Name: _____

Section: _____

Date: _____

Chapter 10 – Lab/Activity #3

Tides: An Ebb and Flow of Life

Introduction:

The ocean waters are a biosystem for a wealth of diverse ocean life as well as the food that nourishes it. Tides are nature's way of creating currents and an ebb and flow of life in the oceans. Learning to read a tide chart is important because it allows you to predict the level of the ocean at any given time of a month. Activities such as shipping, sailing, scuba diving, and fishing are all affected by the tides. Sea life activities such as obtaining food, shelter and the reproduction and evolution of a species are also part of the cyclic nature of the ocean. For example, tides made it possible for prehistoric species such as the ancestors of water mammals to come onto shore and evolve into land animals and mammals.

Materials:

- Tide tables for one month (from the internet search of tides)

Procedure:

1. Research Question(s):

When are the highest tides in the month? When are the lowest tides in the month? When you look at a moon cycle of the same month, how does the full moon and the quarter moon affect the tides?

2. Literature Review:

Tides are caused by the gravitational pull of the sun and the moon. The sun, although much larger than the moon, exerts a gravitational pull that is less than the moon. In reality the pull is much greater, but because the sun is so much farther away from the Earth, its gravitational pull lessens. The moon then, is the main source of gravitational pull on Earth. Both the sun and the moon pull on the surface of the ocean, which in turn causes predictable changes in the ocean level that occurs approximately twice during a 24 hour period. The highest and lowest tides occur during a full moon and a new moon. The second highest and lowest tides occur during the quarter moons.

Learning Outcomes:

After completing this lab activity and studying Chapter 10, Tides, you should be able to:

1. Explain the cause of tides.
2. Compare and contrast Newton's equilibrium theory of the tides with Laplace's dynamic theory.
3. Read a tide table and be able to plot the tides to illustrate tidal curves over a month.
4. Describe the relationship between tides and the development and maintenance of sea life.

Vocabulary:

Dynamic theory – tide theory developed by Laplace that takes into account that there are several tidal bulges due to the imperfect sphere of the Earth, lunar and solar gravity, the shape of the ocean basin and the Coriolis effect.

Equilibrium theory – tide theory proposed by Newton, which assumes that the Earth is perfectly uniform and that the water depth, landmasses, and other influences don't affect the tides.

Flood current – a body of water that flows into a restricted area (bay, river, and harbor).

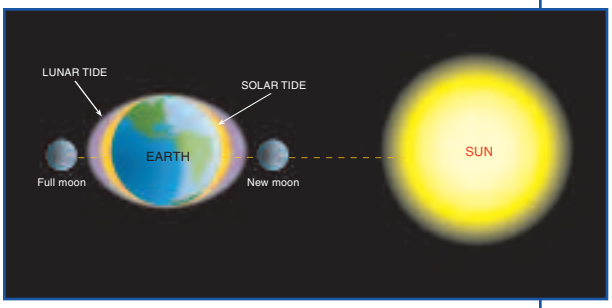
Slack current – a body of water that flows out of a restricted area (bay, river, and harbor).

Spring tides – occur during a new or full moon; the sun and moon are aligned on the same side or the opposite sides of the earth.

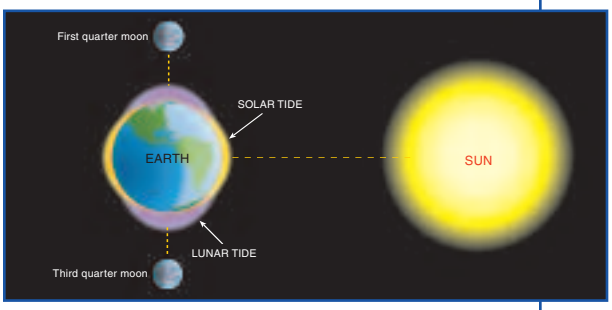
Neap tides – occur during quarter moons and the sun is at a right angle to the Earth.

Safety Issue:

Not applicable.



Spring Tides



Neap Tides

The original theory about tides was put forth by Isaac Newton. In his theory, the Earth had two tidal bulges, at the opposite sides of a perfectly uniform Earth that did not take into consideration the water depth, landmasses, and other influences.

Pierre Laplace modified this theory and developed a *dynamic theory*, which showed that there were in fact four tidal bulges due to factors such as lunar and solar gravity, the imperfect sphere of the Earth, the season, the shape of the ocean basin, and the Coriolis effect.

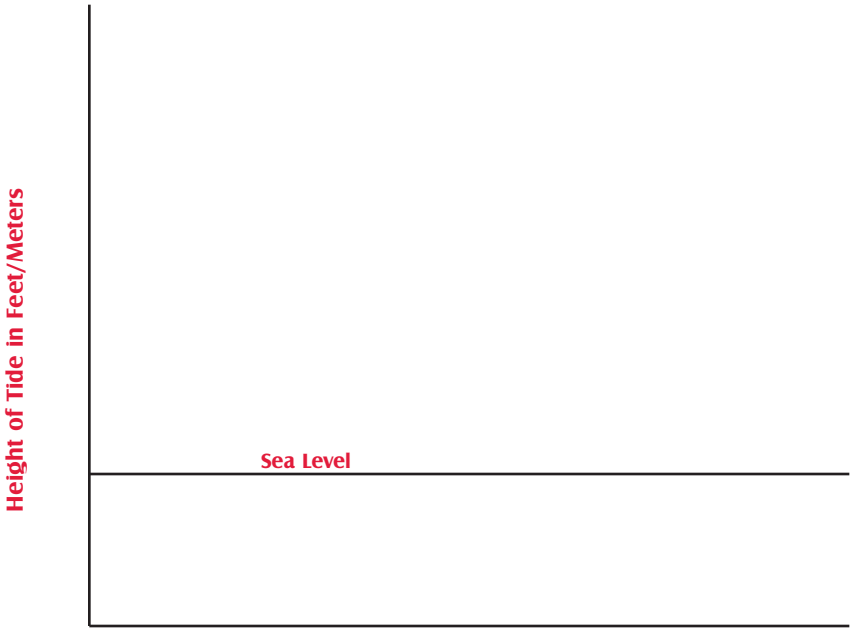
3. Hypothesis:

Based on the research question(s) and the literature review write your hypothesis/predictions below:

Answer varies. Students should say something about how high tides relate to moon phases. For example, the highest tides occur at a full moon phase, the next highest tides occur at the quarter moon.

4. Activity:

Using a Tide Table



1. Plot the height of the tide.

Station 1: Learning to use a tide table to predict full moon and quarter moon phases.

1. On a tidal website that provides monthly tidal information near your geographical area, print the page of data.
2. In Station 1 Data Collection box draw a graph, on the horizontal axis list the 30 days of a month - each day is further divided into 6am, 12 noon, and 6pm; on the vertical axis list measurements in feet/meters. Draw the "sea level" line, which represents the average sea level (a marker) regardless of high and low tides.
3. For each day and time of the month, plot the height of the tide.
4. With a pencil, join the points with a line and you should be able to see the flow of the tides.

Sample Tide Chart – Tide Prediction for Hansville, Washington

Date	Day	Time	Height	Time	Height	Time	Height	Time	Height
09/04/2005	Sun.	12:04AM	4.3 L	05:29AM	8.9 H	11:56AM	0.8 L	06:36PM	10.2 H
09/05/2005	Mon.	12:33AM	3.5 L	06:13AM	9.0 H	12:28PM	1.5 L	06:54PM	10.2 H
09/06/2005	Tues.	01:05AM	2.6 L	06:58AM	9.0 H	01:01PM	2.4 L	07:14PM	10.1 H
09/07/2005	Wed.	01:38AM	1.9 L	07:47AM	8.9 H	01:36PM	3.3 L	07:36PM	10.0 H

All times are listed in Local Standard Time (LST) or, Local Daylight Time (LDT) (when applicable). All heights are in feet referenced to Mean Lower Low Water (MLLW). Reference station: Seattle, WA Latitude 47° 55.1′ Longitude 122° 32.7′

Mean Range (Feet) 6.83 – The mean difference between high and low tidal levels.

Spring Range (Feet) 10.44 – The mean difference between high and low tidal levels during "spring tides". Spring tides are periods of increased tidal range which occur around the dates of the full moon and the new moon.

Mean Tide Level 6.19 – The arithmetic mean of high and low tidal levels.

The highest points are the full and the new moons. The second highest are the quarter moons.

5. On an astronomical data website that provides monthly lunar information near your geographical area, print the page of data.

Sample Moon Phases for September 2005 - Hansville, Washington
(Northern Hemisphere)

Phase	Month	Day	Hour/Minutes
Moon in apogee	September	1	03:—
New Moon 	September	3	18:45
Moon on equator	September	5	13:—
First quarter moon 	September	11	11:37
Moon farthest south of equator	September	12	11:—
Moon in perigee	September	16	14:—
Full moon 	September	18	02:01
Moon on equator	September	18	14:—
September equinox	September	22	22:33
Last quarter moon 	September	25	06:41
Moon farthest north of equator	September	25	07:—
Moon in apogee	September	28	15:—

Observation statements:
Which day has the highest tide?
Which day has the second highest?
Which day has the lowest tides?

The ebb and tide flow will be quite noticeable once the points are joined.

Analyze and apply the knowledge of the graph to what you have read in the textbook and in the literature review about moon cycles and tides. Write a concluding statement about tide heights types of moons.

The highest tides indicate a time of the full or new moon. The second highest tides indicate the occurrence of quarter moons.

Analysis of Results:

Interpret and analyze your results by answering the following questions.

1. Discuss the evidence you have graphed that measures tides.

   What can you say about what affects tides? At certain times of the month the heights of tides fluctuate. High tides occur at a new or full moon; low tides occur at quarter moons.

2. How do these tides in turn affect wave action?

   The gravitational pull of the sun and the moon pulls the ocean into a huge wave with a wavelength half the circumference of the world thus creating many bulges around the Earth as it rotates.

3. Why are waves and tides important? What do they tell us about global warming, melting ice caps, changing climate and natural disasters such as earthquakes, hurricanes, and tsunamis?

   This question does not have one "right" answer. Rather, judge students' responses based on several attributes. These include accuracy, applying information to problems, respect for differing views, original thinking, and the students' ability to defend it. This critical thinking question focuses on what the student does with the information rather than whether they learned.

Conclude and Communicate:

1. The research question(s) for this activity:

   When are the highest tides in the month? When are the lowest tides in the month? When you look at a moon cycle of the same month, how does the full moon and the quarter moon affect the tides?

2. Your hypothesis/prediction(s) for this activity:

   Answer varies. Students should say something about how high tides relate to moon phases. For example, the highest tides occur at a full moon phase, the next highest tides occur at the quarter moon.

3. Is your original hypothesis/prediction(s) supported by your data? Why or why not?

   Answer varies. Students should say something about how high tides relate to moon phases. For example, the highest tides occur at a full moon phase, the next highest tides occur at the quarter moon. Students started this activity with this same hypothesis.

4. Write two new research questions based on what you have learned from this activity:

   Answers vary. Students should design questions that refer to the causes of the tides, the causes of spring tides and neap tides, the difference between Newton's equilibrium theory for tides and Laplace's dynamic theory, and/or lunar influences on tides.

5. The value and importance of this activity to the study of science:

   Answers vary but should emphasize that physics, mathematics, and space science lend themselves to explaining the behavior of tides on Earth.

Student Workspace: