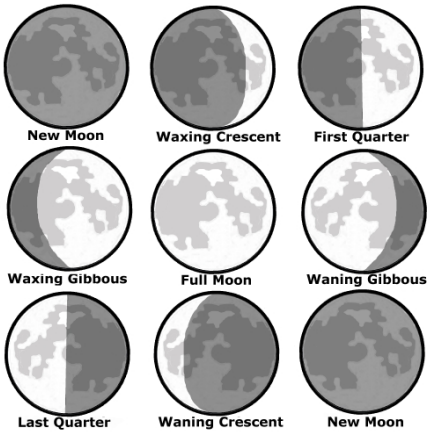
MiSP Cyclic Phenomena Worksheet #1 L3

Name _____ Date _____

Moon Phase Changes over a Two-Month Period

Introduction:

If you go outside on a cloudless night you will often see the moon. If you do this frequently enough you will notice that the shape of the moon appears to change. These changes follow a regular pattern. The shape of the illuminated moon waxes from the new moon, when we cannot see its illuminated half, through the first quarter until it is full. The moon then wanes through the third quarter until the new moon is present again. See the pictures below.



The changing view of the moon is an example of a cycle—phenomena or events that repeat themselves over a certain period of time again and again.

Brainstorm/discuss other examples of cycles in our lives. Indicate whether they are natural or human-made.
Identify the cause of the cycle.

Cycle	Natural or Human-made	Cause

Procedures:

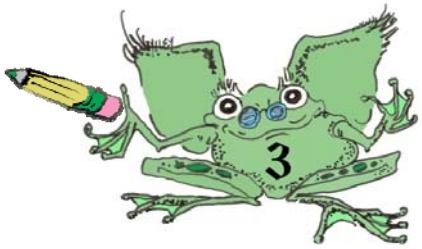
- Look at the chart "Fraction of the Moon Illuminated, 2010" from the U.S. Naval Observatory. Instead of describing the phases of the moon with words, this chart shows the changing phases of the moon by listing the fraction of the illuminated moon that is visible. The full moon is 1.00, the new moon is 0.00, the first quarter is 0.50 when the moon is waxing, and the last quarter is 0.50 when the moon is waning. So, when looking at January 2010, you will see that the full moon occurred on the 1st of the month, the third quarter sometime around the 7th, the new moon on the 15th, and the first quarter around the 23rd. There was a second full moon in January on the 30th. (What is the second full moon in a month, when it rarely occurs, called?

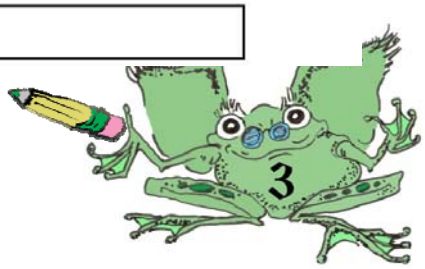
  _____ Ask your teacher if you don't know.)

Graph your data:

Graph the data for January and February, together, on a separate sheet of graph paper to show the relationship between the day and the fraction of the moon illuminated.

- Label the *x*-axis with time (days). Identify the month and the day. Also label the February part of the *x*-axis with a continuing list of the day number: February 1, will be day 32, February 2 will be day 33, etc., all the way up to February 28. which will be day 59. Position the graph paper horizontally (landscape view). Each line of the graph paper will probably have to represent two days
- Label the *y*-axis with "fraction of the moon illuminated" (0-1; there is no unit).
- Graph each data point and then connect the data points.

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Discussion Questions:

1a. It takes 27 1/3 days for the moon to completely revolve around the Earth. But since the Earth is moving in its orbit around the sun, the relative positions of the Earth, the sun, and the moon are constantly changing. Therefore, it takes longer for our view of the moon's phases to cycle from one full moon to the next. According to your graph, how many days does it take for us to see one complete cycle of all the moon's phases?

_____

1b. On what month and day was the first full moon in 2011? (Use the "Fraction of the Moon Illuminated, 2010" chart to help you answer the question.)

_____

2a. The graph you made has peaks (highest points) and valleys (lowest points). The distance from one highest point to the next highest point or from one lowest point to the next lowest point represents one complete moon phase cycle. How many complete cycles are present on your graph?

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2b. If you continued to graph the moon phase data for all 12 months in 2010, would the peaks always have the same *y*-values and the valleys always have the same *y*-values? Why or why not?

_____

_____

3. The moon is always moving, so the fraction of the illuminated half of the moon that is visible is always changing. The chart of data used is for 12:00 midnight. The fraction of the moon illuminated on January 7 at midnight was 0.53. When would people in New York see the moon

when it is precisely the last quarter (0.50 illuminated)—before midnight or after midnight? Explain.

before midnight or **after midnight** *(circle one)*

_____

_____

_____

4. The graph of the moon phases is not a line. Even so, we can compare parts of the graph by looking at the slopes of lines formed by drawing a line segment between data points. Compare the changes in moon illumination in two regions of the graph (January 4–6 / days 4–6 and January 16–18 / days 16–18) by calculating the unit rate of change (slope).

Unit rate of change = $\frac{\Delta y}{\Delta x} = \frac{(y_2 - y_1)}{(x_2 - x_1)} = \frac{\Delta \text{ Fraction of the Moon Illuminated}}{\Delta \text{ Time (days)}}$

Section of Graph Ordered pairs	Δ Fraction of Moon Illuminated Δy	Δ Time (days) Δx	**Unit Rate of Change (slope)**
January 4–6 (Days 4–6)			
January 16–18 (Days 16–18)			

5a. During which of the two time periods does the amount of moon that is illuminated change the most?

_____

5b. Why is the sign of the unit rate of change (slope) calculated for the interval between January 4 and January 6 negative (-)?

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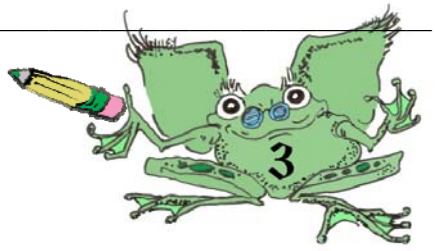

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5c. When would the unit rate of change (slope) be positive on the graph? Give a specific date range.

Comment [BAL1]: Bev: Date?

_____

5d. When would the unit rate of change (slope) of moon illumination in February be the same as the unit rate of change from January 4 to January 6? Give a specific date range and prove your answer.

Comment [BAL2]: Bev: Date?

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Proof:

_____

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6. If the line segment from January 4 to January 6 (days 4–6) was extended, it would intersect the *y*-axis. Use the equation for a line and one of the ordered pairs to determine the *y*-intercept for the line for this section of the graph. The equation for a line is

$y = mx + b$
where m is the unit rate of change (slope) and
b is the *y*-intercept

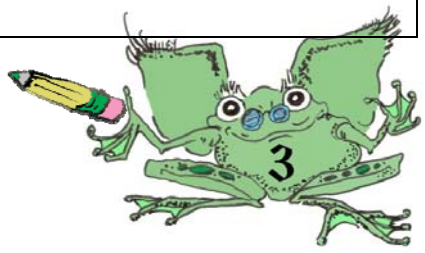
Y-Intercept
m = Ordered pair (x, y) = (___ , ___) $y = mx + b$ Solve for b:

7. Based on the unit rate of change and the y-intercept that you calculated above, write a linear equation for the January 4–6 / days 4–6 section of the graph.

Equation

8a. Use the formula you determined above to calculate the days when the fraction of moon illuminated would be 0.00 (new moon) and 0.50 (last quarter).

Fraction of Moon Illuminated	Calculated Day in January
0.00	



0.50	

8b. Even though your calculation in 8a is correct mathematically, the days calculated are not the same as those on the graph or chart and are therefore incorrect. Why does the calculation using the formula not result in correct days?

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