Teacher Guide: Tides

Learning Objectives

Students will:

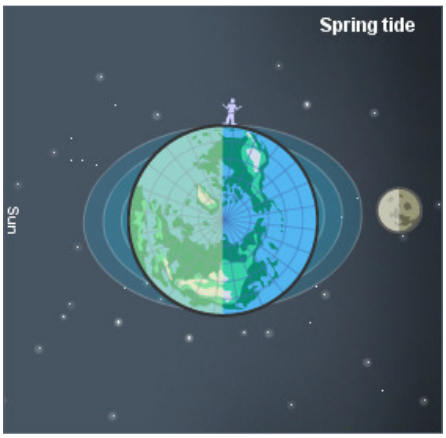
- Define tides.
- Describe the effects of the Moon and Sun on tides.
- Identify and explain spring and neap tides.
- Interpret a graph of tidal changes over time.

Vocabulary

gravity, high tide, low tide, neap tide, spring tide, tidal bulge, tides

Lesson Overview

Have you ever been to the beach for a day? You may have noticed that the waves reached higher and higher as the day went on. Perhaps you had to move your beach blanket to higher ground to avoid the onrushing water. (On the other hand, you may have noticed the waves receding as the day went on.) If so, you were observing the tides.



The *Tides* Gizmo™ illustrates how the Moon, Sun, and Earth's rotation affect the tides. The left side of the Gizmo shows a view from space, while the right side can show a bar graph, a table, or a line graph of the height of water over time.

(Note: The *Ocean Tides* Gizmo covers similar topics, but is aimed at grade 3-5 students.)

The Student Exploration sheet for the *Tides* Gizmo contains two activities:

- Activity A – Students explore the effect of the Moon on tides.
- Activity B – Students determine how the Sun causes spring and neap tides.

Suggested Lesson Sequence

1. **Pre-Gizmo Activity** (10 – 20 minutes)
   Project a series of high tide/low tide images to the front of your classroom. Ask students to explain what is happening in each image. The extraordinary tides in the Bay of Fundy are particularly fascinating. See the **Selected Web Resources** on page 3 of this document for helpful image sources.

2. **Prior to using the Gizmo** (10 – 15 minutes)
   Before students are at the computers, pass out the Student Exploration sheets and ask students to complete the Prior Knowledge Questions. Discuss student answers as a class, but do not provide correct answers at this point. Afterwards, if possible, use a projector to introduce the Gizmo and to demonstrate its basic operations, such as how to use the tools, view data, and take Gizmo snapshots.

3. **Gizmo activities** (10 – 20 minutes per activity)
Assign students to computers. Students can work individually or in small groups. Have students work through the activities in the Student Exploration, using the Gizmo. Alternatively, you can use a projector and do the Exploration as a teacher-led activity.

4. **Discussion questions** (15 – 20 minutes)
As students are working or just after they are done, discuss the following questions:
   - What causes the tides?
   - Why do you think there is a tidal bulge on the side of Earth *opposite* the Moon?
   - What do you notice about the position of the Moon and Sun during spring and neap tides?
   - Which has a greater effect on tides, the Moon or the Sun? Why do you think this is so?
   - What impact do tides have on human life? On ocean life?

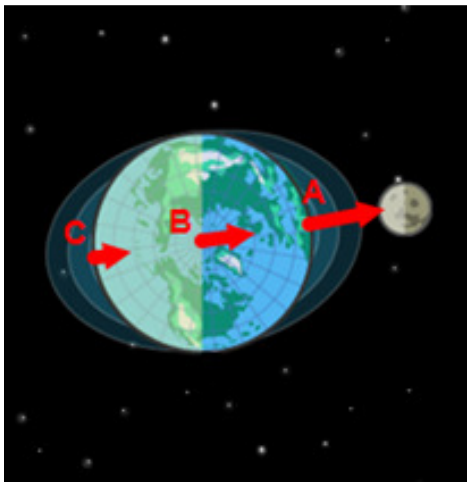
5. **Follow-up activities: Tide pool fun** (1-2 days)
If you are located near the coast, take a field trip (or a pair of field trips) to observe the tides. Try to schedule your field trip during a spring tide so that the changes are more dramatic. During low tide, students may see exposed mud -flats teeming with sea birds, tide pools, sand bars, and exposed pilings on docks and causeways. Ask students what adaptations organisms must have to survive in the *intertidal zone*, the area between the highest water level during high tide and the lowest water level in low tide.

   If such a field trip is not available in your area, there are many excellent films and Web sites that will allow your students to experience life in the intertidal zone. See the **Selected Web Resources** for some helpful links.

Scientific Background

Tides are defined as the regular rise and fall of ocean surfaces caused by the gravitational forces of the Moon and, to a lesser degree, the Sun.

- The Moon's gravitational pull is strongest on the ocean surface nearest the Moon (point **A** on the diagram at right). Water in this area is pulled toward the moon, forming a tidal bulge.
- On the opposite side of the Earth, the ocean also accelerates toward the Moon (point **C**), but not as much as the center of the Earth (point **B**). The ocean is "left behind," forming a similar bulge.
- Water covering the middle region is pulled downward (inward) and flows out (left and right in the picture), increasing the size of the bulges.
- A location on Earth's surface will experience a high tide when it rotates into one of the tidal bulges. At most points on Earth, there are two high tides and two low tides each day.



The relative magnitude of the Moon's gravity is shown by red arrows

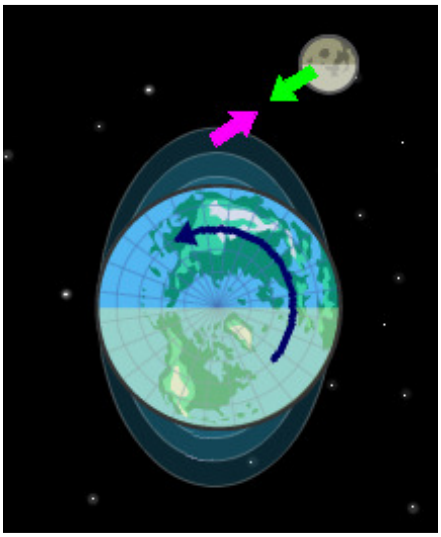
The Sun also influences tides. When the Sun and Moon are aligned (on the same side or opposite sides of Earth), their combined gravitational pull causes unusually high and low tides, referred to as **spring tides**. At these times the high tides are very high and the low tides are very low. When the Sun and Moon are at right angles to each other with respect to the Earth, the gravity of the Sun competes with the gravity of the Moon. During this time, the difference between high and low tides is smaller and known as a **neap tide**. Neap tides are especially weak tides.

Why does the Moon have a stronger effect than the Sun on tides? The force of the Sun's gravity on Earth is over 100 times stronger than the force of the Moon's gravity (which is why Earth orbits the Sun and not the Moon). Because the Sun is so far away, its gravitational force is nearly the same on the near side as the far side. The Moon is much closer, so there is a greater difference between its pull on the near side and its pull on the far side of Earth. It is the *difference* in gravitational pulls that causes tides, not the overall gravitational force.

Astronomy connection: Longer days

Have you ever felt like there were too few hours in a day to get everything done? If you've ever wished for longer days, your wish will come true (eventually). Over time, Earth's rotation has gradually slowed. (When Earth was formed, a day was only six hours long!) The reason for this slowdown is the tides.

In the *Tides* Gizmo, the tidal bulges are aligned perfectly with the Moon. In reality, the tidal bulges are a pointed a little bit *ahead* of the Moon. Viewed from the North Pole, Earth's rotation and the Moon's orbit are counterclockwise (blue arrow). As Earth rotates, the oceans and tidal bulges are carried with it, moving slightly ahead of the Moon.



The tidal bulge nearest the Moon exerts a gravitational force on the Moon (green arrow), causing it to accelerate. As the Moon speeds up it moves farther from Earth by about 4 cm per year. At the same time, the Moon's gravity pulls back on the tidal bulge (pink arrow), slowing Earth's rotation and lengthening the day. The effect is tiny, however. Every century the length of a day increases by a mere 1.7 milliseconds.

Selected Web Resources

Bay of Fundy images: http://bayoffundy.blogspot.com/search/label/High-low%20tide%20pics
Barwon Bluff educational resources: http://www.barwonbluff.com.au/education/education.htm
Life in the intertidal zone: http://www.nhptv.org/NATUREWORKS/nwep6b.htm
Tide demonstrations and explanation: http://www.exo.net/~pauld/activities/tides/tides.html
NOAA on tides: http://www.oceanservice.noaa.gov/education/kits/tides/tides03_gravity.html
Detailed explanation of tides: http://www.oc.nps.edu/nom/day1/partc.html
Mathematical explanation of tides: http://www.jal.cc.il.us/~mikolajsawicki/tides_new2.pdf
Tidal acceleration (explanation of longer days): http://en.wikipedia.org/wiki/Tidal_acceleration

Related Gizmo:
Ocean Tides: http://www.explorelearning.com/gizmo/id?634