Physics 2170: Modern Physics

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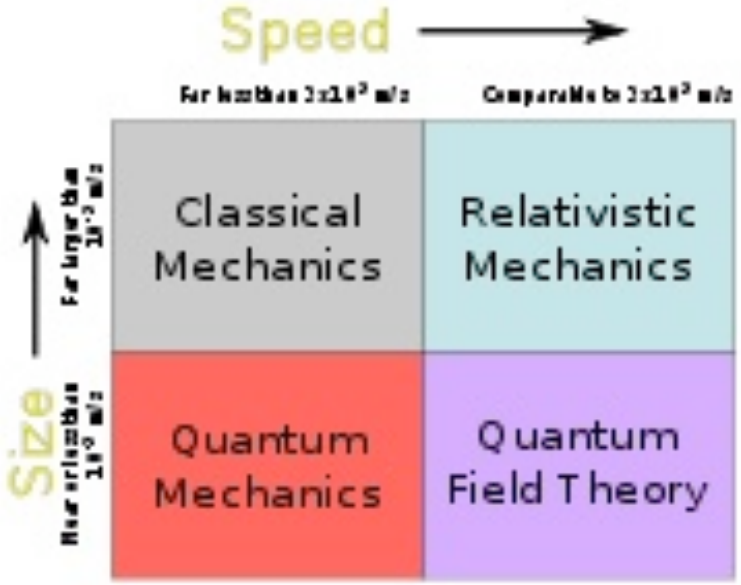
  - Course Web page: http://www-hep.colorado.edu/~jcumalat/phys2170_f13
- Classroom: HUMN 1B50 (here)
- Text: Modern Physics for Scientists and Engineers Second Edition by Taylor, Zafiratos, and Dubson

Today will basically be an introduction to the class.

Two major topics = twice the fun!

- special relativity, electromagnetic waves
  - What happens to things that are moving *really fast.*
- quantum mechanics
  - What happens to things that are *really small.*

These subjects are quite different, and both appear counter-intuitive at a first pass.



Guiding principles: (basis for how course is run)

1. People understand concepts by seeing, discussing, and applying them, not by passively listening to explanations.
2. Understanding physics & solving problems is a learned skill, like golf or playing basketball or violin.
   Takes time, effort, and practice. Research says better retention if sustained effort rather than cramming.
3. People learn best by sharing and getting feedback
   Student-student even more so than student-faculty.
4. Students learn best when they take responsibility for what is learned.

Physics is not a collection of facts
It is a way of thinking. *Only you can teach yourself to think!*
Analyzing, applying concepts, solving problems.

Homework

- Real understanding of physics comes about from solving problems. Physics is about understanding the universe and applying that understanding to solving problems.
- The homework assignments in this class are **crucial** to developing good problems solving skills and learning the material.
- Weekly assignments will be available online by Wednesday at 5pm. You need to print out your own copy.
- Homework is due the following Wednesday at 1:00pm in the wood cabinet at the entrance to the physics help room (G2B90)
- Solutions will be available by 5pm Wednesday.

Problem solving sessions

Working together on homework problems is encouraged because it helps you get feedback on your thinking.

To facilitate this, I will host problem solving sessions

- Times: Tuesday 1:00-3:00pm (may be changed after 2150 lectures are finished).
- Location: G146 (Old Library in Duane Physics)
- This is to allow a convenient time and location for you to work together on homework.
- I will be there only to guide you in developing your own problem solving abilities (problem solving coach).

Note, no meeting tomorrow.

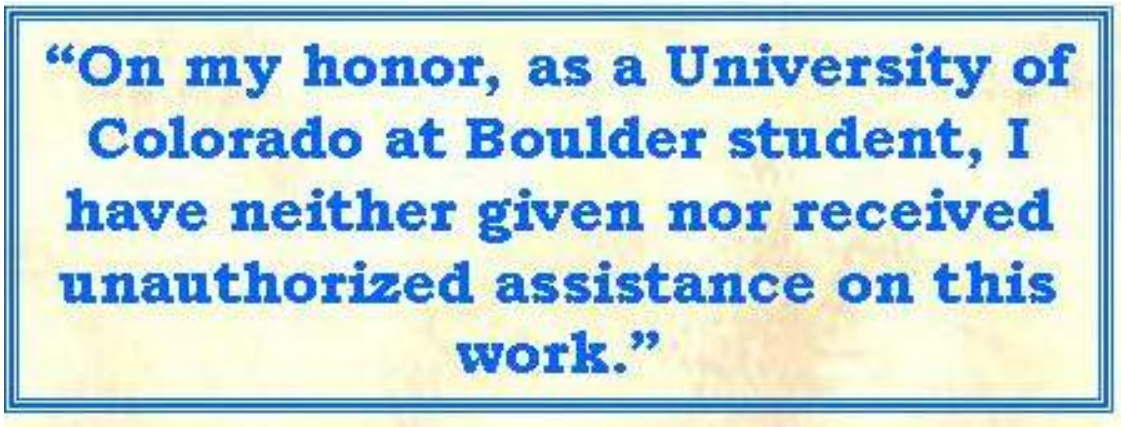
Collective Work vs. Independent work...

Group Work **is** Encouraged

What is authorized:
- working with others to make sense of questions
- collectively sorting out the answer (explaining reasoning)
- writing up your own solution in your own words

What is NOT authorized:
- telling students the answer
- representing someone else's work as your own

The CU honor code



Reading the text

The textbook is Modern Physics for Scientists and Engineers Second Edition by Taylor, Zafiratos, and Dubson

It is strongly suggested that you do reading assignments before each class. The assignments are given in the course calendar.

You will get much more out of lecture if you have read the material first

You are responsible for all material assigned in the book *even if it is not covered in class!*

Classroom response system (clickers)

- iClickers are required: can purchase at bookstore
  - You should label yours in case of loss or mixup
- Register on CUConnect.
- Score keeping starts 9/4
- Why do we use clickers?
  - Breaks up lecture, allows you to think and talk about the concepts, gives me feedback on your understanding of the material.
  - It has been proven to work
    - Physics Education Research has shown that active engagement, such as provided through the use of clickers, results in students with a better understanding of physics.

Details on how clickers are used

- During each lecture there will be 1-5 questions based on the material just covered.
  - You should discuss these questions with a nearby "study group" of a few students
  - Then, everyone in the group should vote the same
  - If you disagree you should try to explain to the group why you think your answer is correct
  - The group discussion is required!

Clicker question 1

Set frequency to AD

Q. Do you have a working clicker?

A. Yes

B. No

C. Not sure

D. Who wants to know?

To set frequency, hold down on/off button until power light starts flashing. Then enter AD and vote light should flash green and power light should be solid blue. Can only set frequency after the first question of the class has started. If you turn off your clicker, repeat procedure before answering.

Can vote as often as you like during the allowed time; only the last vote counts

Only use your own clicker. Answering for someone else using their clicker is a violation of the CU honor code.

Grades

- 60% Exams: 2 midterms count 17% each and one cumulative final counts 26%
- 30% Homework: Can work together but must write up the answers on your own
- 10% In-class work
  - From standard group answer clicker questions

Clicker question 2

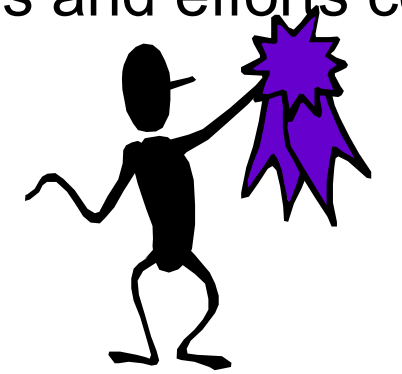
Set frequency to AD

Q. Why are you in this class?

A. Interested in modern physics – not required
B. Interested in modern physics and is required
C. Not really interested but it is required
D. Not really interested but heard that it was better than Business class.
E. I refuse to allow my many varied and complicated reasons for taking this class to be summarized in one bullet point thank you very much.

We provide you with opportunities to help you learn.
Content, problems, simulations, guidance, organization.

Reward activities and efforts conducive to your learning (grade)

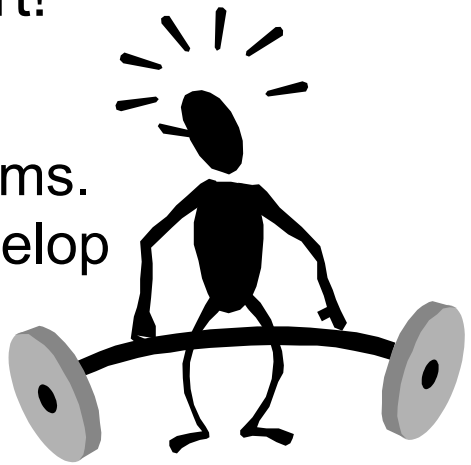


Learning only comes as a result of your effort!

Model for learning 2170

1. Reading before class: introduce ideas and terms.
2. Analysis and discussion in class: explore, develop basic ideas and understanding.
3. Master and retain ideas through use in extensive HW (4-6 hrs/wk)

(collaboration good, but submit own work)



Physics 2170 website, source of all knowledge!

http://www.colorado.edu/physics/phys2170

Syllabus: Please read. It describes in more detail many of the items mentioned today

Course calendar: contains lots of stuff:

- Reading assignments for each day
- Lecture notes (posted after lecture)

Important class rules:

1)No cell phones on, or newspapers in class.
Laptops can only be used for class activities

2)Lots of physics discussion during clicker questions

What will be covered in 2170:

big picture

Basic properties of spacetime.
Basic properties of light.
Basic properties of matter: atoms to solids.
How light and matter interact.

What we will be starting with

Topics in relativity

* Relativity before Einstein
* Simultaneity
* Time dilation and length contraction
* Geometry of "spacetime"
* Momentum, energy, and "$E=mc^2$"

We will *not* study

* effect on electromagnetism
* gravity (general relativity)

Clicker question 3

Set frequency to AD

Q. What do you know about relativity?

A. Nada
B. I have read popular books and/or articles about it
C. I have studied it in a physics class before
D. I could be teaching this class
E. I have built a working time machine

Galilean relativity

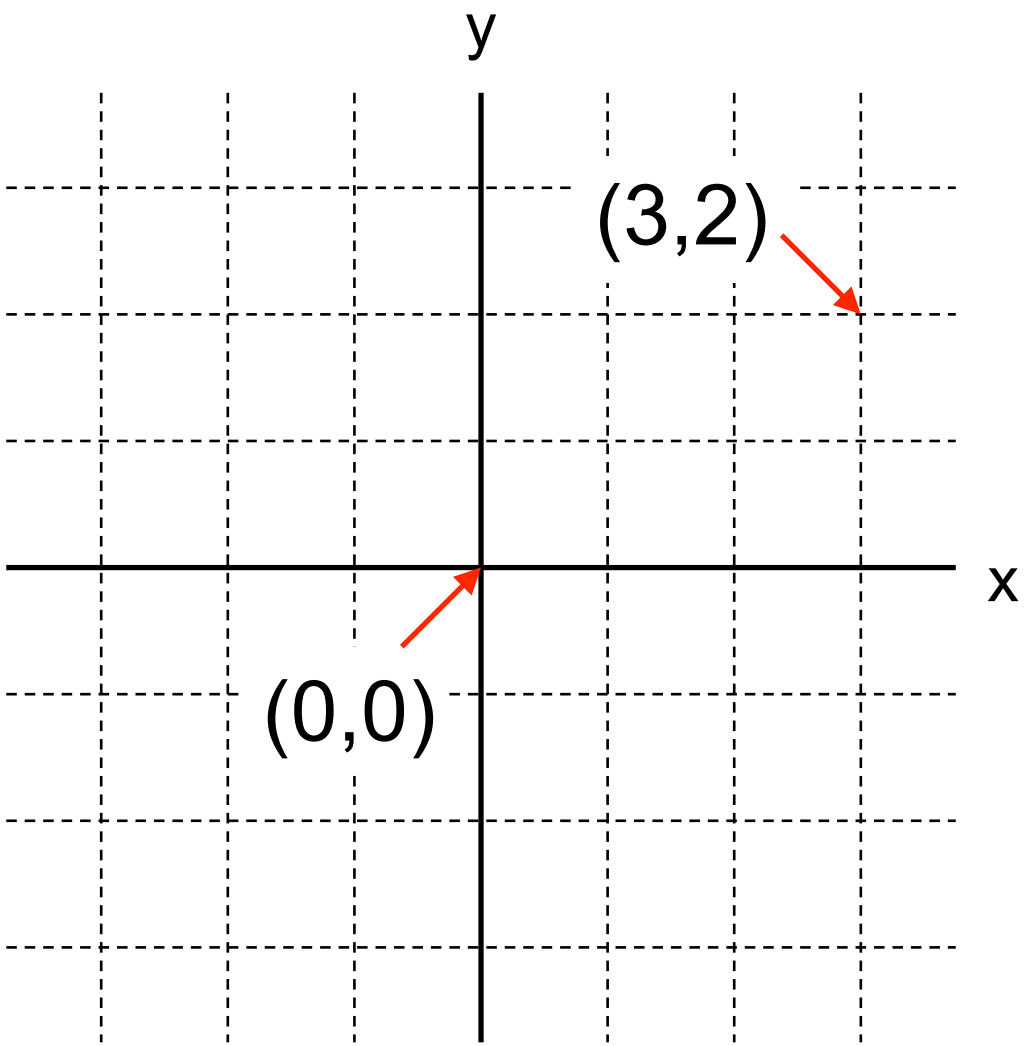
Today:

- No Einstein yet!
- Explore how things move with respect to things that are also moving
- Where are you? Where are you going? Says who?

Galileo Galilei
1564-1642, *Italian*

Father of Modern Science

Where are you?

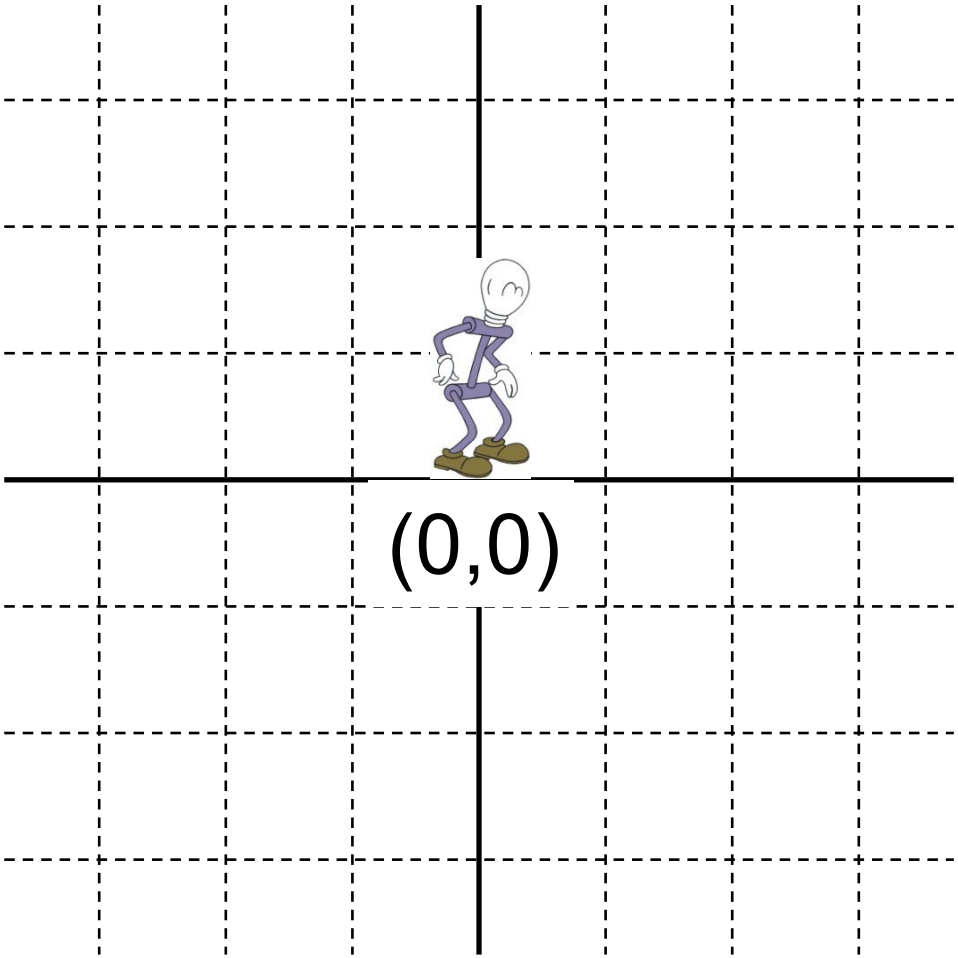


A reference frame is a set of coordinate axes that *never move with respect to each other*.

Think about laying out a set of meter sticks in a pattern like this one, and never moving them again.

And it goes on forever b/c you might want to measure things far away.

Reference frames

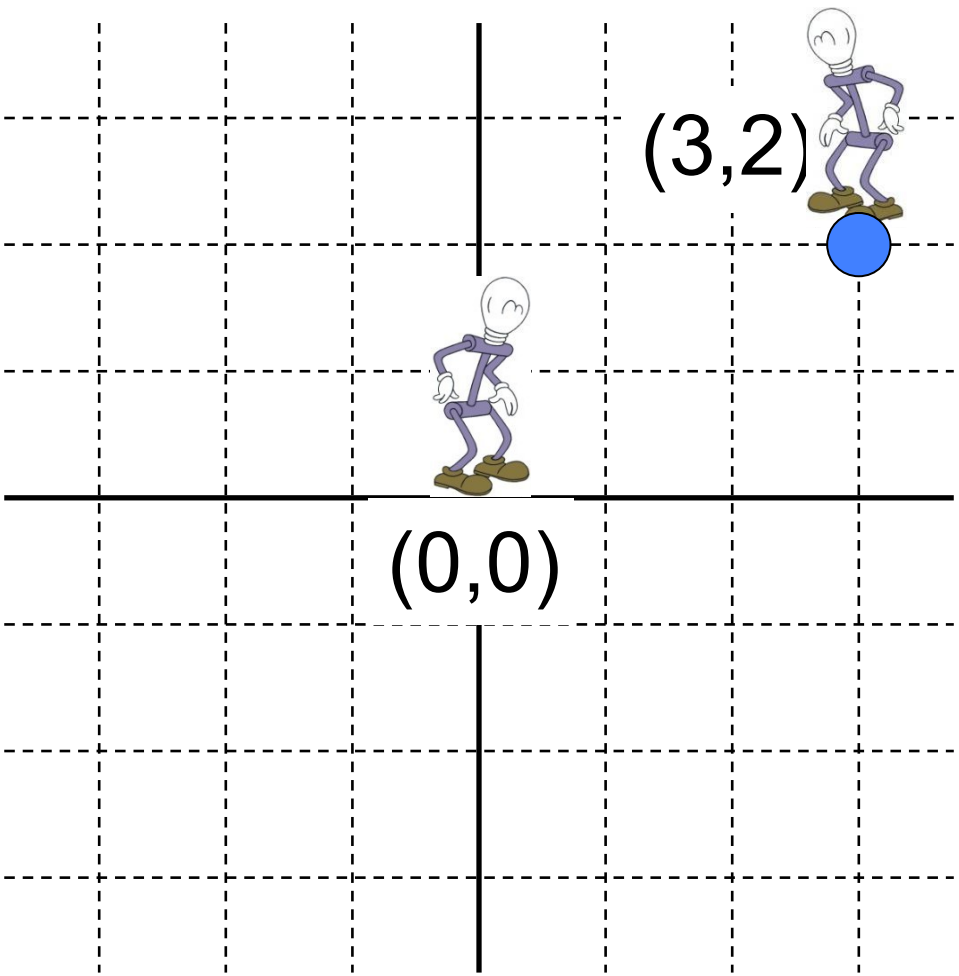


Q: Where do I put the origin, (0,0)?

A: Anywhere you like! There is no “preferred place.”

I might choose it to be where I’m standing.

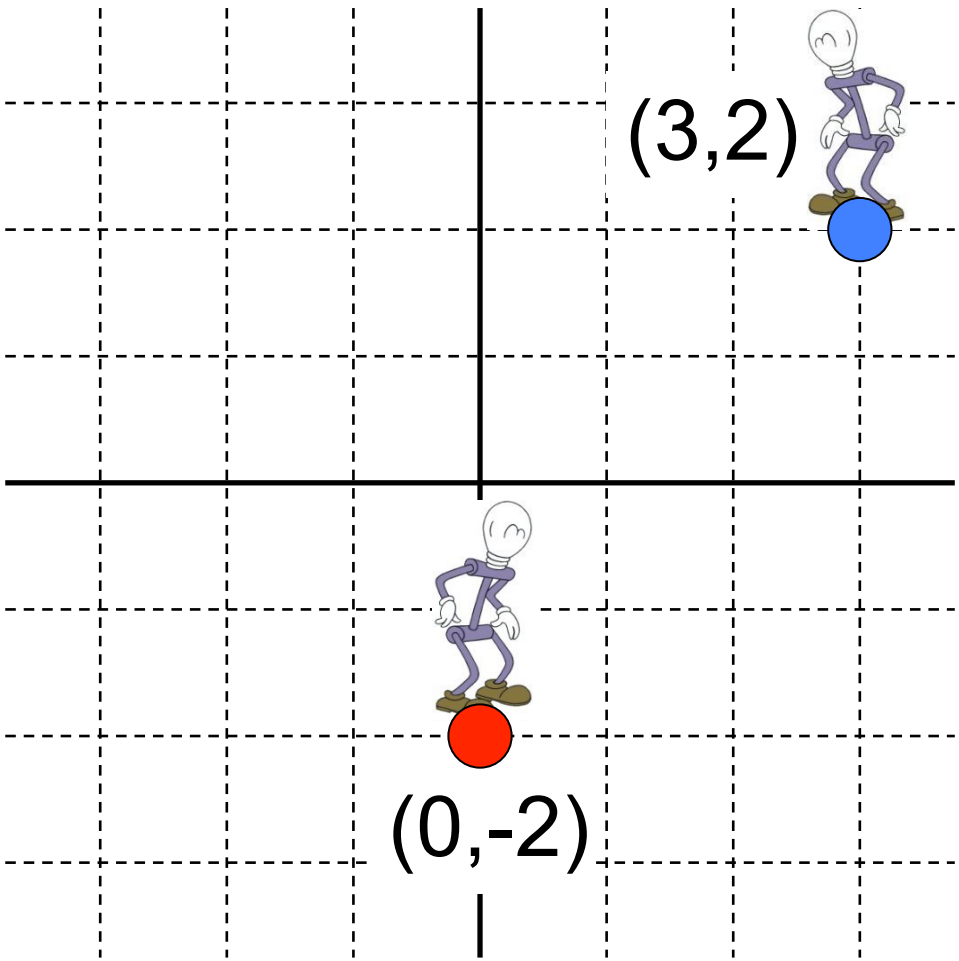
Reference frames



Now I locate an object in my frame, at, say, (3m, 2m).

A measurement of the ball position is best done by a '<u>local observer</u>', someone at that location.

Reference frames



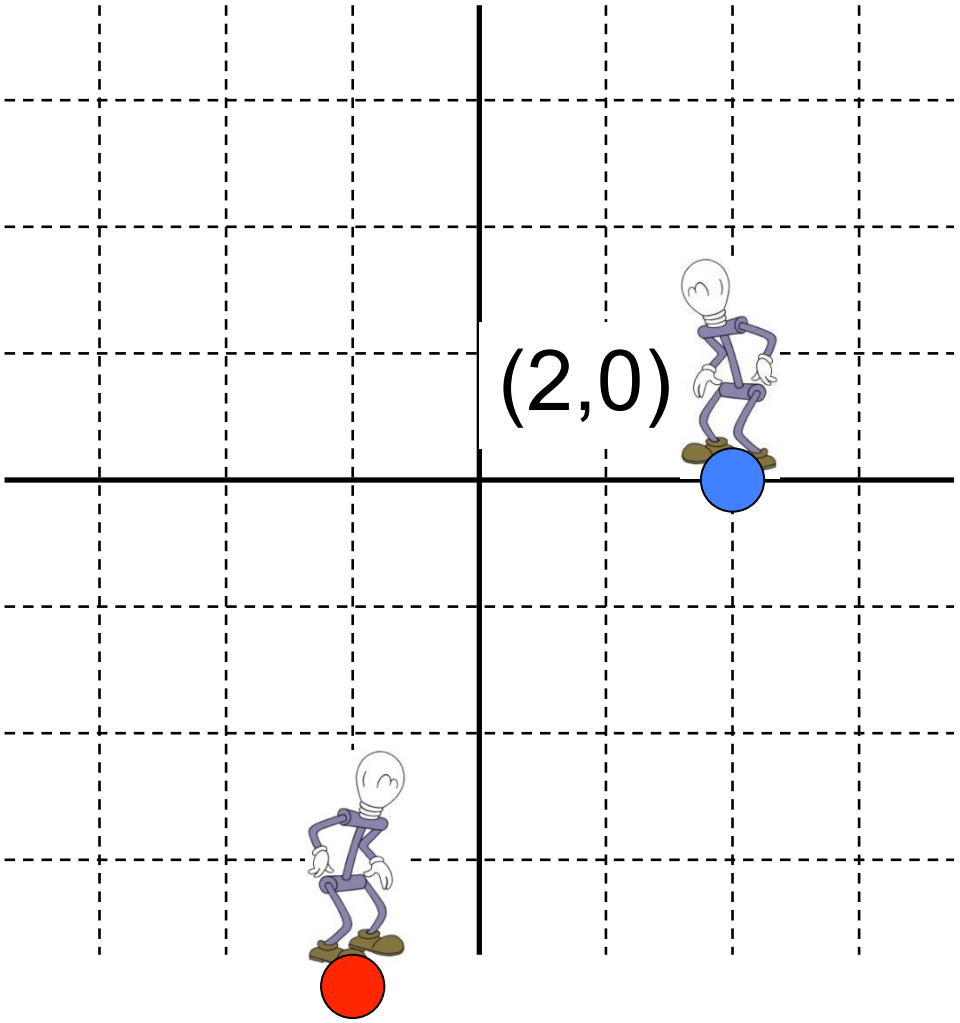
The blue ball is at (3m, 2m).

The red ball is at (0m, -2m).

Distance from red ball to blue ball is

$$\sqrt{(3m)^2 + (4m)^2} = \sqrt{25m} = 5m$$

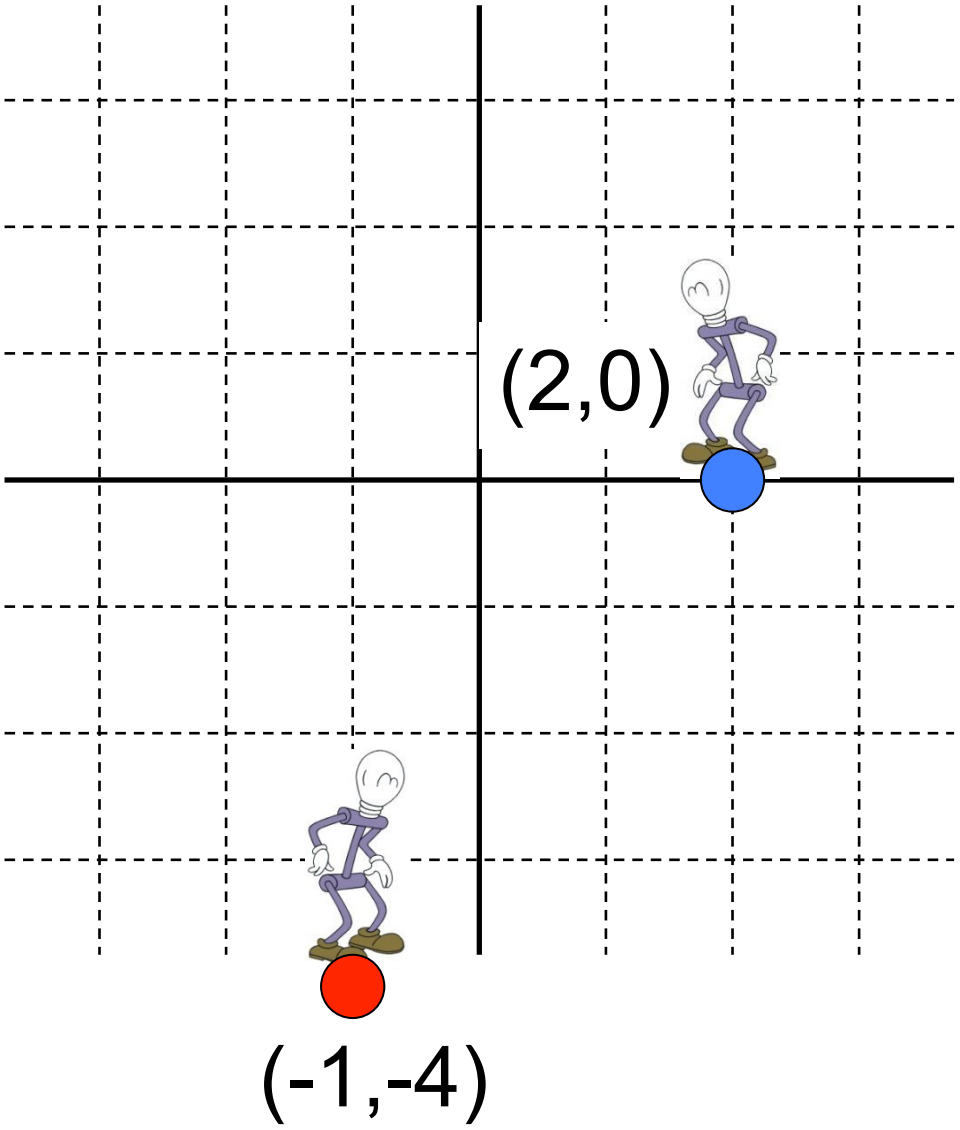
Reference frames



In a different reference frame, the blue ball is at (2m,0m) and the red ball is at (-1m,-4m). The balls are still 5m apart.

Which reference frame we use should not change the laws of physics, just the reference numbers we use to see them.

Remark



The distance between two objects that are not moving in this reference frame is a constant.
We say this distance is an “invariant.”

Law of Inertia

- Newton's first law – often called **law of inertia-**
- "A body is at rest or moves with a constant velocity unless acted upon by an external force".
- An **inertial frame** is the choice of a set of coordinate axes where the law of inertia holds.
- An accelerated frame is "**noninertial**".