

PHYSICS 570 – Master's of Science Teaching

“Electricity”

Lecture 6 – Vector Components

Instructor – Richard Sonnenfeld

mpsonnenfeld@gmail.com

575-835-6434

Lecture 6 – Outline

Correction –

Vector components

Why bother?

The princess and the circle

What are components?

Getting magnitude from components

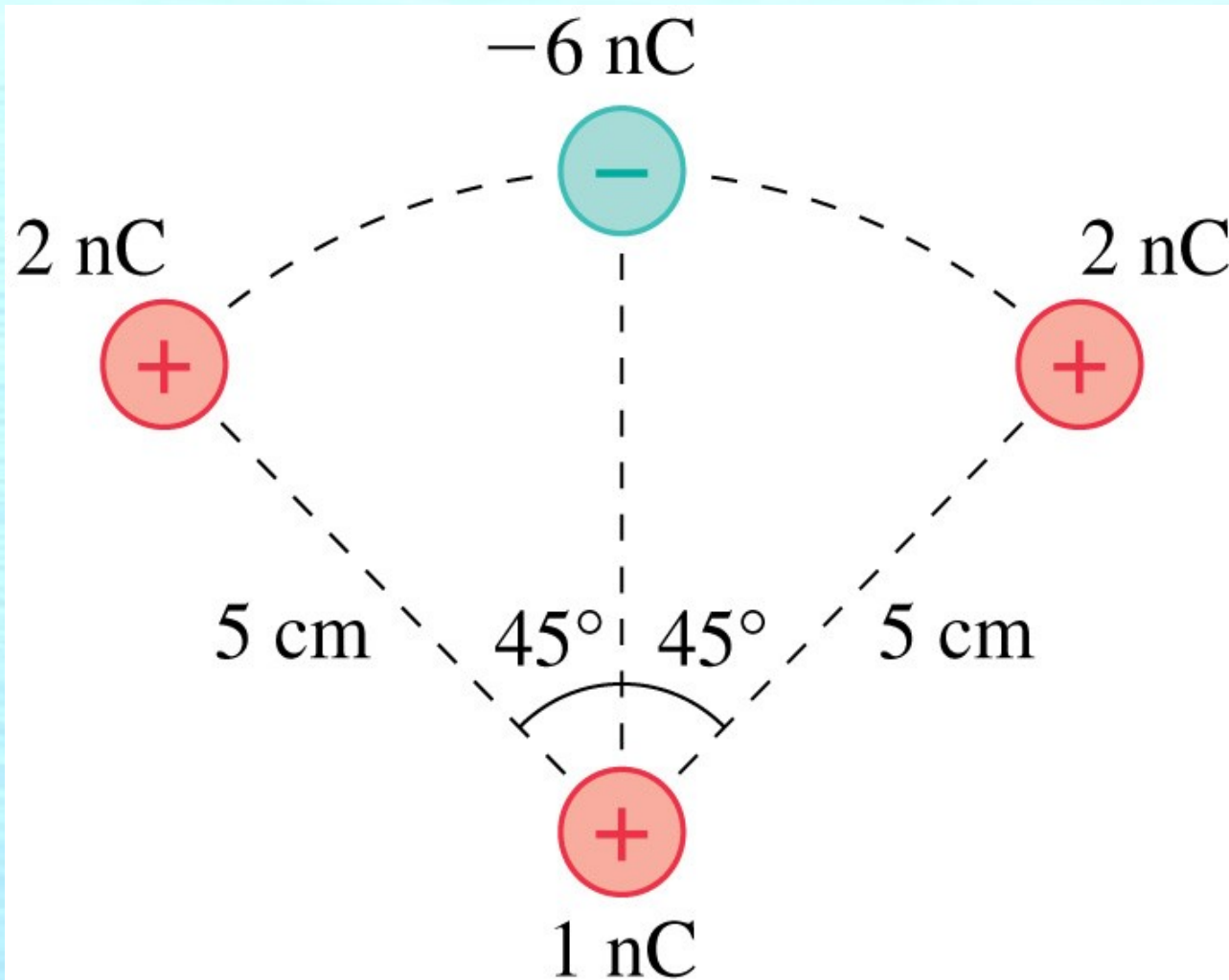
Getting angle from components

Getting components from magnitude
and angle.

Adding Vectors w/ Components

Applying to electrostatics

Force and Field on 1 nC?

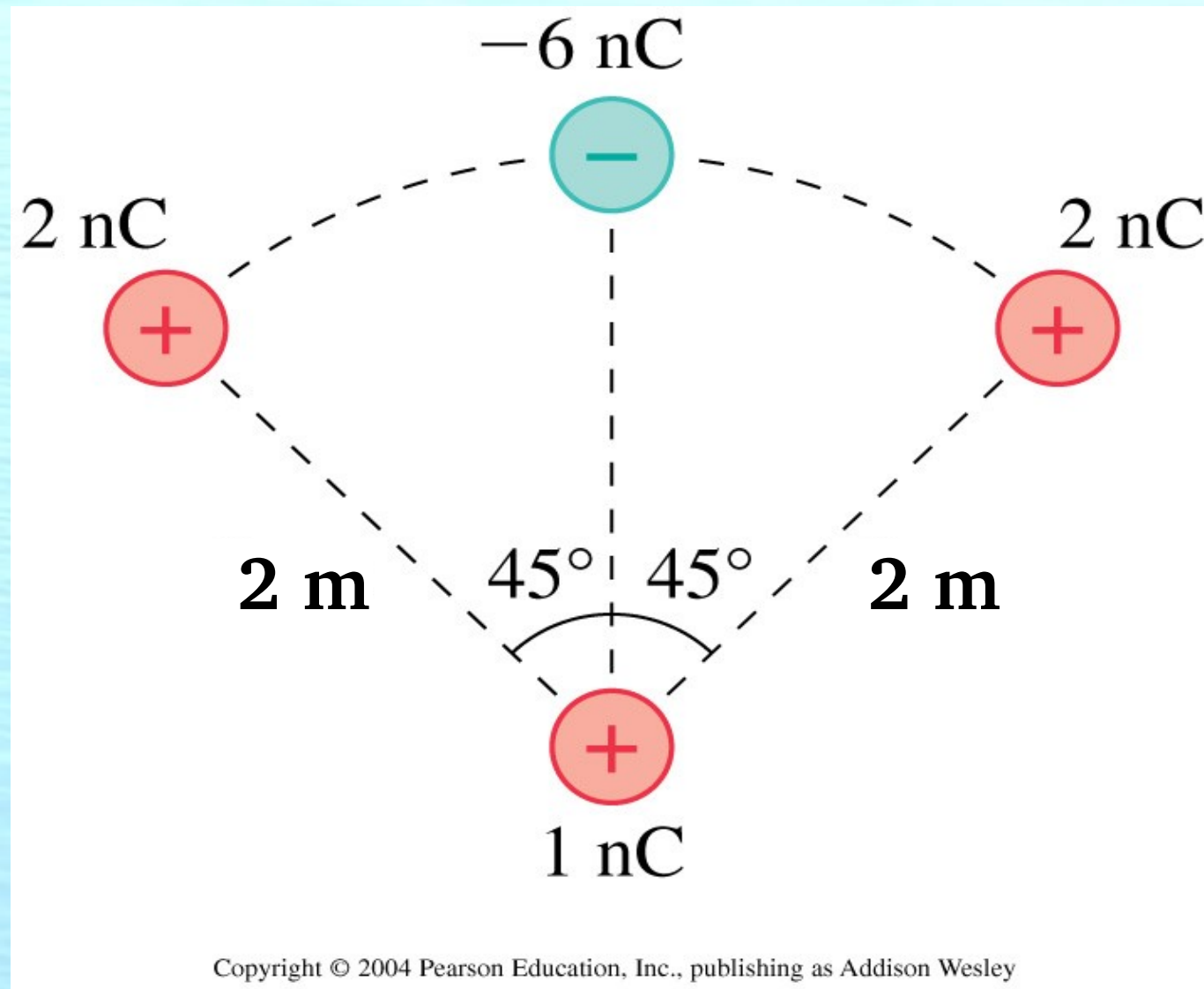


Copyright © 2004 Pearson Education, Inc., publishing as Addison Wesley

Last lecture I asked you to calculate the force on the 1 nC charge using pHeT and send a screen shot.

pHeT doesn't handle 5 meters ... so do 2 meters.

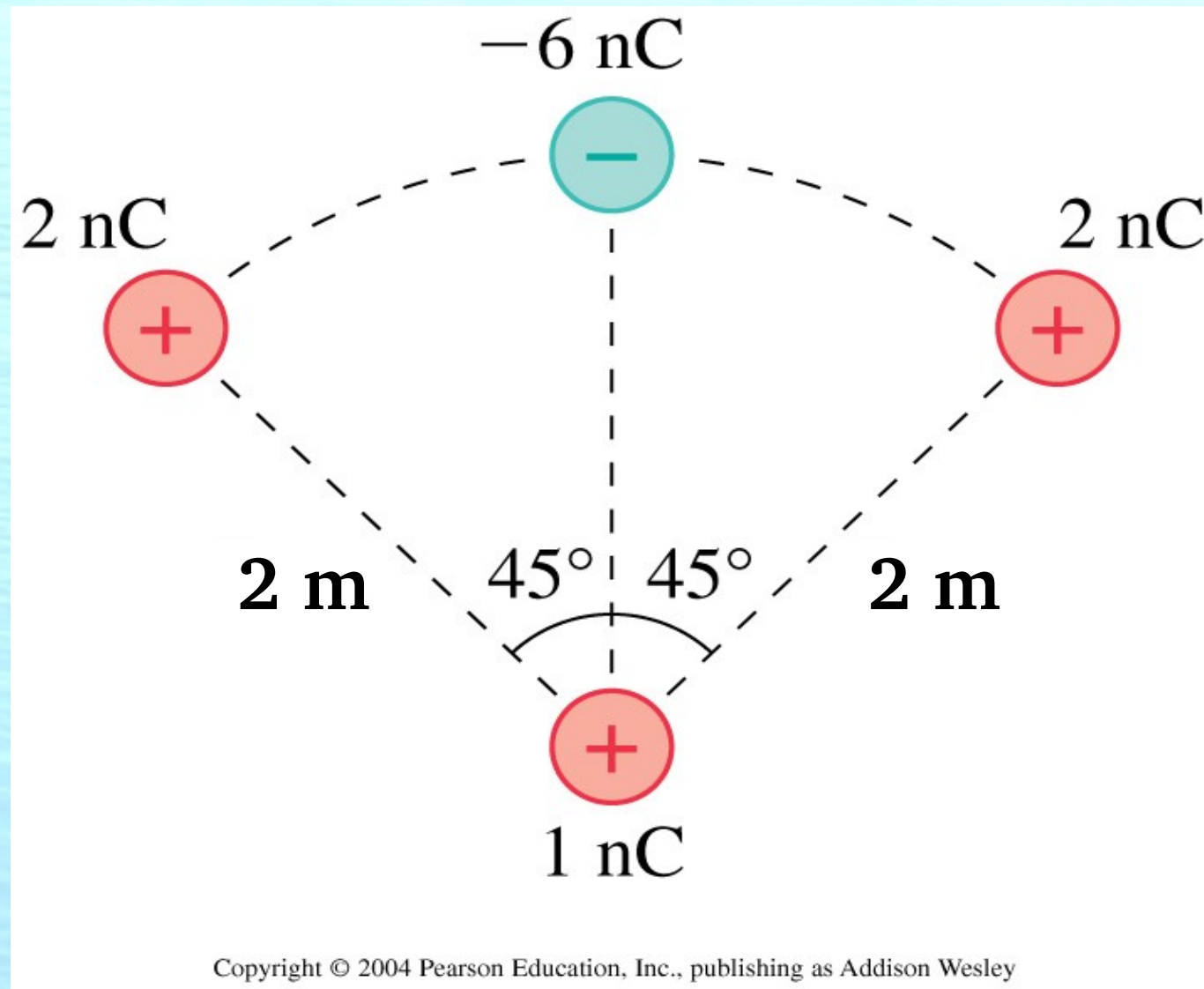
Force and Field on 1 nC?



Last lecture I asked you to calculate the force on the 1 nC charge using pHeT and send a screen shot.

pHeT doesn't handle 5 meters ... so do 2 meters.

Force and Field on 1 nC?



By end of this lecture you will also be able to do this analytically (without pHeT) Do this and submit for homework. but I will assign at end.

Vector Components – Why bother? I

Vectors are the language of physics.

Forces, gravitational, electric, magnetic ... ALL FORCES, add vectorially.

Physicists build up complex systems from simple systems (e.g. Atoms from protons and electrons, Molecules from atoms, Viruses from molecules, Motors from wires, Galaxies from stars)

Computers make this easier.

To do superposition on complex systems, you must do vector addition.

Vector Components – Why bother? II

Politicians tell you to teach math.

Politicians tell you to test your students on math.

Do politicians tell you WHY your students need math?

Math is the servant of science and engineering. While math is beautiful in itself, and some people appreciate that beauty, math is really important for its applications.

Vector Components – Why bother? III

Vectors are a WONDERFUL way to tie together lots of math that you have taught.

To understand vector components, you need basic trigonometry AND basic geometry.

and MAYBE, understanding vectors will help your students understand “the point” of trig.

Trigonometry – The Unit Circle and the Indian Princess.

Unit circle has advantages in terms of showing when trig functions are positive and negative.

It also makes the link between trig functions and rotation (wheels!). Clearly the wheel is **STILL** an important invention, and it is linked to trig.

HOWEVER ... the unit circle **HIDES** the connection of trigonometry to its namesake ...

Trigonometry – The Indian Princess.

Trigonometry

TRI-gonometry ... TRI-

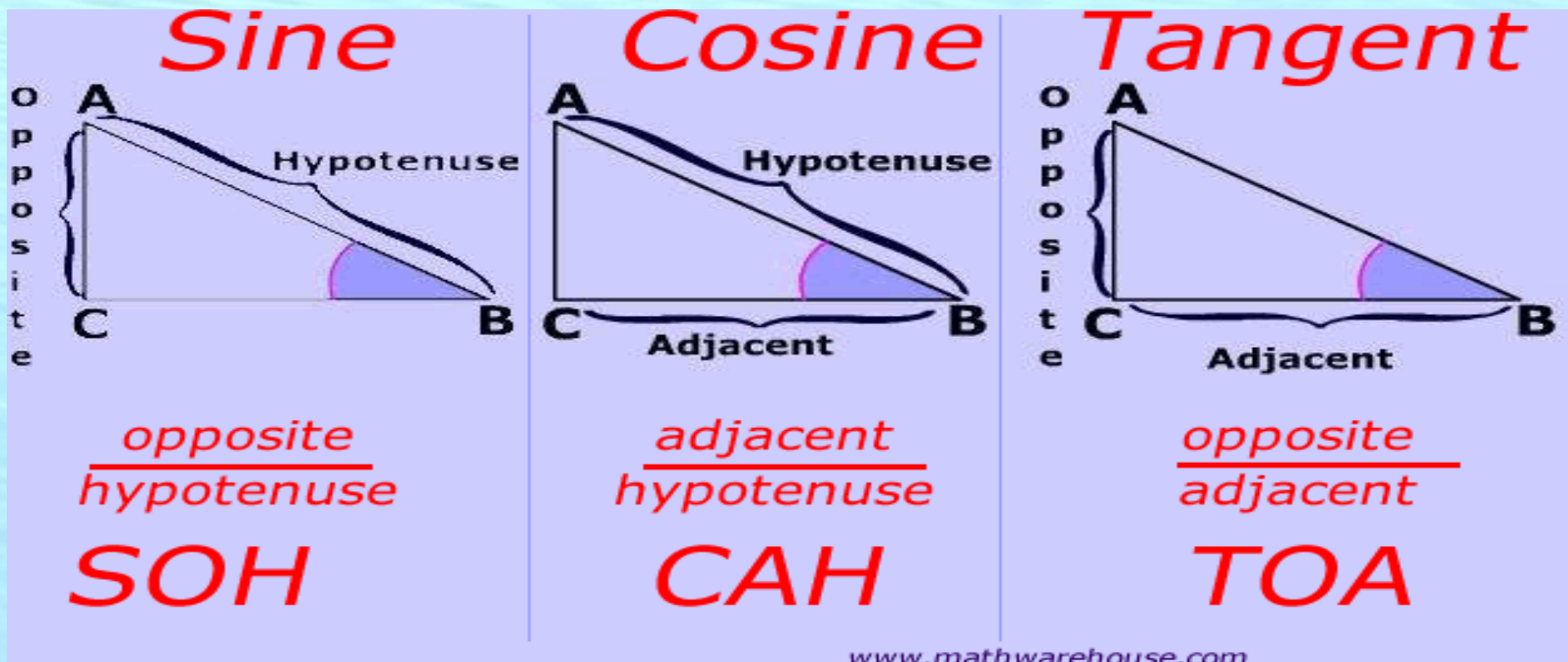
Trigonometry is about TRIANGLES.

POH-CAH-HON-TAS meet **SOH-CAH-TOA!**

Trigonometry - The Indian Princess.

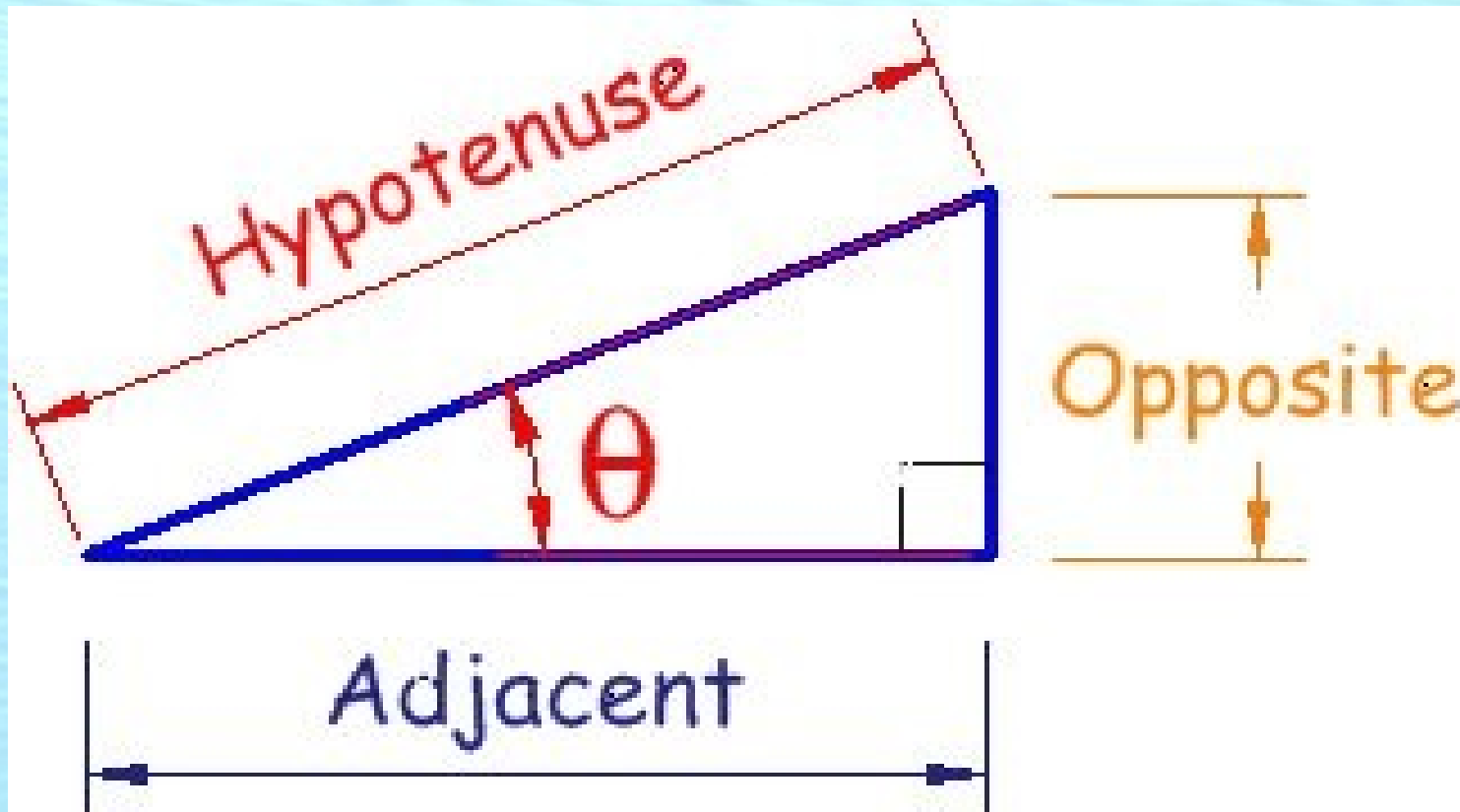
If SOH-CAH-TOA is a problem in New Mexico ... try

“Some Old Hippy Caught Another Hippy Tripping on Acid”



Trigonometry - The Indian Princess.

Please note that which side is “Opposite” and which is “Adjacent” depends on which angle you care about.



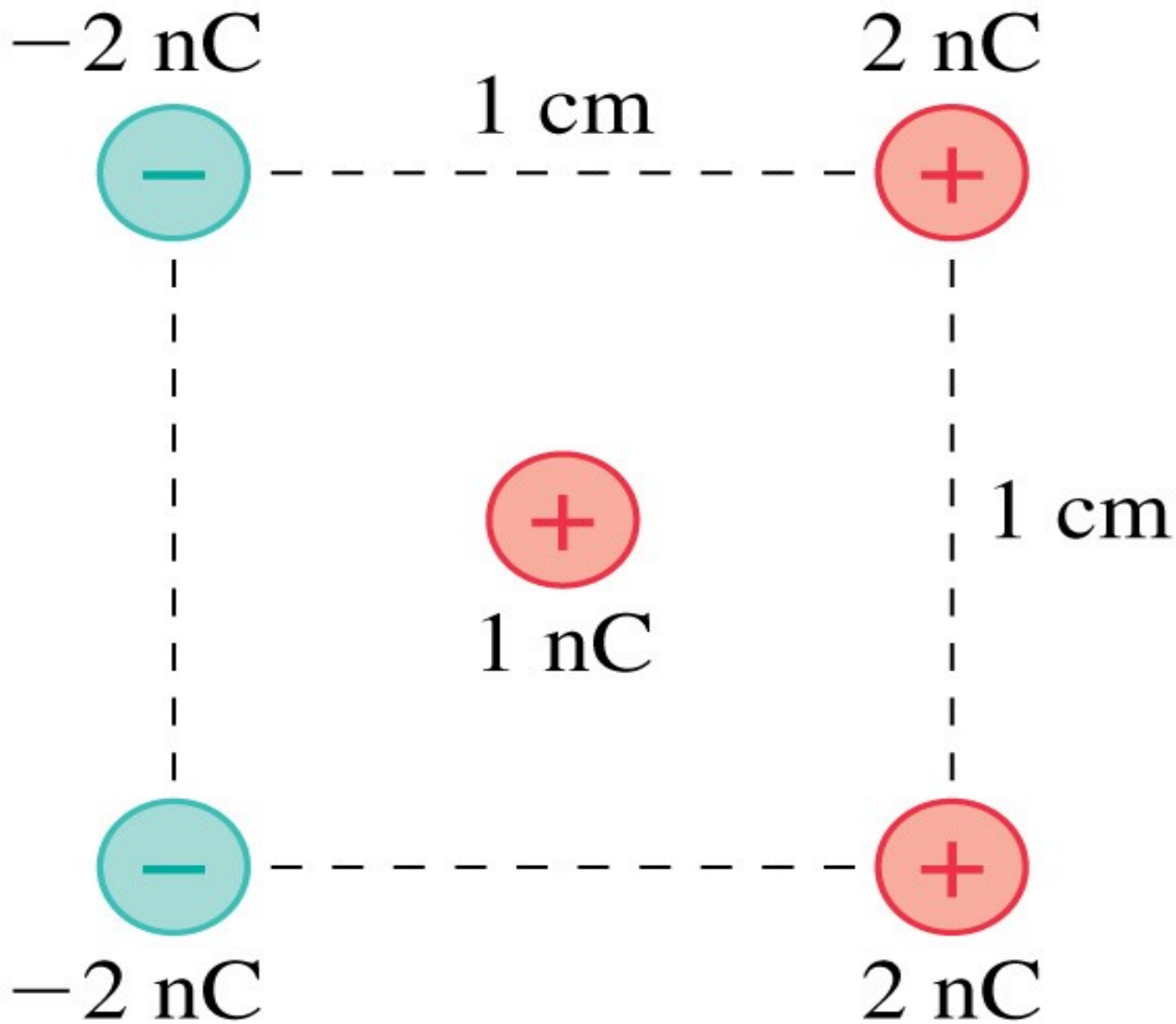
Coulomb's law and the Principle of Superposition

States that the force from multiple charges is the sum of force from individual charges (as if the others weren't there) So long as you mean the VECTOR SUM.

$$\vec{F}_{12} = k \frac{q_1 q_2}{d_{12}^2} \hat{r}_{12}$$

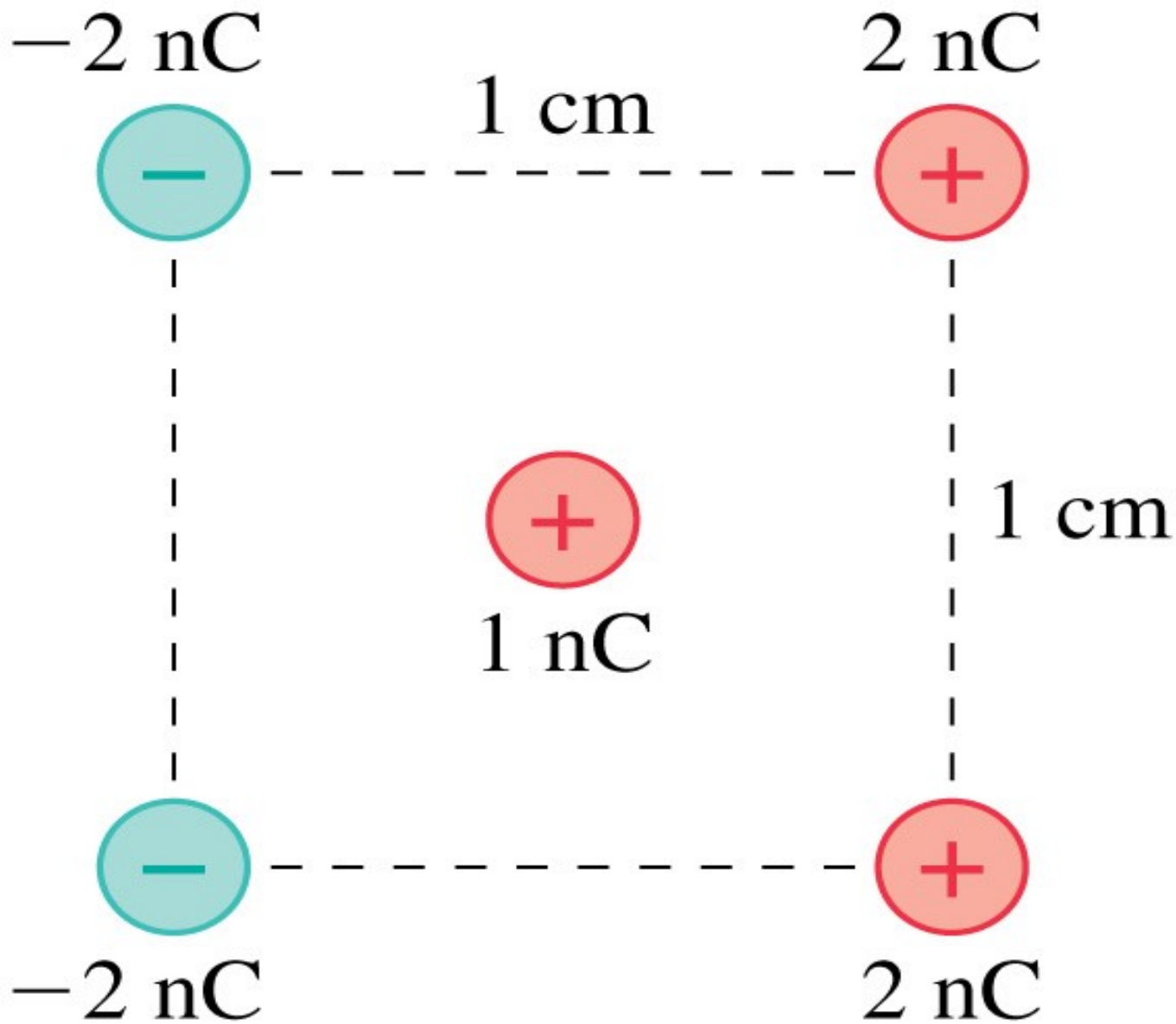
\hat{r}_{12} is math shorthand for “force is along the line joining the charges.”

Superposition problem #2



Estimate the direction and magnitude of the force on the central charge due to the other four charges.

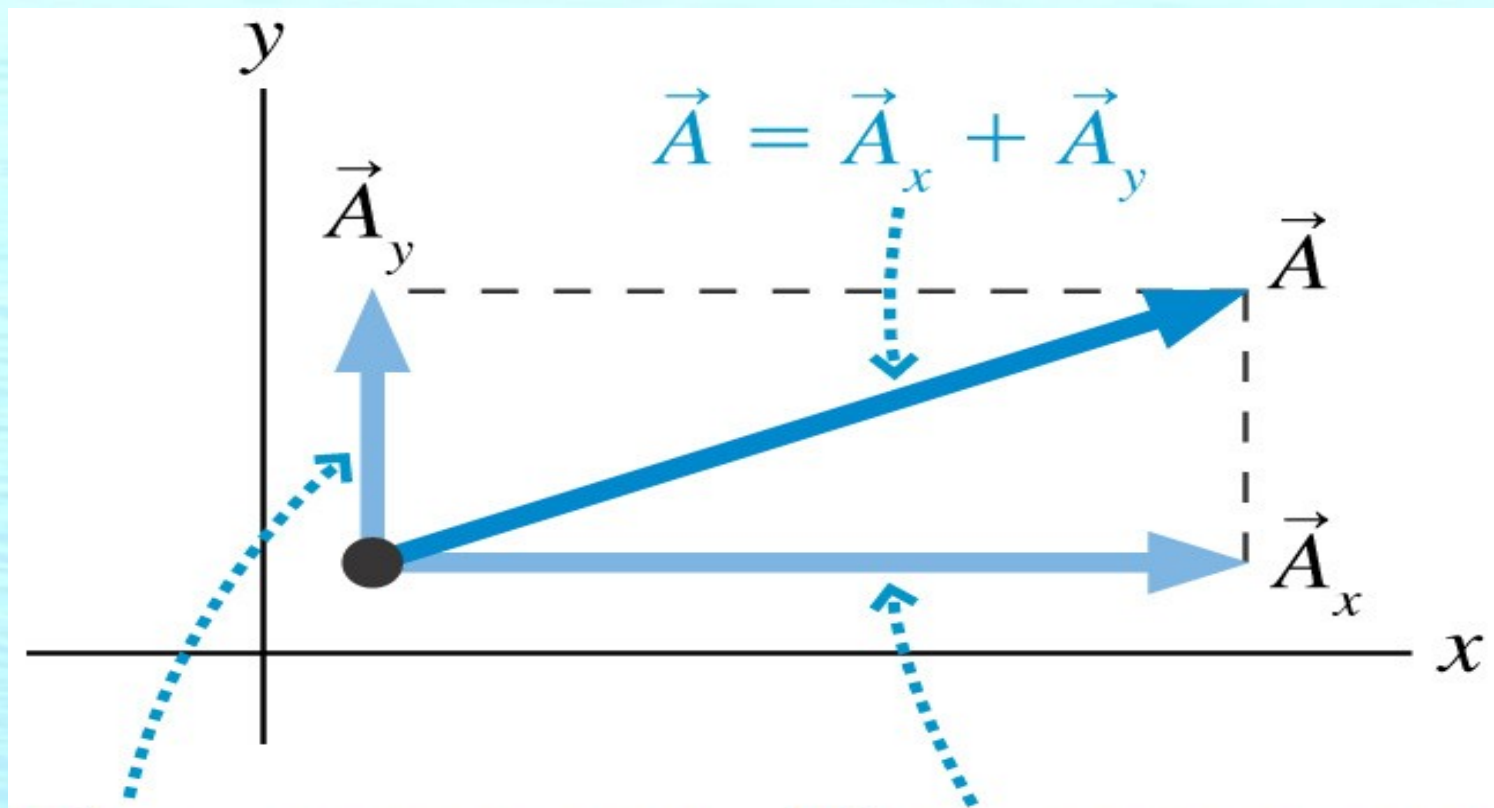
Superposition problem #2



We can get the direction by sketching.

The magnitude is painful, though we did it before.

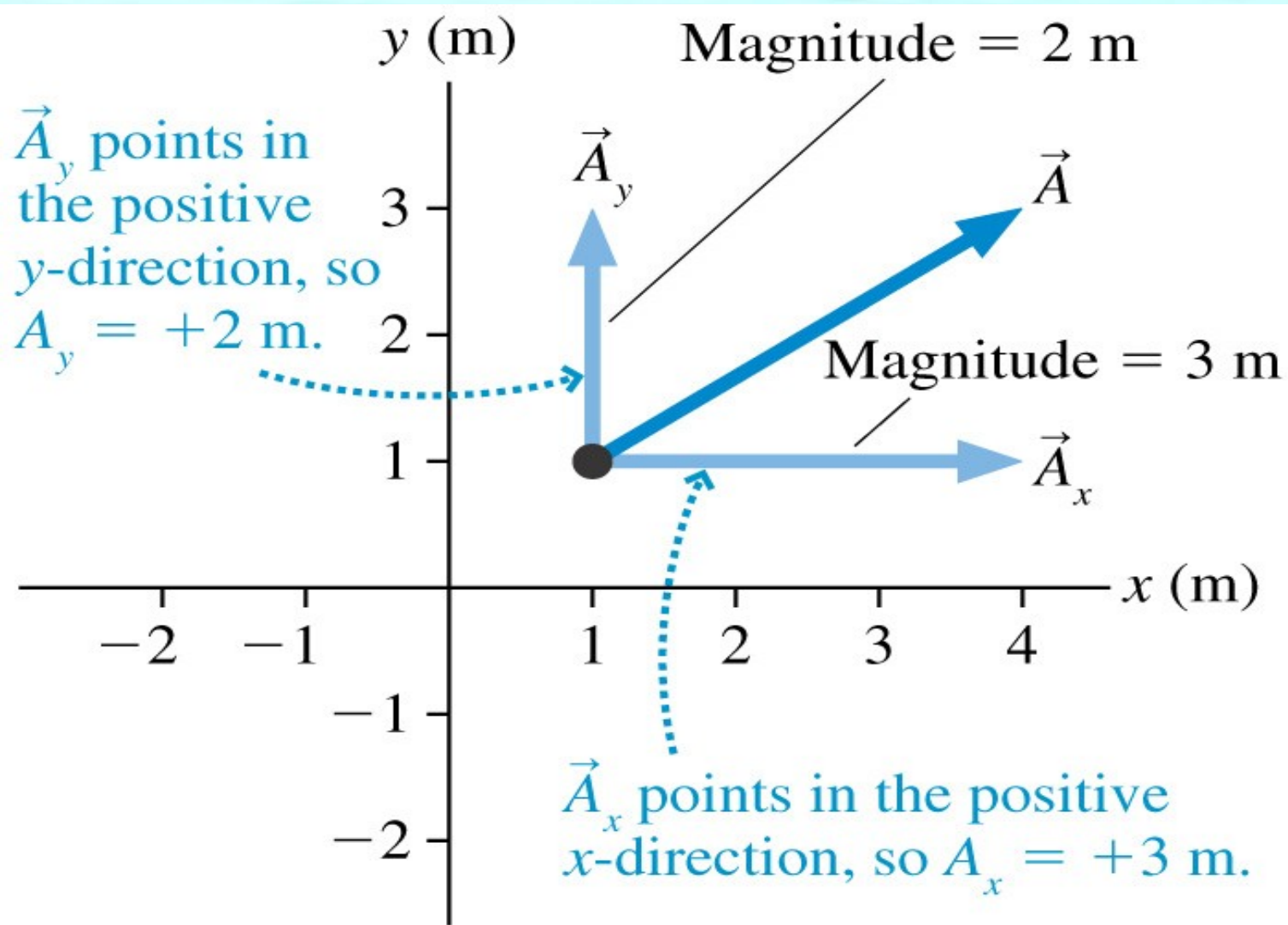
Vector components



The y -component vector is parallel to the y -axis.

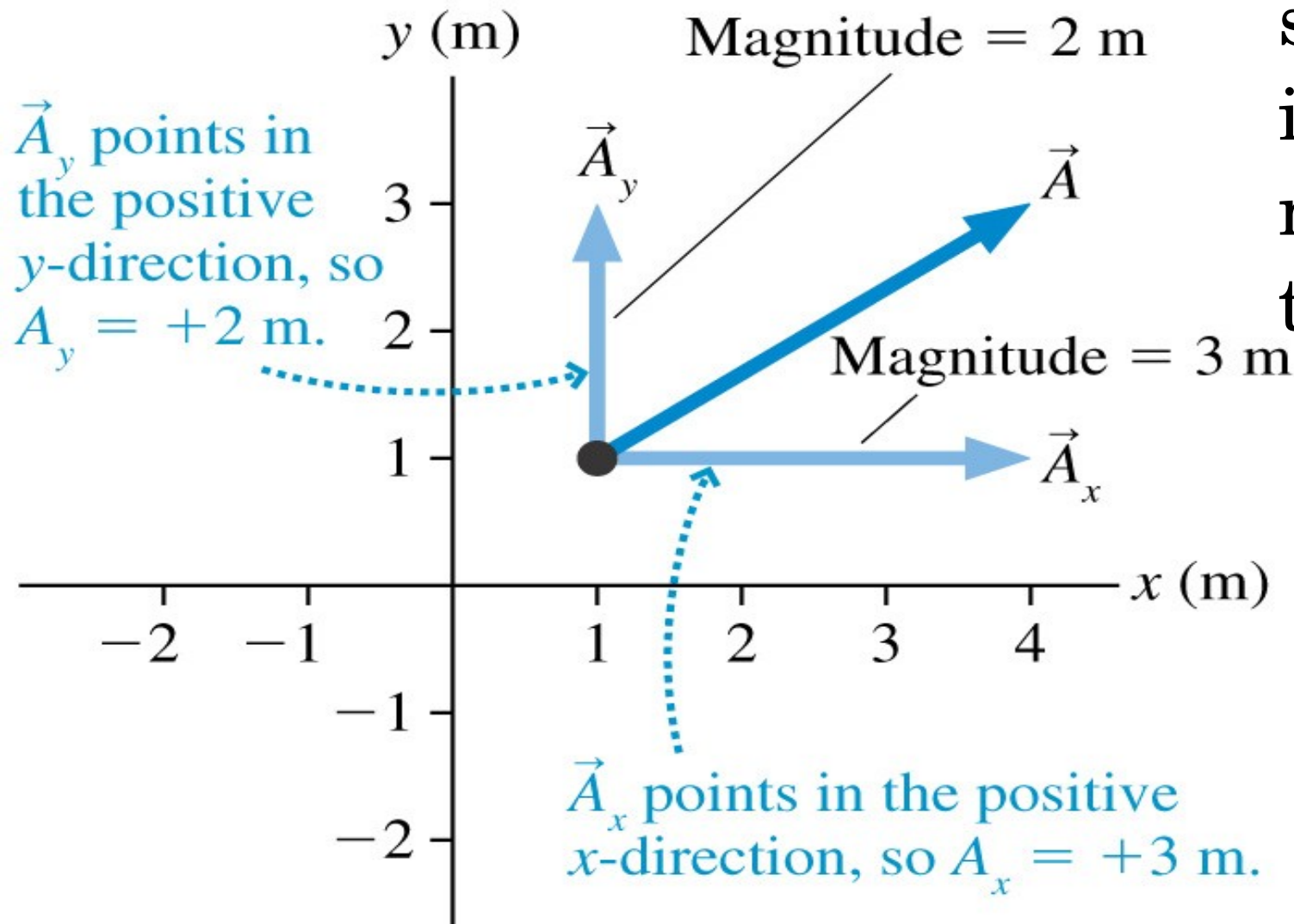
The x -component vector is parallel to the x -axis.

Vector components

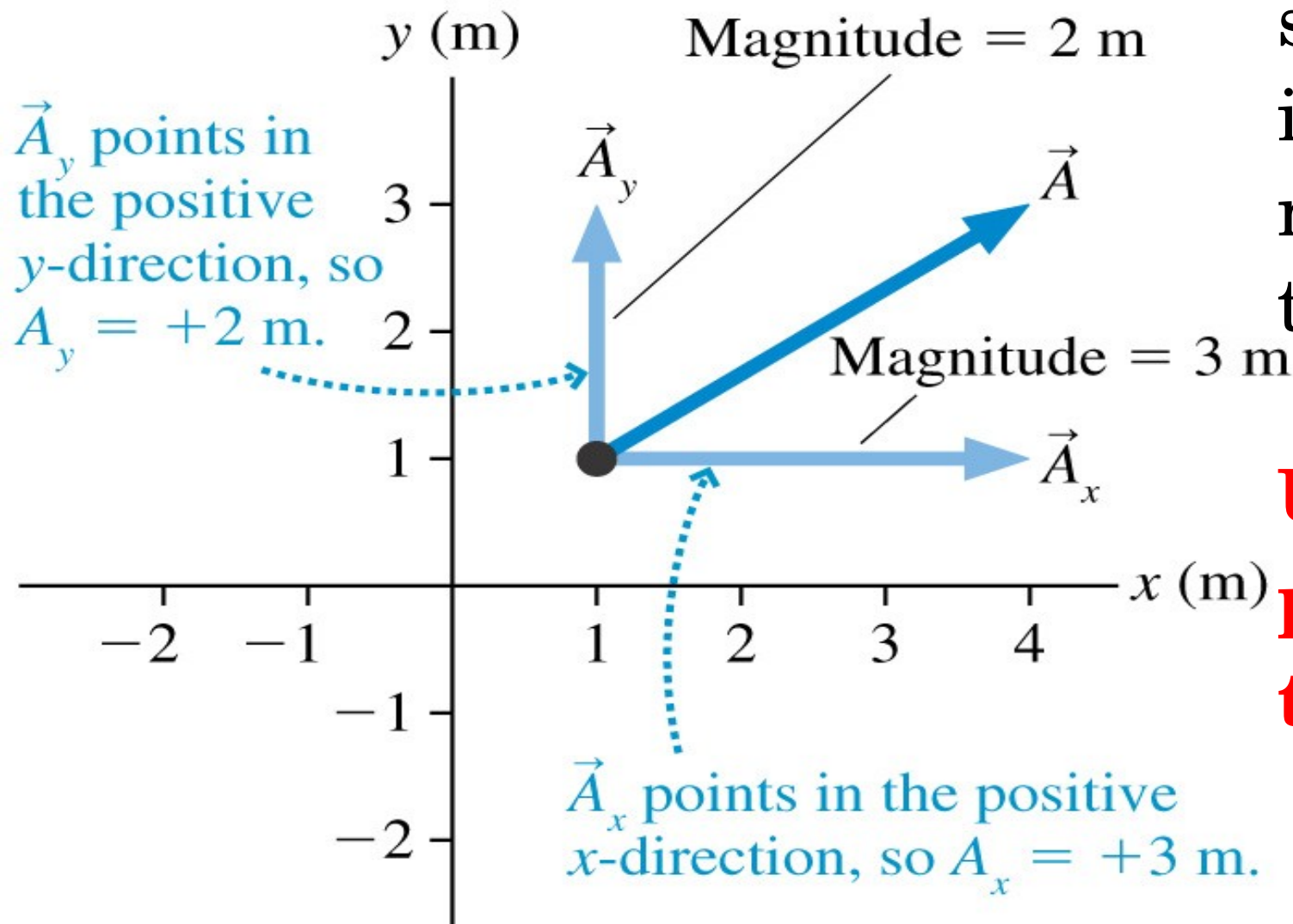


Vector components

Given the components shown, what is the magnitude of the vector?



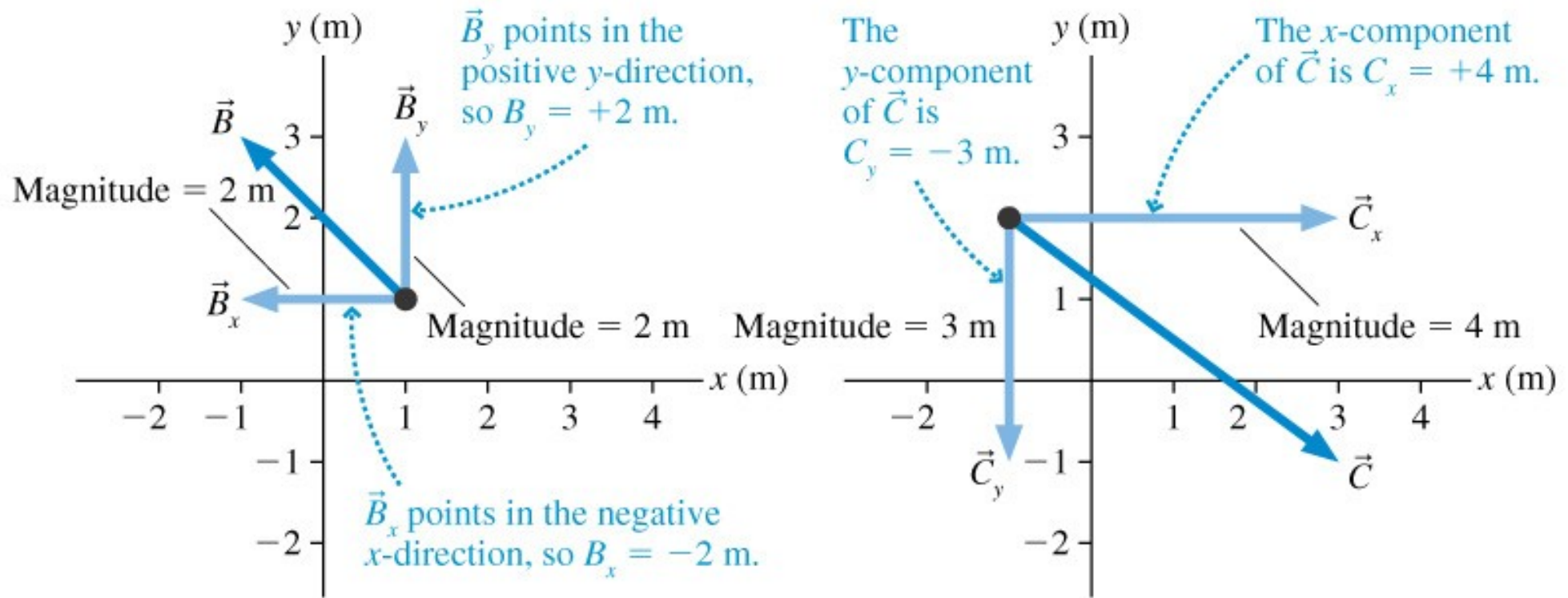
Vector components



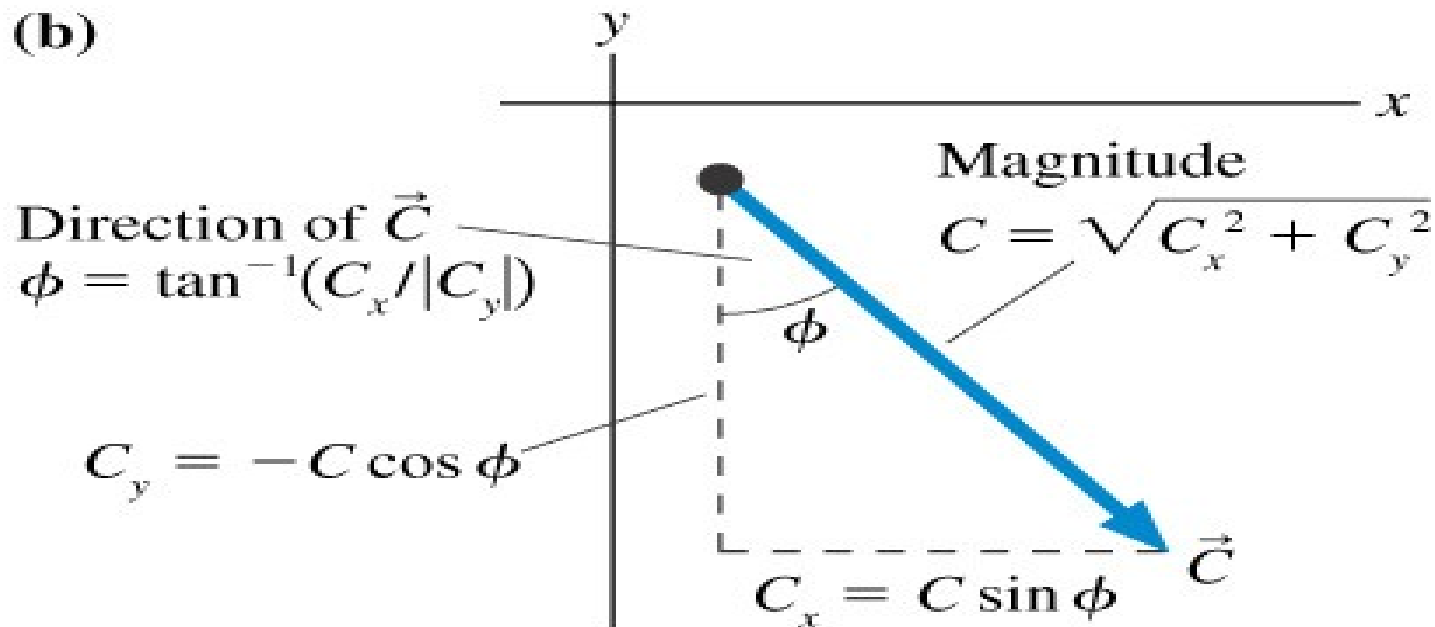
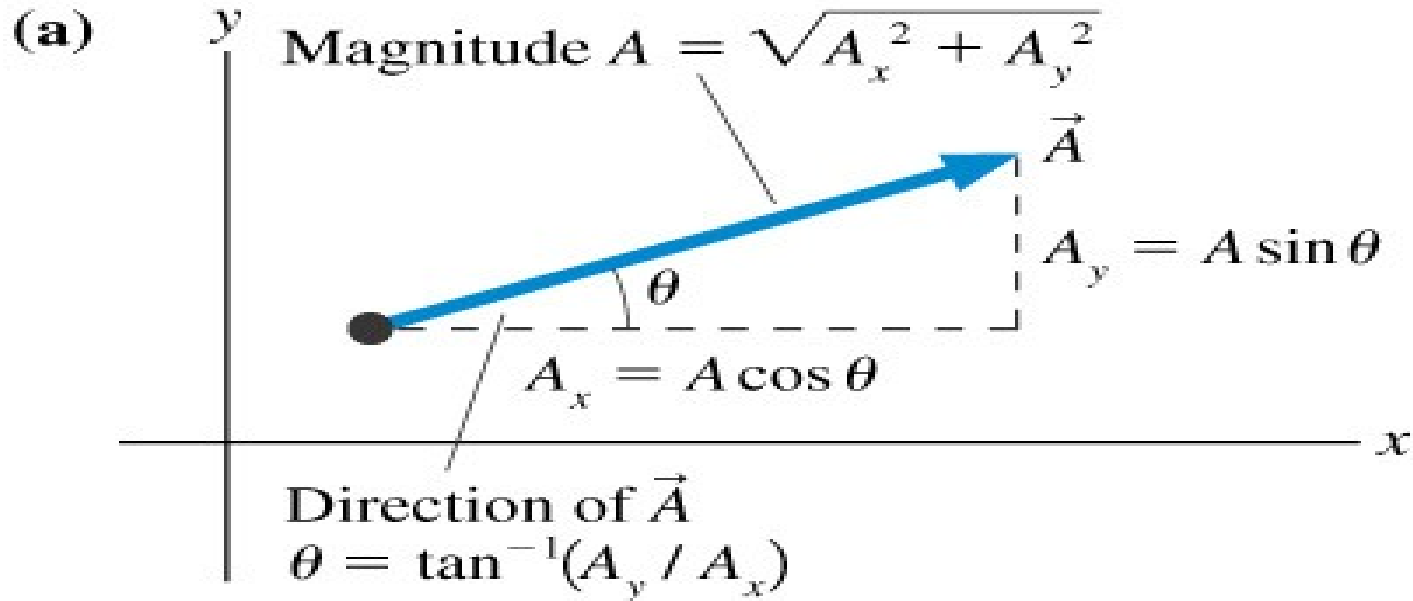
Given the components shown, what is the magnitude of the vector?

Use the pythagorean theorem

Vector components



Vector components



Component Practice I

$$\vec{E}_1: |\vec{E}| = 15 \text{ N/C} \quad \theta = 30^\circ \quad \vec{E}_x?, \vec{E}_y?$$

$$\vec{E}_2: |\vec{E}| = 30 \text{ N/C} \quad \theta = 135^\circ \quad \vec{E}_x?, \vec{E}_y?$$

$$\vec{E}_3: |\vec{E}| = 5 \text{ N/C} \quad \theta = -20^\circ \quad \vec{E}_x?, \vec{E}_y?$$

pHeT

Component Practice II

$$\vec{E}_4: \vec{E}_x = 3 \text{ N/C}, \vec{E}_y = 4 \text{ N/C} \quad |\vec{E}|? \quad \theta ?$$

$$\vec{E}_5: \vec{E}_x = -8 \text{ N/C}, \vec{E}_y = 12 \text{ N/C} \quad |\vec{E}|? \quad \theta ?$$

$$\vec{E}_6: \vec{E}_x = -6 \text{ N/C}, \vec{E}_y = -2 \text{ N/C} \quad |\vec{E}|? \quad \theta ?$$