# Tides of Time

**Grade Level**

6th-12th

**Objectives**

* To become familiar with the processes that shape tidal rhythms.

* To be able to read tidal charts.

* To apply knowledge of the tide tables to preparing a tidal graph.

**N.C. Standard Course of Study**

Grade 6
(1.05, 1.06, 5.03)

Grade 8
(1.05, 1.06)

Earth/ Environmental Science
(1.02)

**Overview:**

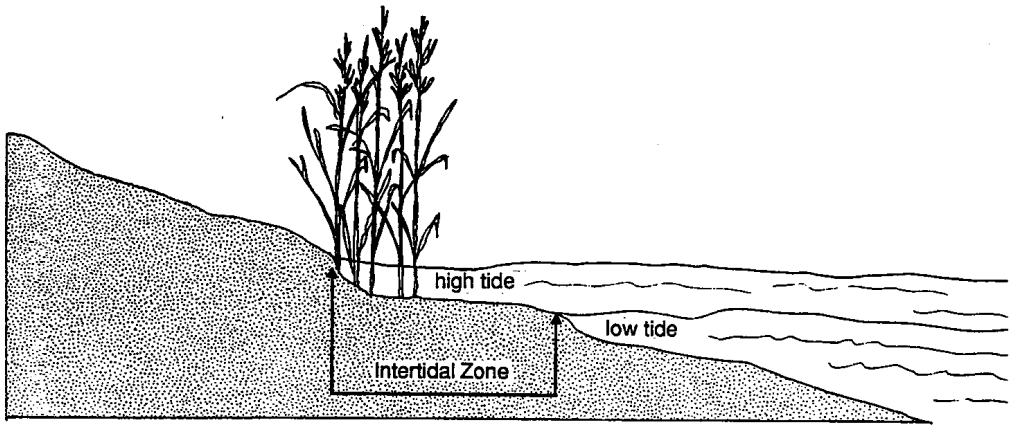
In this activity students will learn the different processes that shape tidal rhythms. They will also learn how to read tidal charts and graph tidal information.

**Materials:**

- Tide charts
- worksheet (included)

**Background:**

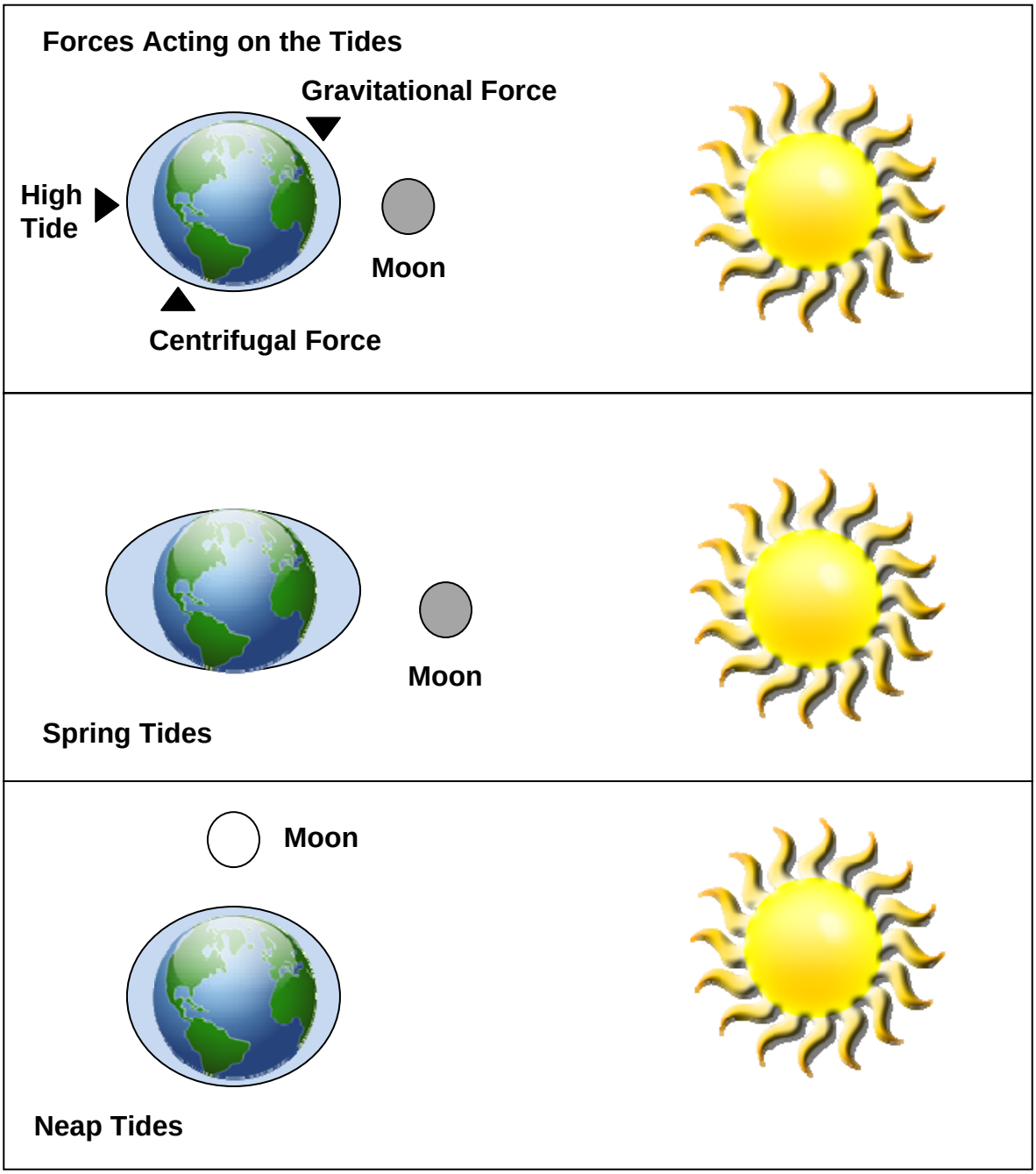
Fiddler crabs disappear from the surface of the mud flat as the high tide rolls in. They escape down into their burrows, plugging the hole as they go. The fiddler crab, like most of the plants and animals in the estuary, must adapt to the rapid changes brought on by the ebb and flow of the tides. North Carolina coasts may experience changes in tide levels of as much as 6 feet. The land area on the beach or sound between the height of the high tide and the point of the low tide is known as the intertidal zone.




North Carolina ocean beaches experience two high tides and two low tides about every 24 hours and 50 minutes (a lunar day). Tides result as a response to the centrifugal force created by the turning of the earth and the gravitational attraction of the sun and moon on the oceans. The water that covers the surface of the earth is pulled as the moon travels around the earth and as the earth rotates around the sun. The centrifugal force created by the rotation of the earth creates a bulge of water on the opposite side of the earth from the sun. Remember centrifugal force is the force that tends to impel an object outward from a center of rotation; an example would be water spinning off the tire of a bicycle.

Two high and low tides occur each day - the high tide occurs as the water bulges in response to the centrifugal and gravitational forces and the low tides occur as the earth rotates away from the gravitational influence of the moon. This pattern of two high and low tides each day is know as semidiurnal (semi = half, diurnal = day).

The greatest tidal change occurs when the gravitational effects of the sun and moon combine their influences on our oceans.  These tides, known as spring tides, occur when the moon, earth and sun are aligned. Spring low tides expose a much wider intertidal zone, which is useful to know when observing animals. The smallest tide occurs when the moon and the sun are at right angles to the earth and the gravitational pulls on the earth are minimized. These small tides are known as neap tides.



**Activity:**

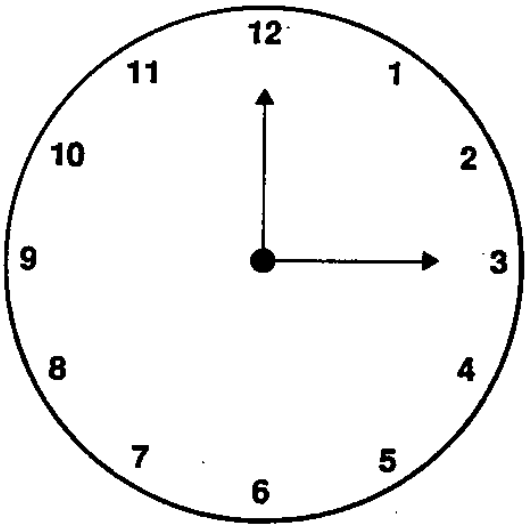
**Part I: Tide Charts**

Tide charts are useful to those who live by or visit the sea. Using the tide table, you can plan your visit to the marsh or mudflat at a time when the tides are at the lowest and many intertidal organisms are exposed.

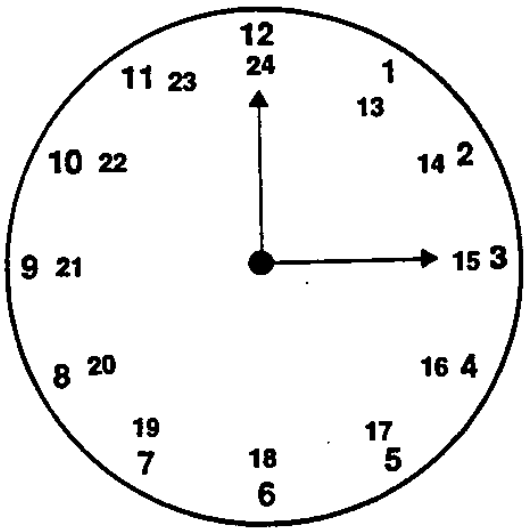
Examine the September tide chart constructed for Wilmington, North Carolina. Across the top of the table, time and height are labeled. Time refers to the hour and the minute of the high and low tides for that day.

Tide charts are often listed according to a 24-hour clock. The 24-hour clock allows a navigator to easily convert time to Greenwich Mean Time or Universal Time and avoid confusion by not having to denote a.m. or p.m. The hours from 1 a.m. to 12 p.m. are the same on the 12 and 24-hour clock. A 24-hour tide time of 0321 means 3:21 a.m.

**What is 1154 on a 12-hour clock?**




**12 Hour Clock**




**24 Hour Clock**

After 12 noon, the hours of the 24-hour clock continue to add up rather than repeating themselves. One in the afternoon is 1300, (12 hours plus 1 hour); 5:10 in the afternoon would be 1710. The first two numbers of a tide chart time represent the hour and the next two numbers represent the minutes.

Complete the chart by filling in the blank spaces.

| **Time**<br>12 hour clock | **Time**<br>24 hour clock |
|---|---|
| A) 3:15 a.m. | _____ |
| B) 9:45 p.m. | _____ |
| C) 11:54 a.m. | _____ |
| D) _____ | 0200 |
| E) 12:00 noon | _____ |
| F) _____ | 2400 |
| G) _____ | 1733 |
| H) _____ | 0508 |
| I) 1:00 p.m. | _____ |
| J) _____ | 1223 |

*The tide charts are arranged by date of month and day of the week.*

**Tide Chart for Wilmington, N.C. - September**

| **Day** | **Time** | **Height feet** | **Meters** |
|---|---|---|---|
| 8 | 0647 | -0.1 | -0.02 |
| Th | 1207 | 5.2 | 1.60 |
| | 1918 | 0.1 | 0.02 |

The times represent the first low tide, the first high tide, the second low tide, and the second high tide (remember there are usually two low tides and two high tides each day). The change in height of the tides is given in feet (the second column) and in meters (the third column). The height given represents the tide change above or below mean low water, which is recorded as 0.0.

The first low tide Thursday, September 8 would occur at 6:47 a.m., and would be 0.1 foot or 0.02 meters below average. The same day, the first high tide would occur at 12:07 p.m. and would be 5.2 feet above mean low water. At 1918 (7:18 p.m.), the tide would be 0.1 foot below the average low tide reading for that location.

Would this be a high tide or low tide?

**Wilmington NC Tide Chart for September**

| *Day* | *Time* | *Height feet* | *Height Meters* |
|---|---|---|---|
| 1 Th | 0114 | 0.7 | 0.20 |
| | 0651 | 3.9 | 1.20 |
| | 1312 | 0.3 | 0.08 |
| | 1909 | 4.5 | 1.36 |
| 2 F | 0208 | 1.5 | 0.16 |
| | 0741 | 4.1 | 1.25 |
| | 1409 | 0.3 | 0.05 |
| | 1957 | 4.6 | 1.42 |
| 3 Sa | 0258 | 0.4 | 0.11 |
| | 0827 | 4.3 | 1.32 |
| | 1503 | 0.1 | 0.02 |
| | 2041 | 4.8 | 1.47 |
| 4 Su | 0346 | 0.2 | 0.06 |
| | 0911 | 4.6 | 1.39 |
| | 1555 | 0.0 | -0.01 |
| | 2123 | 5.0 | 1.52 |
| 5 M | 0432 | 0.1 | 0.03 |
| | 0954 | 4.8 | 1.47 |
| | 1646 | -0.1 | -0.02 |
| | 2205 | 5.1 | 1.55 |
| 6 Tu | 0516 | 0.0 | 0.00 |
| | 1036 | 5.0 | 1.53 |
| | 1736 | -0.1 | -0.02 |
| | 2247 | 5.1 | 1.56 |
| 7 W | 0601 | -0.1 | -0.02 |
| | 1120 | 5.2 | 1.58 |
| | 1826 | 0.0 | -0.01 |
| | 2332 | 5.1 | 1.55 |
| 8 Th | 0647 | -0.1 | -0.02 |
| | 1207 | 5.2 | 1.60 |
| | 1918 | 0.1 | 0.02 |
| 9 F | 0020 | 4.9 | 1.51 |
| | 0734 | 0.0 | -0.01 |
| | 1258 | 5.2 | 1.59 |
| | 2011 | 0.2 | 0.06 |
| 10 Sa | 0113 | 4.7 | 1.44 |
| | 0834 | 0.0 | 0.00 |
| | 1357 | 5.1 | 1.55 |
| | 2107 | 0.3 | 0.10 |

| Day | Time | Height feet | Height Meters |
|---|---|---|---|
| 11 Su | 0213 | 4.5 | 1.37 |
| | 0917 | 0.1 | 0.03 |
| | 1502 | 5.0 | 1.51 |
| | 2205 | 0.4 | 0.13 |
| 12 M | 0320 | 4.3 | 1.31 |
| | 1015 | 0.2 | 0.05 |
| | 1610 | 4.8 | 1.47 |
| | 2306 | 0.5 | 0.14 |
| 13 Tu | 0429 | 4.2 | 1.27 |
| | 1116 | 0.2 | 0.06 |
| | 1715 | 4.8 | 1.45 |
| 14 W | 0007 | 0.4 | 0.12 |
| | 0634 | 4.1 | 1.26 |
| | 1218 | 0.2 | 0.05 |
| | 1816 | 4.7 | 1.44 |
| 15 Th | 0105 | 0.3 | 0.09 |
| | 0635 | 4.2 | 1.29 |
| | 1318 | 0.1 | 0.04 |
| | 1913 | 4.7 | 1.45 |
| 16 F | 0200 | 0.2 | 0.06 |
| | 0731 | 4.4 | 1.33 |
| | 1416 | 0.0 | 0.01 |
| | 2005 | 4.8 | 1.46 |
| 17 Sa | 0251 | 0.1 | 0.02 |
| | 0823 | 4.5 | 1.37 |
| | 1509 | 0.0 | 0.00 |
| | 2054 | 4.8 | 1.46 |
| 18 Su | 0338 | 0.0 | 0.01 |
| | 0912 | 4.6 | 1.42 |
| | 1558 | 0.0 | 0.00 |
| | 2140 | 4.8 | 1.47 |
| 19 M | 0422 | 0.0 | 0.01 |
| | 0958 | 4.8 | 1.45 |
| | 1645 | 0.1 | 0.02 |
| | 2223 | 4.8 | 1.46 |
| 20 Tu | 0503 | 0.1 | 0.02 |
| | 1042 | 4.8 | 1.46 |
| | 1729 | 0.2 | 0.06 |
| | 2305 | 4.7 | 1.43 |

| Day | Time | Height feet | Height Meters |
|---|---|---|---|
| 21 W | 0542 | 0.2 | 0.05 |
| | 1122 | 4.8 | 1.46 |
| | 1811 | 0.4 | 0.11 |
| | 2345 | 4.6 | 1.40 |
| 22 Th | 0619 | 0.2 | 0.08 |
| | 1200 | 4.7 | 1.44 |
| | 1852 | 0.5 | 0.16 |
| 23 F | 0024 | 4.5 | 1.36 |
| | 0656 | 0.3 | 0.10 |
| | 1235 | 4.7 | 1.42 |
| | 1933 | 0.7 | 0.21 |
| 24 Sa | 0101 | 4.3 | 1.31 |
| | 0732 | 0.4 | 0.12 |
| | 1306 | 4.6 | 1.39 |
| | 2015 | 0.8 | 0.24 |
| 25 Su | 0140 | 4.1 | 1.26 |
| | 0810 | 0.4 | 0.14 |
| | 1338 | 4.5 | 1.36 |
| | 2100 | 0.9 | 0.27 |
| 26 M | 0222 | 4.0 | 1.22 |
| | 0851 | 0.5 | 0.15 |
| | 1418 | 4.4 | 1.34 |
| | 2149 | 0.9 | 0.28 |
| 27 Tu | 0312 | 3.9 | 1.18 |
| | 0939 | 0.5 | 0.15 |
| | 1510 | 4.3 | 1.32 |
| | 2242 | 0.9 | 0.28 |
| 28 W | 0411 | 3.8 | 1.17 |
| | 1035 | 0.5 | 0.15 |
| | 1613 | 4.3 | 1.32 |
| | 2338 | 0.8 | 0.28 |
| 29 Th | 0511 | 3.9 | 1.19 |
| | 1136 | 0.5 | 0.14 |
| | 1719 | 4.4 | 1.33 |
| 30 F | 0034 | 0.7 | 0.21 |
| | 0608 | 4.1 | 1.24 |
| | 1239 | 0.4 | 0.12 |
| | 1819 | 4.5 | 1.37 |

**Questions:**

Use the tide table to answer the following questions.

1. What is the difference, in meters, between mean low water and the second low tide on Saturday, September 24?

2. On Monday, September 12, you want to walk on the beach to hunt for seashells when the tide is at its lowest. When would you go on your walk?

3. The two low tides will occur on September 7 at _____ and _____.

4. The highest tide on September 7 will occur at

   _____ (time) and will be a change of _____ feet from the last low tide.

5. On September 15th, the change between the highest high tide and the lowest low tide is

   _____ feet.

6. Someone told you that a spring tide may occur during the first week in September but you don't remember the exact day. Looking at the tide table, predict the day the spring tide is most likely to occur.

7. How much time passed between the first high tide on Thursday, September 15 and the first low tide?

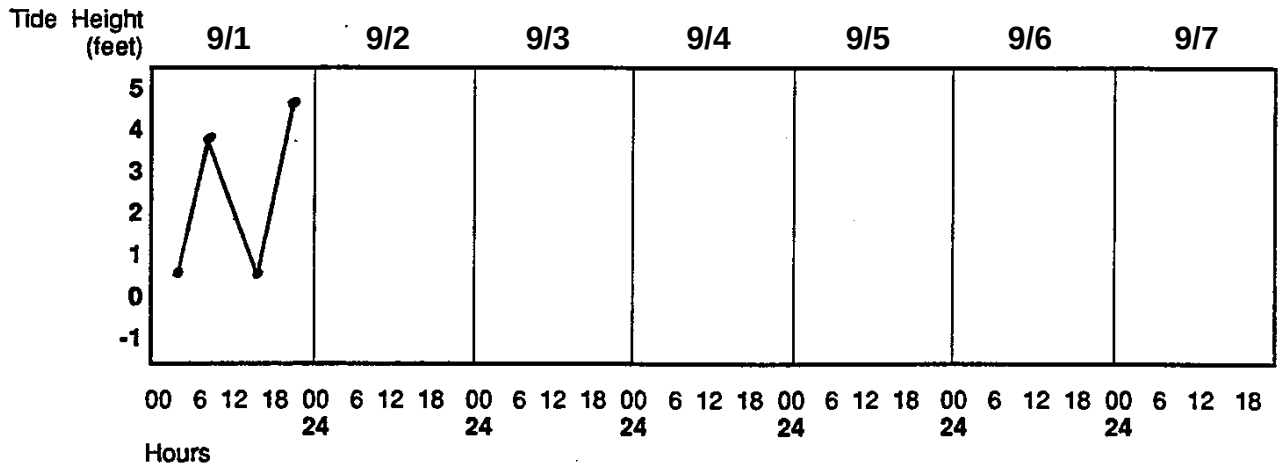
8. List three reasons why people need to know when high and low tides occur:

**Part II: Graphing tides**

Now that you know how to read a tide table, apply your knowledge to complete the graph below. The tide graph includes a block for each day to be charted. On the vertical axis you will need to find the height of the first tide. The horizontal axis is divided into four times that correspond to a 24 hour clock: 00 (midnight), 6 a.m., 12 noon, 18 (6 p.m.), and back to midnight. Using the tide table, estimate the location for time on the horizontal axis and then go up the vertical axis until you find the height. Place a dot on the graph for the height that corresponds to the time on the first tide. For example: on September 1, the first tide occurs at 1:14 and is a height of 0.7 feet. Your graph would look like the one below.

* Note: You have to estimate the horizontal point that corresponds to 1:14 a.m.

Continue to graph the tide times for September 2-7. After you have placed a dot for each tide time for the week, connect the dots with straight lines and answer the questions.




**Questions:**

1. How many low tides occurred each day?
2. How many hours separate the first high and low tide on September 4?
3. Is the pattern of tides the same each day? Explain.
4. Do the high tides occur at the same time each day?
5. Suggest an explanation for your answer to question 4.
6. Are the high tides the same each day?

**Extension:**

**1.** Look up local tide charts (www.tidesonline.com is one resource) for a local beach that coordinates with a surf or web cam that allows you to see the beach area. Watch the web cam for a couple of days at different time intervals to see how the water level on the beach changes.

**2.** Visit a local beach or sound for a field trip. Get tide charts ahead of time and study the area and note the tide. If possible time your visit so that you go at low tide. Make observations of where the high tide mark is and the different things that you can see at

low tide that are covered by water at high tide. Measure the distance between low tide and high tide (horizontally).

3. Visit a local beach or sound at low tide for a field trip and conduct a beach profile. Working in teams, students conduct a topographic survey (beach profile) using a pair of Emery rods (profile poles), a metric tape, and a sight level to accurately survey a shore from the fore dunes to the water line.

**Vocabulary:**

- centrifugal force
- intertidal zone
- lunar day
- neap tide
- semidiurnal
- spring tide

**References:**

Pilkey, O.H., T.M. Rice and W.J. Neal. 2004. How to Read a North Carolina Beach: Bubble Holes, Barking Sands, and Rippled Runnels. The University of North Carolina Press, Chapel Hill, NC. 162 pgs. (ISBN: 0-8078-5510-3)

**National Science Standards:**

*Content Standards* *Unifying concepts and processes. [5-8] [9-12]*

*Science as inquiry. [5-8] [9-12]*

*Earth and space science. [5-8] [9-12]*

**Ocean Literacy Principles:**

*Essential Principle #1.* *The Earth has one big ocean with many features. (Fundamental Concepts – c, d)*

The North Carolina National Estuarine Research Reserve is a cooperative program between the North Carolina Department of Environment and Natural Resources, Division of Coastal Management and the National Oceanic and Atmospheric Administration.

200 copies of this document were printed at a cost of $ or $. per copy.
Printed on recycled paper.
Publication date: March 2008

*Teachers page:*

1. What is the difference, in meters, between mean low water and the second low tide on Saturday, September 24?
   *0.24 meters*

2. On Monday, September 12, you want to walk on the beach to hunt for seashells when the tide is at its lowest. When would you go on your walk?
   *10:15a.m.*

3. The two low tides will occur on September 7 at _*6:01a.m.*____ and ___*6:26p.m.*____.

4. The highest tide on September 7 will occur at

   __*11:20a.m.*___ (time) and will be a change of _*5.3*____ feet from the last low tide.

5. On September 15th, the change between the highest high tide and the lowest low tide is ___*4.6*____ feet.

6. Someone told you that a spring tide may occur during the first week in September but you don't remember the exact day. Looking at the tide table, predict the day the spring tide is most likely to occur.
   *September 7th*

7. How much time passed between the first high tide on Thursday, September 15 and the first low tide?
   *5 hours and 30 minutes*

8. List three reasons why people need to know when high and low tides occur:
   *Navigation, boating, harvesting shellfish, fishing are some examples.*

*Part II Questions:*

1. How many low tides occurred each day? *2*

2. How many hours separate the first high and low tide on September 4?
   *5 hours and 35 minutes*

3. Is the pattern of tides the same each day? Explain.
   *It is similar by not exactly the same.*

4. Do the high tides occur at the same time each day? *No*

5. Suggest an explanation for your answer to question 4.
   *The tides follow a lunar day which is longer than a solar day.*

6. Are the high tides the same each day? *No*