Telling Tides

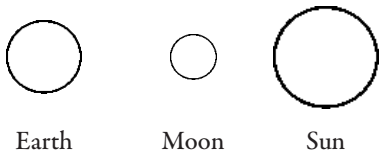
Students will learn to read a tide chart and to determine the day's high and low tide times for a standard reference point as well as the tidal height relative to mean low water. Using this information, they will learn how to correct for differences in tidal times and heights for any other location on the same day.

Background

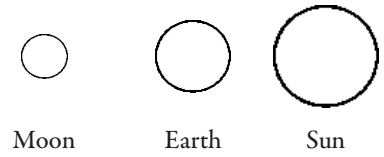
A tide is a special type of wave perceived as the vertical movement of ocean waters. Tides are caused by the gravitational pull of the moon and sun. Although the moon is very small compared with the sun, it is much closer to the earth. As a result, its tidal influence is more than twice that of the sun. These gravitational forces "pile up" water into bulges that move as long waves around the planet, creating in the Chesapeake Bay and in many other locations two high and two low tides every 24 hours and 40 minutes. Such tides are called semi-diurnal tides. Other parts of the earth, such as the Gulf of Mexico, experience diurnal tides—one high and one low every day.

The height of the tides in a given location is not the same every day of the year. As the moon revolves around the planet, the relative positions of the sun, moon and earth change. Twice a month—when the moon is full and when it is new—the moon, sun and earth are in alignment, and their combined gravitational forces create "spring tides" with water levels higher and lower than average. When the moon is in 1/4 and 3/4 phases, the sun and moon are at right angles, and their gravitational forces counteract one another. The results are "neap tides," where the change in water level between high and low tides is the least.

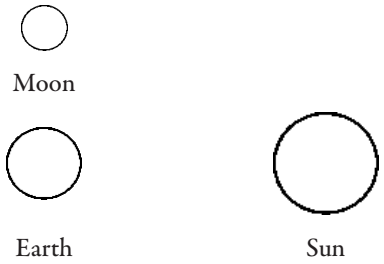
Position during new moon, spring tide:



Position during full moon, spring tide:



Position during a neap tide:



As the water level rises, approaching high tide, the tide is flooding. As the water drops towards low tide, the tide is ebbing. Slack water is the period just before the tide changes when the tidal current movement is minimal. Mean low water is the average height of all low tides measured at a given place over a 19-year period, and mean high water is the average height of all high tides at a given location over the same period of time. Sea level is the mean level halfway between high and low tide, used as a standard in reckoning land elevation or sea depths.

The ability to predict tides is useful to many people—fishermen, boaters, oceanographers, marine biologists, meteorologists—to name a few. For example, meteorologists tracking hurricanes are able to determine the potential

Grade Levels: 6-12

Objectives

Students will investigate tidal patterns by:

- *determining* the times and water heights of low and high tides at a designated reference station for a particular day using a tide chart;
- *calculating* the tidal differences between the reference station and any other location;
- *comparing* the effects of the moon phases on tidal height.

Materials

Per student:

- copy of Tide Graphs (or copies of the excerpts provided)
- pencil, ruler
- worksheet

Where

In the classroom.

When

Whenever it is appropriate prior to making a field trip.

Time Required

At school: Allow about 1 to 1 1/2 hours for the activity.

impact of the hurricane on a shoreline in terms of water level by knowing the phase of the moon and the time of high or low tide.

Procedure

Tide charts are widely published for most locations throughout the bay and its tributaries. Most tide charts list the time for each high and low tide during a span of dates and list the heights of the tides relative to mean low water for the location. Such charts can usually be obtained from tackle shops and marinas near tidal areas. Some agencies (see "Resources") also publish tide charts. These are based on the tides at a given location and have conversion figures to calculate the times and heights of tides at other places in the vicinity. In the bay region, tides are most often listed relative to Sewell's Point in Hampton Roads, Washington, D.C., or Baltimore. Daily tide information can be obtained from many newspapers, from recorded telephone services and from some radio station announcements.

1. Review the background information on tides with the class. Discuss:
   - *Why is it important (useful) to be able to predict the times and heights of tides?*
   - *Whom do you think uses tide charts?*
2. Give each student a copy of the accompanying excerpts of the "Tidal Difference Table" and "Tide Graph Calendar" from *Tide Graphs*. Explain that these are taken from tables used by scientists to predict tides in the Chesapeake Bay.
3. Explain how to interpret the calendar with a similar diagram on the board. Point out:
   - The curved line represents the change in the level of the tide with time. The high points, or crests, represent high tides. The low points, or troughs, represent low tides.
   - The Y-axis represents the tide height above or below mean low water (the zero mark). It is marked off in half-foot increments.
   - The X-axis represents the change in time. It is marked off in one-hour increments up to 24 hours. To convert times after noon to conventional time, subtract 12. Thus 18 would be 6 p.m. Each day is marked with a tall vertical line
   - The second row of numbers below the X-axis gives the tide height for each high tide. A short, vertical line extends from each of these numbers through the X-axis, directly below each crest. This makes it easy to pinpoint the time of the tide.
   - The third row of numbers below the X-axis gives the height for each low tide. A positive number means the tide is above mean low water. A negative number means the tide is below mean low water. Again, a short vertical line extends from the number through the X-axis to facilitate reading the time.
4. Next explain that the tide times and heights differ throughout the bay and review the *"Tidal Difference Table."* Point out:
   - The "place" column represents the exact locations for which the tides can be predicted.
   - The "tidal differences/time" columns list the average difference in time for each location from the tidal time for Sewell's Point in Hampton Roads. Since the average difference is not usually the same for high and low tides, these are listed under the columns marked "HW" and "LW," respectively.
   - Time differences are listed in hours and minutes. A "plus" (+) indicates the tide occurs later than the tide at Hampton Roads and must be added. A "minus" (-) means the tide occurs before the tide at Hampton Roads and must be subtracted.
   - The "tidal differences/height" columns list the average differences in height from the tidal heights for Hampton Roads. Again, the average differences are not usually the same for high and low water, thus these are listed in the "HW" and "LW" columns.
   - To calculate the tide height for a location, subtract the "minus" figures (listed for that location) from, or add the "plus" figures to, the height for Hampton Roads, as determined from the calendar.
5. Give each student several copies of the accompanying *Worksheet*. Complete one with the class using a specific date and location as an example. Use the following steps to complete the worksheet.
   - Enter the date and location at the top with the selected example.
   - Under the "Hampton Roads" column, enter the times and heights for the tides as taken from the calendar for the selected date.
   - Under the "Tidal Differences" column, enter the corresponding figures from the "Tidal Differences Table." Be sure to indicate (+) or (-).

Resources

National Oceanic and Atmospheric Administration websites:
http://www.noaa.gov
http://tidesandcurrents.noaa.gov/map/

Tide Graphs. Virginia Institute of Marine Science, Gloucester Point, VA 23062. http://www.vims.edu/bayinfo/tidecharts/, 804-642-7170. Free.

Tide Log. Chesapeake Tidewater—Graphic Almanac for the Chesapeake Bay area. Printed annually. Pacific Publishers, LLC - P.O. Box 2813 - Tybee Island, GA 31328. http://www.tidelog.com/, 912-472-4373. Approx. $15.95 each, discounted bulk orders.

- Sum the figures (watching the + and - signs) in the "Hampton Roads" and "Tidal Differences" columns to complete the "Corrected Tides" column.

6. Students can then calculate tides for other dates and locations on their own.

Follow-up:

1. Students can use their tide chart reading abilities in conjunction with any of the other site activities by predicting the tides for the specific day and site of their field trip. "Water Motion and Commotion" is an especially appropriate tie-in activity. Use the correct tide charts for the site visited. The specific locations of each site are indicated in the table below, *State Park and Natural Area Preserve Tidal Conversion Figures.*

2. Compare the phases of the moon and the resulting tides for a specific month. Chart the differences in the tidal heights over the month and indicate the occurrence of the spring and neap tides.

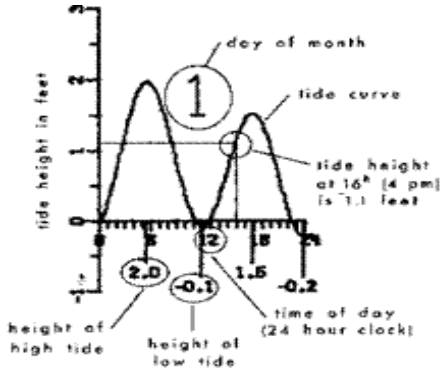
Telling Tides - Worksheet

Tidal Difference Table

Tidal Differences From Sewell's Point, Hampton Roads

	Time (Hrs, Mins)		Height (ft)	
Place	HW	LW	HW	LW
York River				
Tues Marshes Light	-0 09	-0 07	-0.3	0.0
Glouster Point	+0 16	+0 07	-0.1	0.0
Yorktown	+0 07	+0 07	-0.1	0.0
West Point	+2 03	+2 28	+0.3	0.0
James River				
Mulberry Point	+1 56	+2 16	-0.1	0.0
Hog Point	+2 11	+2 28	-0.4	0.0
Janestown Island	+2 54	+3 26	-0.5	0.0
Outer Coast of Virginia, Virginia Beach	-1 30	-1 35	+0.9	0.0
Chesapeake Bay Eastern Shore				
Onancock	+2 52	+3 09	-0.7	0.0
Fisherman's Island	-0 47	-1 00	+0.5	0.0

Tide Graph Calendar



HAMPTON ROADS, Virginia
Feb. 1999

Telling Tides - Worksheet

Name		Date	
		Location	
	#1 Hampton Roads	#2 Tidal Differences (enter + or -)	#3 Corrected Tides (Add #1 to or subtract #2 from)
Time of first high tide:			
Height (ft) of first high tide above mean low water:			
Time of first low tide:			
Height (ft) of first low tide below mean low water:			
Time of second high tide:			
Height (ft) of second high tide above mean low water:			
Time of second low tide:			
Height (ft) of second low tide below mean low water:			

State Park and Natural Area Preserve Tidal Conversion Figures

Park/Natural Area Preserve	Designated Reference Station*	Average Time Difference (Hrs, Mins) from Sewell's Point, Hampton Roads**	
		High Water	**Low Water**
Belle Isle	Bayport	+3 17	+3 46
Bush Mill Stream	Glebe Point	+3 16	+3 22
Chippokes	Scotland (James River)	+2 44	+3 15
False Cape	False Cape	-1 45	-1 45
First Landing			
Ches. Bay Beach	Cape Henry	-0 52	-1 15
Broad Bay	Lynnhaven Inlet	-0 13	+0 01
York River	Allmondsville (York River)	+0 55	+0 57
Hughlett Point	Dividing Creek	+2 38	+2 36
Kiptopeke	Kiptopeke Beach	-0 39	-0 30

Park/Natural Area Preserve	Designated Reference Station*	Average Time Difference (Hrs, Mins) from Washington, DC**	
		High Water	**Low Water**
Caledon	Riverside, MD (Potomac River)	-3 35	-4 19
Leesylvania	Quantico Creek, VA (Potomac)	-1 04	-1 59
Mason Neck	High Point, Occoquan Bay, VA (Potomac)	-1 02	-1 28
Westmoreland	Colonial Beach, VA (Potomac)	-5 27	-6 12

* Nearest landmark with published tides on which conversion figures are based; actual times of tides at sites may be slightly different.

** Hampton Roads times from *Tide Graphs*; Washington, DC, times from *TideLogs*. Slight discrepancies may exist between the references.

Standards of Learning: Sols: Science 4.6, 5.6, 6.1, 6.2; ES.1, ES.2, ES.10; PS1, PS.9; Mathematics 7.12, 7.13, 8.13, 8.14

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