

# Graphing Moon Phases

## OVERVIEW —

Students examine and analyze lunar phase data by creating and analyzing graphs that plot the data for different weeks.

**Grades:** 3 to 8

**Duration:** 30 minutes

This activity can be used to explore lunar phases, but will not enable students understand the causes of the phases. It can be followed by other [lunar phase activities](#) and can be paired with "[The Moon's Relation to Ocean Tides](#)" using tide data for the same time period.

## OBJECTIVE —

Students will:

- Create graphs depicting how the percent of the Moon (as seen from Earth) illuminated by sunlight changes over time.
- Analyze the graphs to indicate which dates depict the major phases of new moon, full moon, first quarter, and third quarter, and to describe the pattern.

## MATERIALS —

For the class:

- Tape to place the students' graphs in order on the wall

For each student or pair of students:

- A week of data
- Student graph sheet

## ACTIVITY —

**Facilitator's Note:** The data for this activity were selected to match data for the Moon's Relations to Ocean Tides. If more recent or future data is preferred, use the US Naval Observatory's Fraction of the Moon Illuminated program, at <http://aa.usno.navy.mil/data/docs/MoonFraction.php>.

1. Gather students' prior knowledge of Moon phases, through an earlier activity, a formative assessment, or a class discussion.
  - *What are the names of the phases of the Moon?* (Responses can include New, Full, First Quarter, Third Quarter, and even waxing and waning gibbous and crescent.)
  - *Why is the Moon bright?* (Sunlight is reflecting off of its surface.)
  - *When the Moon is "New," how much of its surface can we see?* (none or 0%)
  - *When the Moon is "Full," how much of the side facing us do we see?* (All of it—100%)
2. Let the students know they will be creating graphs of the amount of the Moon (just the side that we see) that is illuminated by the Sun, to help analyze how the Moon's appearance changes over time.
3. Give each student or pair of students one week's worth of data, and a graph sheet. Provide them with appropriate directions based on their graphing experiences in your class, and with a reasonable time limit for creating their graphs. (For instance, teachers might choose to create the first graph together as a class, to remind students how to do it, then provide students with 10 minutes; another class might need a reminder that this is a line graph and just 5 minutes to create their graphs.)
4. Assemble the graphs in order by taping them up on a wall. Ask each student to examine their graph compared to the others. Invite them to write "Full" at the top of the graph for the full moon, "New" at

the top for the new moon, and to estimate and write down “1<sup>st</sup> Q” and “3<sup>rd</sup> Q” above the appropriate dates for first and third quarter moon.

### ***IN CONCLUSION —***

Discuss the patterns in the data with the students.

- *What trends or patterns do they observe as they look at all the graphs?*
- *What is the order of the Moon’s phases? Does the order ever change? (no)*
- *How often is there a full moon? A new moon? (about once a month—every 29 days)*

Share that people around the world see the same phases, in the same order, when the Moon rises in their sky.

### ***BACKGROUND INFORMATION***

This activity is intended as an explore activity after some initial lunar phase engagement activities have been conducted. This activity will not be sufficient to help students conceptualize why we have phases; understanding the cause of lunar phases is a spatially complex topic that confuses many people.

#### **The phases follow a predictable pattern**

- New phase is followed by several days of waxing crescent.
- First quarter is about 7 days after new, and is followed by several days of waxing gibbous.
- Full is about 7 days after first quarter and is followed by several days of waning gibbous.
- Third quarter is about 7 days after full, and is followed by several days of waning crescent.
- New is about 7 days after third quarter.

The “new” and “full” phases are technically just the moment that the Moon’s surface facing us is completely in darkness or completely revealed by sunlight—a specific time and date; however, the Moon is hard to see for multiple days around its “new” phase and appears very close to “full” for a couple nights. Similarly, first and third quarter phases are on specific dates, while the phases of waxing and waning crescent and gibbous are several days.

#### **Why do we see lunar phases?**

The “amount” of Moon that we see as we look from Earth changes in a cycle that repeats about once a month (29.5 days). The relative positions of our Sun, Earth, and Moon, cause these changes. The side of the Moon facing the Sun is always illuminated, just like Earth’s daylight side is illuminated by the Sun. From our perspective on Earth, we see different parts of the Moon’s illuminated surface as the Moon orbits the Earth.

Additional information is available at

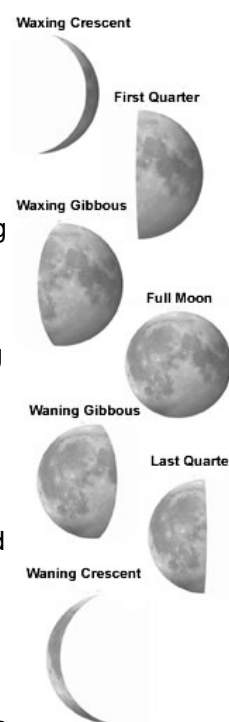
[http://www.lpi.usra.edu/education/skytellers/moon\\_phases/about.shtml](http://www.lpi.usra.edu/education/skytellers/moon_phases/about.shtml).

### ***ADDITIONAL RESOURCES —***

#### **Space Place: The Moon’s Phases in Oreos**

<http://spaceplace.nasa.gov/oreo-moon/en/>

This article explains the monthly variations in the Moon’s appearance as seen from Earth. Directions for using Oreo cookies to illustrate the four major phases of the Moon are provided. The article is targeted to children ages 10-12.



### Explore: Marvel Moon

Background: <http://www.lpi.usra.edu/education/explore/marvelMoon/background/>

Activities: <http://www.lpi.usra.edu/education/explore/marvelMoon/activities/>

This informal education program explores NASA's investigations into the ongoing saga that has shaped our Moon. Discover our scientific, cultural, and personal understanding of Earth's nearest natural neighbor.

### Sustainable Trainer Engagement Program: Lunar Phases

[http://www.lpi.usra.edu/education/step2012/participant/lunar\\_phases/](http://www.lpi.usra.edu/education/step2012/participant/lunar_phases/)

This website has activities and resources for teaching lunar phases to middle school students.

### Moon Posters

[http://www.lpi.usra.edu/education/moon\\_poster.shtml](http://www.lpi.usra.edu/education/moon_poster.shtml)

Three posters, designed for students in 6<sup>th</sup> through 9<sup>th</sup> grades, explore how the Moon formed and changed through time, spacecraft missions measuring different wavelengths of light reflected off the Moon's surface, and how we can use the available materials to support future lunar outposts.

### Unknown Moon Institute

<http://www.lpi.usra.edu/education/workshops/unknownMoon/agenda.html>

This website has a series of activities, data sets, and resources for high school classroom teachers, related to lunar exploration, lunar science, and lunar phases.

## *CORRELATION TO STANDARDS*

### Next Generation Science Standards

#### Disciplinary Core Ideas

- ESS1.B: The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year.

#### Science and Engineering Practices

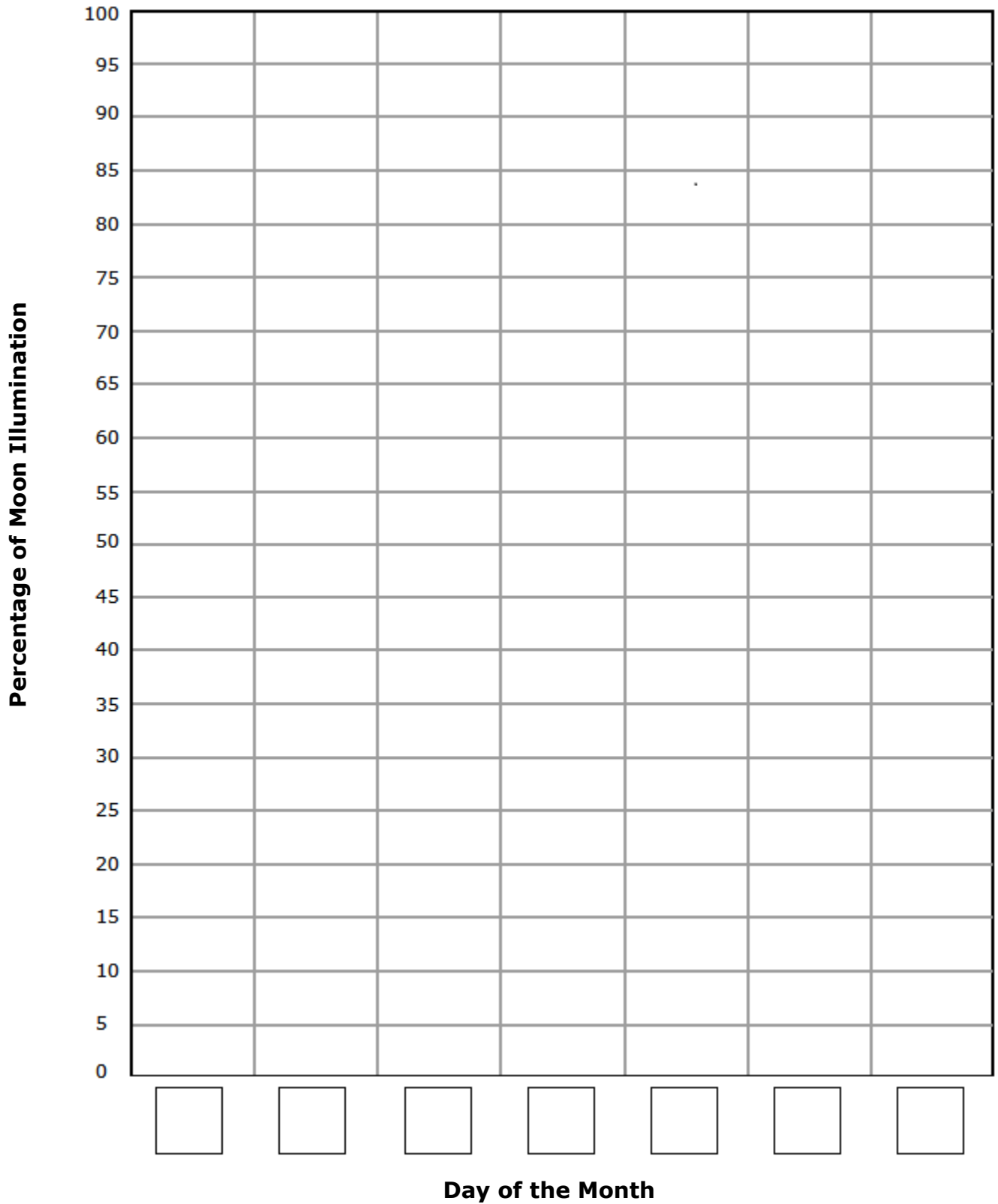
- Analyzing and Interpreting Data: Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal and spatial relationships.
- Analyzing and Interpreting Data: Represent data in graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships.
- Analyzing and Interpreting Data: Analyze and interpret data to provide evidence for phenomena.
- Using Mathematics and Computational Thinking: Describe, measure, estimate, and/or graph quantities (e.g., area, volume, weight, time) to address scientific and engineering questions and problems.

#### Crosscutting Concepts

- Patterns: students identify patterns in rates of change and other numerical relationships that provide information about natural and human designed systems. They use patterns to identify cause and effect relationships, and use graphs and charts to identify patterns in data.
- Patterns: Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena.

Month: \_\_\_\_\_ Year \_\_\_\_\_ Name: \_\_\_\_\_

### Percentage of Moon Illumination vs. Day of the Month



<b>April</b>	<b>2008</b>
<b>Day</b>	<b>Percentage</b>
1	28
2	19
3	11
4	5
5	1
6	0
7	2
8	6
9	13
10	22
11	33
12	44
13	55
14	65
15	75
16	83
17	90
18	95
19	98
20	100
21	99
22	97
23	93
24	87
25	81
26	73
27	64
28	54
29	44
30	34

<b>May</b>	<b>2008</b>
<b>Day</b>	<b>Percentage</b>
1	24
2	15
3	8
4	3
5	0
6	1
7	5
8	11
9	19
10	29
11	40
12	51
13	61
14	71
15	79
16	87
17	92
18	97
19	99
20	100
21	99
22	96
23	91
24	85
25	78
26	69
27	60
28	49
29	39
30	28
31	18

<b>June</b>	<b>2008</b>
<b>Day</b>	<b>Percentage</b>
1	10
2	4
3	1
4	0
5	3
6	9
7	16
8	25
9	35
10	46
11	56
12	66
13	75
14	82
15	89
16	94
17	98
18	100
19	100
20	98
21	94
22	89
23	82
24	74
25	64
26	53
27	42
28	31
29	21
30	12

<b>July</b>	<b>2008</b>
<b>Day</b>	<b>Percentage</b>
1	5
2	1
3	0
4	2
5	6
6	13
7	21
8	30
9	40
10	50
11	60
12	69
13	78
14	85
15	91
16	96
17	99
18	100
19	100
20	97
21	92
22	85
23	77
24	67
25	57
26	45
27	34
28	23
29	14
30	7
31	2

<b>August</b>	<b>2008</b>
<b>Day</b>	<b>Percentage</b>
1	0
2	1
3	4
4	10
5	17
6	25
7	34
8	44
9	54
10	63
11	72
12	80
13	87
14	93
15	97
16	100
17	100
18	98
19	94
20	88
21	80
22	70
23	59
24	48
25	36
26	26
27	16
28	9
29	3
30	0
31	0

<b>Sept</b>	<b>2008</b>
<b>Day</b>	<b>Percentage</b>
1	2
2	7
3	12
4	20
5	28
6	37
7	47
8	56
9	65
10	74
11	82
12	89
13	95
14	98
15	100
16	99
17	96
18	90
19	82
20	72
21	62
22	50
23	39
24	28
25	19
26	11
27	5
28	1
29	0
30	1

<b>October</b>	<b>2008</b>
<b>Day</b>	<b>Percentage</b>
1	4
2	8
3	15
4	22
5	30
6	39
7	49
8	58
9	67
10	76
11	85
12	91
13	96
14	99
15	100
16	97
17	92
18	85
19	75
20	65
21	53
22	42
23	32
24	22
25	14
26	8
27	3
28	1
29	0
30	2
31	5

<b>November</b>	<b>2008</b>
<b>Day</b>	<b>Percentage</b>
1	10
2	16
3	23
4	32
5	41
6	51
7	60
8	70
9	79
10	87
11	94
12	98
13	100
14	98
15	94
16	87
17	79
18	68
19	58
20	47
21	36
22	27
23	18
24	11
25	6
26	2
27	0
28	0
29	2
30	6

<b>December</b>	<b>2008</b>
<b>Day</b>	<b>Percentage</b>
1	11
2	17
3	25
4	34
5	43
6	53
7	64
8	74
9	83
10	91
11	96
12	99
13	100
14	96
15	91
16	83
17	73
18	63
19	53
20	42
21	32
22	24
23	16
24	10
25	5
26	2
27	0
28	0
29	3
30	6
31	12

<b>January 2009</b>	
<b>Day</b>	<b>Percentage</b>
1	19
2	27
3	37
4	47
5	58
6	69
7	79
8	87
9	94
10	99
11	100
12	98
13	94
14	87
15	79
16	69
17	59
18	49
19	39
20	30
21	22
22	15
23	9
24	4
25	1
26	0
27	1
28	3
29	8
30	14
31	22

<b>February 2009</b>	
<b>Day</b>	<b>Percentage</b>
1	31
2	42
3	53
4	64
5	75
6	84
7	92
8	97
9	100
10	99
11	97
12	91
13	84
14	76
15	66
16	57
17	47
18	38
19	29
20	21
21	14
22	8
23	3
24	1
25	0
26	1
27	5
28	11

<b>March 2009</b>	
<b>Day</b>	<b>Percentage</b>
1	18
2	27
3	38
4	49
5	60
6	71
7	81
8	89
9	95
10	99
11	100
12	98
13	95
14	89
15	82
16	73
17	65
18	55
19	46
20	36
21	28
22	19
23	12
24	7
25	2
26	0
27	1
28	3
29	8
30	15
31	24



<b>April</b>	<b>2009</b>
<b>Day</b>	<b>Percentage</b>
1	34
2	46
3	57
4	68
5	78
6	87
7	93
8	98
9	100
10	99
11	97
12	93
13	87
14	80
15	72
16	63
17	54
18	44
19	35
20	26
21	17
22	10
23	5
24	1
25	0
26	2
27	6
28	13
29	21
30	32

<b>May</b>	<b>2009</b>
<b>Day</b>	<b>Percentage</b>
1	43
2	54
3	65
4	75
5	84
6	91
7	96
8	99
9	100
10	99
11	96
12	91
13	85
14	78
15	70
16	61
17	51
18	41
19	32
20	22
21	14
22	7
23	3
24	0
25	1
26	4
27	10
28	19
29	29
30	40
31	51

<b>June</b>	<b>2009</b>
<b>Day</b>	<b>Percentage</b>
1	62
2	72
3	81
4	88
5	94
6	98
7	100
8	100
9	98
10	95
11	90
12	83
13	76
14	67
15	57
16	47
17	37
18	27
19	18
20	10
21	4
22	1
23	0
24	3
25	8
26	16
27	26
28	36
29	47
30	58

<b>October</b>	<b>2009</b>
<b>Day</b>	<b>Percentage</b>
1	91
2	96
3	99
4	100
5	99
6	96
7	90
8	83
9	74
10	63
11	52
12	41
13	30
14	20
15	11
16	5
17	1
18	0
19	1
20	5
21	10
22	17
23	25
24	33
25	42
26	52
27	61
28	70
29	79
30	86
31	92

<b>November</b>	<b>2009</b>
<b>Day</b>	<b>Percentage</b>
1	97
2	99
3	100
4	97
5	93
6	86
7	77
8	66
9	55
10	44
11	33
12	23
13	14
14	8
15	3
16	1
17	0
18	2
19	6
20	11
21	18
22	26
23	34
24	44
25	53
26	63
27	72
28	80
29	88
30	94

<b>December</b>	<b>2009</b>
<b>Day</b>	<b>Percentage</b>
1	98
2	100
3	99
4	95
5	89
6	80
7	70
8	59
9	48
10	37
11	27
12	18
13	11
14	5
15	2
16	0
17	0
18	3
19	7
20	12
21	19
22	27
23	36
24	45
25	55
26	65
27	74
28	83
29	91
30	96
31	99

<b>July</b>	<b>2009</b>
<b>Day</b>	<b>Percentage</b>
1	68
2	77
3	85
4	91
5	96
6	99
7	100
8	99
9	97
10	93
11	87
12	80
13	72
14	62
15	52
16	42
17	31
18	21
19	12
20	5
21	1
22	0
23	2
24	7
25	14
26	22
27	32
28	43
29	53
30	63
31	72

<b>August</b>	<b>2009</b>
<b>Day</b>	<b>Percentage</b>
1	80
2	87
3	93
4	97
5	99
6	100
7	99
8	96
9	91
10	84
11	76
12	67
13	56
14	45
15	34
16	24
17	15
18	7
19	2
20	0
21	1
22	5
23	11
24	19
25	28
26	37
27	47
28	57
29	67
30	75
31	83

<b>September</b>	<b>2009</b>
<b>Day</b>	<b>Percentage</b>
1	89
2	94
3	98
4	100
5	100
6	97
7	93
8	87
9	80
10	70
11	60
12	49
13	38
14	27
15	17
16	9
17	4
18	1
19	0
20	3
21	8
22	14
23	22
24	31
25	41
26	50
27	60
28	69
29	77
30	85