Tides

Strand		Interrelationships in Earth/Space Systems
Topic		Investigating the relationship between the gravitational pull of the moon and the cycle of tides
Primary SOL	6.8	The student will investigate and understand the organization of the solar system and the interactions among the various bodies that comprise it. Key concepts include h) the cause of tides.
Related SOL	6.1	The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which h) data are analyzed and communicated through graphical representation.

Background Information

A tide is a special type of wave that is perceived as the vertical movement of ocean waters. Tides are caused by the gravitational pull of the moon and sun on the Earth. Although the moon is very small compared to the sun, it is much closer to Earth. As a result, its influence on ocean tides is more than twice that of the sun. These gravitational forces "pile up" water into bulges, which move as long waves, called *tides,* around Earth. The heights of the tides in a given location are not the same every day of the year; indeed, they vary throughout each month. As the moon revolves around Earth, the relative positions of the sun, moon, and Earth change, and the way they are aligned directly affects the heights of the tides.

The ability to predict tides is useful to many people—e.g., fishermen, boaters, oceanographers, marine biologist, meteorologists, vacationers. For example, meteorologists tracking hurricanes are able to gauge the potential impact of a hurricane on a shoreline in terms of water level by knowing the phase of the moon at the time of the storm and the resulting times of high tide and low tide.

Tide charts are widely published for most locations throughout the Chesapeake Bay and its tributaries. Most tide charts list (1) the time for each high and low tide during a span of dates and (2) 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 also publish tide charts based on the tides at a given location and showing 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 Hampton Roads (Sewell's Point), Washington, D.C., or Baltimore. Daily tide information can be obtained from many newspapers, from recorded telephone services, from some radio stations, and from the Internet.

Materials

- Copies of the attached handouts
- Rulers

Vocabulary

crests, diurnal tide, ebb tide, flood tide, mean high water, mean low water, neap tide, sea level, semidiurnal tide, slack water, spring tide, troughs

Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

Introduction

1. Review with the class the information on tides found above under Background Information. Lead a discussion based on the students' responses to the following questions: "Why is it important to be able to predict the times and heights of tides? Who do you think uses tide charts?"

Procedure

1. Give each student a copy of the attached Tide Calendar and the Tidal Differences Table. Explain that these are excerpts taken from tables used by scientists to predict tides in the Chesapeake Bay. Explain how to interpret the calendar, displaying a similar diagram. Point out the following:
   - The curved line represents the change in the level of the tide with time. The highpoints, or *crests*, represent high tides, while 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 12:00 noon to conventional time, subtract 12: thus 18 would be 6:00 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, while 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.
2. Explain that the tide times and heights differ throughout the Bay, and review the Tidal Difference Table, pointing out the following:
   - The "PLACE" column represents the exact locations for which the tides are predicted.
   - The "TIDAL DIFFERENCES, Time" columns list the average differences in time (in hours and minutes) at each location from the tidal times at Sewell's Point in Hampton Roads. Since the average differences are not usually the same for high and low tides, these are listed under the columns marked "HW" and "LW," respectively. A plus sign indicates that the tide occurs *after* the tide at Hampton Roads and the time difference must be added. A minus sign means the tide occurs *before* the tide at Hampton Roads and the time difference must be subtracted.
   - The "TIDAL DIFFERENCES, Height" columns list the average differences in height (in feet) at each location from the tidal heights at Sewell's Point. Again, since the average differences are not usually the same for high and low tides, these are listed under the columns marked "HW" and "LW," respectively. A plus sign indicates the tide is higher

that that at Hampton Roads and the height difference must be added. A minus sign means the tide is lower than that at Hampton Roads and the height difference must be subtracted.

3. Give each student several copies of the Telling Tides Worksheet. Complete one with the class as an example, using a specific date and location and the steps listed.
4. Have students use the worksheet and other handouts to calculate tides for other dates and locations on their own.

Assessment

- **Questions**
  - What causes the tides?
- **Journal/Writing Prompts**
  - Explain why it is important to predict tides.
- **Other**
  - Assess the completed Telling Tides Worksheet.

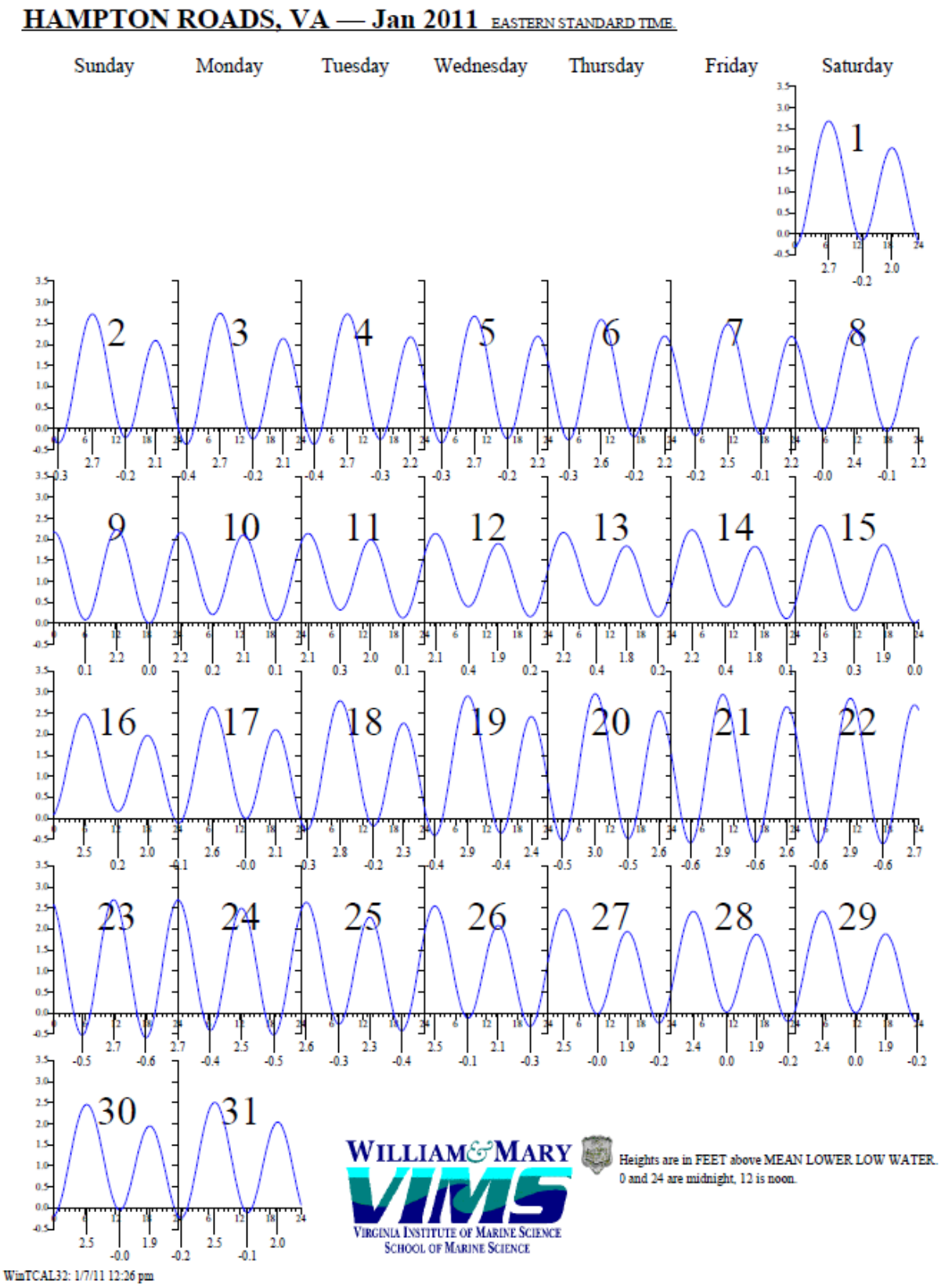
Extensions and Connections (for all students)

- Have students create a model of the Earth, sun, and moon to demonstrate how the sun and moon cause the tides.

Strategies for Differentiation

- Have each students create a tide cube featuring each of the six types of tides, including the term, a picture, and a written description of each.
- Place students in heterogeneous groups to compare the daily moon phase to high or low tides.
- Form cooperative student groups, and assign each group a tidal location. Have students in each group work together to research and record daily tides on dry erase graph boards over the period of a week or a month. The, have each group write a summary of what the daily recordings appear to indicate over the time period. Oral presentations are a good option.
- Have students create picture dictionaries of the different types of tides.
- Provide students with picture examples of words from the vocabulary list to identify, sort, and label.
- If possible, take students to a local beach to investigate tides. Watching the tide change is instructive.
- Invite a local meteorologist to discuss moon cycles and tides.
- Have small groups or pairs of students pull the tied end of a teacher-prepared water balloon to represent the gravitational pull of the moon on the Earth. Have them discuss what is happening to the water in the balloon as the moon is pulling. *(The balloon elongates in one direction and flattens in another.)* Make sure that students can relate this conclusion to the content of the lesson.

Tide Calendar



Tidal Differences Table

PLACE	TIDAL DIFFERENCES			
	Time (hrs.:mins.)		Height (ft.)	
	HW	LW	HW	LW
York River				
Tues Marshes Light	−0:09	−0:07	−0.3	0.0
Gloucester Point	+0:16	+0:07	−0.1	0.0
Yorktown	+0:07	+0:01	−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
Jamestown 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

Telling Tides

Name: _____ **Date:** _____ **Class:** _____

Procedure

1. In the table below, enter the date and location of the tides.
2. In the "Hampton Roads" column, enter the times and heights of the tides for the selected date, as found on the Tide Calendar.
3. In the "Tidal Differences" column, enter the corresponding figures from the Tidal Differences Table. Be sure to indicate + or −.
4. Sum the figures in the "Hampton Roads" and "Tidal Difference" columns to complete the "Corrected Tides" column. Either add #1 and #2, or subtract #2 from #1. Be careful with the + and − signs!

Date: **Location:**			
	#1 **Hampton Roads**	**#2** **Tidal Difference**	**#3** **Corrected Tides**
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			