

CLASSROOM ACTIVITY

THE MOON'S RELATION TO OCEAN TIDES

Overview Middle School and High School Level

This activity is designed to show students the relationship between ocean tides and the lunar movements. It uses the tide charts for Boston Harbor to show these relationships. It has been used with both middle school and high school students with success.

Time Frame

The activity can be completed in two class periods, with time allowed out of class for each student to complete his/her tide chart plotting.

Objectives

1. Students will learn the effect the moon has on tidal ranges.
2. Students will plot high and low tides for an area as well as the lunar phases using actual tidal data for a one-week period.
3. Students will learn that extremely high and low tides are related to very specific times of the month..

Education Standards Reference

National Science Education Standards

Grades 5-8:

- Content Standard A Science as Inquiry Standards:
 - Abilities necessary to do scientific inquiry
 - Understanding about scientific inquiry
- Content Standard B Physical Science Standards:
 - Motion and forces
 - Transfer of energy
- Content Standard D Earth and Space Science Standards:
 - Structure of the earth system

Grades 9-12

- Content Standard A Science as Inquiry Standards:
 - Abilities necessary to do scientific inquiry
 - Understanding about scientific inquiry
- Content Standard B Physical Science Standards:
 - Motion and forces
- Content Standard D Earth and Space Science Standards:
 - Energy in the earth system
- Content Standard F Science in Personal and Social Perspectives Standards:
 - Environmental quality
 - Natural hazards

National Geography Standards:

- How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information
- The physical processes that shape the patterns of Earth's surface
- How physical systems affect human systems

(MA Science Frameworks 2001 Revision)

Grades 6-8 Earth and Space Science

Describe lunar and solar eclipses, the observed moon phases, and *tides*. Relate them to the relative positions of the earth, moon, and sun.

Explain the effect of these eclipses and moon phases on tides

Links across the curriculum

- Graphing - math
- Interpretation of data - math

Materials

- Tide plotting chart and one week's tide data (different week for each student)
- Copy of tide plotting chart for each student
- Blue and red markers, pencils or crayons
- Peelable labels for each student to draw lunar phase
- Yellow marker, or crayon for lunar phase fill in
- One set of tidal readings for Boston Harbor for 2004. A partial set has been supplied.

(If you would like the complete set of these tides for the 2004 or 2005 year for Boston Harbor, you can find them at the Massachusetts Marine Educators Web site, click on curriculum where the 2004 and 2005 tides and the plotting chart in pdf format are posted. The url is <http://www.massmarineeducators.org/curriculum/tides.shtml>. A full year tide chart allows each student to plot a different week, and they may be assembled on a wall to see the cyclical pattern that is produced).

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Instructions for Activity

Tide charts should be duplicated and then cut so that each student has the information for a single week to plot. The data supplied is for Boston Harbor which may be used if you have no other source of data.

Begin by explaining how to read the chart and how to interpret where time and height are on the plotting sheet. Give to each student a week of data. (It is best to go up and down rows when passing these out so the students have data close to theirs to check at a later time) On receipt of the plotting sheet and tide data, students fill in the month, year and dates at the top of the sheet. Students are asked to plot tide points on the sheet. Try to check at least a few points on each student's paper before the end of class. The assignment is finished at home. **ALL INITIAL plotting should be done in pencil to allow for corrections to be made.**

After the tides are plotted, students connect the points for high and the points for low tide and then ink in the line. Students should be cautioned not to extend their black line to the edge of the chart from the last point they have on each side until they are in class the next day. At that time, students are asked to fold the right side of the chart to the black edge line. Students match their chart with the chart for the week prior to and the week after their chart (data found on other students sheets). Students then connect their final points on each side with the other charts and finish their data and coloring. Directions for coloring the charts are found at the bottom of the plotting chart. Before students pass in the charts, they are told to trim their data table and attach it at the bottom of the page with a piece of scotch tape, allowing it to hang over the bottom of the paper.

Students should determine the tidal range for each day, by subtracting the lowest of the low tides for each day from the highest of the high tides for the day. This figure is now placed in the blank box on the chart between the 5 and 6-foot tide levels.

After all the sheets are collected, (STRESS THAT EACH STUDENT MUST COMPLETE THE ASSIGNED WEEK OR THE CLASS WILL HAVE AN INCOMPLETE RECORD OF THE TIDES FOR THE TIME PERIOD BEING CHARTED, AND A COLORED BLANK PIECE OF PAPER WILL BE POSTED FOR MISSING DATA) check the charts for accuracy, and then use a paper cutter to remove the

right side margin from each chart. The charts are now posted on the bulletin board in date order to develop a continuous tide chart. Students now can see that a very definite cyclical pattern develops over several weeks or months.

The class now traces a dime on the yellow paper to cut out the phases of the moon and attach them over the correct day on their chart. Lunar phases are pasted in the time block at the top of the day the phase occurs on. A dime as a template assures uniform sizes. Use the following for phases:

- New moon - full circle shaded gray
- First quarter - half circle with opening to the right
- Full moon - full yellow circle
- Last quarter - half circle with opening to the right

When this work is completed ask students to answer the questions on their activity sheet. After they have finished the questions, a class discussion can be held discuss their answers and the reasons for the cyclical pattern for the tides, what relationship they see with lunar phases, and why some months will show the tidal ranges quite large compared to other months. The results can be used to discuss the moon and its tidal relationship, as well as the fact that the orbits of the earth and moon are not circular, resulting in the distance between the earth and moon being different from month to month. This distance change daily and monthly changes the gravity exerted by the moon on the earth and its oceans.

Extensions

As an extension have several students (at least 6) or another class research another location along the coastal US, whether the Atlantic, Gulf or Pacific region locate the tide charts for another station covering the same time as the original activity. Information below will locate over 3000 stations, which have this data. The class might decide on a specific region, then find a point in that region to get data. When the date for the second station is plotted, place these sheets on the bulletin board above the same dates as the original set your classes have completed. Now look for similarities and differences between the two sets of data.

Additional Resources

The two url's below give you information for over 3000 coastal points in the United States for which tidal data is available. Click on a state either the name or from the map. Now locate the coastal point you want to use and click on predictions to get data for a year.

<http://co-ops.nos.noaa.gov/tides04/>

Tides for 2004

<http://co-ops.nos.noaa.gov/tides05/>

Tides for 2005

These charts do not give you the lunar data for the month. This url will give you this information. Click on the month and year, then hit the submit button,

<http://co-ops.nos.noaa.gov/astromical.shtml>

Astronomical Phases 1997-2005

Using these NOAA sites, you can produce a tide chart for any of these coastal locations.

Assessment suggestions

A good assessment tool is to take part of a tide chart (two or three days and the data for two or three days (not those already plotted) and have the students plot them. Add several questions to assess students understanding of the lunar-tide relationship for students to answer.

Credits

Jack Crowley, Executive Director of the Massachusetts Marine Educators Association, first devised this activity while a marine science teacher at Hingham MA High School. It has been modified to a standards based activity.

5. Can you see any relationships between the pages and the moon's phases? At what point in the month is the tidal range the greatest? What lunar phase is closest to this time of the month? Where do you think the moon is at this time?

6. At what point in the month is the tidal range the smallest? What lunar phase is near this point? Where do you think the moon is relative to the earth at this time?

7. Why is solar gravity only a secondary source of tidal range when the sun is so much larger than the moon?

If your teacher has had two sets of data plotted, then use this data to answer the following questions

8. Are the tidal ranges for the two cities the same? Propose a theory to explain your answer.

9. Do the high and low tides occur at the same time at each location? Explain your answer.