



## GRAVITATIONAL FORCES

Classroom  
45-60 minutes

### Goal(s):

Introduce and analyze tide patterns and its relation to astronomical patterns

### Measurable Objective(s):

By end of lesson, 80% of students will understand tides are due to gravitational forces.

By end of the lesson, 50% of students will recognize tides follow a pattern.

### Interpretive Thought(s):

Gravity is like a big hug.

### Materials:

Tide Pictures (2), Tide Graphing Worksheet, Tide Photos, Tide Diagram (2), Tide Time Lapse Video

### Supports NGSS:

MS-PS2-B

## INTRODUCTION

1. Introduce the upcoming trip to Ballona Wetlands - Saltwater Marsh.
  - a. *Answer questions if any arise, especially if there are fears*
2. In a few days/weeks you will be visiting Ballona Wetlands Saltwater Marsh. I have some pictures of the wetlands and I'd like to get your thoughts on them.
  - a. *Show **Picture 1** and have students make observations*
  - b. *Show **Picture 2** and have students make observation about it and how the pictures are similar and different.*
3. What is happening at Ballona Wetlands to have such a dramatic change?
  - a. *Allow students to make some guesses and if students don't guess tides provide some additional clues:*
    - i. These photos were taken on the same day!
    - ii. It was during the summer.
    - iii. Nothing was going wrong at the time.
4. Tides are causing the wetlands to fill and drain with water over just the span of a few hours.
  - a. We are going to explore the topic of tides and on our Outdoor Classroom visit to the Saltwater Marsh, we'll discover how plants and animals have adapted to survive tide changes.

## BODY

1. *(Transition) Have all students stand next to their desk and then jump.*
  - a. Why is it that when we jump, we come back to the ground? Gravity
  - b. Why is it when I toss a ball, it falls back to the ground? Gravity
2. What is gravity?
  - a. Gravity is an invisible force that pulls objects towards each other
    - i. It is sort of like an object wanting to give another object a hug, pulling things towards itself.
  - b. Everything exerts gravity but why can't I use it to pull a pencil towards me?
    - i. Gravity is affected by mass: the larger the mass the more gravity it exerts
    - ii. Ex: The bigger the bear giving the hug, the stronger the hug is.
    - iii. Gravity is affected by distance: the further away an object is the less gravity it exerts.
    - iv. Ex: It is harder to give something a hug when it is further away
  - c. The Earth has a really big mass (made up of a lot of matter/stuff) and is really close to us so exerts a lot of gravity on us, pulling things towards its center.
    - i. The Earth's gravity is really important so we don't go flying off the planet when we jump and also holds our atmosphere in place.
3. Why are we talking about gravity when just a few minutes ago we were talking about tides?
  - a. Gravity is what causes tides but whose gravity? The Moon and the Sun!
  - b. The moon is pretty big, about a quarter the size of the Earth and pretty close to us (average 238,000 miles) and exerts gravity on Earth.
  - c. It is this gravitational force that causes the ocean to bulge towards the moon in some places and because the ocean is a connected body of water, lower in other areas (**Tide Diagram**). As the moon orbits the Earth and the Earth rotates, those high and low areas move across the Earth, giving us tides!
4. **Activity: Tide Graphing** - This gravitational effect on Earth's oceans creates a tide pattern that we are going to graph out and then discuss what it shows.
  - a. We are going to be graphing the height of water in Ballona Wetlands channels over time based on some of the images we are going to analyze. Each image given to your group will have a date and time on it. You'll have to put them in order and then using the measuring stick in the image, record on your chart the estimated height of water at each day and time. Once your chart is filled in, graph the rest of the data points on the bar graph.

- b. *Make sure there aren't questions and then hand out the images to groups along with the Tide Graphing Worksheet for each student.*
  - c. *Walk through the class to help with questions as they come up and keep groups on task. For students stuck on exact numbers, remind them it is only an estimate. Once everyone has finished, continue together.*
  - d. Let's discuss what your graphs show\*.
    - i. 2 high tides (not the same height)
    - ii. 3 low tides (not the same height)
5. The tides change bringing a high tide and low tide approximately every 12 hours (6 hours between high and low tide)
- a. High tide is when the moon is more directly "overhead" or on the opposite side of the Earth (**Tide GIF or [use this link](#)**)
  - b. Low tide is when the moon is at a 90° angle to that location on Earth
  - c. There are in many places of the Earth, 2 high and 2 low tides each day but land forms and other factors can affect this. Some places only get 1 high and low tide each day.
6. Now that we know what we are looking at and how it works, let's take a look at the video showing the tide changes that you graphed here. (**Tides Time Lapse Video - [YouTube Link](#)**)

## CONCLUSION

1. When we head out for the Outdoor Classroom field trip we are going to observing where the tide is and examining how the plants and animals survive when they are flooded some of the day and in the open air the other part.
2. We will also take a look at how Ballona Wetlands Saltwater Marsh uses something called a tide gate to mediate the tides so water can still get into the wetland but not too much, which might cause flooding in the nearby streets and buildings.

## VOCABULARY

**Gravity:** an invisible force that pulls objects toward each other. and the force by which a planet or other body draws objects towards its center. The force of gravity keeps all of the planets in orbit around the sun. More mass means more gravity and more distance means less gravity.

**Mass:** the amount of matter something is made of

**Moon:** a natural object that travels around a bigger natural object

**Orbit:** the curved path that a planet, satellite (moon), or spacecraft moves as it circles around another object

**Sun:** the star in the center of our solar system

**Tide:** a very long-period wave which moves through oceans due to the forces exerted by the moon and sun

*\* Tide graphing data is from NOAA Tide Predictions for El Segundo, CA and not a direct measurement of tide changes within Ballona Wetlands Saltwater Marsh which have muted tides due to self-regulating tide gates.*

## References and Resources

Astronomical Society of the Pacific - The Moon: A Resource Guide

<https://www.astrosociety.org/education/astronomy-resource-guides/the-moon-a-resource-guide/#A5>

NASA Space Place

<https://spaceplace.nasa.gov/what-is-gravity/en/>

NOAA Ocean Service Education - Tides

[https://oceanservice.noaa.gov/education/kits/tides/tides01\\_intro.html](https://oceanservice.noaa.gov/education/kits/tides/tides01_intro.html)

NOAA Tides and Currents

<https://co-ops.nos.noaa.gov/education.html>

PBS Digital Studios: Space Time - What Physics Teachers Get Wrong About Tides!

<https://www.youtube.com/watch?v=pwChk4S99i4>