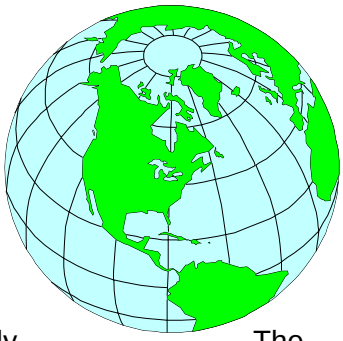
Lab: Tidal Range



The daily rise and fall of the ocean waters is called the ***tides***. Like the moon, the tides rise 50 minutes later each day on average. Tides are unusually large at the new moon and the full moon. They are unusually small at times of the quarter moon. All of these facts show that the moon and tides are related.

Sir Isaac Newton first explained how the moon causes the tides. According to Newton, the moon's gravity pulls the earth and its oceans unequally. The ocean waters on the side of the moon facing the earth are nearest the moon. The ocean waters on the far side of the earth are farthest away. In between is the solid earth.

The moon, Newton said, pulls the ocean waters on the side of the earth near the moon more strongly than it pulls on the solid earth. This causes the waters to bulge toward the moon in a ***direct high tide***. On the far side of the earth, the ocean waters are pulled less strongly than the solid earth. The result is a bulge away from earth's surface, which is called an ***indirect high tide***. Halfway between the two high tides, low tides are formed. This happens because the ocean waters flow to the areas of high tides.

If the earth and moon stood still, the tides would always be in the same places. But the moon turns on its axis, and the moon moves around the earth. As the earth rotates, all parts of the oceans pass under the moon influence every 24 hours and 50 minutes. In one/fourth of this time –or about 6hours and 12.5 minutes- the tides change. Each high tide area moves to low tide. Each low tide area moves to a high tide. Then 6 hours and 12.5 minutes later, the tides change again. The original high tides are high tides again. Thus every 12 hours and 25 minutes, this sequence of high and low tides are repeated. As the earth and moon move, the tides continue their regular rise and fall. Each day, the cycle starts over again, about 50 minutes later than the day before.

The sun has the same kind of effect on the earth's waters as the moon. But the sun is much further away than the moon. Therefore its tide-making effect is only about half that of the moon. The moon is the chief maker of the tides. The sun, however, can strengthen or weaken the moon's effects. Tides are always high in line with the moon. They are always low midway between the moon's high tide points. When the sun is in line with the moon, its effect is added to the moon's tides. When sun is 90^0 away from the moon, its effect weakens the moon's tides.

At the new moon and the full moon, the sun and the moon are working together. This makes very high, high tides and very low, low tides. The ***tidal range,*** (difference in level between high and low tides) is large. These tides are ***spring tides***. These spring tides come twice a month. At quarter phases, the sun is opposing the moon. This makes high tides not very high and low tides not very low. The tidal range is small and these tides are called ***neap tides***.

Tidal ranges differ greatly on ocean shores. The shape of the oceans and ocean bottoms influence the tides. In the Gulf of Mexico, the tidal range may be only half of a meter. In the Bay of Fundy in Nova Scotia, it may reach 20 meters. The Bay of Fundy is a long V-shaped bay. Water from the ocean tide is funneled into the wide end of the V. Then it piles up high at the narrow end. The Gulf of Mexico does just the opposite. It has a shoreline broader than its mouth. As the ocean tide enters the Gulf, its waters spread out over the long shore.

Purpose: to determine how the moon affects the tidal range of an area. You will examine the relationships between the tides in Boston Harbor and the phase of the moon, orbit, and Earth's rotation.

Materials:

Graph Sheet Map colors Instruction sheet

Procedure:

1. On the X axis put the days of the month—Label it “Month”
2. On the Y axis put the height…make sure you include negatives. A good range should go from -2.0 to +12. Heights in the data are given in feet—Label it “Height (ft)”
3. Plot each data point for the high tides.
4. Connect the points with a color.
5. Plot each data point for the low tides.
6. Connect the low tide points with a different color.
7. Create a key/legend for the colors used to graph the tides.
8. Using the information in the data table, draw in and label the phases of the moon in the circles above the graph.

Data Points for the Tides:

Day	high	low	moon phase
1	11.2	-0.7	
2	10.6	0	
3	9.9	0.6	
4	9.4	1	
5	9.1	1.3	3rd quarter
6	9	1.4	
7	9	1.3	
8	9.3	1.2	
9	9.7	1.1	
10	9.9	1	
11	10.2	0.4	
12	10.2	0.2	New moon
13	9.4	1	
14	9.3	1.1	
15	9.2	1.2	
16	9.1	1.3	
17	9	1.4	
18	9	1.3	
19	9.2	0.2	1st quarter
20	9.5	0.1	
21	10	-0.1	
22	10.6	-0.3	
23	11.1	-0.4	
24	11.6	-0.7	
25	11.8	-1.2	
26	11.9	-1.4	Full moon
27	11.7	-1.5	
28	11.4	-1.3	
29	10.9	-0.9	
30	10.4	-0.4	

Background.

Tides are a result of the pull of the moon and the centrifugal force. At anytime the earth has two bulges on its surface that stay aligned with the moon. As the earth rotates, different places pass through the bulges. When it passes through a bulge, the place experiences high tide and when it passes through areas of no bulge, it experiences low tides.
Most places experience two high tides and two low tides a day, so about every 6 hours there is a new tide.

Over the course of a month the tidal range from day to day varies. The tidal range is the highest high tide minus the lowest low tide. It varies because of the earth sun and moon alignment. Spring tides occur when the sun and moon both pull on the bulges on earth’s surface during full and new moons. Since the high tide is so large it is called a SPRING TIDE because the waters appear to spring upwards. When the sun earth and moon are at right angles to each other (during 1st and 3rd quarter) the tidal range is low and a NEAP TIDE occurs. The tides are also affected by the size, shape and depth of the ocean basin.

Analysis of Data: Answer the following questions—Fill in to complete the sentences:

1. Describe what happens to the high tide line (ie—it increases/decreases until…then")

2. How many peaks are there in your high tide line?_____ Which moon phases do these match? _____ and _____

2. How many dips are there in your high tide line?_____ Which moon phases do these relate to?_____

3. Look at your low tide line. On what day of the month is low tide at its lowest point? Lowest low tide occurs during which moon phase(s)?_____

4. Which day of the month has the largest tidal range (highest high tide and lowest low tide?_____This is when a _____(Spring/neap) tide occurs. What is the tidal range on this day?_____ Feet. _

5. Based on the graph, which moon phase(s) creates the smallest tidal range?_____
Is this a spring or neap tide? _____

Conclusions: answer in your ISN.

1. What is the daily rise and fall of the ocean waters called?

2. On average, how much later are the tides each day than the day before?

3. When are the tides unusually high?

4. During what phases of the moon are the tides unusually low?

5. Who was the first scientist to explain the relationship between the moon and the tides ?

6. According to Newton, what causes the tides?

7. What waters does the moon's gravity pull on strongly?

8. What results from the pull of the moon on the waters nearest the moon?

9. Explain why the tides are constantly changing places on the earth.

10. How often is the sequence of high and low tides repeated in a location?

11. Explain why the sun does not have the same amount of influence on the ocean waters as the moon.

12. What type of tides occur when the sun, moon and earth are lined up in a row ?

13. During what phases of the moon is the tidal range very large?

14. What are spring tides?

15. What happens to the effect of the moon's gravity on the waters during neap tides?