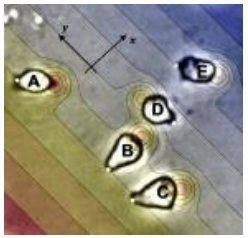
Physics 131- Fundamentals of Physics for Biologists I



Professor: Wolfgang Losert
wlosert@umd.edu

Forces and Newton's Laws

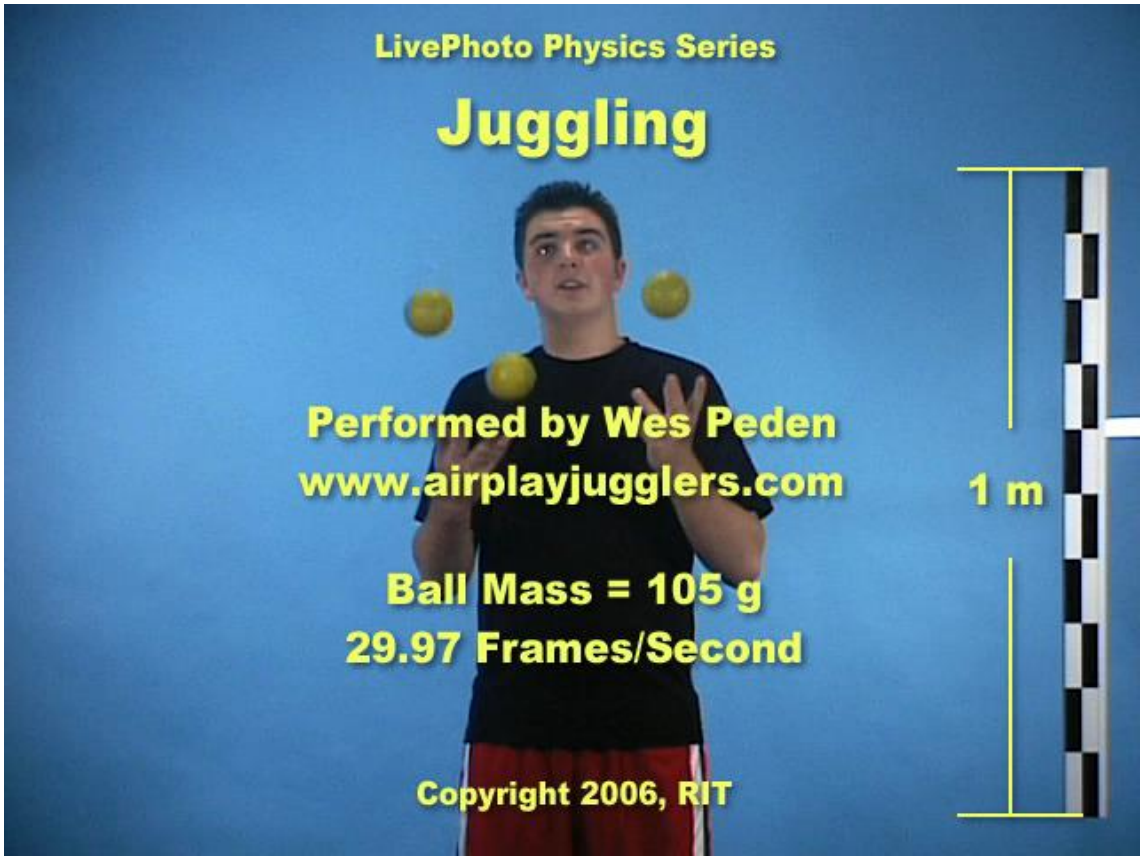
Movie of the Day
My grad student flying on the "vomit comet"

Naomi Murdoch

Kinematics and Dynamics

- Kinematics: Describing motion (Chapter 3)
  - Acceleration
- Dynamics: What causes motion
  - Forces and Newton's laws (Chapter 4)

What causes Motion?

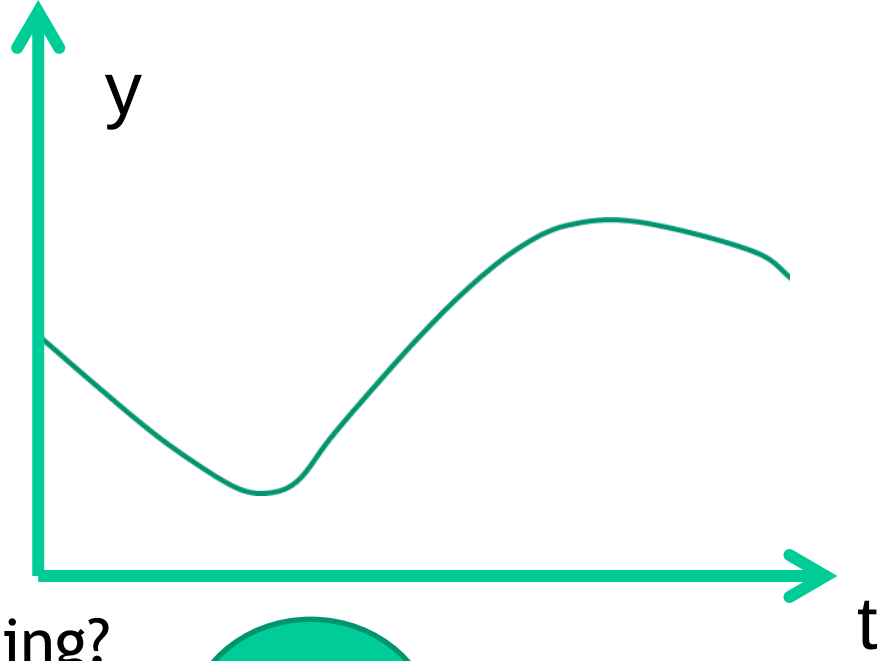


Our object of interest is the ball with the red dot.

Sketch a system schema of the juggling.

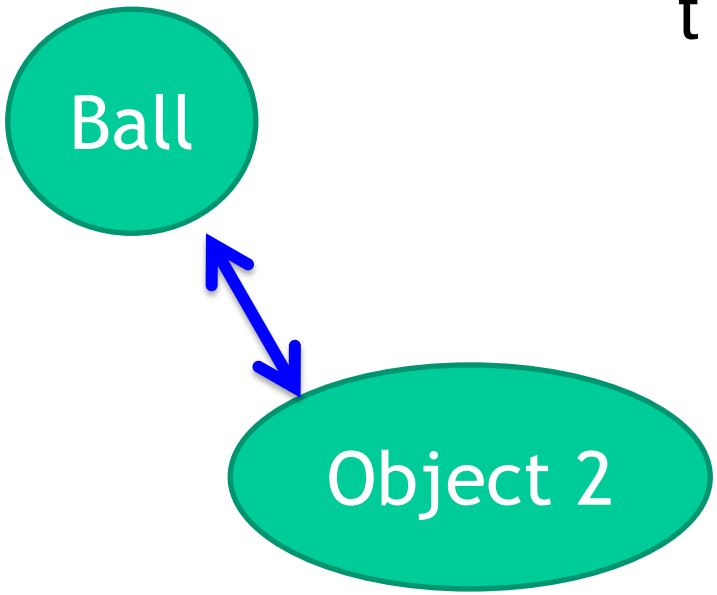
Whiteboards – TA and LA

What causes Motion?



Whose motion we are describing?

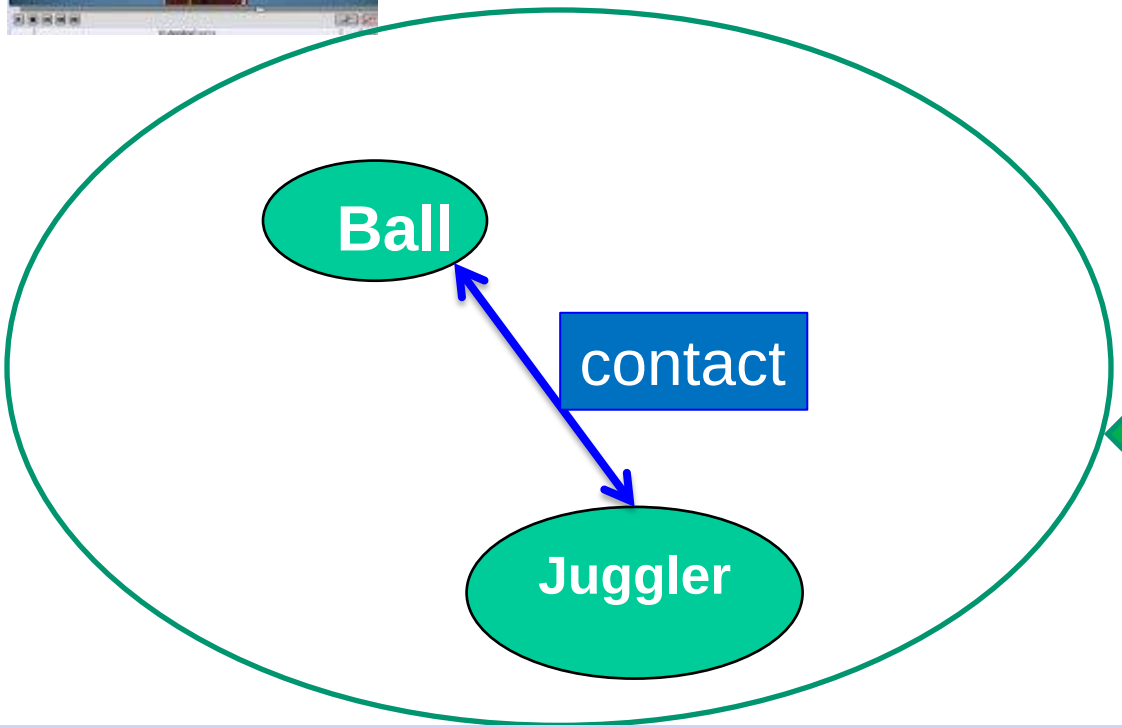
An object of interest (the ball)



What Causes its motion?

Other objects interacting with ball

System Schema



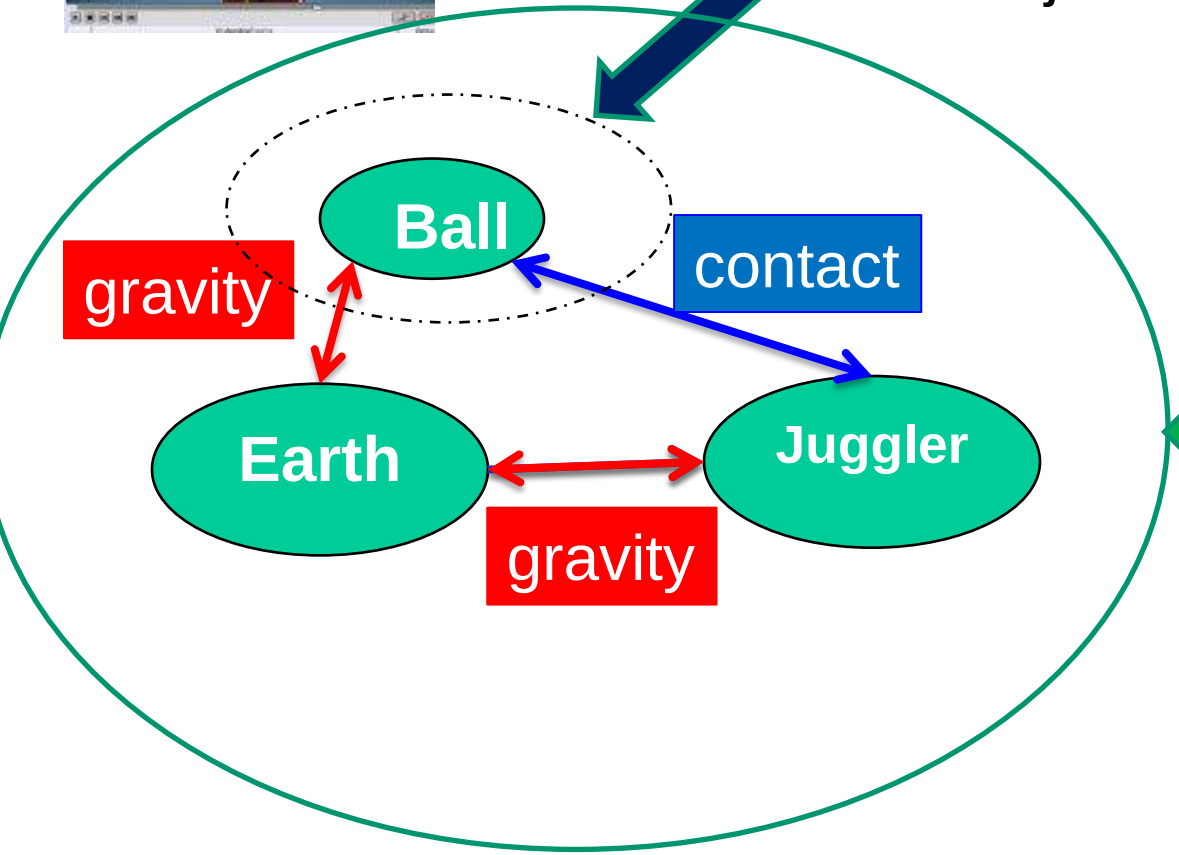
The Ball interacts with other objects, it is part of a system

How can we take all of these concepts into consideration when we are dealing with more than two objects?

How exactly would this principle be applied to … living organisms?

System Schema

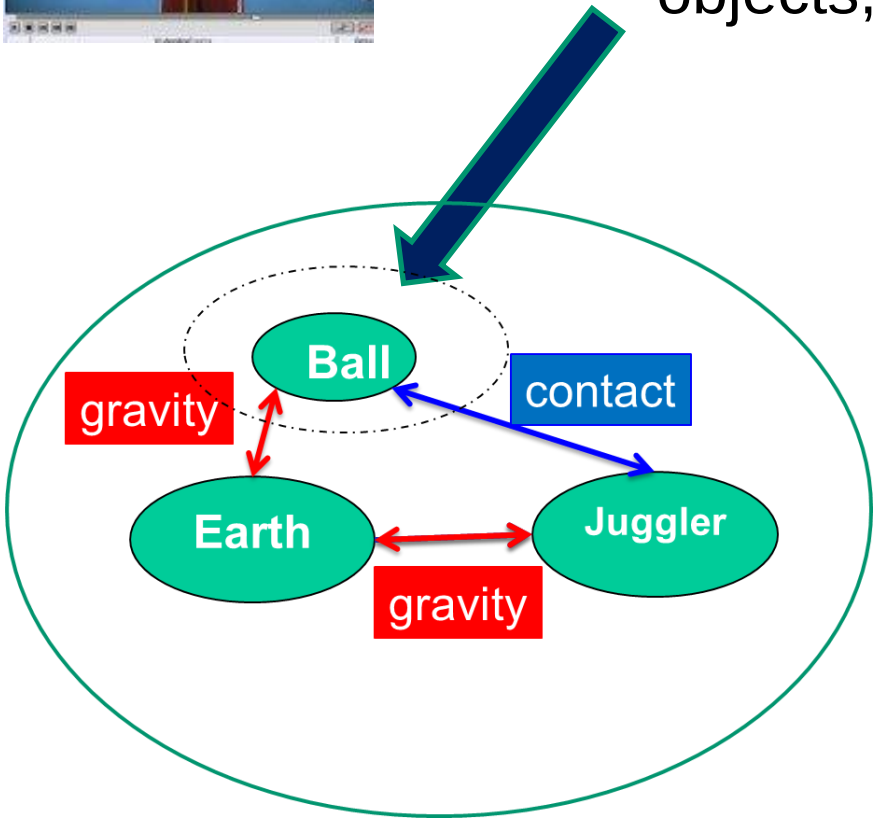
We want to understand & calculate what causes the motion of one of the objects, **the ball.**

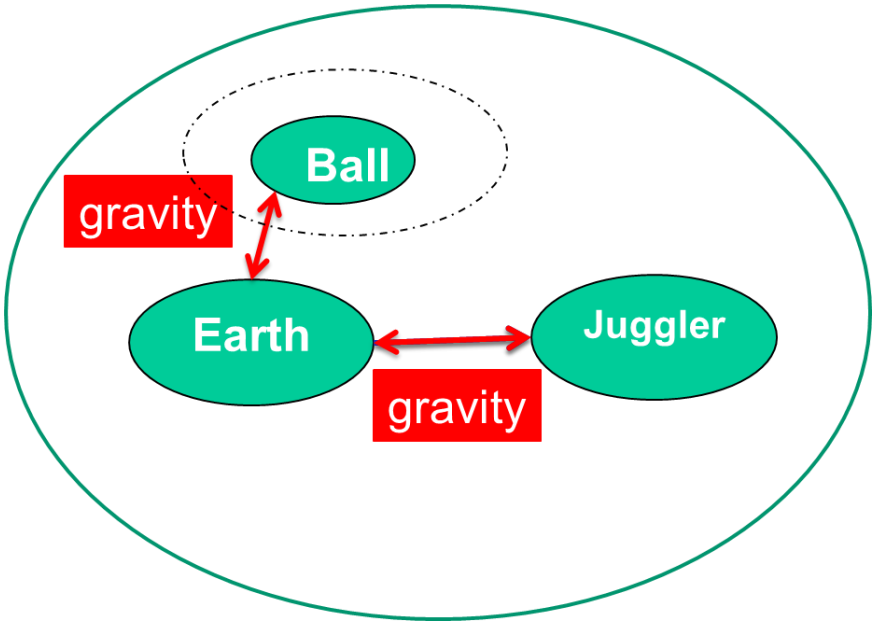


The Ball interacts with other objects, it is part of a system

What Changes in System

We want to understand & calculate what causes the motion of one of the objects, **the ball.**





Technical term alert: What's a "Force"?

Although the technical term for this is "force" it is different from the common speech idea of force.

- It is an interaction between two objects.
- It occurs
  - **via contact** or
  - by **"non-touching interactions"** Examples are **gravity**, electricity, and magnetism.

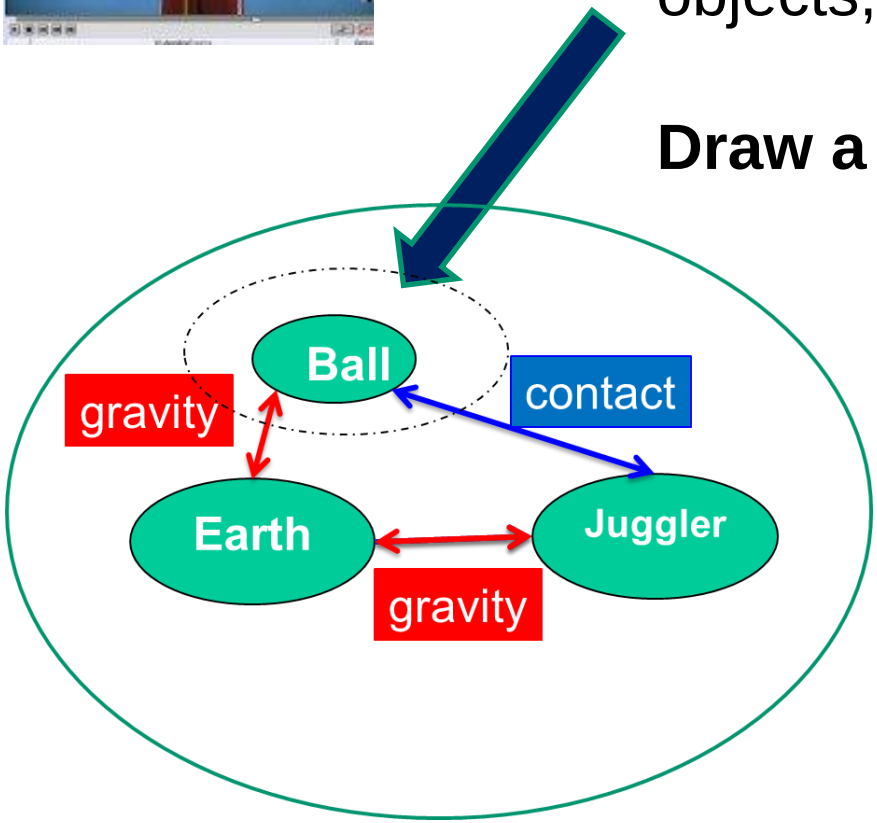
Conceptual ideas underlying Newton's Laws

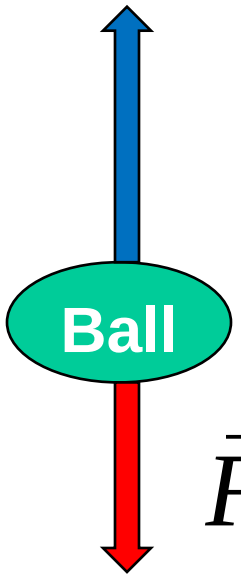
1. Every change in velocity an object experiences is caused by the object interacting with some other object – **forces**. (Interactions)
2. Objects respond only to forces ***acting upon them*** and they do so only at the instant that those forces act. (Object egotism) [Newton 0]
3. If there are a lot of different objects that are interacting with the object we are considering, the overall result is the same as if we **add up all the forces as vectors and produce a single effective force** -- the **net force.** (Superposition)
4. When one *solid* object exerts a force on another, that force is shared over all parts of the object. (Mass)

The Free Body Diagram

We want to understand & calculate what causes the motion of one of the objects, **the ball.**

Draw a Free Body Diagram for Ball





$\vec{F}^{net} = ??$

Can we do examples in class with adding forces like vectors?

Interaction of the ball with the earth leads _____ to change with time

1. Position
2. Velocity
3. Acceleration
4. All of the above
5. 1&2
6. 1&3
7. 2&3
8. None of the above changes with time

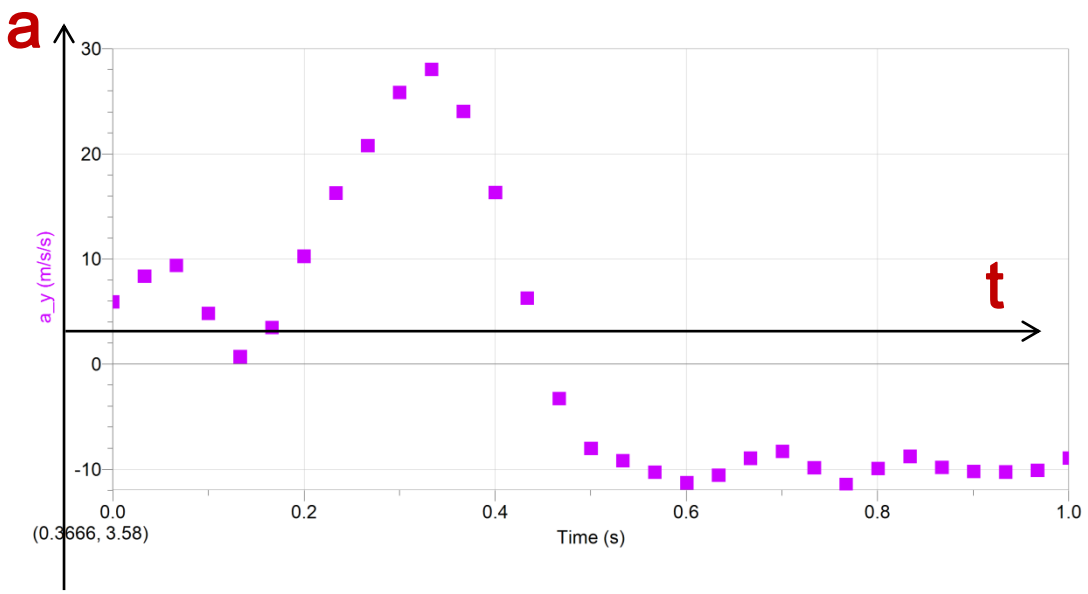
Newton's Laws

1. All outside effects on an object canceling out (net force of zero), the object maintains its velocity (including direction). The velocity could be zero, which would mean the object is at rest. (Inertia) [Newton 1]
2. The acceleration felt by an object (at a given instant) is the net force on the object at that instant divided by the object's mass. [Newton 2]

$$\vec{a} = \vec{F}^{net} \Big/ m$$

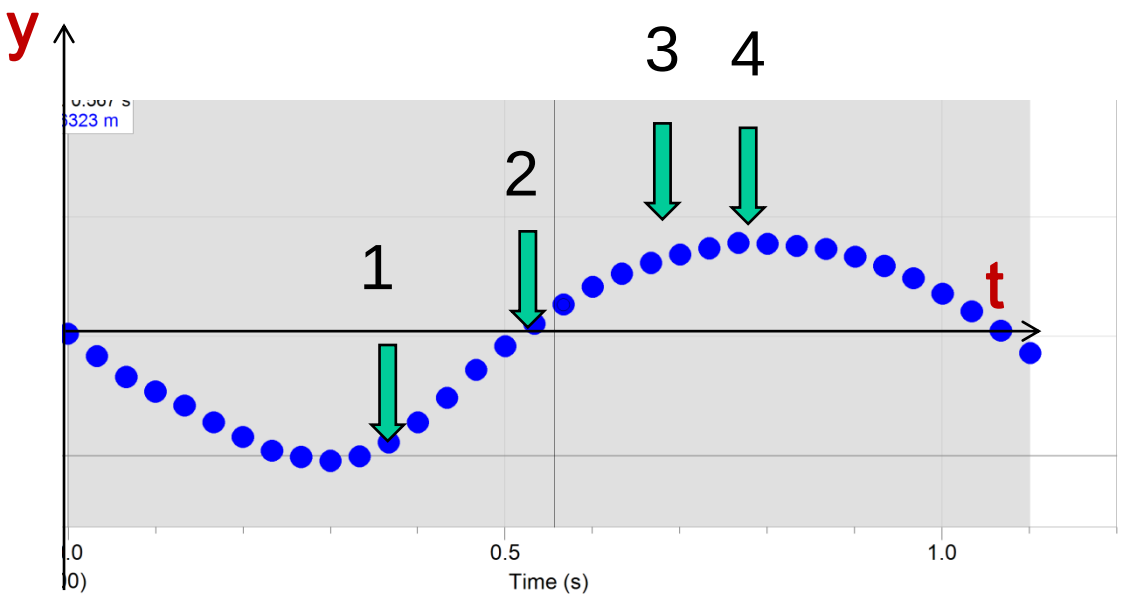
3. Whenever two objects interact, the forces they exert on each other are equal in magnitude and opposite in direction. (Reciprocity) [Newton 3]

Draw the force vs time graph



Looking at the position vs time graph, where does the juggler let go of the ball?

1. At 1
2. At 2
3. At 3
4. At 4
5. Before 1
6. After 4



Looking at the acceleration vs time graph, where does the juggler let go of the ball?

1. At 1
2. At 2
3. At 3
4. At 4
5. Before 1
6. After 4