

# The Pilgrim Tides

Geology

February/March, 2010

Mr. Traeger

Name: \_\_\_\_\_

Period: \_\_\_\_\_

Date: \_\_\_\_\_

## Background and Purpose

Most of us have heard the story of the Pilgrims' exodus from England to the New World in the year 1620. The Pilgrims anchored the *Mayflower* at the site of Provincetown (Cape Cod), Massachusetts for almost a month before settling at Plymouth Harbor. Imagine that you are the ship's captain of the *Mayflower II* and you need to know the tidal fluctuations at Provincetown in order to keep the ship from running aground while at anchor. You will use the tide chart given to you to estimate/graph the tidal fluctuations for March 2010 arrival at Provincetown. In doing so, you will become familiar with the differences in tidal ranges during each phase of the moon.

## Materials

- Tide chart
- Ruler
- Graph Paper on Back
- Pencil

## Procedure

1. Using a sheet of graph paper, divide the paper lengthwise into 4 separate sections.
2. Plot time of day on the *x*-axis and water level in feet on the *y*-axis for the dates corresponding to the third quarter, new moon, first quarter, and full moon. Be careful to scale your graph correctly and to account for negative tides, which are below mean sea level. The origin for the time axis should be 12:00 A.M. for each graph.
3. Once you have plotted your points, connect the points with a smooth curve. Make sure to label your graphs with a title and units on each axis.
4. Answer the questions that follow concerning your 4 graphs.

## Pre Graphing Questions (Refer to pages 541-543 in your text to do these)

1. Draw the orientation of the Earth, Sun, and Moon for **Spring** tides. Also make sure to draw the tidal bulge of the ocean. See page 542.
  
2. Draw the orientation of the Earth, Sun, and Moon for **Neap** tides. Also make sure to draw the tidal bulge of the ocean. See page 542.
  
3. How many high tides and how many low tides are there (usually) per day? Why is this? Drawing a diagram of how the Earth rotates underneath the tidal bulge would be helpful.

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[◀ back to the Tides Index](#)

[◀ Cape Cod Tides](#)

## Provincetown Cape Cod Bay



Provincetown Cape Cod Bay, Massachusetts

Data obtained from <http://www.boatma.com/tides/>

## February/March Tide Chart

2010

### February, 2010 Tides

DAY	DATE	HIGH				LOW				☀		☾
		AM	hgt	PM	hgt	AM	hgt	PM	hgt	rise	set	moon
Saturday	13	11:02	9.4	11:30	8.6	4:47	0.8	5:19	0.2	6:39	5:10	
Sunday	14	11:39	9.5			5:26	0.6	5:54	0.1	6:38	5:12	🌑
Monday	15	12:04	8.8	12:16	9.4	6:05	0.4	6:28	0.1	6:36	5:13	
Tuesday	16	12:38	9.0	12:52	9.3	6:43	0.3	7:03	0.2	6:35	5:14	
Wednesday	17	1:12	9.1	1:29	9.1	7:22	0.3	7:40	0.3	6:34	5:15	
Thursday	18	1:47	9.2	2:08	8.8	8:01	0.4	8:17	0.5	6:32	5:17	
Friday	19	2:25	9.2	2:50	8.5	8:44	0.5	8:59	0.8	6:31	5:18	
Saturday	20	3:07	9.1	3:37	8.2	9:31	0.6	9:44	1.0	6:29	5:19	
Sunday	21	3:54	9.1	4:29	8.0	10:23	0.7	10:36	1.2	6:28	5:20	
Monday	22	4:47	9.1	5:28	7.8	11:21	0.7	11:35	1.2	6:26	5:22	
Tuesday	23	5:47	9.2	6:32	7.9	12:23 PM	0.6			6:25	5:23	
Wednesday	24	6:50	9.5	7:36	8.2	12:37	1.1	1:26	0.2	6:23	5:24	
Thursday	25	7:54	9.9	8:37	8.8	1:41	0.7	2:26	-0.3	6:22	5:25	
Friday	26	8:55	10.4	9:34	9.4	2:41	0.1	3:23	-0.8	6:20	5:27	
Saturday	27	9:53	10.8	10:27	10.1	3:39	-0.5	4:16	-1.3	6:19	5:28	
Sunday	28	10:47	11.1	11:17	10.6	4:34	-1.1	5:06	-1.6	6:17	5:29	🌑

### March, 2010 Tides

Monday	01	11:39	11.2			5:27	-1.6	5:55	-1.7	6:16	5:30	
Tuesday	02	12:06	11.0	12:30	11.0	6:18	-1.7	6:42	-1.5	6:14	5:31	
Wednesday	03	12:54	11.0	1:21	10.6	7:09	-1.6	7:29	-1.1	6:12	5:33	
Thursday	04	1:42	10.9	2:12	10.0	8:00	-1.3	8:18	-0.6	6:11	5:34	
Friday	05	2:31	10.5	3:04	9.3	8:52	-0.7	9:08	0.1	6:09	5:35	
Saturday	06	3:22	9.9	4:00	8.6	9:46	-0.1	10:01	0.8	6:07	5:36	
Sunday	07	4:17	9.4	4:59	8.1	10:44	0.5	10:58	1.4	6:06	5:37	
Monday	08	5:17	8.9	6:03	7.7	11:47	1.0	11:59	1.7	6:04	5:39	
Tuesday	09	6:20	8.6	7:07	7.6	12:51 PM	1.2			6:03	5:40	
Wednesday	10	7:23	8.5	8:07	7.7	1:01	1.8	1:54	1.2	6:01	5:41	
Thursday	11	8:20	8.7	8:58	8.0	2:01	1.7	2:47	1.1	5:59	5:42	
Friday	12	9:11	8.8	9:43	8.3	2:53	1.4	3:31	0.9	5:57	5:43	
Saturday	13	9:55	9.1	10:21	8.6	3:39	1.1	4:10	0.7	5:56	5:44	
Sunday	14	11:35	9.2	11:57	8.9	5:21	0.7	5:46	0.5	6:54	6:46	

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February/March, 2010

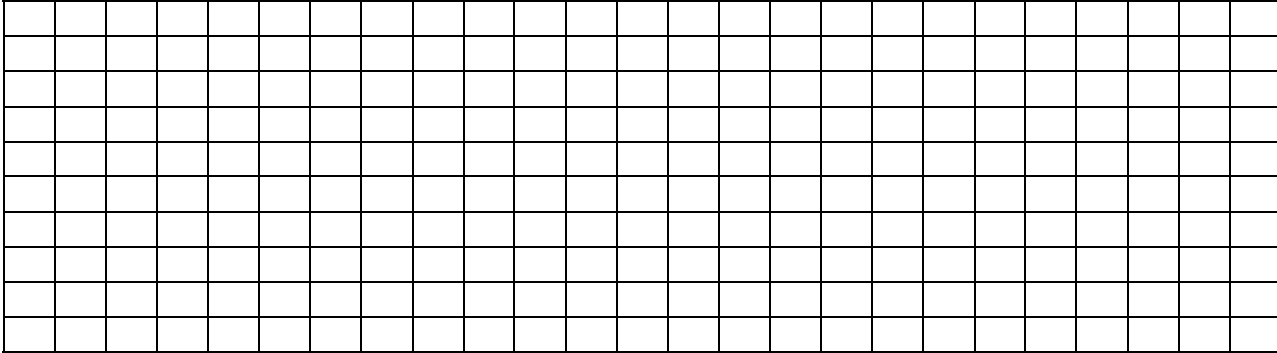
Mr. Traeger

Monday	15	12:13 PM	9.3		6:00	0.4	6:21	0.4	6:52	6:47	
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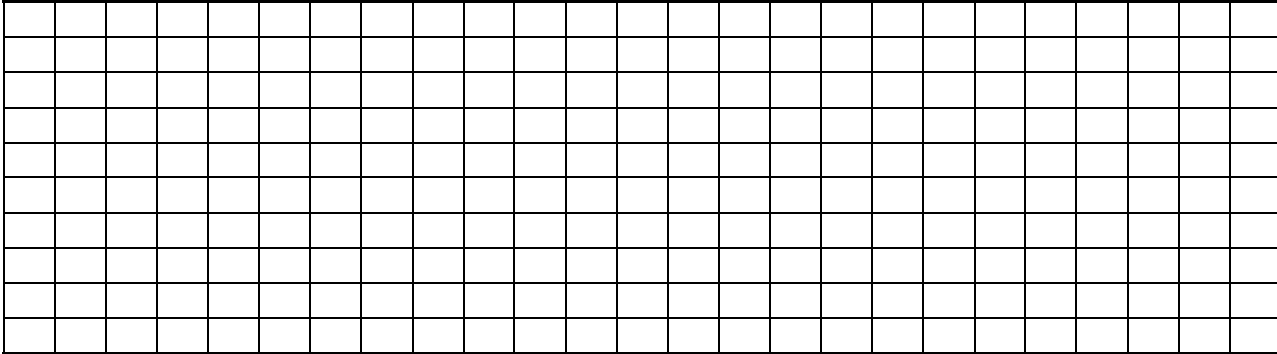
## Making Tide Graphs

Use the following graph sheet to plot your tides. Make sure to make 4 separate graphs, one for each phase of the moon. Plot time of day (hours) on x axis and height variation (feet) on y axis.

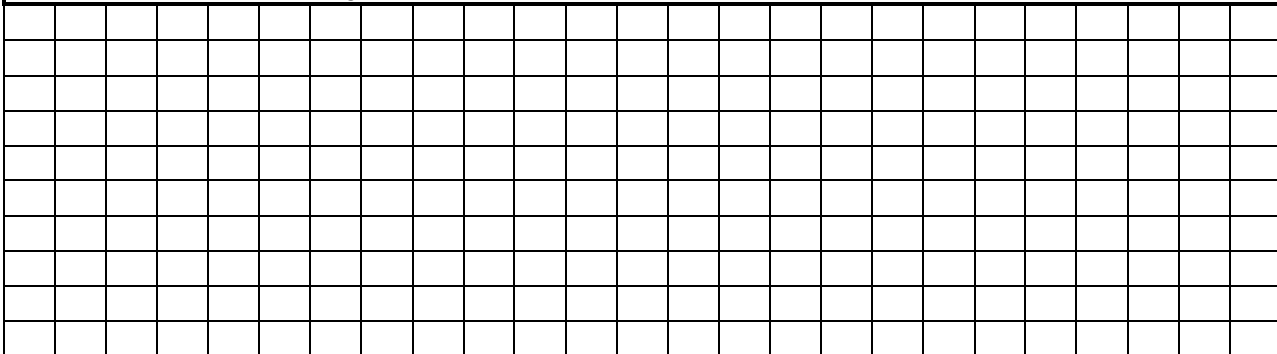
### **New Moon (Plot February 14, 2010)**



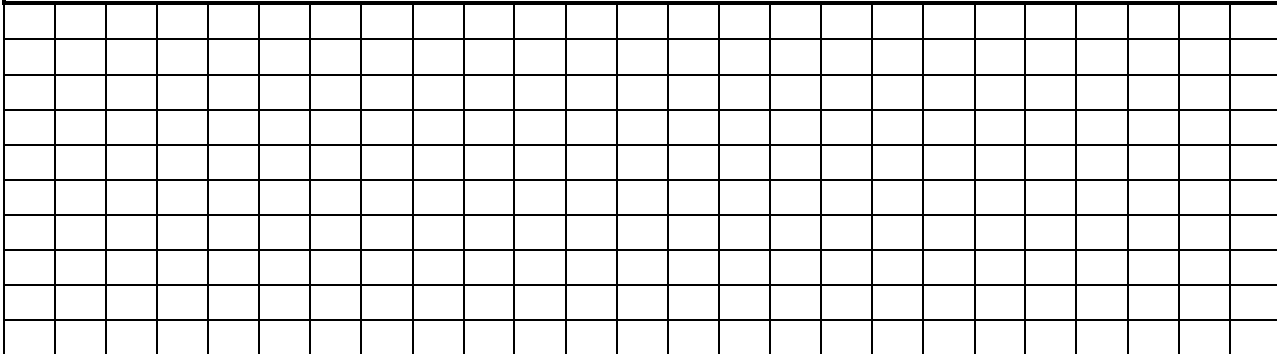
### **First Quarter (Plot February 21, 2010)**



### **Full Moon (Plot February 28, 2010)**



### **Third Quarter (Plot March 7, 2010)**



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## Post Graphing Questions (Refer to pages 541-543 in your text to do these)

1. Subtract the height value for the lowest low tide from the height value for the highest high tide for each date below. This is called tidal range. Show your mathematical work.

2/14/10 (New Moon)	2/21/10 (1 <sup>st</sup> Quarter)	2/28/10 (Full Moon)	3/7/10 (3 <sup>rd</sup> Quarter)
Highest high tide:	Highest high tide:	Highest high tide:	Highest high tide:
Lowest low tide:	Lowest low tide:	Lowest low tide:	Lowest low tide:
Difference (Range):	Difference (Range):	Difference (Range):	Difference (Range):

2. Which two dates above would be considered as Spring Tides? Which two dates above would be considered as Neap Tides? Use the tidal range to figure this out.

Dates of Spring Tides	Dates of Neap Tides

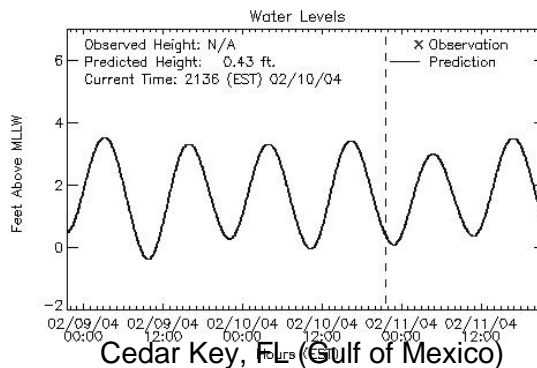
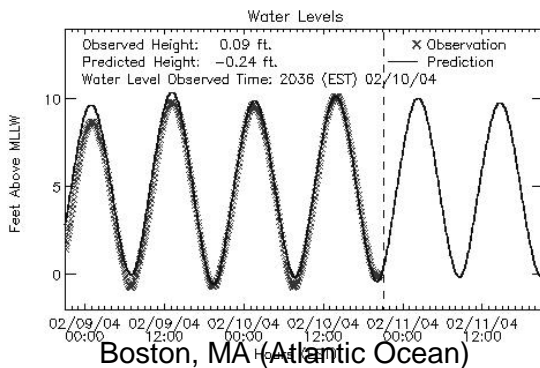
3. Look at the times of the AM high tides for the whole tide chart. By how many minutes does the time advance for each successive day? Why is this?

4. Which has the greatest influence on tides, the sun or the moon? Why?

5. Which side of the Earth is more attracted to the moon? The side facing the moon or the side away from the moon? How does this explain the difference between AM high tides (night side of Earth facing away from new moon) and PM high tides (day side of Earth facing towards new moon) on February 15<sup>th</sup>?

6. Apogee is on February 13<sup>th</sup> and the moon is a distance of 406,541 km. Perigee is on February 27<sup>th</sup> and the moon is a distance of 357,831 km. How does this explain the difference of tidal range between the February 14<sup>th</sup> new moon and the February 28<sup>th</sup> full moon? Draw an orbital diagram to explain this.

7. Look at the following two tide graphs from different locations. Then look at the map on page 708-709 in your book. Explain why the tidal range (size of the tides) is different for each geographic location.



8. Why is it that oceans have larger tides and large lakes have smaller tides? Explain.

9. Predict what might happen on the Earth if we did not have the moon to cause our tides.