Welcome to Intro Physics I!

You have successfully found your way to Phys 221!

- Important things to keep in mind:
    - Labs are meeting this week. Make sure you attend!
    - Homework is starting right away. Your first problem is due by midnight on Wednesday
        - Will be submitted through WebWorK
        - Username is the first portion of your email
        - Initial password is your student id number, and then change it!
- To-Do's:
    - Check out the class webpage (WISE and... otherWISE)
    - Take a closer read through my syllabus to understand what you are getting into
    - Consider getting some form of the book (or soon to have)
    - Remember your phone or computer for polling on Wednesday
    - Get crack-a-lacking on the first homework

The Fundamentals

Matter

Interactions

Identifying Interactions

Take a few minutes to discuss with your neighbors how you could determine whether a particular object is interacting with another object. Assume that you could ONLY see the object in question, nothing else!

Changes in Motion

- Most interactions can be boiled down to a change in motion
  - Speeding up or slowing down
  - Changing direction
- Many other apparent interactions also boil down to these same interactions on a microscopic level
  - Changes in temperature for example
  - Or changes in shape / volume
- Means we need methods to quantify and describe “motion”

Quantifying Position

How could you unambiguously describe my position at the front of the room?

Upcoming:

Vectors

Vector Basics

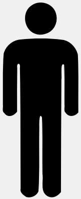
Important Concept!

Vectors allow us to unambiguously quantify something's position.

- Unambiguous: Everyone will agree on that object's position
- Quantify: Assign numbers to a certain position
- Graphically they look like arrows

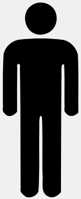
Laying the Foundation

- You have some object you want to describe



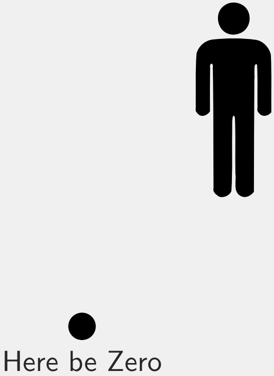
Laying the Foundation

- You have some object you want to describe
- You decide the zero point!



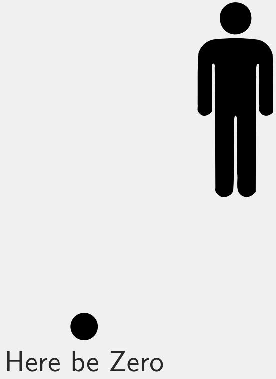
Laying the Foundation

- You have some object you want to describe
- You decide the zero point!



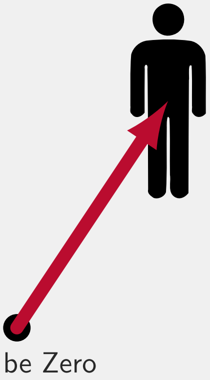
Laying the Foundation

- You have some object you want to describe
- You decide the zero point!
- Arrow extends from zero to the object of interest



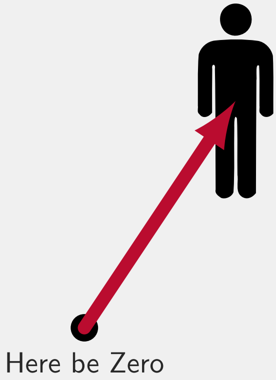
Laying the Foundation

- You have some object you want to describe
- You decide the zero point!
- Arrow extends from zero to the object of interest



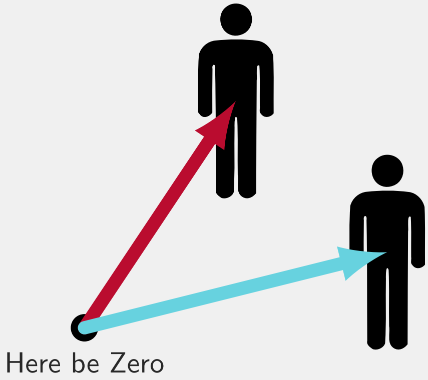
Laying the Foundation

- You have some object you want to describe
- You decide the zero point!
- Arrow extends from zero to the object of interest
- Can describe other objects with more arrows



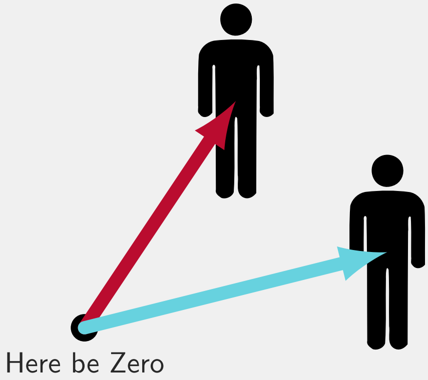
Laying the Foundation

- You have some object you want to describe
- You decide the zero point!
- Arrow extends from zero to the object of interest
- Can describe other objects with more arrows



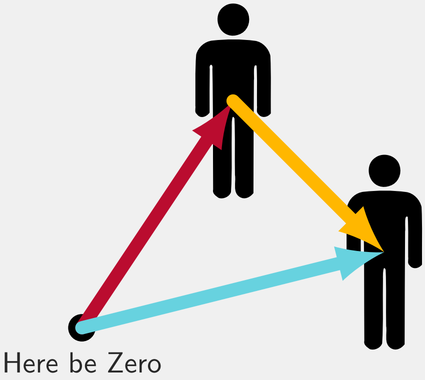
Laying the Foundation

- You have some object you want to describe
- You decide the zero point!
- Arrow extends from zero to the object of interest
- Can describe other objects with more arrows
- Can describe relative positioning with another vector!



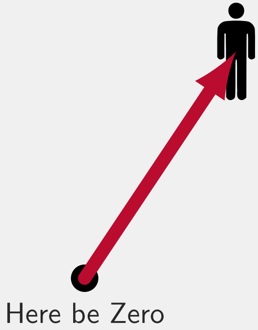
Laying the Foundation

- You have some object you want to describe
- You decide the zero point!
- Arrow extends from zero to the object of interest
- Can describe other objects with more arrows
- Can describe relative positioning with another vector!

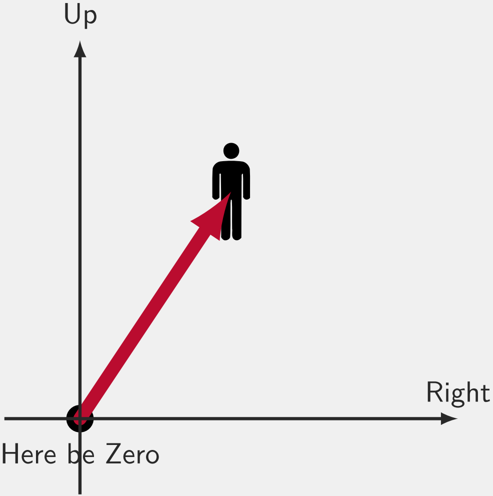


Here be Zero

Quantifying Things

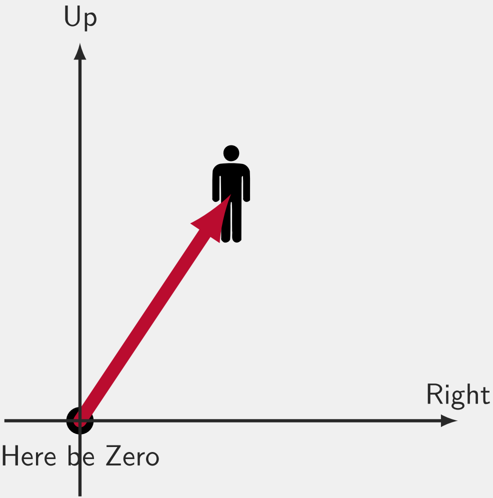


- Draw in perpendicular axes



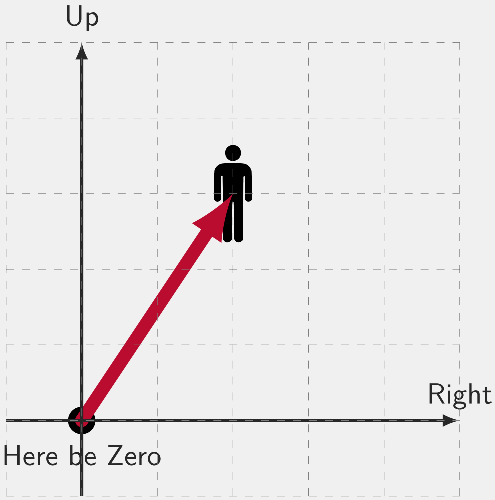
- Draw in perpendicular axes

Quantifying Things



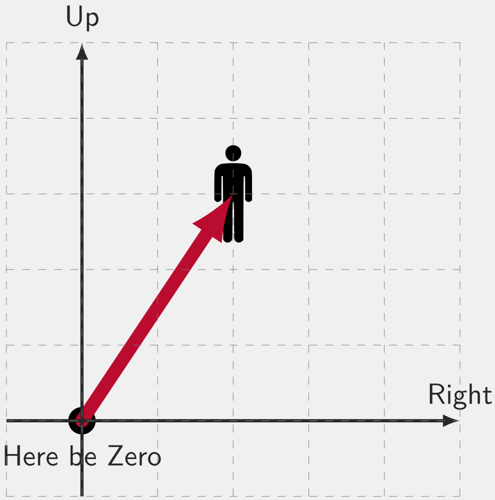
- Draw in perpendicular axes
- Decide primary unit of measurement (*usually meters*)

Quantifying Things

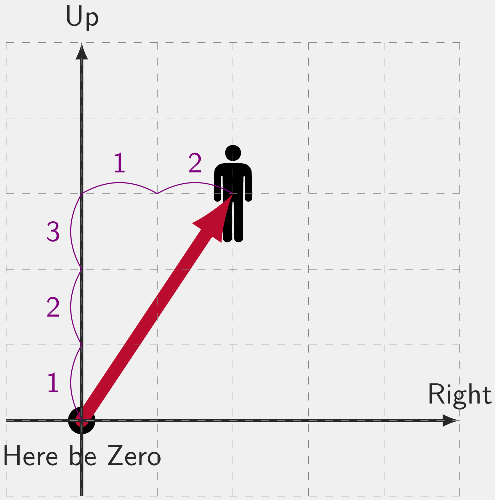


- Draw in perpendicular axes
- Decide primary unit of measurement (*usually meters*)

Quantifying Things



- Draw in perpendicular axes
- Decide primary unit of measurement (*usually meters*)
- Determine how many units it travels in each direction:

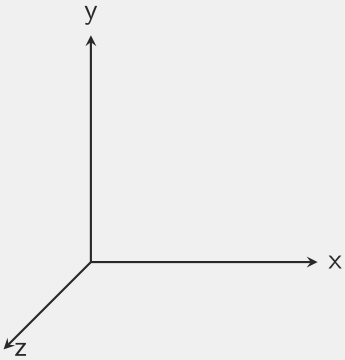


- Draw in perpendicular axes
- Decide primary unit of measurement (*usually meters*)
- Determine how many units it travels in each direction:

3 Up and 2 Right

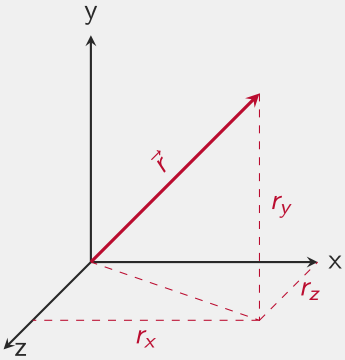
A Notational Note

- When we have 3 dimensions, we'll adopt a convention where the z-axis comes out toward us



A Notational Note

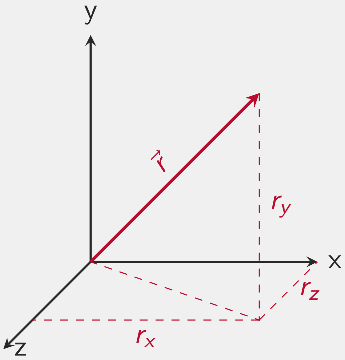
- When we have 3 dimensions, we'll adopt a convention where the z-axis comes out toward us
- Vector components describe how far the vector travels in each axis direction



A Notational Note

- When we have 3 dimensions, we'll adopt a convention where the z-axis comes out toward us
- Vector components describe how far the vector travels in each axis direction
- We'll use the notation:

$$\vec{r} = \langle r_x, r_y, r_z \rangle$$

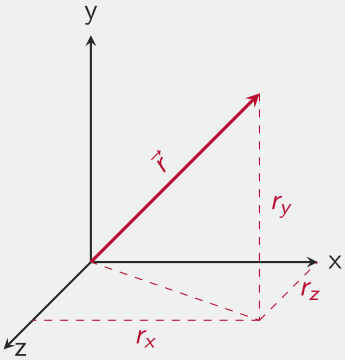


A Notational Note

- When we have 3 dimensions, we'll adopt a convention where the z-axis comes out toward us
- Vector components describe how far the vector travels in each axis direction
- We'll use the notation:

$$\vec{r} = \langle r_x, r_y, r_z \rangle$$

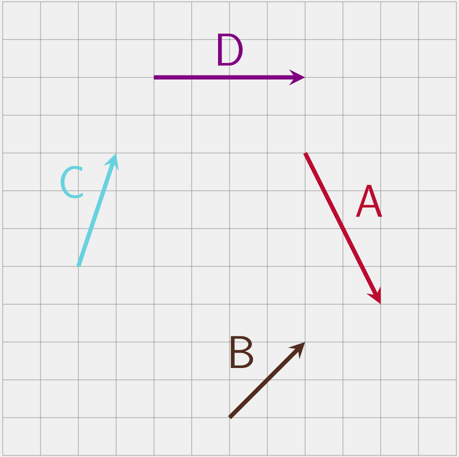
- This notation would describe *any* vector with those lengths, regardless of where it started!



Understanding Check (Unofficial)

If you have an internet capable device, navigate to `rembold-class.ddns.net`

Which of the arrows to the right could represent the vector $\langle 2, 2, 0 \rangle$?



Upcoming:

Manipulating Vectors

Oh the Possibilities!

- As mathematical constructs, there are a host of things we can do with vectors:
  - Multiply or divide by scalars
  - Find the magnitude
  - Find a unit vector
  - Add and subtract vectors
  - Differentiate vectors
  - Take the dot product
  - Take the cross product

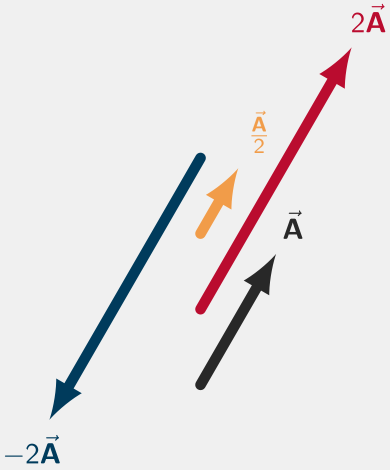
Oh the Possibilities!

- As mathematical constructs, there are a host of things we can do with vectors:
  - Multiply or divide by scalars
  - Find the magnitude
  - Find a unit vector
  - Add and subtract vectors
  - Differentiate vectors
  - Take the dot product
  - Take the cross product

Multiplying by Scalars

- Scales the vector by the given scalar
- Does not change the vector direction
- Negative scalars flip the direction
- Multiplies each component

$$2\langle 1, 2, 1\rangle = \langle 2, 4, 2\rangle$$



Magnitude and Direction

- Magnitude
  - How long is your vector?

$$|\vec{\mathbf{w}}| = \sqrt{w_x^2 + w_y^2 + w_z^2}$$

  - Magnitude is a scalar (not a vector)
  - Note: Magnitude changes when multiplied by a scalar!

- Direction
  - Given by a unit vector (magnitude = 1)

$$\hat{\mathbf{w}} = \frac{\vec{\mathbf{w}}}{|\vec{\mathbf{w}}|}$$

  - Unit vectors are indeed vectors (*shocking!*)
  - Direction does not change when multiplied by a scalar

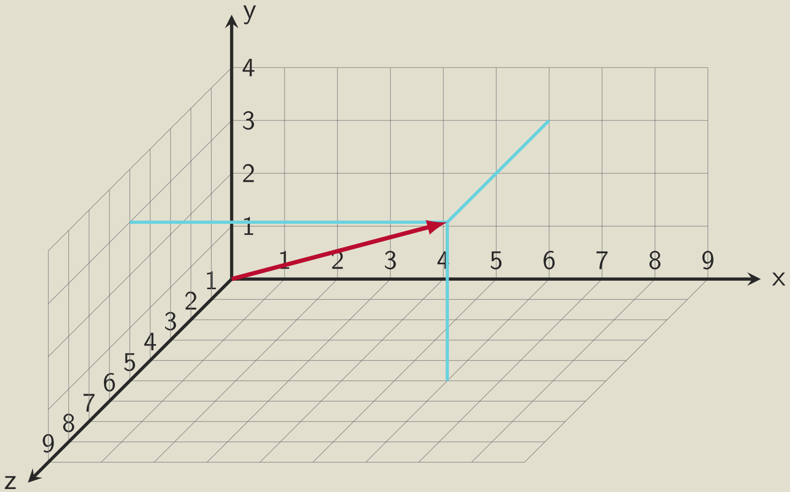
Important Concept!

A vector can be written in full as:

$$\vec{\mathbf{w}} = |\vec{\mathbf{w}}| \cdot \hat{\mathbf{w}}$$

Example

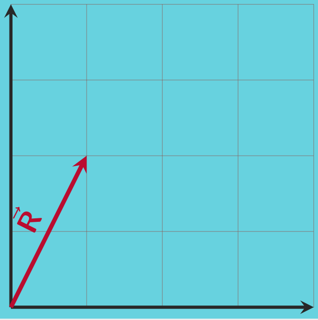
Determine the magnitude and direction of the below vector.



Adding and Subtracting

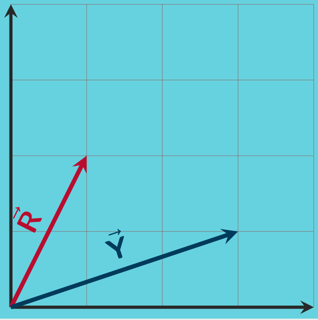
Graphically

Uses the "head-to-tail" method:



Graphically

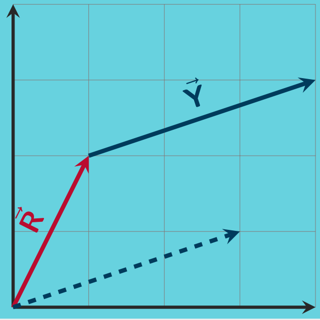
Uses the "head-to-tail" method:



Adding and Subtracting

Graphically

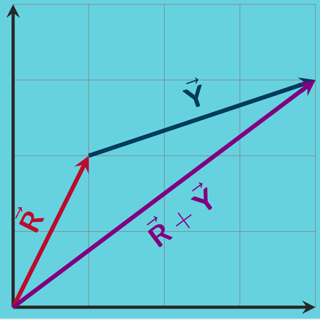
Uses the "head-to-tail" method:



Adding and Subtracting

Graphically

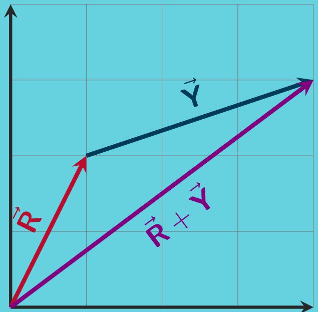
Uses the "head-to-tail" method:



Adding and Subtracting

Graphically

Uses the "head-to-tail" method:



Component-wise

Adding triangles, which is the same as just adding the components!

$$\begin{array}{r} \langle 1, 2, 0 \rangle \\ + \langle 3, 1, 0 \rangle \\ \hline \langle 4, 3, 0 \rangle \end{array}$$

Upcoming:

Syllabus Highlights

My Vitals

Name: Jed Rembold

Office: Collins 311 (it's shared)

Office Hours: MW 4:15–5:15pm, TTh 2:00-4:00pm, *and open door*

Email: `jjrembold@willamette.edu`

Office Phone: (503)-370-6860

Grading

Attendance	Lab	Written HW	Video HW	3 Midterms	Final
5%	15%	15%	10%	30%	25%

Homework

- Online
  - Assigned Mon, Wed
  - Due Wed, Fri at midnight
  - Completed on WebWorK, *no penalty for incorrect answers*
- Video
  - Assigned Fri
  - Due Mon at midnight
  - <4 min video to show objective mastery
    - Objective provided
    - You choose/create problem
    - Can be a simple video!
  - I'll request permission to post my favorites to the webpage
  - One question on each test will pull from those videos

Tests

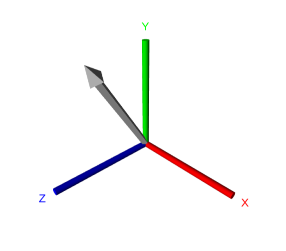
- 3 Midterms
  - First is September 17
  - Get a 3x5 inch index card, one side, handwritten
  - In class, so 1 hour in length
  - Will have about 5 minutes at the start to discuss with peers, but no writing during this time!
  - I will give out old tests and other study materials about a week before each exam
- Final
  - On Friday, December 17
  - Comprehensive
  - Can use previous index cards $+ 1$

Labs

- All labs mixed between sections
- You need to be at lab to receive lab credit
- Let both me and your lab instructor know if you need to miss:
  - Best to make it up at a different lab that week
  - In the worst case, there is 1 potential day old labs can be made up
- **You can not pass the class if you miss more than 4 labs**

Computation

- This course introduces computational skills that are often times ignored in other Intro courses
- The bulk of these will happen during lab
- A few homeworks throughout the semester will rely on these skills, and basic versions could show up on tests.
- Don't neglect them! I can't really think of any scientific discipline in this day of age that could not benefit from applying computational methods in certain cases!
- Lab these first few weeks will focus on teaching you the basics so that you can then start applying them to class concepts



Practice Time

Given that

$$\vec{\mathbf{a}} = \langle 1, 3, 5 \rangle\,, \quad \vec{\mathbf{b}} = \langle 2, 4, 6 \rangle\,, \quad \vec{\mathbf{c}} = \langle 4, 1, 0 \rangle\,, \quad \vec{\mathbf{d}} = \langle 2, 4, 0 \rangle$$

can you answer the following?

1. What is $5\vec{\mathbf{a}} + \vec{\mathbf{b}} + \frac{1}{2}\vec{\mathbf{d}}$?
2. Is $\vec{\mathbf{c}} + \vec{\mathbf{d}}$ the same as $\vec{\mathbf{d}} + \vec{\mathbf{c}}$? Can you support your claim graphically?
3. Is $\vec{\mathbf{c}} - \vec{\mathbf{d}}$ the same as $\vec{\mathbf{d}} - \vec{\mathbf{c}}$? Can you support your claim graphically?
4. What is the magnitude of $\vec{\mathbf{b}} - \vec{\mathbf{a}}$?
5. Is $\vec{\mathbf{b}} - \vec{\mathbf{a}}$ a unit vector? If not, what unit vector points in the same direction?