Concept Check: Which of the following is a valid trig identity? How do you know?

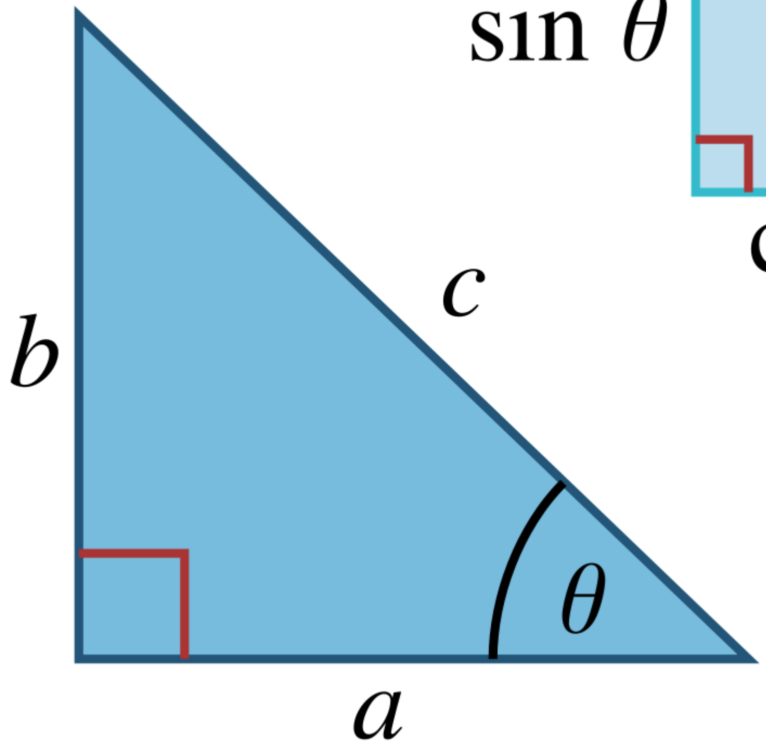
$A) \sin^2\theta - \cos^2\theta = 1$

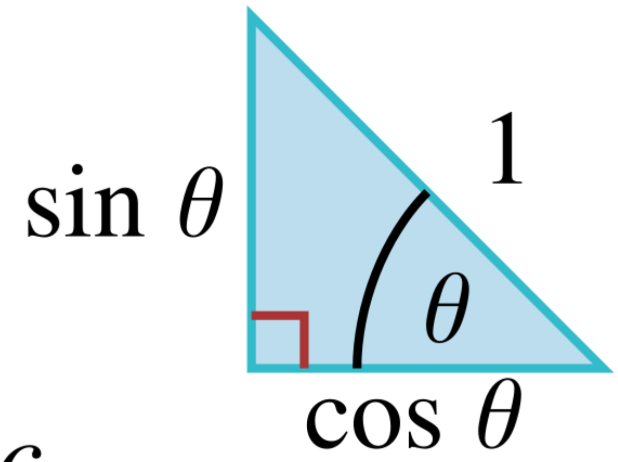
$B) 1 + \tan^2\theta = \frac{1}{\cos^2\theta}$

$C) 1 + \tan^2\theta = \frac{1}{\sin^2\theta}$

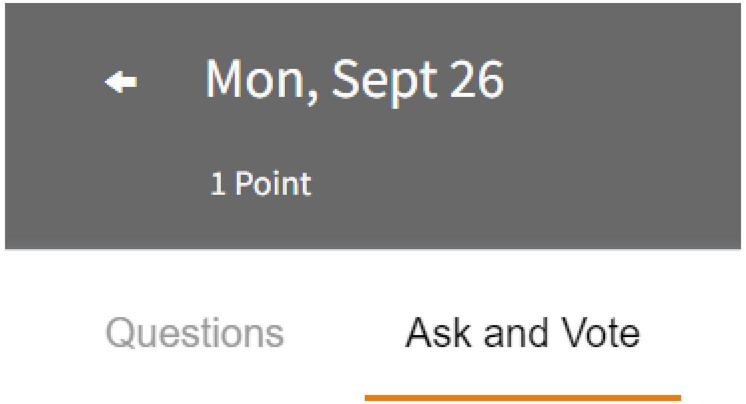
$D) 1 - \tan^2\theta = \frac{1}{\sin^2\theta}$

E) None of these



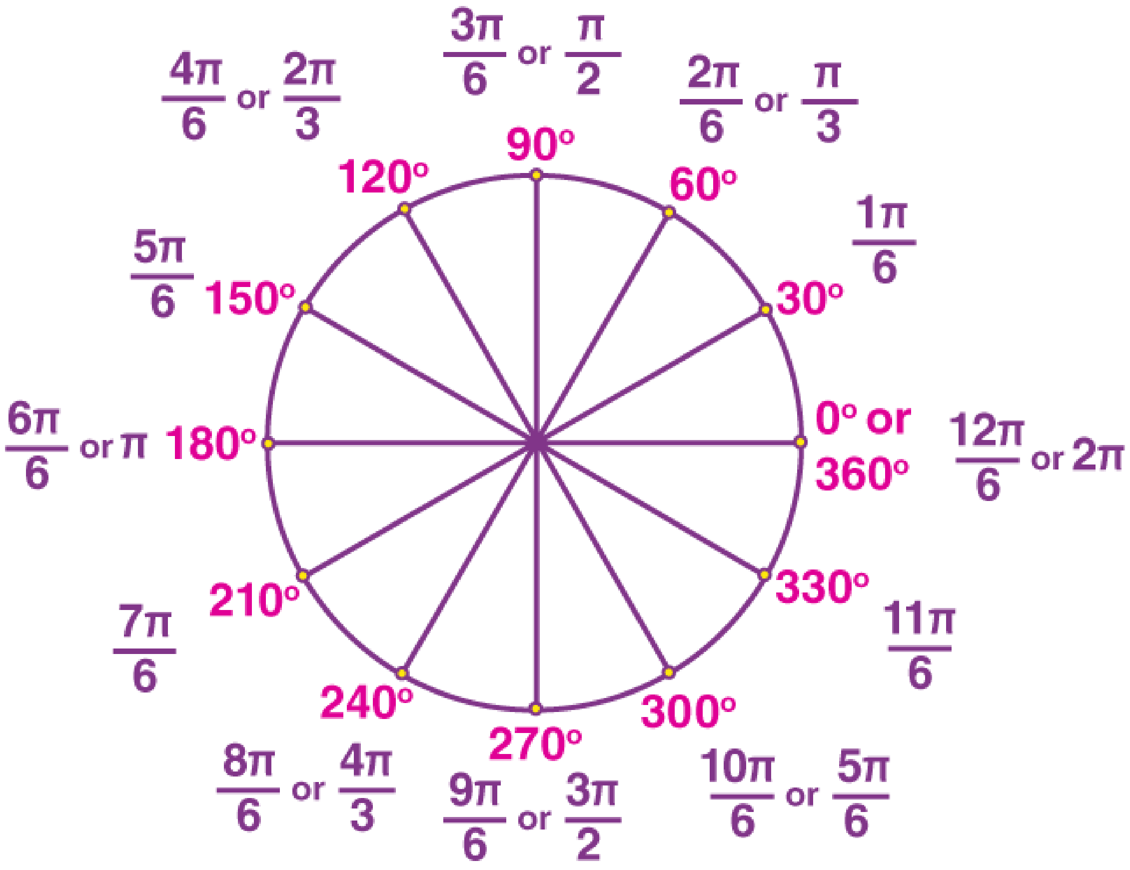


Note: Ask and Vote



HW1 Open: On Canvas

Recap and Elaboration: Radians and the Small Angle Approximation



$$r\Delta\theta = \Delta l$$

In radians!

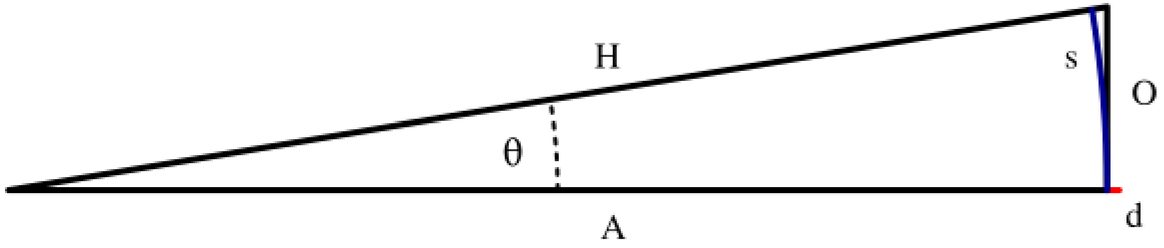
$$\sin\theta \approx \tan\theta \approx \theta$$

In radians!

$$\cos\theta \approx 1$$

Recap + Elaboration: Small Angle Approximation

Geometric Perspective



$$\sin(\theta) = \frac{O}{H} \approx \frac{s}{R} = \theta \text{ (radians!)}$$

$$\cos\theta = \frac{A}{H} \approx \frac{R}{R} = 1$$

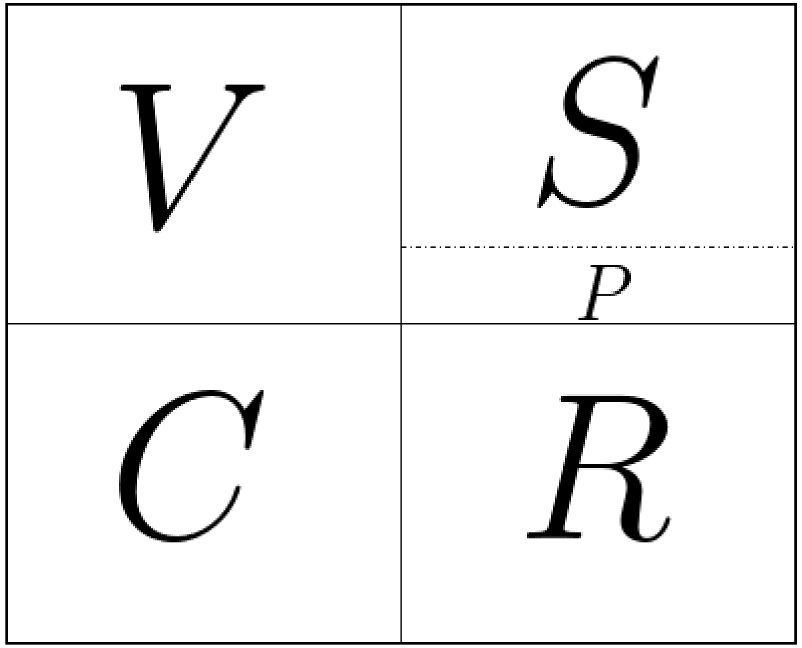
Calculus Perspective

$$y = \sin(\theta)$$
$$y' = \cos(\theta)$$

$$\sin(\theta) = y \approx \sin(0) + \cos(0)\,\theta$$
$$= 0 + \theta = \theta$$

How to Solve a Physics Problem

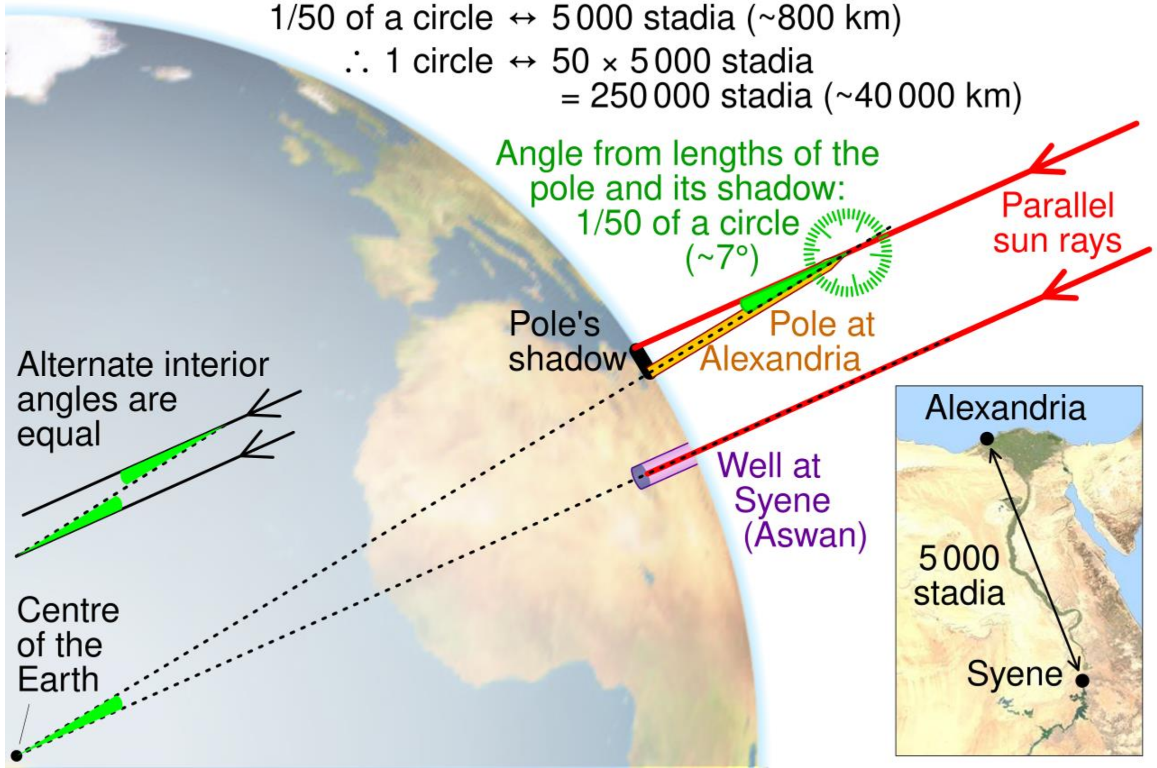
(An example of *Structured Problem Solving*)



1. Visualize: Draw/imagine a picture or diagram, label it
2. Collect Info: Relevant concepts, relations, equations
3. Solve: Work out ***symbolically***, then plug in at the end
4. Review/check the answer: Units, size, relationships

Example: Size of the Earth

Let's say that when the sun is directly overhead in Syene, a meterstick stuck in Alexandria 800km away casts a shadow of length 12.6cm. What's the circumference of the Earth?

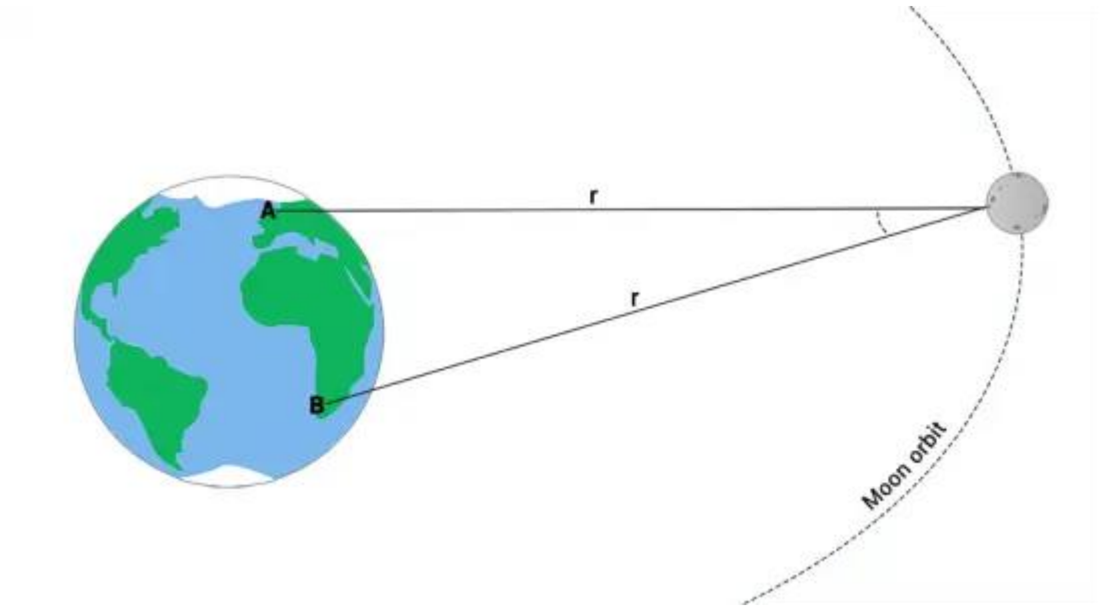


The Distance to the Moon

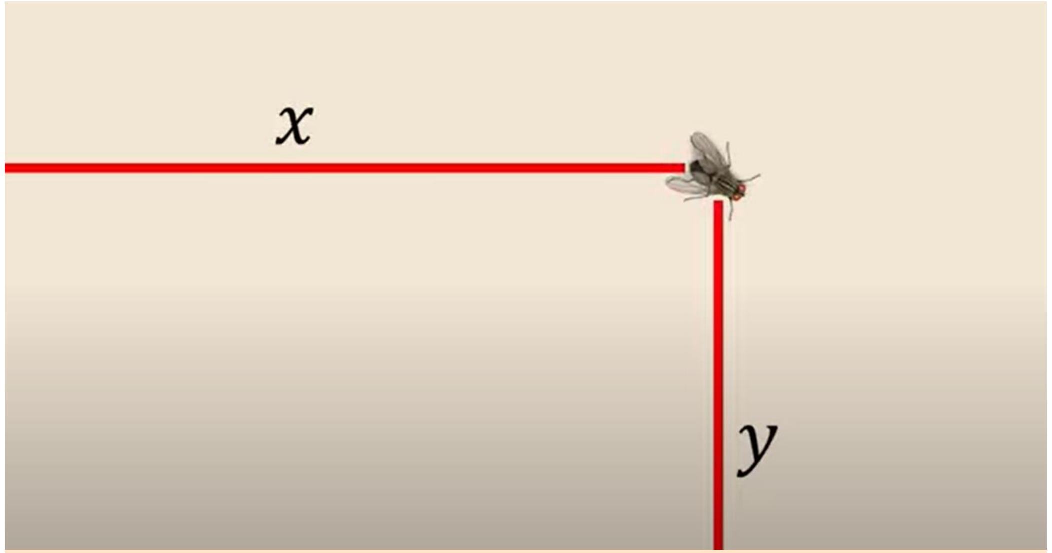
- Parallax Distance:

$$D = \frac{b}{2 \times \tan(\theta/2)}$$

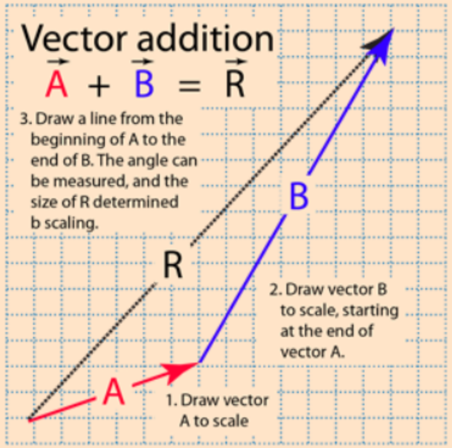
- Hipparchus and later Ptolemy were among the first to use this method. They estimated the distance to the Moon to be about 60 times the Earth's radius, which is fairly close to the actual value of approximately 60.3 times.



Prelecture Review: Coordinate Systems and Vectors



Graphical Vector Addition



Adding two vectors A and B graphically can be visualized like two successive walks, with the vector sum being the vector distance from the beginning to the end point. Representing the vectors by arrows drawn to scale, the beginning of vector B is placed at the end of vector A. The vector sum R can be drawn as the vector from the beginning to the end point.

The process can be done mathematically by finding the components of A and B, combining to form the components of R, and then converting to polar form.

Index

Vector concepts

HyperPhysics***** Mechanics   *R Nave*   Go Back

Position

Vector

Displacement Vector

Vector Addition

Coordinate form

Polar form

What are our questions and/or comments?

Comments and Questions

- All of this is to a certain degree imaginary. How do we tie down physics to something that is fundamentally an imaginary coordinate system.
- I understand that solving for R using graphical vector addition requires me to find the vector components to form R, but I don't understand why I need to convert to polar form?
- For vector addition with 3 or more vectors, is that the angle on a 3D or 2D graph?
- I first off want to say that I don't think people like Rene Decartes get enough recognition for what they did compared to other people like Isaac Newton. Everyone acts like Newton singlehandedly figured out physics when it was certaintly a lot more deep than that.
- I wanted to know if there are any limits to 'vectors' and does it fully represent what we are wanting to quantify?
- I understand the Cartesian Plane, but I was wondering whether Descartes created using "x" and "y" to solve for variables or if someone else decided to use "x" and "y" first to solve algebraic equations.

My Comments and Questions

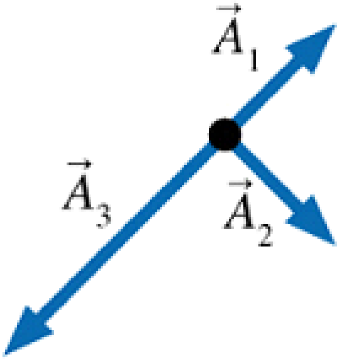
- Comment: I am reminded by a quote of Einstein:

"In 1908, already, I knew that to find a theory of gravitation I had to generalize the theory of relativity. Why were another seven years required for the solution of the problem? The reason is that it is not so easy to free oneself from the idea that coordinates must have an immediate metrical meaning."

→People invented coordinates, then had to un-invent them later

- Question: What new mathematical descriptions are needed for future physics?

Which figure below best shows $\vec{A}_1 + \vec{A}_2 + \vec{A}_3$?



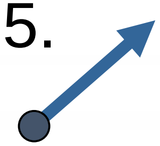
1.

2.

3.

4.

5.



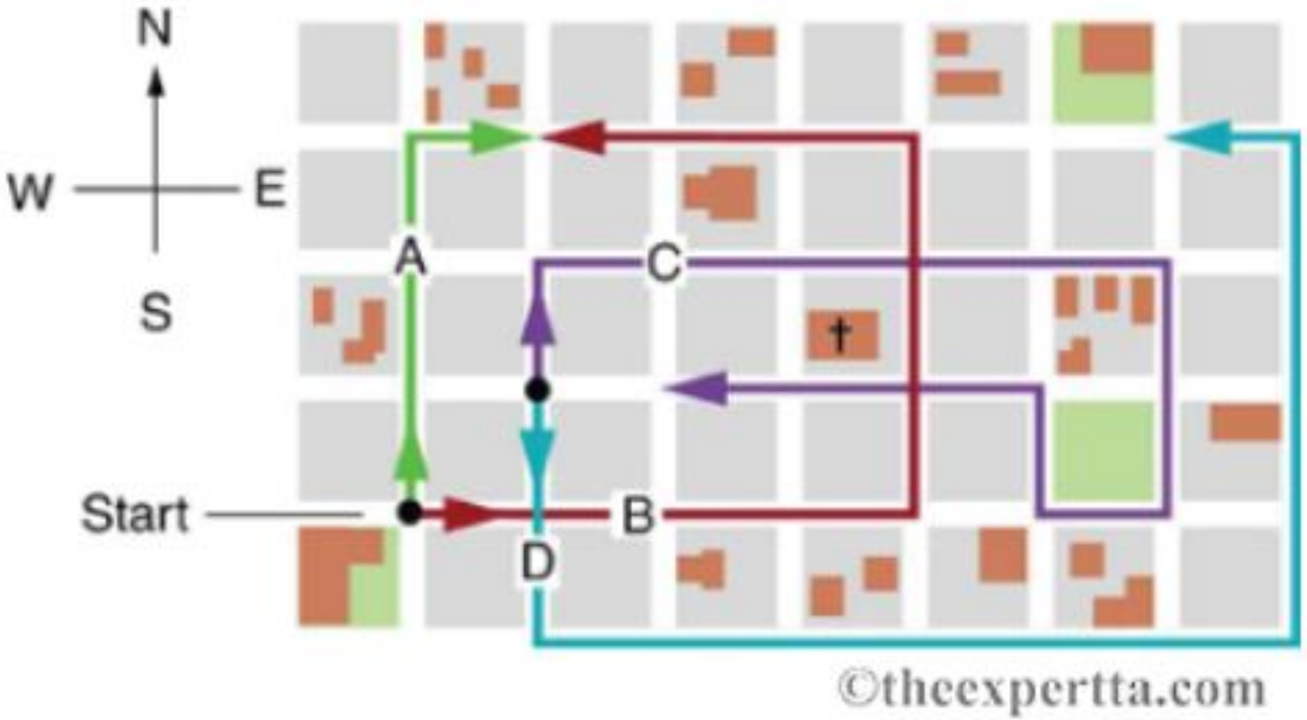
Concept Check: Vector Addition

1. Can two vectors of unequal magnitude sum to 0?

2. Can three vectors of equal magnitude sum to 0?

Problem 17: The various lines represent paths taken by different people walking in a city. All blocks are square and 120 m on a side.

1. Find the total distance travelled for Path B
2. Find the total displacement for Path B
3. Find the magnitude of the displacement for Path B
4. Compare?



First Homework Due: Friday Sept 6
First Discussions: Wednesday Sept 4
(so none this week!)

Coordinates in 3D and Cross Product…

Example: Area of a right triangle

Let's say we want the area of a right triangle, but know only the hypotenuse? What can we say?

$$A = kh^2$$

The quantity k is some dimensionless constant that depends on the kind of right triangle → So it's the same for ones that are similar!