IMHOTEP'S
LEGACY ACADEMY

Relative positions of the earth, moon and sun

Activity Workbook

REVIEWS AND UPDATES

REVIEWER	ACTIONS/COMMENTS	DATE
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Relative Positions of the Earth, Moon and Sun

OBJECTIVES:

- To show the approximate relative size of the planets and sun and the approximate relative orbits of the planets around the sun.
- To show how the Earth's rotation causes the day and night cycle and how Earth's revolution causes the yearly cycle of seasons.
- To show how the relative positions of Earth, the moon and the sun are responsible for moon phases.
- To show how the relative positions of Earth, the moon and the sun are responsible for eclipses.

AFRICAN PROVERB
You can't use your hand to force the sunset.
• Nigeria

BACKGROUND INFORMATION:

The words “solar system” refers to the sun and all the objects that travel around it.

Question 1:
Some key natural satellites includes the moon, _____, comets and _____.

Question 2:
The _____ is a spiral galaxy to which our solar system is part of.

Question 3:
At the center of our solar system, intense energy and heat from the _____ is responsible for life on earth.

Question 4:
An _____ is the curved path of a celestial object around a star, planet or moon.

Question 5:
The _____ is the only planet with any known life forms.

Question 6:
The _____ is a thin layer separating us from space.

Question 7:
The _____ is a thin layer separating us from space.

Question 8:
The moon makes the _____ a more livable planet by moderating our home planet’s wobble on its axis.

Question 9:
The moon was likely formed after a _____ -sized body collided with Earth

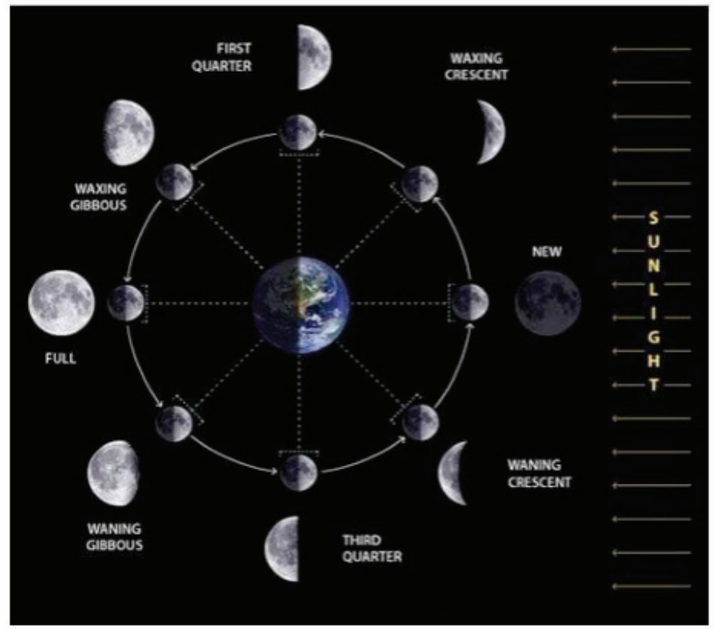
Question 10:
How many high tides occur on the earth every day? _____

Question 11:
If the moon didn’t spin at all, then eventually it would show its far side to the _____ while moving around our planet in _____.

Question 12:
Rotational period is the same as the orbital period and the same portion of the moon’s sphere is always facing the earth. True or False. _____.

Question 13:
All parts of the Moon are lit in turn by the _____.

Question 14:
The Moon changes from a thin crescent to a full moon and back again to a crescent in one month (29 days, which is a lunar month). True or False.



This diagram shows the phases of the moon, from a new moon, which you can hardly see at all, round to a full moon and back again in just over four weeks. Follow the phases in an anticlockwise direction (the opposite way from how the hands of a clock move).

Question 15: Define the following

Waxing Moon

_____

_____

_____

The waxing moon

_____

_____

_____

Gibbous Moon

_____

_____

_____

The waning Moon

_____

_____

_____

The waning crescent Moon

_____

_____

_____

Anytime there are three bodies (the sun, the moon, or planet) lined up so that one blocks the light from another, we call that an eclipse.

Question 16:
During a solar eclipse, the _____moves between us (on Earth) and the _____ and blocks the sunlight.

Question 17:
During a lunar eclipse, _____ blocks the sun's light that normally lights up the moon. Since we are standing on Earth, what we see is that the moon gets _____

Activity 1a: Effect of Earth's Rotation and Orbit on Light and Seasons

Materials:

5 Styrofoam ball (slightly larger than an orange)

5 Skewers

10 Toothpicks

5 Flashlights

5 Markers

5 Protractors

Methods:

1. Make a globe: a. Place the toothpicks in the ball to represent the north and south poles. b. Draw rough outline of North America (or the entire world map if time permits) in relation to the poles and draw a dot on Halifax. c. Tilt the ball approximately 23° and insert the skewer from top to bottom through the ball to that the ball is permanently tilted at 23°. This represents the earth.
2. Dim or turn off the lights.
3. Day and night:
    a. Have student 1 turn on the flashlight and adjust its position or beam size so it shines over the entire width of the globe.
    b. Have student 2 hold the ball and vertically rotate it in place using the skewers. This demonstrates how the rotation of the Earth causes day and night. Even though the sun is always shining, it is dark on the side of the Earth that is not facing the sun.
4. Seasons:
    a. Have student 1 turn on the flashlight and adjust its position or beam size so it shines over the entire width of the globe.
    b. Have student 2 rotate the globe so that Canada is facing the sun.
    c. Have student 2 keep the globe facing in a direction (for example keep one side directed at a poster) and rotate around student 1.
    d. Student 1 should keep the flashlight aimed at the globe.

e. Rotate the globe vertically so the same country as before is facing the flashlight. This shows how the tilted rotation of the Earth causes half of Earth to face the sun more directly as our planet moves in its orbit. The seasons gradually change as different parts of the Earth move to face the sun more directly or more indirectly.

Follow-up Questions/Analysis:

How much of the globe is in darkness as the rotation exercise is done?

_____

_____

_____

Why do we have seasons on earth?

_____

_____

_____

Activity 1b: Eclipses

Materials:

5 Globes from part (a)

5 Flashlights

5 Ping-Pong ball or Styrofoam ball the size of a ping pong ball

5 Pipe cleaner or wire

5 Flashlight

Methods:

1. Make the moon by inserting the pipe cleaner into the top of the Ping-Pong ball.
2. Have student 1 point the flashlight directly on the earth's equator.
3. Have student 2 hold the globe in one hand and the moon in the other by the pipe cleaner.
4. Have student 2 stand facing the flashlight.
5. Student 2 should then line the moon's equator up with the earth's equator and hold the moon about a finger's length away from the earth.
6. Dim or turn off the lights.
7. Solar eclipse:
    a. Have student 2 hold the moon directly in-between the earth and the flashlight; the moon will cast a shadow on the earth.
    b. Since the moon is now between earth and the sun and it is blocking the sunshine for some people on Earth. Point out that only people directly in the shadow see a complete eclipse of the sun.

8) Lunar eclipse:

    a. Have the student 2 hold the moon directly behind the earth, no light should be hitting the moon.
    b. Since the earth is between the sun and the moon, it is casting a shadow over the entire moon. Explain that unlike during the solar eclipse, the entire 'night side' of Earth can see the lunar eclipse.

Follow-up Questions/Analysis:

Between a solar and lunar eclipse, which lasts longer and why?

_____

_____

_____

Activity 2a: Moon Phases

Materials:

6 Regular Oreos (two standard sized packs totaling 60)

10 Plastic spoons or knives

10 sheets of Paper towels

10 Handout

Methods:

1. TO BE DONE BY MENTOR PRIOR TO ACTIVITY: Print off the “Lunar Cycle” worksheet from the next page or the following website: http://sciencewear.net/assets/lcstudent-plan-(revised-2015)2.pdf

2. TO BE DONE BY MENTOR: Draw and label the moon phases on the board in the orientation of the handout. Explain why we see the different phases and where they got their names.

3. Demonstrate how to twist open an Oreo so that all the frosting is on one side

4. Pass out 6 cookies, a paper towel, a plastic spoon or knife, and a copy of the hand out (attached below) to each student

5. Each cookie should be able to make two Moon phases

6. Twist open and scrape the cookies to illustrate the moon phases 7) Arrange the cookies on the handout in order

Follow-up Questions/Analysis:

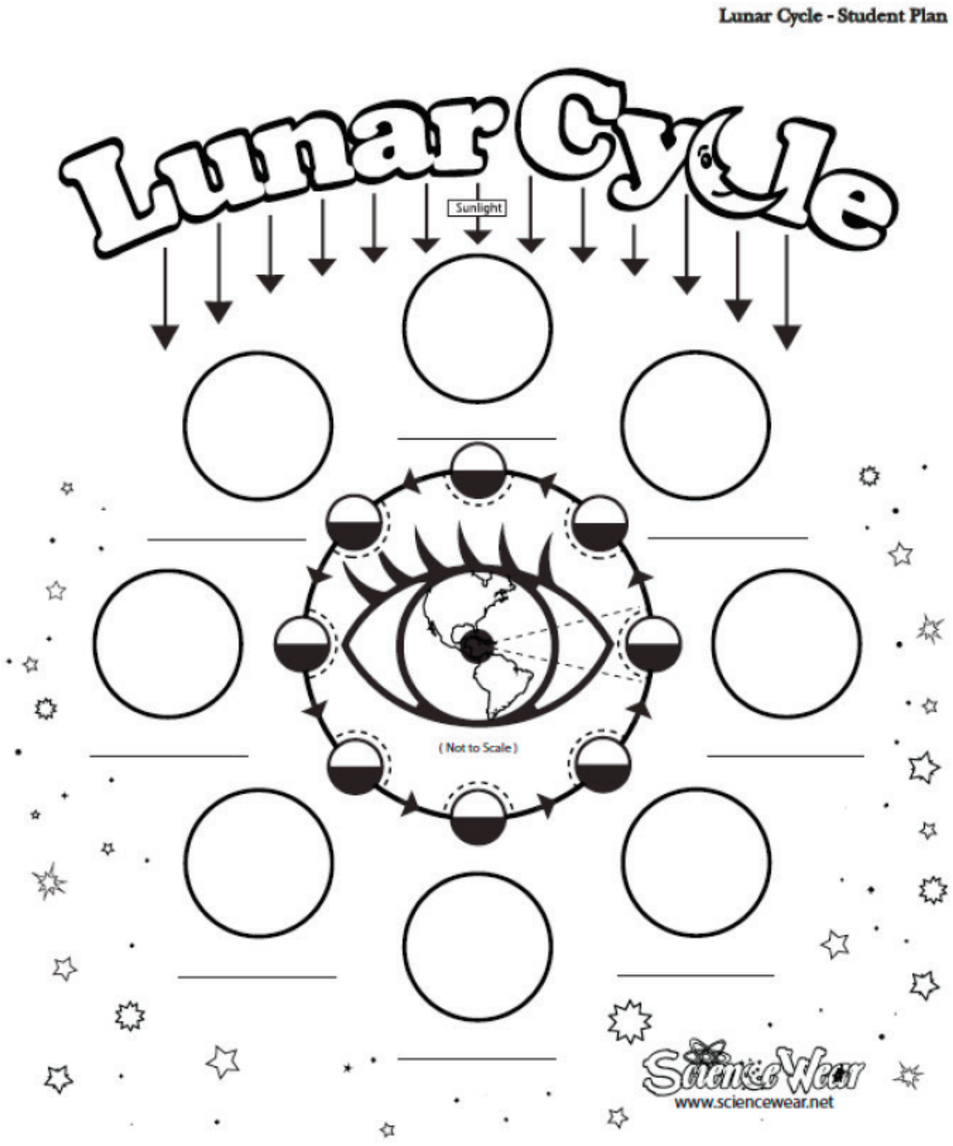
At what phase of the moon does a lunar eclipse occur?

_____

_____

_____

Lunar Cycle - Student Plan



Activity 2b: Lunar Cycle Prediction

Materials:

10 Handouts

Methods:

1) **TO BE DONE BY MENTOR PRIOR TO ACTIVITY:** Print out "Lunar Cycle Predictions" worksheet.

2) Play the NASA video taken by the Deep Space Climate Observatory (DSCOVR) satellite of the dark side of the moon: https://www.youtube.com/watch?v=DMdhQsHbWTs

3) Pass out the worksheet and explain the activity.

Follow-up Questions/Analysis:

1. In the video clip, what side of the moon is captured?
   a) Near side
   b) Far side

2. In what direction of the screen is the moon exiting the earth?

Lunar Cycle Predictions

Predictions

Phase	First Appearance	Second Appearance	Third Appearance
New Moon	Day 8		
Full Moon			
Last Quarter			

BONUS ACTIVITY 3: Introduction to Lunar Geology

THE MOON

- Only known permanent natural satellite to the earth
- Mass 7.34 x 10^{22} kg
- Density 3340 kg m^{-3}
- Volume 2.2 x 10^{10} km^3
- Average Temp. -20.15 °C
- Average Pres. < 10^{-7} Pa

MOON

- No atmosphere
- No seasons
- No plate tectonics
- Extreme temperatures
- No active magnetic field
- Smaller than Earth
- Diameter: 3,476 km

Spheres
Orbit the sun
Landforms

EARTH

- Has atmosphere
- Has seasons
- Plate tectonics
- Moderate temperatures
- Active magnetic field
- Larger than moon
- Diameter: 12, 756.3 km

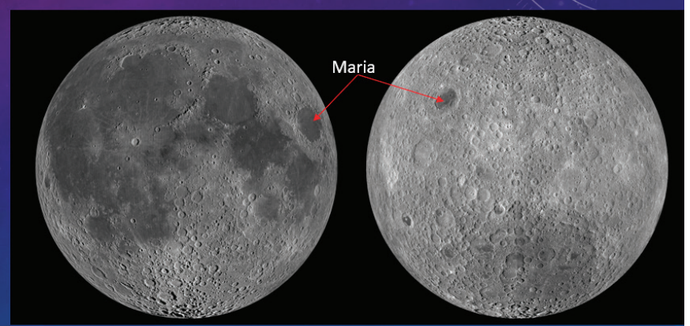
LUNAR TERRAINS

Maria
- Flat to gentle plains
- Craters with smaller diameter
  - (< 20 km)

Terrae
- Rugged, cratered terrain
- Craters with larger diameter
  - (> 20 km)

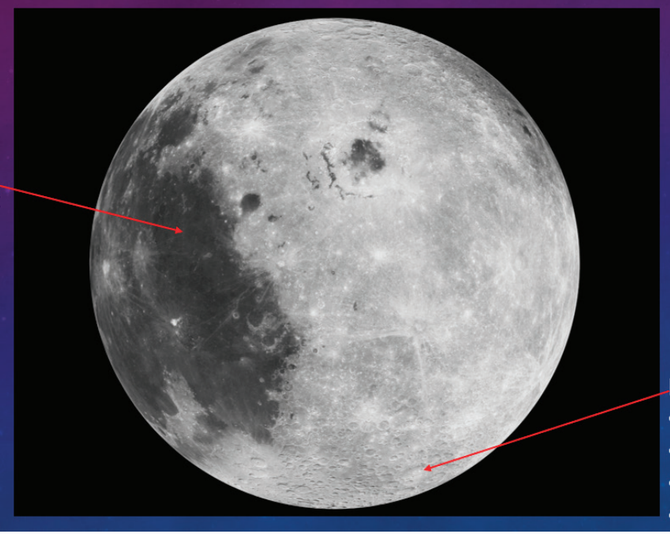
PHYSIOGRAPHY

- Surface shaped by two processes
  - Impact and Volcanism
- Mapped telescopically
- Less Maria on far side
- Few minor landforms
  - Domes and cones
  - Faults and Grabens



THE LUNAR SURFACE

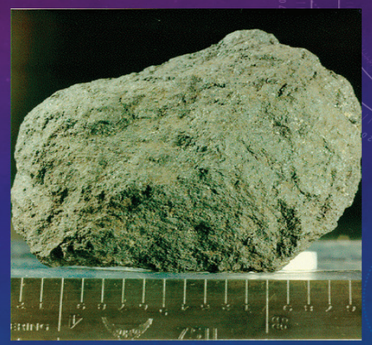
Lowlands
- Volcanic crust
- Basaltic
- Few craters
- Relatively flat



Highlands
- Magmatic crust
- Anorthositic
- Heavily cratered
- Relatively rough

LUNAR BASALT

- Similar to terrestrial basalt
- Contains pyroxene, plagioclase, olivine
- Abundant in mare, rare in highlands



IMPACT BRECCIA

- Clast rich
- Product of impact
- All grades (Fine to coarse)
- Contains various rock types

Lunar History

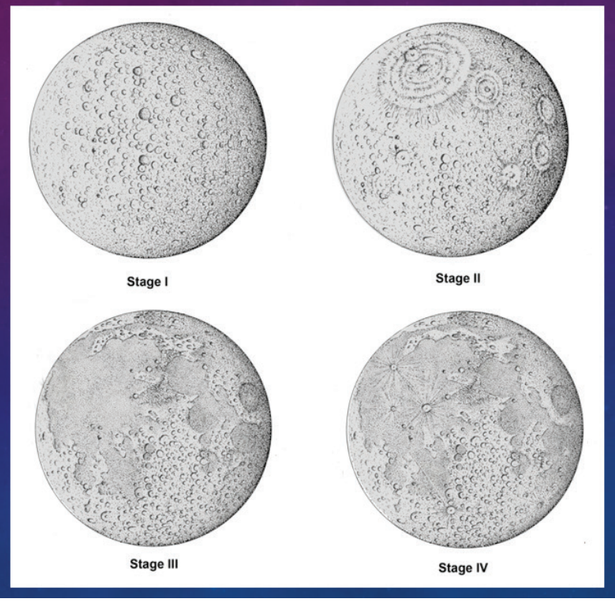
ANORTHOSITE

- Found in highland crust
  - Rare in mare
- Crystallized at depth
  - Coarse grained
- Commonly significantly shocked
- Similar to crustal rocks on earth with some chemical difference

LUNAR HISTORY

4.6 – 4.5 Ga

3.9 – 3.2 Ga



4.6 – 3.9 Ga

3.2 Ga – present

The major events in lunar history include:

- intense meteorite bombardment during an early period
- formation of multi-ring basins
- extrusion of mare basalts, and, subsequently
- light meteorite bombardment.

(A) Stage I. Formation of Moon by accretion (about 4.55 billion years ago) created densely cratered terrain over the entire surface of the Moon. The outer layers of the Moon may have been completely molten before this surface was shaped.

(B) Stage II. The formation of multi-ring basins (Imbrium Basin formed 3.9 billion years ago) is attributed to the impact of asteroid-sized bodies. The infill of these meteoritic bodies may represent the final stages of accretion. Remnants of this cratered surface are preserved in the lunar highlands.

(C) Stage III. Extrusion of the mare basalts (from about 4 billion to perhaps 2.5 billion years ago) was a manifestation of a major thermal event in lunar history, which occurred when the lithosphere was still relatively thin. Lava flows filled many of the multi-ring basins on the Moon's near side and in some areas, they covered parts of the highlands that lack obvious multi-ring structures.

(D) Stage IV. Relatively light meteorite bombardment (from 3.2 billion years ago to the present) formed some craters with bright rays, but the rate of cratering has been greatly reduced. The lunar landscape has changed little during the last 3 billion years.

What have you learned about the Moon?

1) What is the average temperature of the moon and how does it compare to the average temperature on earth estimated to be 15° C by NASA in 2013?

2) List 3 differences between the earth and the moon.

Earth	Moon

3) Do we always see the same side of the moon from the earth?

a. Yes

b. No

4) There is more Maria on the far side of the moon.

a. True

b. False

5) During a lunar eclipse the earth's shadow blocks the sun's light from hitting the moon

a. True

b. False

6) List 3 differences between the Highlands and Lowlands of the Moon.

Highland	Lowland

7) We can see the moon at night because

a. It is a star

b. It reflects the light of the sun

c. It gives off its own light

8) What mineral is responsible for the green color of a Lunar Basalt?

a. Pyroxene

b. Plagioclase

c. Olivine

9) Which of the lunar rocks results from an impact?

a. Lunar Basalt

b. Anorthosite

c. Breccia

10) The major events in lunar history are divided into ___ stages. The third stage is characterized by the formation of Multi-ring basins.

a) True

b) False

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