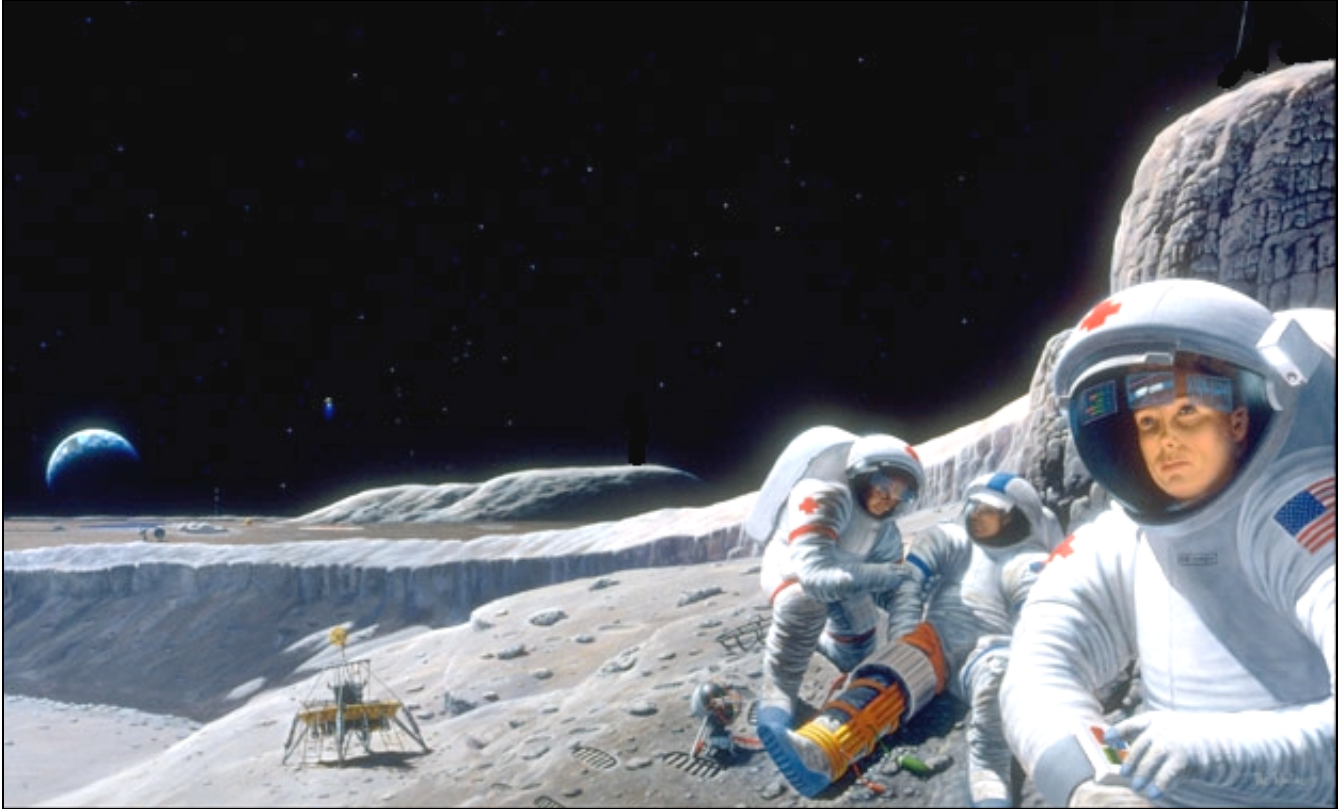


Group Activity: Lunar Crash Landing!



Picture credit: Pat Rawlings/NASA

BACKGROUND STORY:

Imagine a time in the not-so-distant future, when there are lunar bases and people are living and working on the Moon. On a routine trip from Earth to Tranquility Base, there is an accident on board the spacecraft and you crash land on the Moon's surface, 100km (about 60 miles) from your destination. The spacecraft has lost its seal against the vacuum of space, so you have to rely on your spacesuit for protection.

Fortunately for you, it is just after first quarter moon, and so dawn has just begun over your location. In the Moon's low gravity, 100km is not far to travel on foot. You *are* limited in what you can carry, though, so which items in the list should you choose to take with you or leave behind, and how can you best use them?

TO DO:

1. AS A GROUP: Discuss the usefulness of each item on the "ship's manifest" of items recovered from the spacecraft (page 3). First decide - by vote, if you like - what to leave behind and what to bring. Then assign priorities to items you would bring with you. Unusual and imaginative uses are encouraged!

2. ON YOUR OWN: Complete the item lists on the worksheet, giving your reasons for taking or leaving each item. Please provide any feedback on this activity, and hand the worksheet only back to the instructor.

MOON MISSION FAST FACTS

- ❑ Since the Moon rotates at the same rate as it orbits around Earth (about once every 28 Earth days), daylight on the Moon lasts 14 Earth days, followed by 14 days of darkness.
- ❑ As seen from the Moon, Earth itself does not rise or set, but appears to “hang” in the sky, changing phase over the course of a lunar month.
- ❑ Daytime surface temperatures on the Moon can reach +110°C (230°F), while nighttime temperatures drop as low as -200°C (-328°F).
- ❑ With no atmosphere to scatter sunlight, you can see stars even during the daytime on the Moon, as long as you are in the shade and not looking in the direction of the Sun.
- ❑ Unlike the Earth, the Moon does not have a rapidly spinning molten iron core.
- ❑ Due to the Moon’s smaller size, the lunar horizon is about half as far away as on Earth, so from level ground you can only see about 3 kilometers (1.8 miles) in any direction.
- ❑ Craters have steep walls, and the entire lunar surface is covered with fine, powdery dust.
- ❑ NOT EVERYTHING YOU NEED TO KNOW IS HERE! So if you need help, please ask the instructor!

Just FYI: The “Man in the Moon” Illusion (Northern hemisphere)

The “Man in the Moon” is one of many shapes which people have seen in different cultures. (From the Southern hemisphere of Earth, the Moon appears upside-down relative to the view below, so observers there see different figures).

The illusion goes away when we look through a telescope or at an enlarged image (e.g. page 5), but it does allow us to recognize some of the features on the Moon’s near-side with the naked eye.



Eye on left: Mare Imbrium (*Sea of Rains*)

Eye on right: Mare Tranquilitatis (*Sea of Tranquility*)

Nose: Appennine Mountains

Mouth: Mare Nubium (*Sea of Clouds*)

The *maria* are not actual seas, of course, but plains of dark solidified lava. These ancient lava flows leaked out of cracks in the Moon’s crust, which were caused by giant impacts billions of years ago. The older lunar highlands are made of more reflective (brighter) rocks. The bright marks on the maria are craters formed by later impact events.

LUNAR CRASH LANDING! RECOVERED ITEMS LIST

Discuss which items to leave behind and which to bring (and why), then fill out the form on page 5.

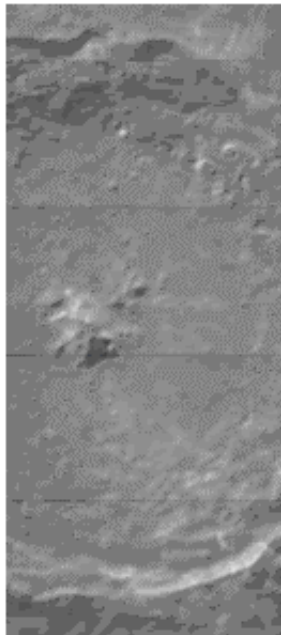
- 1. Box of matches:** These might be useful to make a signal fire or campfire on Earth.
- 2. Two 50kg pressurized oxygen tanks:** You can refill your spacesuit supply from these. On Earth, these tanks weigh 110 pounds each. Could you carry them easily on the Moon?
- 3. Magnetic compass:** On Earth, Magnetic North varies from True North by as much as 20 degrees. Could you navigate on the Moon with this?
- 4. Food concentrate:** These food packs can be plugged in to a tube on your spacesuit, which leads to a feeding tube inside your helmet. Notoriously bland and similar in texture to baby food, but lightweight, non-perishable, and packed with calories, protein, fiber, and vitamins.
- 5. Self-igniting signal flare:** Originally designed to work underwater, these flares produce a brilliant flame without outside oxygen. They might be visible to a rescue craft in lunar orbit.
- 6. Solar-powered FM radio transmitter:** requires sunlight to function, but FM radio waves can only be received by someone with a clear, straight line-of-sight to the transmitter.
- 7. Nylon rope, 30 meters (about 100ft):** it's rope - not much else to say!
- 8. Constellation chart:** You learned to navigate by the stars during a sailing voyage across the Pacific, using this same chart. Could it still be useful so far from home?
- 9. Portable heat radiator:** This bulky heater at 30kg can produce 2kW of radiant power on its own batteries for about 12 hours. Perhaps you could all stand around it like a glowing campfire?
- 10. 100 liters (=100kg) of water:** About 30 U.S. gallons in a large plastic container. Could you carry it? What would happen if you opened the container on the lunar surface?
- 11. First Aid Kit:** including hypodermic needles that fit special openings in your spacesuit.
- 12. Self-inflating life raft:** This 60kg raft uses an integral CO₂ bottle to inflate. Standard issue on spacecraft in case of a water landing back on Earth, the inflated raft is large enough for your team to sit comfortably inside.
- 13. 20kg helium tank and 600 party balloons, assorted colors:** Your spacecraft was supposed to deliver party supplies to the lunar base for the anniversary of Neil Armstrong's first steps on the Moon in 1969. Some party you'll be having now...but can you use them anyway?
- 14. Fire extinguishers:** 5kg each, standard issue in any spacecraft, one per person.



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SKYWATCHER'S GUIDE TO THE MOON



Impact!

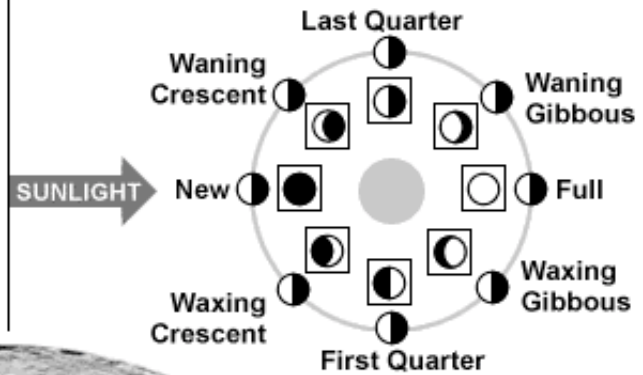
The Moon's cratered surface tells a violent story. Bright areas are ancient crust that make up the highlands. Dark areas are newer regions of lava that formed after asteroid impacts.

Copernicus

This crater (left) is easy to spot. It formed about 800 million years ago, and is 57 miles (92 km) wide. Note central peaks and terraced walls, caused by impact.

Moon Phases

Outer circle is Moon's orbit and shows sunlight hitting the Moon at each phase. Inside the squares is what you see from Earth.



Aristarchus

Young crater. So bright that Sir William Herschel thought it was an active volcano.

Kepler

Small version of Copernicus.

Grimaldi

Lava-filled crater is one of the darkest spots you can see on the Moon. It's 145 miles wide (233 km).

Mare Humorum

The Sea of Moisture is about 220 miles (350 km) across. You can spot it with the naked eye. With a telescope, you might notice two craters along its edge.

Tycho

Young crater best seen during a full Moon. Rays of bright material are ejecta blasted out of the crust when a large asteroid struck about 109 million years ago.

Mare Serenitatis

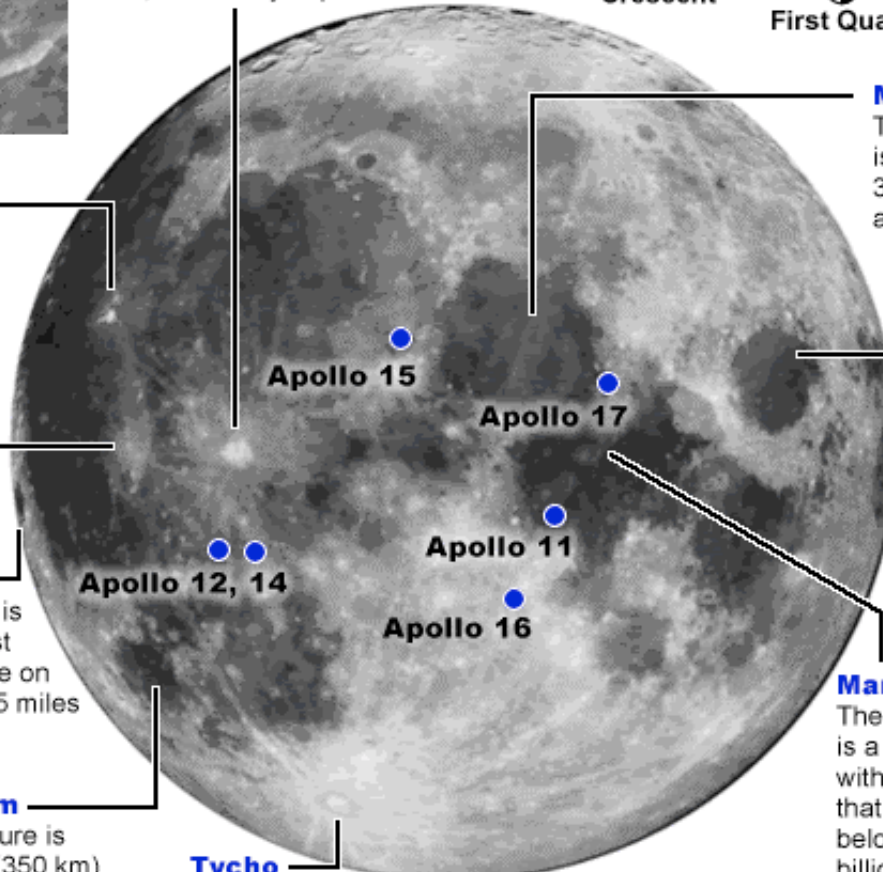
The Sea of Serenity is solid lava, some 380 miles (610 km) across.

Mare Crisium

The Sea of Crisis is about 340 miles wide (550 km) and visible to the naked eye

Mare Tranquillitatis

The Sea of Tranquility is a smooth plain filled with once-molten lava that welled up from below after an impact billions of years ago. The first humans to walk on the Moon, Apollo 11 astronauts, landed near the edge.



SOURCES: NASA; ADVANCED SKYWATCHING; CAMBRIDGE ATLAS OF ASTRONOMY; DK VISUAL ENCYCLOPEDIA

Robert Roy Britt / SPACE.com

Daily skywatching tips: www.space.com/spacewatch

Lunar Crash Landing Worksheet – *TO BE HANDED IN*

Team members: _____

ITEMS TO BRING:

Item (from page 3)	Reason(s) for bringing it with you (be creative!)	PRIORITY (1=highest)

ITEMS TO LEAVE BEHIND:

Item (from page 3)	Reason(s) for leaving it behind

FEEDBACK ABOUT THIS ACTIVITY: Do you feel that you learned more about the Moon from this activity? What did you like about it? What would make it better? (Please continue on the back of this page):

FEEDBACK CONTINUED.....

Credits: Originally from the *Space Age Activity Guide*, then adapted by Suzanne Chippendale of the Astronomical Society of the Pacific. Further adapted by Dr. Philip Blanco of Project ASTRO San Diego (pblanco@sciences.sdsu.edu). Comments welcome!