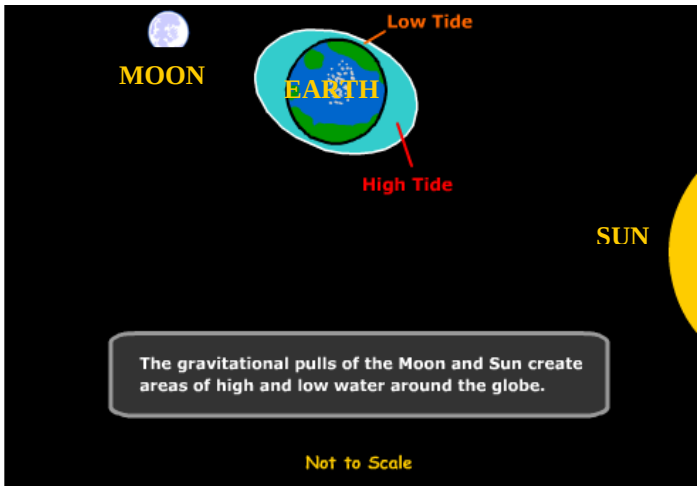
Tracking the Tides

Tides are the periodic rise and fall of the ocean waters. They are caused by the gravitational pulls of the moon and (to a lesser extent) sun, as well as the rotation of the Earth. The sun and moon both pull on the Earth, the water, even you! Because the moon is much closer to Earth than the sun (about 400 times closer!), its influence on our oceans is stronger than that of the sun.



The key to tides is the varying strength of the moon's gravitational pull on different parts of the globe. The moon pulls most on the water nearest to it, creating a high tide bulge in the waters closest to the moon. On the opposite side of the planet inertial forces on the opposite side of the Earth causes a similar "bulge" creating another high tide. Low tides are found halfway between the highs. The rotating Earth carries us through these regions of high and low water.

When the moon, earth, and sun fall in a straight line we notice the greatest difference between high and low tide water levels. These are called **spring tides** and occur twice each month, during the full and new Moon. If the Moon is at **perigee**, the closest it approaches Earth in its orbit, the tides are especially high and low.

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August Teachers' Workshop, 2004
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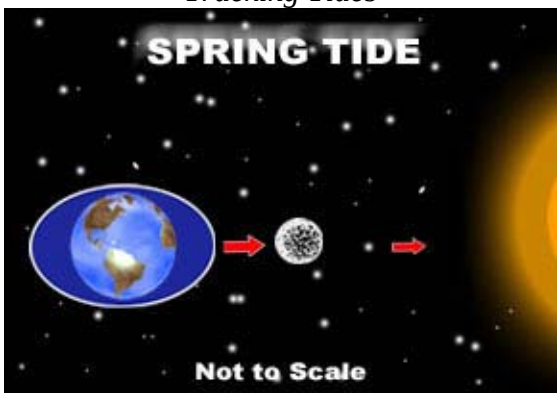
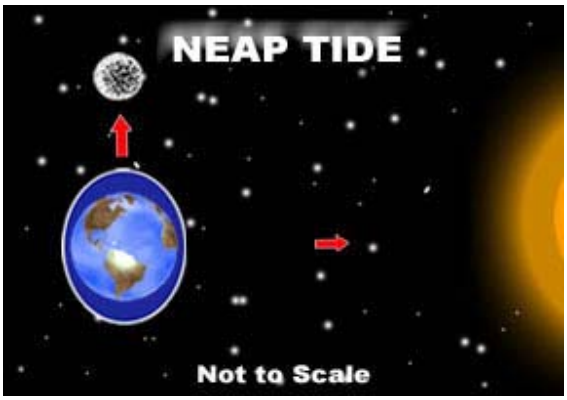


When the Sun and Moon form a right angle, as when we see a half moon, their pulls fight each other and we notice a smaller difference between high and low tides. These are called **neap tides**.



Earth, Sun, and Moon; Students Modeling Tidal Forces

1. Divide into groups of 3 and decide who in the group will be the sun, the moon, and the earth.
2. The person who is the earth should put a sticker or post-it on their left shoulder. This will be the location we are focused on, let's pretend it is the Oregon Coast.
3. Work together as a group to set up a spring tide. The earth person should rotate through a day while the sun and moon are stationary. When is it high tide for your location? Where else is it high tide at that time? How many high tides are there in one day?
4. Switch roles so that another member of the group is Earth. Set up a neap tide. The earth person should rotate through a day while the sun and moon are stationary. When is it low tide for your location? Where else is it low tide at that time? How many low tides are there in one day?

Timing the Tides

Adapted from NASA's "visit to an Ocean Planet" Curriculum
http://topex-www.jpl.nasa.gov/education/activities.html

1. The *Tide Time Diagram* shows Earth at the center as seen from far above Earth's North Pole. Which direction (clockwise or counterclockwise) is Earth rotating? Draw an arrow on the diagram showing the direction of rotation.
2. The outer ring in the diagram shows the daily positions of the Moon relative to Earth during one lunar month lasting from one new Moon phase to the next new Moon. How long does it take for the moon to revolve once around the earth?
3. The *Tidal Bulge/Moon Diagram* on the overhead is also the earth as viewed from above the North Pole with the depth of the ocean greatly exaggerated. It shows the theoretical locations of the ocean's two dominant tidal bulges. One always faces the Moon (where lunar gravitation is strongest) and the other always faces directly away (where lunar gravitation is weakest).
4. Place the *Tidal Bulge/Moon Diagram* directly over the *Tide Time Diagram* so that the center points of the diagrams coincide. Use a compass point to hold the two together at their centers. Twist the overlay so the Moon progresses from one daily position to the next. Is the moon is advancing in the same or opposite direction as Earth's rotation?
5. Place the Moon at its Day 1 position. The arrow on Earth represents the Oregon Coast. At about what time would this point experience high tide on Day 1?
6. Advance the Moon to its day 2 position. On this day, the point would experience a high tide at about what time?
7. Comparing the time of the Day 2 high tide to the Day 1 high tide, the time of the high tide is about how much later than on the day before?
8. To determine the lag between successive high tides more accurately, determine from the diagrams the times of comparable high tide on Day 10 and Day 20. From this information, find how many minutes later the tide occurred on Day 20 than on Day 10, and divide by 10. According to these calculations, the daily time lag rounds off to about how many minutes?

The SMILE Program
August Teachers' Workshop, 2004
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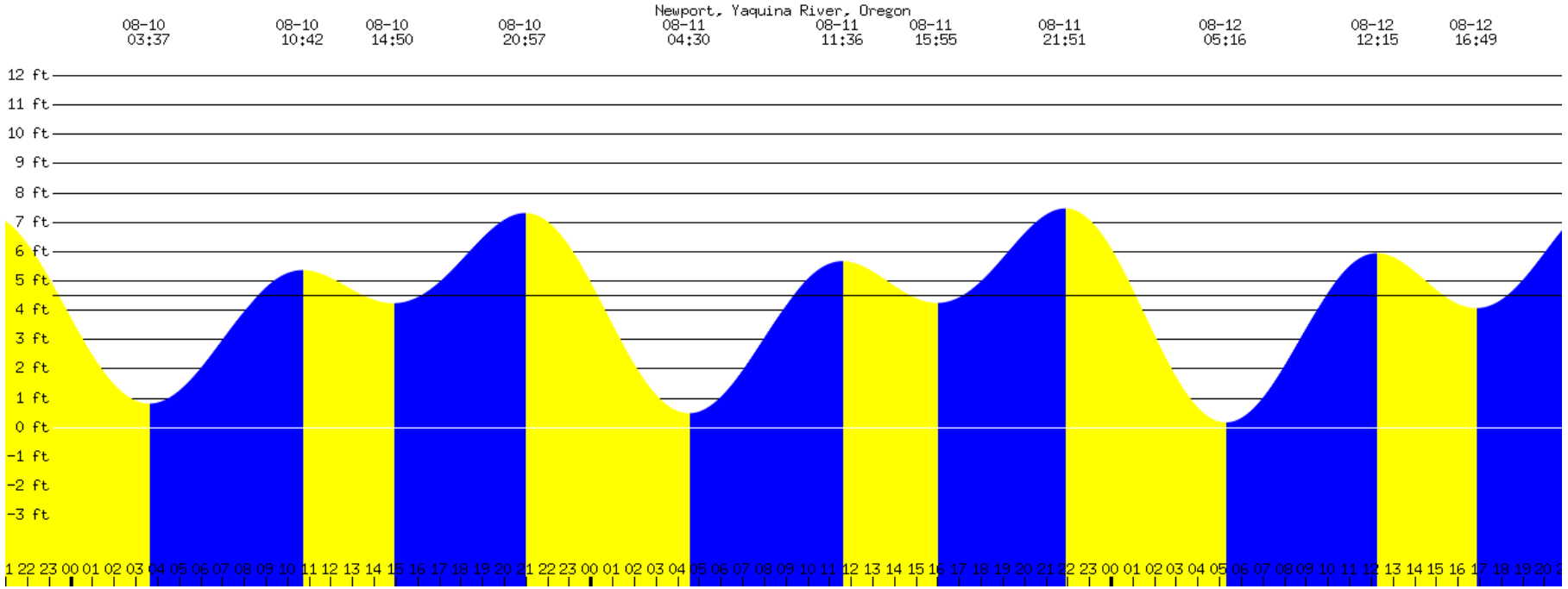

1. The graph above represents the predicted tides for Newport, Oregon for August 10-12. The dark gray sections represent the rising tide and the light gray sections show the falling tide. How many high tides are predicted each day? How many low tides?

2. What do you notice about the strength of the tides? Can you predict at which high tide is due to this location facing the moon and which is due to it facing away from the moon?

3. Look at the times of the lowest and highest tides for each day. How long is the lag from one day to the next? Can you explain this lag using what you learned in the previous activity?

The SMILE Program
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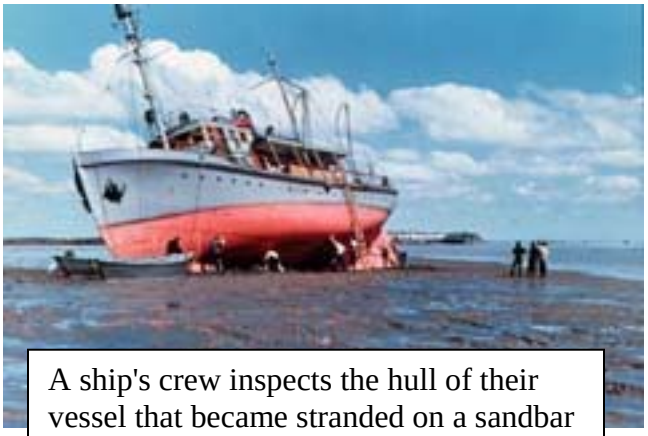


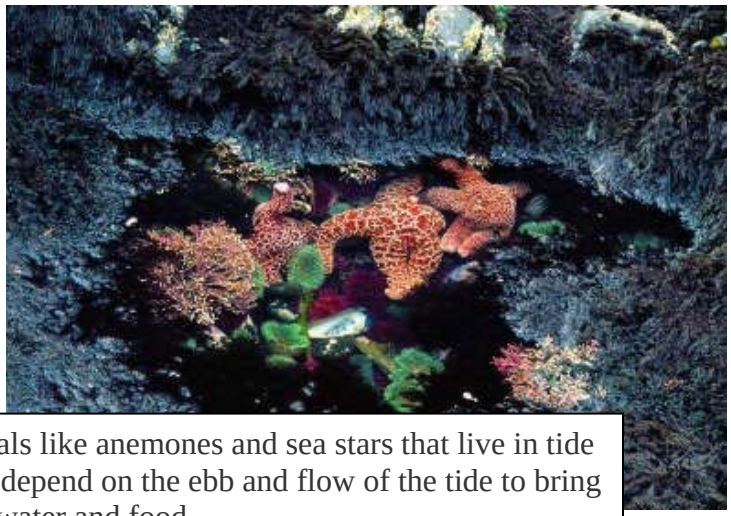
A ship's crew inspects the hull of their vessel that became stranded on a sandbar following a rapidly receding tide.

Tides – Why Do They Matter?

1. Why do you think understanding tides and being able to predict tides are important?
2. What affect do you think tides have on people who live in coastal communities?
3. Why might tides be important to plants and animals that live along the coast?

This marine crane valued at $5 million cleared the Oakland Bridge in San Francisco Bay by approximately 6 feet due to well-predicted tides.

Plants that live in estuaries are adapted to living in salt water and to the ebb and flow of the tides.



Animals like anemones and sea stars that live in tide pools depend on the ebb and flow of the tide to bring them water and food