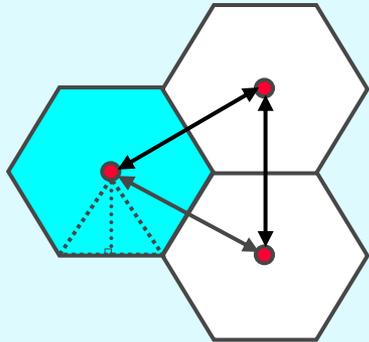
Trigonometric Waveforms!



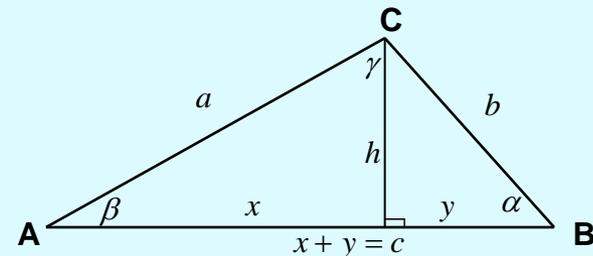
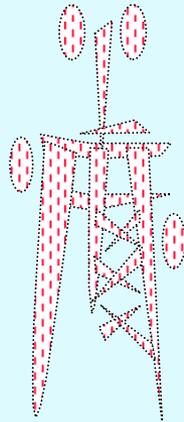
Even the height of that cell tower has to be precisely set per the earth's curvature so none of its emitted signals interfere with those of the six surrounding towers. Again, trigonometry is the mathematical tool required to do this.

Here, Our Cell Area =  $12 \times (1/2) \times (1.155) \times (2) = 13.85$  square miles

# Surveying Cellular Tower Placement



- Initial placement done by use of GPS system
  - Heavily dependent on trigonometric principles
- Placement fine-tuned by traditional surveying
- Traditional surveying is founded on two major tools, which allow trigonometry to expand capability from right triangles to general triangles
  - Law of Cosines
  - Law of Sines



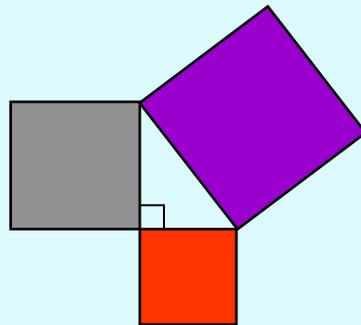
$$a^2 = c^2 + b^2 - 2bc \cos(\alpha)$$

**Law of Cosines**

$$\frac{b}{\sin(\beta)} = \frac{a}{\sin(\alpha)} = \frac{c}{\sin(\gamma)}$$

**Law of Sines**

# Cell Phones, Cell Towers, and Cellular Technology as a Dynamic Synthesis of Trigonometric Principles.



# Summary

- ◆ Technologically speaking, the totality of the cellular industry rests on trigonometric principles
- ◆ Throughout this course, we will return to the cellular industry again and again as we learn various aspects of the trigonometric language and discipline
  - Will work applications directly related to corresponding technical aspects of the cellular industry
- ◆ Will also discuss the various jobs available in the booming worldwide cellular industry, many of which require the technical skills that you will be learning in this course!



**Pythagoras, if you could only hear us now! Thank you!**

