Title: Moon Maneuvers

Author: Wynne Clarke-Anderson

Subject(s): Science, Mathematics

Topic(s): Moon, Topography, Metrics, Geography, Space Science, Longitude, Latitude, Map skills

Grade/Level: 5-8

Objective:
By the end of this lesson, students will be able to:

- use longitude and latitude coordinates to locate and plot Apollo Moon Mission landing sites.
- read a large shaded relief map to locate designated areas on the map that include physical lunar features.
- plot on a grid designated areas and a variety of physical lunar features.
- become familiar with the Apollo Mission time lines, crews, and landing sites.
- plan and plot a moon trip using a Moon Relief Map for the Lunar Rover using specific guidelines. (The goal is to plot a course that is the shortest trip time.)
- use math functions to calculate the shortest trip time.
- use metric conversions for length.

Summary of Lesson: Students locate and plot Apollo Moon Missions and learn about a variety of lunar surface features by plotting and planning a moon trip that will visit designated lunar sites.

Time Allotment: 1 hour 45 minutes

Procedures/Instructions:

Vocabulary:

- *Mare:* singular, means sea; *Maria* is the plural. They are the low plains (lowlands) on the Moon that appear dark and smooth. They were formed by ancient lava flows.

- Highland areas are the mountain areas on the surface of the Moon.
- Impact crater is a circular depression in the ground caused by meteoroids and asteroids hitting the surface of the Moon.
- Frigoris (Latin) means Cold
- Imbrium means Rains
- Nubium means Clouds
- Humorum means Moisture
- Procellarum means Storms
- Mons means Mountains Angular distance on the Earth's surface, measured east or west from the prime meridian at Greenwich, England, to the meridian passing through a position, expressed in degrees (or hours), minutes, and seconds.
- The angular distance north or south of the Earth's equator, measured in degrees along a meridian, as on a map or globe.

Part One:
Students work in pairs with 4 students per table.

Teacher - Brief discussion of the Moon.

The Moon is the brightest object in our night sky, it is Earth's only satellite, the Moon's gravity pulling on Earth causes daily ocean tides, it was probably formed by a Mars-size meteoroid hitting Earth when it was newly formed, there is no atmosphere on the Moon, so there are temperature extremes, and it is the only body in the Solar System that humans have actually visited.

Encourage students to share in the discussion and add information that they know about the Moon (eclipses, phases, mythology).

Today you are going to investigate Apollo Mission landing sites and explore different places on the Moon using a map.

- Pass out the Moon Maps with the Apollo Site locations. Instruct students to locate and then plot with an X the landing sites on the grid paper. Instruct students to write the Longitude and Latitude in degrees next to the number/letter location. Reinforce Longitude and Latitude with students before they begin their map work.
-

If you have a computer lab or computers in your classroom:

Go to the Google Moon site and locate and learn about the crew of Apollo Missions http://moon.google.com
Go to the website where students try to land a Lunar Lander:
http://spaceevent.com/kid_activities/games.asp

Closure:
Show a short clip of early Apollo Missions from videotape or the internet.
http://history.nasa.gov/40thann/videos.htm
http://www.hq.nasa.gov/alsj/a11/video11.html

Check student maps for locations, allow students to share some of the things they learned.

Part Two:
Teacher explains: Next you and your partner must plan a lunar excursion to investigate eight different areas of the Moon. The trip must begin and end at Hercules Crater. **Remember, you must keep your trip time to a minimum**.

- Place the large scale Moon Relief Maps, the Moon Spec Sheet, the Moon Data Log, and other supplies on the tables. Instruct students to follow the direction given on the spec sheet and data log keeping in mind the goal is to calculate the **shortest trip time** visiting all sites:
    1. Locate your destinations on the relief map.
    2. Complete the Lunar Site Location table on the data log.
    3. Plot the lunar sites on the grid paper.
    4. Plan the shortest trip time back to Hercules Crater.
    5. Complete the Lunar Excursion Time table on the data log.

The Lunar Vehicle information below is based on the following:

- **1mm = 5km** = The map scale
- **25km /hour** is the traveling speed of the vehicle
- **10 hrs** = How far the vehicle will travel on 1 full battery charge
- **10 hrs** = The amount of time it takes for the battery to recharge
- **1** = Replacement battery

The Lunar Vehicle must visit the following Lunar Sites:

1. Start at Hercules Crater 42º E 48º W
   19cm = 950km = 38 hours

2. Alpine Valley 2º W 46º N
   13cm = 650km= 26hours
3. Archimedes Crater 3º W 29 N
   13.5cm = 675km = 27hrs
4. Copernicus Crater 20º W 10º N
   10 cm = 500km = 20hrs
5. Apennine Mountains 15º E 24ºN
   11cm = 550km = 22hrs
6. Sea of Serenity 20º E 23º N
   23cm = 1150km = 46hrs
7. Rupes Altia 25º E 25º S
   26cm = 1300km = 52hrs
8. Sea of Crisis 60º E 14ºE
   12.5cm = 625 = 25hrs
9. Apollo 17 Landing Site 38º E 27ºN
   13cm = 650km = 26hrs
10. Home Landing site Hercules Crater 42º E 48º W

Instructional Materials:

- Pencils
- Calculators
- Grid paper 1 per 2 students
- Set of colored pencils 1 set per 2 students
- Miniature post it notes
- Scratch paper for calculations
- Metric rulers
- Moon Maneuvers Student Sheet
- Moon Maneuvers Student Data Log
- USGS Near Side Moon Relief Maps 1 per table of 4 students
  http://www.lunarrepublic.com/atlas/index.shtml
  http://astrogeology.usgs.gov/Projects/BrowseTheSolarSystem/moon.html
- Lunar Landing Sites maps 1 per 2 students
  http://moon.google.com
- Moon Maps with areas labeled 1 per 2 students
  http://www.adlerplanetarium.org/cyberspace/moon/
  http://www.oarval.org/MoonMapen.htm

Additional Resources (Web Links, File Attachments):

- http://www.adlerplanetarium.org/cyberspace/moon/
- http://spaceevent.com/kid_activities/games.asp

National Science or Mathematics Standards:
Science

Science as Inquiry
CONTENT STANDARD A:
As a result of activities in grades 5-8, all students should develop

- Abilities necessary to do scientific inquiry
  - Use appropriate tools and techniques to gather, analyze, and interpret data.
  - Develop descriptions, explanations, predictions, and models using evidence.
- Understandings about scientific inquiry

Earth and Space Science
CONTENT STANDARD D:
As a result of activities in grades 5-8, all students should develop an understanding of

- Earth in the solar system
- Structure of the earth systems

Mathematics

Number and Operations Standard
Instructional programs from pre-kindergarten through grade 12 should enable all students to—

- Understand numbers, ways of representing numbers, relationships among numbers, and number systems
- Compute fluently and make reasonable estimates in problem solving

Geometry Standard
Instructional programs from pre-kindergarten through grade 12 should enable all students to—

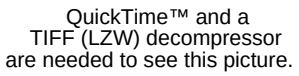
- Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships

Assessment Plan:

Group interview: The teacher will spend time with each group to ask specific questions about the proposed Moon trip. Examples: Explain how you arrived at the total trip time on the Data Log and in your own words describe what longitude measures on a map.

Transfer and Reflection: Students share with another group their proposed Moon trip and justify their Spec Sheet and Data Log to the other group.

Moon Maneuvers Student Sheet



Mission Objective: You and your crew must plan a lunar excursion to investigate eight different areas of the Moon. You must begin and end your trip at Hercules Crater. **Remember, you must keep your trip time to a minimum**.

The Lunar Vehicle must travel to the following lunar sites:

- Alpine Valley
- Rupes Altai
- Apennine Mountains
- Apollo 17 Landing Site
- Archimedes Crater
- Copernicus Crater
- Sea of Crisis
- Sea of Serenity

Procedure:

1. Locate your destinations on the relief map.
2. Complete the Lunar Site Location table on the data log.
3. Plot the lunar sites on the grid paper.
4. Plan the shortest trip time back to Hercules Crater.
5. Complete the Lunar Excursion Time table on the data log.

The following information is needed to calculate the "**Total Time**" of your trip:

- **1 cm = 10 mm**

- Map Scale: **1 mm = 5 km**
- The Lunar Vehicle will travel at a speed of **25 km /hour**.
- The Lunar Vehicle can travel for **10 hours** on a fully charged battery.
- It will take **10 hours** for the battery to recharge.
- "**Total Time" includes travel time and charge time.**

Moon Maneuvers Student Data Log

Lunar Site Location

Lunar Site	Latitude	Longitude
Hercules Crater		
Alpine Valley		
Rupes Altia		
Apennine Mountains		
Apollo 17 Landing Site		
Archimedes Crater		
Copernicus Crater		
Sea of Crisis		
Sea of Serenity		

Lunar Excursion Time

Trip Site	Grid Distance (cm)	Actual Distance (km)	Travel Time (hours)	Total Time (hours)
1. Hercules Crater				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10. Hercules Crater				

			Total Trip Time	