

ONE GIANT LEAP: A MOON ODYSSEY

HIGHLIGHTS	3
TOP FACTS ABOUT THE MOON	3
USEFUL WEBSITES	3
ICEBREAKER SCRIPTS.....	4
SPACE RACE (ON SKY BRIDGE).....	4
LUNAR LANDING (MIDDLE LEVEL).....	4
WALK ON THE MOON (LOWER LEVEL)	4
ABOUT THE MOON (TOP LEVEL).....	5
SURVIVING IN SPACE (LANDING BETWEEN LOWER AND MIDDLE LEVELS)	5
DETAILS AND BACKGROUND.....	5
MAIN ENTRANCE: AT MERCURY SPACESUIT	6
<i>Mercury Spacesuit</i>	6
TIMELINE OF THE SPACE RACE—ON THE SKY BRIDGE	6
<i>Cold War, Hot Race</i>	6
<i>Timeline</i>	7
<i>Sputnik 1 Model</i>	9
<i>Explorer 1 Model</i>	9
<i>Mercury Capsule—Basic Space Transportation</i>	10
<i>Going Where No Dog Has Gone Before!—Laika’s Dog Cabin</i>	10
<i>A Much Higher Primate</i>	11
<i>Gemini Model</i>	11
<i>Apollo Model</i>	11
SECONDARY ENTRANCE: BOTTOM FLOOR.....	12
<i>Walking on the Moon</i>	12
SURVIVING IN SPACE—LANDING BETWEEN BOTTOM AND MIDDLE FLOORS.....	13
<i>Why does an astronaut need a spacesuit?</i>	13
<i>What was the Apollo spacesuit made of?</i>	13
THE LUNAR LANDING—DELLUMS BUILDING, SKY BRIDGE LEVEL	14
<i>The Lunar Module</i>	15
<i>The Six Lunar Landing Sites</i>	15
<i>Lunar Lander Simulator</i>	16
<i>Lunar Module Engine Bell</i>	16
<i>Saturn 5 Rocket</i>	17
ALL ABOUT THE MOON—TOP FLOOR.....	17
<i>Moon Basics</i>	17
<i>A Piece of the Moon—the Moon Rock</i>	18
<i>Whack! The Moon Is Formed—A Theory of the Moon’s Origin</i>	18
<i>Timeline of the Moon</i>	18
<i>The Tide of Life—Did the Moon Have a Hand in Life on Earth?</i>	19
<i>Moon Phase Interactive (the Moon Bike)</i>	19



<i>Moon Orbit Interactive</i>	21
<i>Moon Gravity Interactive</i>	22
<i>Moon Image Flipbook</i>	22
MOON FANCIES—MAGNETIC LUNAR POETRY BOARD	23
FANTASTIC FLIGHTS	23
<i>Jules Verne, From the Earth to the Moon</i>	23
<i>H. G. Wells, The First Men in the Moon</i>	24
MYTHICAL MOON	24
<i>Coyolxauhqui</i>	24
<i>Mawu</i>	24
<i>Soma</i>	25
<i>Rona</i>	25
<i>Anningan</i>	25
<i>Tsuki-Yoma</i>	25
<i>Artemis</i>	25
<i>How Does the Moon Affect You?</i>	26

Highlights

Top Facts About the Moon

Distance from the Earth: 384,000 kilometers (240,000 miles)

Period of revolution: 27.3 days.

Period of Moon phase cycle: 29.5 days.

Diameter: 3,476 kilometers (2,172 miles).

Mass: 1/100 that of Earth.

Age: Approximately 4.5 billion years.

Useful Websites

Apollo Lunar Surface Journal: www.hq.nasa.gov/office/pao/History/alsj/frame.html

LPI 3-Minute Guide to the Moon: www.lpi.usra.edu/expmoon/3minmoon.html

Exploring the Lunar Landing Sites: www.boulder.swri.edu/~durda/Apollo/landing_sites.html

Giant Impact Theory of Moon Origin: www.spacedaily.com/news/lunar-01d.html

Where Did the Moon Come From, Starchild: starchild.gsfc.nasa.gov/docs/StarChild/questions/question38.html

The Big Whack: www.swri.edu/3pubs/ttoday/spring99/moon.htm

Lunar Interior and Geologic Activity: csep10.phys.utk.edu/astr161/lect/moon/moon_interior.html

The Moon: www.physci.org/1/sci/moon/

Flight to the Moon, National Air and Space Museum: www.nasm.si.edu/exhibitions/atm/flightpath/a11.steps.html

Interactive Moon Globe, NOVA Online: www.pbs.org/wgbh/nova/tothemoon/origins.html

The Apollo Program, National Air and Space Museum: www.nasm.si.edu/collections/imagery/apollo/apollo.htm

From the Earth to the Moon, Jules Verne, on-line book: jv.gilead.org.il/pg/moon/

The First Men in the Moon, H. G. Wells, on-line book:
www.pagebypagebooks.com/H_G_Herbert_George_Wells/The_First_Men_In_The_Moon/

Sidereal and Synodic Months, simulation: www.sumanasinc.com/webcontent/anisamples/astronomy/sidereal.html

Lunar Deities, Wikipedia: en.wikipedia.org/wiki/Lunar_deity

Moon Myths, Windows to the Universe: www.windows.ucar.edu/tour/link=/mythology/planets/Earth/moon.html



Icebreaker Scripts

Space Race (on Sky Bridge)

What was the Space Race? (The race for supremacy in space, symbolized by landing people on the Moon) Who was competing? (The United States and the Soviet Union) What were they competing for? (Dominance in space flight and technology)

Why did they send dogs and chimps into space? (To see if spaceflight was safe for humans)

Who was the first human in space? (Yuri Gagarin of the Soviet Union)

What spacecraft carried astronauts to the Moon? (Apollo)

What did the Soviets call their astronauts? (Cosmonauts)

Who was the first to set foot on the Moon? (Neil Armstrong, followed shortly by Buzz Aldrin)

Would you have liked to be the first on the Moon? Would you care if you weren't first, but got to go anyway?

It's been over 30 years since we sent people to the Moon. Do you think we should send people back now? Why? Would you go?

Lunar Landing (middle level)

How many Apollo landings were there on the Moon? (6, with 2 astronauts each)

Why was the LM (Lunar Module) not designed like an airplane, or the Space Shuttle? (The Moon has no atmosphere, so wings are useless and aerodynamic sleekness is not necessary)

If it took the huge Saturn 5 rocket to get Apollo to the Moon, how could the small LM engine get the astronauts off the Moon again? (The Moon's gravity is one sixth as strong as Earth's, and the LM was carrying only its ascent module, not the whole Command and Service Module and both LM modules)

The Saturn 5 rocket model in the stairwell is one-tenth the size of the real one. At that scale, how tall would a model of you be standing next to it? (One-tenth as tall; a 4-foot kid would be 0.4 feet, or 4.8 inches tall)

Walk on the Moon (lower level)

What do you think it would be like to walk on the Moon? (You can read some of the Apollo astronauts' descriptions of this in the full training manual)

If you landed on the Moon, what's the first thing you would try to do?

How far could you throw a ball on the Moon? (Approximately 6 times farther than on Earth)

How high could you jump? (6 times higher)

If you jumped with enough strength, do you think you could escape the Moon's gravity and fly off into space? (No. You'd still have to jump upward at a speed of at least 1.5 miles per second, or about 5,400 miles per hour.)

About the Moon (top level)

You can quiz visitors on the basic facts of the Moon (see Highlights): Size, age, mass, gravity, etc.

Why does the Moon phase? (Good question; see how many people don't know!)

Why does the same face of the Moon always point toward Earth? (The Moon is gravitationally locked by Earth's gravity—in effect, Earth is swinging the Moon around by its face, like a tetherball rope swings the tetherball around, keeping the side the rope is attached to pointing toward the pole)

Does the Moon rotate? How long does it take? In other words, how long is a day on the Moon? (Equal to one lunar month: the Moon rotates on its axis and revolves around Earth at the same rate)

How old is the Moon rock? (3.3 billion years) What kind of rock does it look like? (It's "mare basalt"—lava rock)

How much would you weigh on the Moon? (One-sixth your Earth weight)

Surviving in Space (landing between lower and middle levels)

How many layers does an Apollo spacesuit have? (About 23)

What all does a spacesuit do? (Holds in air and warmth, keeps out radiation, and also keeps the astronaut from overheating)

In what ways might a spacesuit made for walking on the Moon be different from one made for wearing inside a spaceship? (The Moon suit should have more protection against sharp rocks, direct solar radiation, and should have boots made for walking)

What would happen if the helmet bubble broke? (Bad things)

Details and Background

This exhibit technically has two starting points; two entrances. The main entrance is in the Spees Building at the entrance to the Sky Bridge. The secondary entrance is the ground floor entryway to the Dellums Building

("LL" elevator level). This may be a traffic problem in that visitors will not be able to flow naturally through the entire exhibit from end to end, but there's no way around this due to the location of the exhibit in the Dellums stairwell and the Sky Bridge. Help visitors find every part of the exhibit by asking if they've seen the climb-in Mercury Capsule (in the Sky Bridge) or the "Walk on the Moon" green screen theater (level LL, bottom of the well—or elevator shaft).

Main Entrance: At Mercury Spacesuit

In July, 1969, the first astronauts walked on the Moon as half a billion people watched on TV. It was an awesome moment in space exploration – and human history.

How did we get to the Moon—and why? What did we learn? Will we go back to the Moon? Should we?

Mercury Spacesuit

This spacesuit was used in training for the Mercury Project, 1958-1963.

Spacecraft are designed to protect their human occupants from the lethal environment of space. This spacesuit provided backup protection in case of malfunction.

The Mercury spacesuit was a modified version of a U.S. Navy high altitude jet aircraft pressure suit. It had an inner layer of Neoprene-coated nylon and an outer layer of aluminized nylon.

The suit also had laced boots, a helmet that attached to a collar ring, and gloves. The suit was cooled with an external fan that the astronaut carried. The astronaut received oxygen from the spacecraft through hoses connected to the suit.

Timeline of the Space Race—on the Sky Bridge

Cold War, Hot Race

October, 1957. The United States and the Soviet Union, the most powerful nations on Earth, are locked in a Cold War. Each claims to have the strongest military and most advanced technology.

Suddenly, the Soviet Union launches Sputnik 1. The Space Race has begun—and the Soviets have a head start.



Timeline

October 4, 1957 -- First Artificial Satellite

The Soviets launch Sputnik 1, the first man-made object to orbit Earth. It sends radio signals back to Earth for three weeks, and orbits for about three months before burning up in the atmosphere.

See a full-size model of Sputnik 1 hanging above!

January 31, 1958 -- First American Satellite

America launches its first satellite, Explorer 1. It discovers the radiation belts surrounding the Earth—one of the first direct measurements of the space environment around our planet.

See a full-size model of Explorer 1 hanging above!

October 1, 1958 -- NASA is Born

The National Aeronautics and Space Administration (NASA) is founded. Its main job: lead the U.S. effort to challenge the Soviets in space.

January 2, 1959 -- First Spacecraft to Orbit the Sun

The Soviets launch Luna 1, trying to hit the Moon. But it misses and flies off into space, becoming the first artificial object to orbit the Sun.

September 14, 1959 -- First Spacecraft to Hit the Moon

The Soviet Luna 2 becomes the first artificial object to strike the Moon. The spacecraft is sterilized to keep Earth bacteria off the Moon.

October 7, 1959 -- First View of Moon's Far Side

The Soviet Luna 3 orbits the Moon, sending back the first pictures of the side of the Moon that always faces away from Earth.

April 12, 1961 -- First Man in Space

Soviet Cosmonaut Yuri Alekseyevich Gagarin, aboard Vostok 1, becomes the first human in space. He makes one complete orbit of Earth in about two hours.

May 5, 1961 -- First American in Space

U.S. Astronaut Alan Shepard makes a 15-minute flight aboard the Mercury spacecraft Freedom 7.

May 25, 1961 -- President Kennedy's Challenge

In a speech to Congress, President John F. Kennedy dares the nation to land a man on the Moon and return him safely to Earth before the end of the decade.

February 20, 1962 -- First American in Orbit



Astronaut John Glenn makes three complete orbits around the Earth aboard Mercury-Friendship 7, on a flight that lasts about five hours.

June 16, 1963 -- First Woman in Space

Aboard Vostok 6, Cosmonaut Valentina Tereshkova orbits the Earth 48 times in three days.

October 12, 1964 -- First Multi-person Spacecraft

The Soviet Voskhod 1 carries its crew of three cosmonauts on a one-day trip in space.

March 18, 1965 -- First Spacewalk

Tethered to his spacecraft, Voskhod 2, cosmonaut Alexei Leonov "walks" in space for 12 minutes.

December 15, 1965 -- First Space Rendezvous

The U.S. Gemini 6a and Gemini 7 perform the first rendezvous of two spacecraft, maneuvering as close as a foot apart. The two-man Gemini craft is not much larger than the Mercury capsule, but easier to maneuver.

See a one-fifth scale model of Gemini hanging above!

February 3, 1966 -- First Spacecraft Lands on the Moon

The Soviet Luna 9 soft-lands on the Moon and returns the first pictures from the surface—proving that a large spacecraft won't sink into the lunar soil.

March 16, 1966 -- First Space Docking

Gemini 8 completes the first successful docking in space with the unmanned Agena spacecraft.

June 2, 1966 -- First American Spacecraft on the Moon

Surveyor 1 lands on the Moon, only nine miles from its target in Oceanus Procellarum. It transmits over 11,000 images before running out of power.

January 27, 1967 -- First U.S. Space Casualties

During a launch-pad test of the Apollo 1 spacecraft, U.S. astronauts Gus Grissom, Ed White, and Roger Chaffee are killed in a fire caused by faulty wiring.

April 23, 1967 -- First Soviet Space Casualty

Cosmonaut Vladimir M. Komarov is killed when his spacecraft, Soyuz 1, crashes on reentry.

September 18, 1968 -- First Moon Orbit

The Soviet Zond 5 orbits the Moon and returns, demonstrating the "slingshot" maneuver needed to bring a crew back to Earth.

October 11, 1968 -- First Manned Apollo Mission

The Apollo 7 crew—Walter M. Schirra, Jr., Donn F. Eisele, and Walter Cunningham— orbits the Earth 163 times over nearly 11 days.

See the one-quarter-scale model of the Apollo Command Module hanging above!

December 25, 1968 -- First Manned Moon Orbit

Apollo 8 becomes the first spacecraft to orbit the Moon with a human crew aboard, making ten orbits over a six-day trip.

February 21, 1969 -- First N-1 Superbooster Launch Fails

The Soviet rocket that could have sent cosmonauts to the Moon explodes during launch. Future launches also fail, and Soviet hopes for a manned moon landing fade. The N-1 program is cancelled in 1974.

July 20, 1969 -- First Manned Moon Landing

Apollo 11 astronauts Neil Armstrong and Buzz Aldrin, Jr. become the first human beings to set foot on another world. Their mission fulfills the goal set by President Kennedy in 1961.

September 24, 1970 -- First Robotic Return of Lunar Soil

The Soviet Luna 16 becomes the first robotic spacecraft to return lunar soil samples to Earth.

November 17, 1970 -- First Robotic Rover Mission

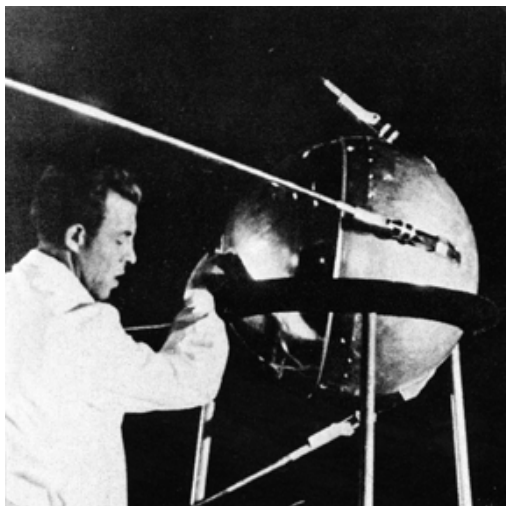
The Soviet Luna 17 lands with the first robotic rover, Lunokhod 1, which roams the Moon's surface for 11 days.

July 30, 1971 -- First Manned Lunar Rover Mission

Apollo 15 carries the first human-operated lunar rover to the Moon, allowing astronauts David Scott and James Irwin to explore the Moon's surface.

December 11, 1972 -- Last Apollo Landing on Moon

Apollo 17 is the last 20th century spacecraft to carry astronauts to the Moon. Astronaut Harrison Schmidt becomes the first and only scientist thus far to land on the Moon.



Sputnik 1 Model

This is a full-sized model of Sputnik 1, the world's first artificial satellite. Sputnik was launched by the Soviet Union on October 4, 1957—the shot that started the Space Race. It weighed about 83.6 kilograms (184 pounds), had a diameter of 58 centimeters (23 inches), and transmitted radio signals back to Earth for 21 days. It remained in orbit for 92 days before burning up in Earth's atmosphere.

Explorer 1 Model

This is a full-sized model of Explorer 1. Explorer 1 was launched on January 31st, 1958, becoming the first successful launch of an artificial satellite by the United States. Explorer 1 made scientific measurements that contributed to the discovery of radiation belts surrounding Earth.

Explorer 1 was 203 centimeters (80 inches) long, had a diameter of 15 centimeters (6 inches), and weighed 13.9 kilograms (30.7 pounds).

Mercury Capsule—Basic Space Transportation

Climb in! Imagine you're one of the seven Mercury astronauts. You fly your tiny capsule hundreds of miles above the Earth at nearly 18,000 miles per hour. You can only get home by plunging through the atmosphere into the ocean.

Climb into this life-size Mercury spacecraft replica to feel what it was like for the first American space explorers. Astronauts couldn't be claustrophobic! Imagine speeding along at nearly 18,000 miles per hour, hundreds of miles above the surface of the Earth. The only way home is a fiery plunge through Earth's atmosphere into the ocean.



Mercury, the first U.S. spaceship, carried astronauts into space between 1961 and 1963. Before any human astronaut flew in a Mercury capsule, a chimpanzee flew into space and returned safely to Earth.

The Mercury flights taught us the most basic lessons of spaceflight: how to get an astronaut into orbit, how to maneuver a spacecraft, how to keep a human alive and functioning in space, and how to land safely.

Mercury was roughly the size of an elevator -- seven feet long and six feet in diameter. The blunt tail end was covered with a heat shield that protected it from the 3,000-degree temperature of re-entry into Earth's atmosphere.



Going Where No Dog Has Gone Before!—Laika's Dog Cabin

The first Earthling in space was a dog. In November 1957, the Soviet Sputnik 2 carried a dog named Laika into space. Laika might have survived for up to a week, or died hours after launch—accounts differ. At the time, there was no way for the satellite or its payload to return to Earth.

This is a full-sized engineering model (made for testing and development, not as a mere display model).

Laika was a mutt, partly a breed of dog called "barker" ("laika"). Laika, along with other dogs drafted into the Soviet space program, was found on the streets of Moscow.

A Much Higher Primate

On January 31, 1961, a chimpanzee named Ham flew in a Mercury capsule, becoming the first higher primate (a relative of humans) to travel in space. Ham traveled 157 miles before splashing down safely in the Atlantic Ocean. He died at the age of 27 in 1983.

Gemini Model

Hanging above is a 1/5 scale model of the Gemini spacecraft.

After Mercury, Gemini was our next step into space. The two-person crew learned the important lessons of long duration flight, maneuvering and docking two spacecraft, venturing outside the spacecraft on "spacewalks," and working together as part of a multi-person crew.

The Gemini spacecraft was a little larger than the Mercury capsule, but was simpler to maintain and maneuver. Gemini was 19 feet long, 10 feet in diameter, and



weighed about 8,400 pounds.

The Titan II rocket, more powerful than the Redstone or the Atlas, placed this larger spacecraft into orbit.

Apollo Model

Hanging above is a 1/4 scale Apollo Command Module model.

The Apollo spacecraft carried astronauts to the Moon, landed them on its surface, and returned them safely to Earth.

Apollo had three parts: the Command Module, for the flight control systems and crew's quarters; the Service Module, for



the propulsion and spacecraft support systems; and the Lunar Module, to transport two members of the crew to the lunar surface, support them there, and return them to the Command and Service modules in lunar orbit.

Secondary Entrance: Bottom floor

Walking on the Moon

The circular alcove at the bottom floor of the Dellums Building is now a "green screen" theater. Walk into the alcove, in front of the green wall, and look back at the video monitor in the cabinet. You will see yourself standing on the Moon! (Or you might find yourself in a smoking scene of devastation from a Godzilla movie, if the channel has been inadvertently changed....)



Imagine what it feels like to walk on the Moon when you're six times lighter than you are on Earth. Neil Armstrong said it was like "kangaroo-hopping." Can you move like an astronaut?

The image taken by the video camera on top the cabinet is run through a special processor that replaces all parts of the scene of the color keyed into the processor (in this case, a range of green shades) with another digital image (in this case a Moon-scape, or a mutant Japanese lizard at work on *Extreme Makeover: Tokyo Addition*).

Quotes of Apollo Astronauts Walking on the Moon

"The surface is fine and powdery. I can kick it up loosely with my toe."

– Neil Armstrong, Apollo 11

"On Earth, you'd fall over leaning that far forward."

–Alan Bean, Apollo 12

"Oh, boy. It's *beautiful* out here! Reminds me of Sun Valley."

–James Irwin, Apollo 15

"Hey, who's been tracking up my lunar surface?"

–Harrison Schmidt, Apollo 17, said of Eugene Cernan's footprints

Surviving in Space—Landing between bottom and middle floors

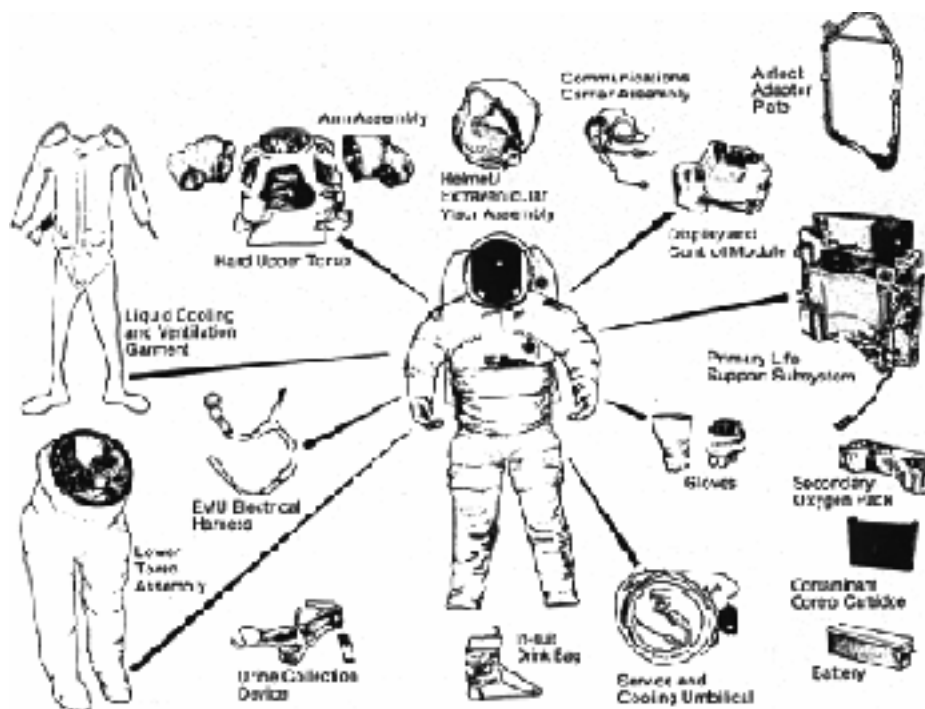
Climbing the stairway to the first landing, try on a simulated space helmet to see what living and working in space might be like. Learn what a spacesuit is made of, and why an astronaut needs one.

Why does an astronaut need a spacesuit?

Astronauts need spacesuits because space is a harsh environment with no air, no air pressure, extreme temperatures, and raw radiation. Spacesuits are protection!

If you were in space with no spacesuit:

- You would pass out within 15 seconds.
- Your organs would expand and possibly burst.
- Your skin would freeze.
- Your side facing the Sun would be 248° F, hotter than boiling water; your other side would be 148° F *below zero*.
- You would be exposed to deadly radiation.
- You would not survive for long.

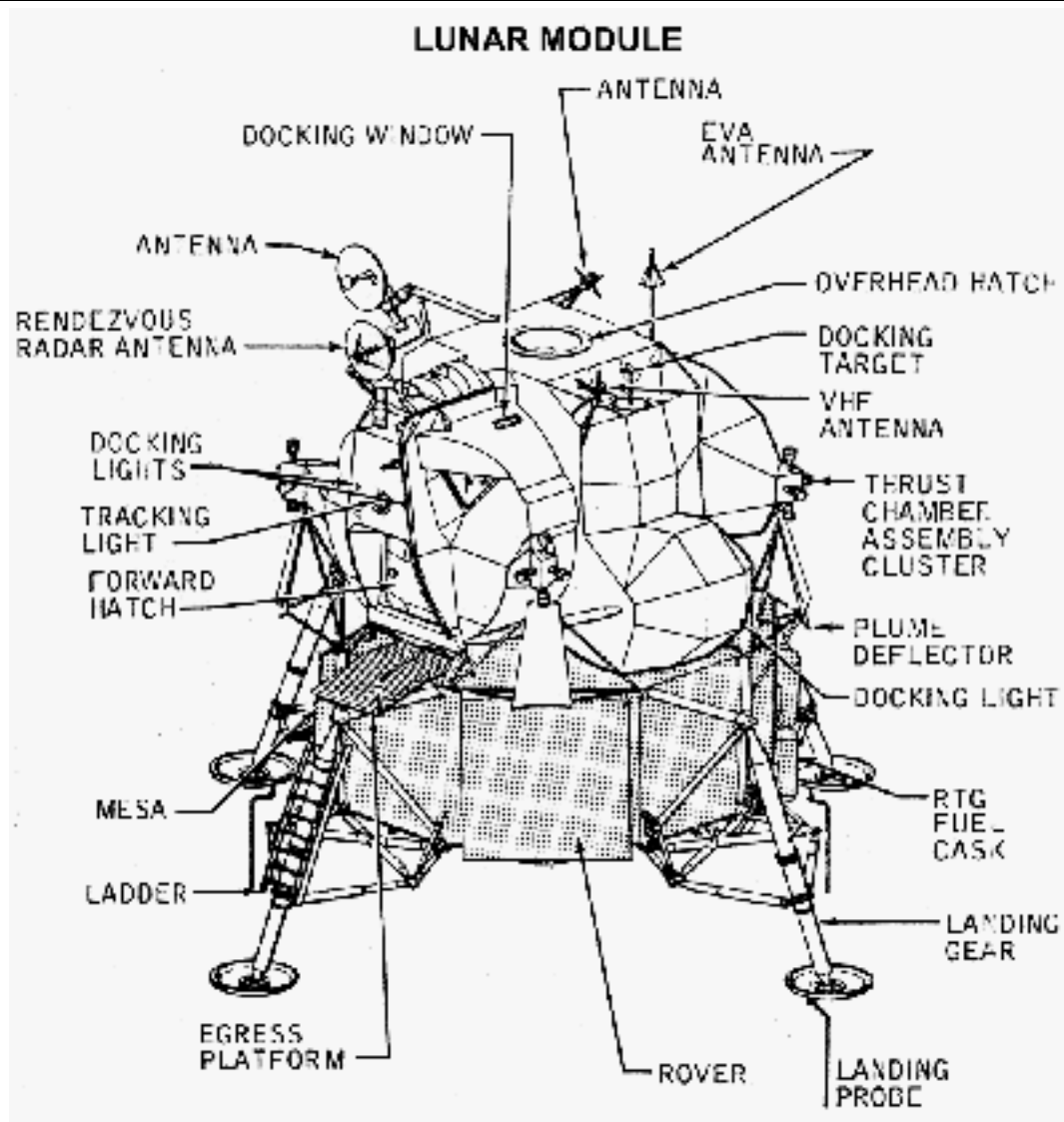


What was the Apollo spacesuit made of?

- A water-cooled nylon undergarment—like air-conditioned underwear
- A layer of lightweight nylon

- A layer of neoprene-coated nylon to hold air pressure, like a balloon
- Another layer of nylon to hold it all in
- Five layers of aluminized Mylar interwoven with four layers of Dacron for heat protection, like a space blanket
- Two layers of Kapton for additional heat protection
- Outer layers of Teflon-coated glass-fiber cloth to protect against scrapes
- The suit had boots, gloves, a communications cap, and a clear plastic helmet. During liftoff, the ship supplied the suit's oxygen and cooling water.

The Lunar Landing—Dellums Building, Sky Bridge level



The Lunar Module

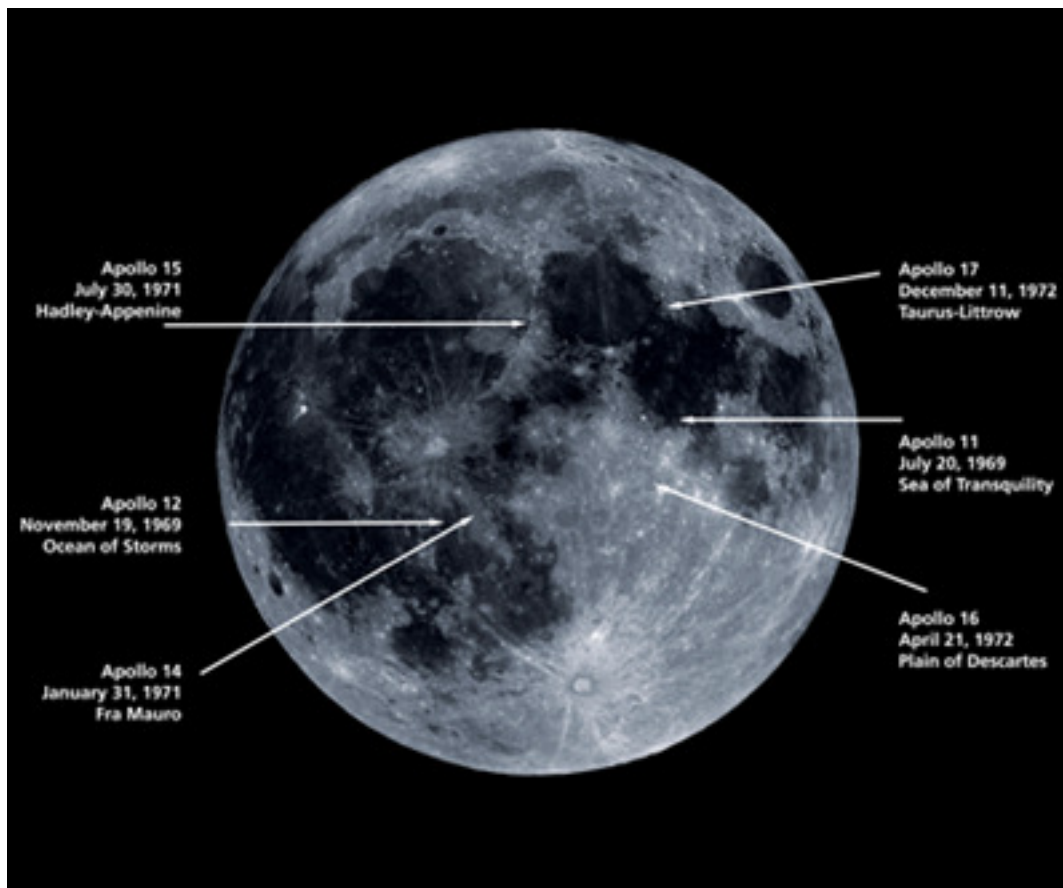
The Apollo Lunar Module, or LM, had two engines—one for landing and one for taking off.

When landing, the LM was powered by its descent stage engine, with just enough fuel for the trip down, plus a little to spare.

For the trip back up, the upper ascent stage separated from the descent module platform and returned the crew to the orbiting Command and Service Module.

The Six Lunar Landing Sites

1. Apollo 11: July 20, 1969. Mare Tranquillitatis (Sea of Tranquility).
2. Apollo 12: Nov. 19, 1969. Oceanus Procellarum (Ocean of Storms).
3. Apollo 14: Jan. 31, 1971. Fra Mauro formation.
4. Apollo 15: July 30, 1971. Hadley-Apennines.
5. Apollo 16: April 21, 1972. Descartes Highlands.
6. Apollo 17: Dec. 11, 1972. Taurus-Littrow.



Details of the Sites

Apollo 11: Mare Tranquillitatis—Sea of Tranquility, July 20, 1969. Neil A. Armstrong, Michael Collins, and Edwin E. "Buzz" Aldrin, Jr. The first landing site was chosen for safety: the great lava plateau was wide and flat, and its location near the Moon's equator required less fuel for landing and ascent.

Apollo 12: Oceanus Procellarum—Sea of Storms, Nov. 19, 1969. Charles "Pete" Conrad, Jr., Richard F. Gordon, and Alan L. Bean. This landing spot was chosen because it was covered by debris ejected from Copernicus crater a couple hundred miles away, making it geologically interesting. Also, the robotic probe Surveyor 3 had landed here a couple of years earlier, allowing the astronauts to visit and examine the craft.

Apollo 14: Fra Mauro formation, Jan. 31, 1971. Alan B. Shepard, Jr., Stuart A. Roosa, and Edgar D. Mitchell. This highland spot is near Mare Imbrium, the "Sea of Rains," an enormous impact basin probably created shortly after the Moon formed. Rock from that ancient blast would provide samples that formed deep beneath the Moon's original crust.

Apollo 15: Hadley-Apennines, July 30, 1971. David R. Scott, Alfred M. Worden, and James B. Irwin. This landing spot near Mare Imbrium and the Apennine mountain range was chosen so that the astronauts could drive their rover to the foot of the mountains to collect rock samples.

Apollo 16: Descartes Highlands, April 21, 1972. John W. Young, Thomas K. Mattingly, and Charles M. Duke, Jr. This spot offered two types of terrain to explore: the smooth surface of the Cayley Plains and the hilly highland plateau of the Descartes formation.

Apollo 17: Taurus-Littrow, Dec. 11, 1972. Eugene A. Cernan, Ronald E. Evans, and Harrison H. Schmitt. This mountainous area at the rim of Serenitatus was chosen for its volcanic formations, including three steep massifs, a dark layer thought to be a volcanic deposit, and several halo craters that looked like volcanic vents.

Lunar Lander Simulator

Can you land safely on the Moon?

This is a copy of part of an Apollo lunar lander. Step inside, and try to land safely from 3000 feet by controlling thruster rockets. Warning: Moon gravity is one-sixth that of Earth's, but you can still crash!

1. Choose your level of difficulty by moving the joystick forward. Try starting at "novice." Watch and listen for instructions.
2. Try to control your speed of descent without running out of fuel.
3. Look at your onscreen gauges to track altitude and speed of descent.

Good luck. Remember—all astronauts need practice!

Lunar Module Engine Bell

This lunar module engine bell was built as a backup for Apollo 17 or Apollo 18, which was cancelled. It would have lifted the lunar module off the Moon's surface to reunite with the orbiting command module. It is pure titanium, which is stronger and lighter than steel.

Engine bell loaned from the collection of the W Foundation, with additional support provided for its display.

Saturn 5 Rocket

The model of the Saturn 5 rocket standing in the stairwell is a one-tenth scale version, standing 36 feet high. The real Saturn 5 is ten times wider and ten times higher.

When NASA decided to send astronauts to the Moon, they didn't have a vehicle that could get them there. The solution was the three-staged Saturn 5 rocket. A "staged" rocket is two or more rockets, one carried on top of another. As one stage runs out of fuel, it is dropped, and the engines of the next stage take over, free of the lower stage's weight.

At 363 feet high and over six million pounds, the Saturn 5 remains the largest operational launch vehicle ever built.

Comparisons

Saturn 5:	Statue of Liberty:	Giraffe:
363 feet tall	152 feet tall	17-19 feet tall
3000 tons	156 tons (not including concrete base)	1-2 tons

(This means that in our 1/10 scale model, the Statue of Liberty would be 15 feet tall (the torch would reach up to just above the banister on the Sky Bridge level), and the giraffe would be less than 2 feet tall—how cute would a 2-foot giraffe be!?)

Flight History

- Thirteen launches, 1967-1973
- First test flight: November 9, 1967 - carried unmanned Apollo 4
- First manned mission: December 12, 1968 - lifted Apollo 8 to lunar orbit
- Final lunar mission: December 6, 1972 - Apollo 17
- Last mission: May 14, 1973 - launched Skylab Space Station into Earth orbit

All About the Moon—Top floor

"To lift a rock by hand from the Moon...what could be more fantastic?"

-Konstantin E. Tsiolkovsky, Father of Russian Astronautics, 1896

"The Moon is the first milestone on the road to the stars."

-Arthur C. Clarke

Moon Basics

- Distance from the Earth: 240,000 miles—167 days' drive, without stopping, at 60 m.p.h.

- Diameter: 2,172 miles—the distance from Oakland to Chicago.
- Mass: 1/100 that of Earth—100 Moons equal the mass of one Earth.
- Age: About 4.5 billion years.
- The Moon takes 29.5 days to complete one cycle of its phases, but only 27.3 days to complete one orbit around Earth.

A Piece of the Moon—the Moon Rock

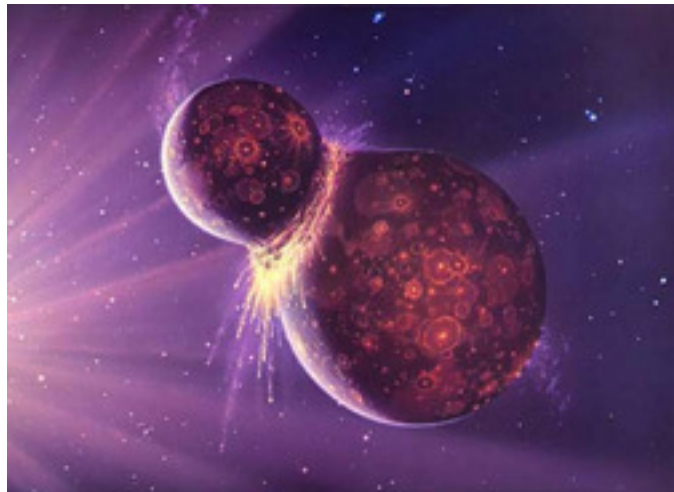
This Moon rock is a piece of ancient lava about 3.3 billion years old, cut from a sample brought back to Earth in 1971 by the Apollo 15 astronauts. It can help tell us about how the moon was formed and what it is made of.

The Hard Facts: Moon Rock Sample 15555,879

- Rock Type: Mare basalt
- Collection Site: Apollo 15 landing site, 12 meters north of the rim of Hadley Rille
- Mass: 123.696 grams
- Age: 3.3 billion years
- Composition: 55% pyroxene, 26% plagioclase, 15% olivine, 3.5% opaque minerals, 0.5% cristobalite

Whack! The Moon Is Formed—A Theory of the Moon’s Origin

Here’s how the moon was formed, according to a theory called “The Big Whack.” About 4.5 billion years ago, when the Solar System was young, a planet about the size of Mars smashed into the Earth. Lighter material from both the Mars-size planet and Earth was blasted out into Earth orbit and came together to form the Moon.



Timeline of the Moon

The First 1.5 Billion Years Were Pretty Exciting

When the Moon first formed 4.5 billion years ago, it was covered by a deep ocean of *lava*—extremely hot liquid rock. Lighter rocks cooled first and floated to the ocean’s surface, forming today’s lunar highlands. As the crust cooled and became solid, one asteroid after another slammed into the Moon’s surface, digging out huge craters and great basins. The basins and some of the larger craters filled with lava that bubbled up from below. That

lava cooled to form the dark areas called *maria*—Latin for seas—that we see from Earth today.

The Next 3 Billion Years: Frozen in Time

During the next 3 billion years, the entire Moon cooled all the way down to its core. Without hot lava or asteroid impacts to change things, the Moon has stayed basically the same for the past 3 billion years or so. Meanwhile, the Earth, which is still hot beneath its surface, is constantly changing. The oldest rocks on Earth are about the same age as the youngest rocks on the Moon. So the Moon is a sort of time capsule. It's the only place we can find preserved evidence—such as our Moon rock—of what happened to the Earth and Moon when they were young.

The Tide of Life—Did the Moon Have a Hand in Life on Earth?

The pull of the Moon's gravity causes most of the rise and fall of the tides on Earth (the Sun helps, too). That pull may have led to the formation of life on our planet. Here's the theory:

Billions of years ago, complex molecules formed in the oceans and concentrated in tide pools along the coasts. Tidal action flooded the pools, swept the molecules out to sea, and returned them to the pools, where they made new combinations. Scientists think that eventually, one of those combinations started reproducing on its own. So the Moon might have helped the beginning of life on Earth.

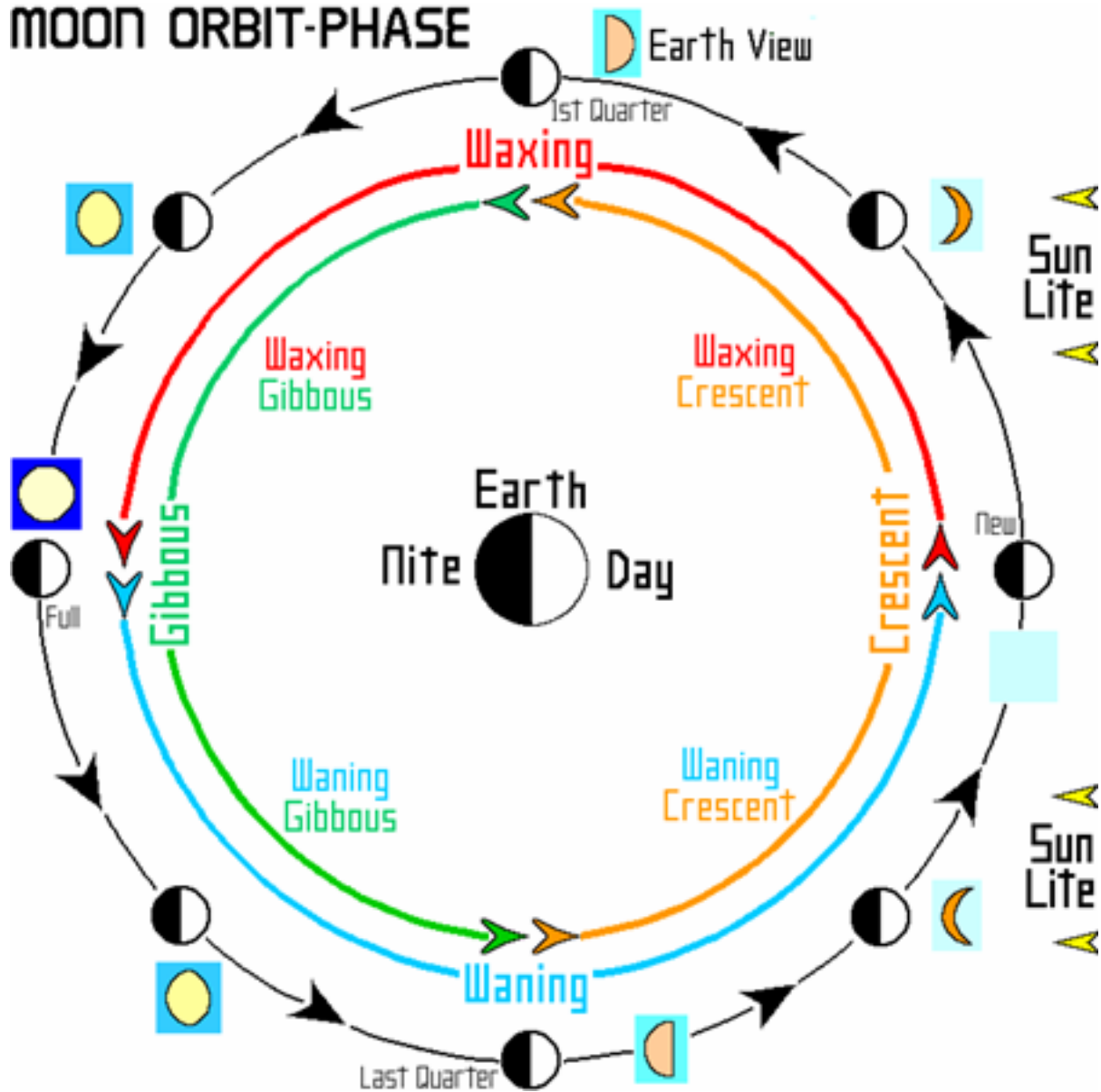
Moon Phase Interactive (the Moon Bike)

Why does the Moon look different each night? It's our changing point of view from Earth!

When you sit on this stool, your head becomes the Earth. Look at the Moon globe and see how the lamp—representing the Sun—makes it appear. Now, spin around to simulate the Moon's orbit around Earth.

You'll see that the Sun always shines on half the Moon's surface—but from Earth, we can't always see that entire half.

MOON ORBIT-PHASE



Things Visitors Can Try

1. Make a "Full Moon" (the Moon is fully lit)
2. Make a "New Moon" (the Moon is all dark)
3. Make as many different "Quarter Moons" as possible (only half the Moon is lit)

Now...is there *really* a "dark side of the Moon"?

Facts about Phases

Though my daughter and I agree that "New Moon" should be called "No Moon," the phase we DON'T see (when the dark side of the Moon fully faces

Earth) is called New because it was always regarded in many cultures as the beginning of the Moon phase cycle.

“Waxing” means growing, describing the time between New and Full Moon phases when the bright side of the Moon gets larger.

“Waning” means fading, the half of the phase cycle when the Moon appears to diminish, from Full back to New.

“First Quarter” and “Third Quarter,” though often thought to be named this way because exactly one quarter of the Moon’s surface is visible to us (half of the half that faces Earth), really refer to the fact that the Moon has completed one quarter and three quarters, respectively, of its orbit around Earth, starting from New.

The time it takes the Moon to complete one phase cycle is 29.5 days, even though it takes only 27.3 for the Moon to complete one orbit around Earth. This is because as the Moon orbits us, the Earth also orbits the Sun, and the Moon has to spend almost two extra days to “catch up” with its phases.

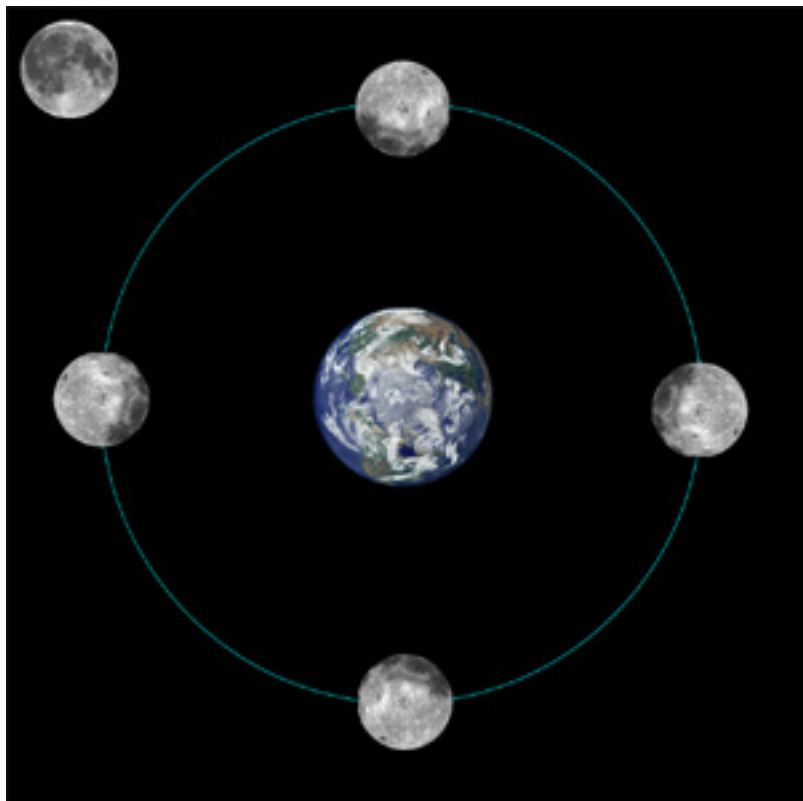
Moon Orbit Interactive

Have you ever seen a face on the Moon—or a rabbit, or a woman carrying a water jug? Different cultures see different pictures there, but everyone notices one thing: the pattern of light and dark—formed by lava plains and mountains—never changes.

The same side of the Moon always faces the Earth. Does this mean the Moon doesn’t rotate?

Instructions

Does the moon spin as it orbits the Earth? Find out for yourself. Move the Moon along its orbit, but make sure you keep the same face of the Moon aimed at Earth at all times. Watch the Moon as you move it completely around the Earth. What do you think now?



Moon Gravity Interactive

Lift the two weights. One weighs just what it should here on Earth. Its twin weighs what the other would weigh on the Moon. Which is which?

The amount of material in your body—your *mass*—is the same everywhere in the Universe. But your *weight* changes with gravity. The Moon's gravity is one-sixth that of Earth, so your Moon weight is one-sixth your Earth weight. A 120-pound person on Earth weighs only 20 pounds on the Moon.

Moon Image Flipbook

Flip through these photos taken by Apollo astronauts on the Moon:

AS16-115-18561: Apollo 16. The shadow of the Lunar Module is cast across the Descartes Highlands. The Lunar Rover and its driver are in the distance.

AS16-116-18614: Apollo 16, Station 11. Descartes Highlands. On the left is one edge of North Ray crater.

AS16-116-18647: Apollo 16. Closeup of "Outhouse Rock," a large boulder. Charles Duke points to a shatter cone, a shock feature created by a meteorite impact. Duke's camera and gloved right hand, holding sample collection bags, are on the left.

AS16-116-18653: Apollo 16. Charles Duke collects samples from the area of "Outhouse Rock." A pack of sample collection bags hangs from Duke's right glove.

AS16-116-18689: Apollo 16, Station 10. Charles Duke is about to take a sample from a rock by hitting it with his hammer. The boot prints show how the area's powdery soil clumps together like flour.

AS17-140-21372: Apollo 17. The Lunar Module rests on its landing site in the mountainous Taurus-Littrow region. The gold-foiled descent stage still stands on the Moon today as seen in this picture.

AS17-140-21425: Apollo 17. Station 6, EVA 3—the third expedition from the landing site. A boulder is in the foreground. The hills of the Taurus-Littrow region are in the background.

A17-140-21482: Apollo 17. Station 6, EVA 3. A dusty rock shelf just after Eugene Cernan scraped a sample from it. Cernan's gloved hand made the mark on the left; the sampled area is in the middle.

A17-141-21517: Apollo 17 landing site, Taurus-Littrow region. Lunar Rover tracks and an astronaut's boot prints lead to the Surface Electric Properties experiment package. The Lunar Module is in the distance.

AS17-141-21596: Apollo 17. Close-up of large boulder.

AS17-141-21599: Apollo 17, Taurus-Littrow region. Eugene Cernan places a Lunar Surface Gravimeter on the ground after doing donuts with the Lunar Rover. Twelve gravimeters were placed in the area to study small differences in surface gravity.

AS17-141-21607: Apollo 17. A gnomon, or shadow-casting vertical pole, placed in front of a rock fragment by Eugene Cernan. The shadow indicates lunar direction. The Lunar Rover is in the background on the right.

AS17-141-21647: Apollo 17. Station 7, EVA 3. An undisturbed lunar scene before rock fragment samples were taken from the area. The foreground is in sharpest focus.

Moon Fancies—Magnetic Lunar Poetry Board

The Moon is the subject of some of the most whimsical and fantastic ideas in myth and fiction. Here's a list of just a few—and you can add your own on the magnet board on the landing between the middle and top floors.

- The Moon is made of cheese.
- There is a man in the Moon.
- A cow jumped over the Moon.
- There is a rabbit on the Moon.
- The Moon and the Sun chase each other across the sky.
- The Moon disappears during certain days of the month.
- There are people or other creatures living on the Moon.
- The Moon was put in the sky by a person or animal.
- The Moon is a living creature or a god.
- The Moon controls how we act and how we feel.
- The Full Moon turns some people into wolves.
- A person, animal, or other force pulls the Moon across the sky.

Fantastic Flights



"I'm sure we would not have had men on the Moon if not for Wells and Verne and the people who write about this..."

-Arthur C. Clarke

People imagined traveling to the Moon long before astronauts got there. Here are some dusty old favorites for you to read:

Jules Verne, *From the Earth to the Moon*

People made imaginary voyages to the Moon long before astronauts got there. In Jules Verne's 1865 "From the Earth to the Moon" a group of Civil War veterans find themselves with nothing interesting to do when the war ends--so naturally they decide to build a

cannon to send a projectile to the Moon! But when an adversary bets against their success, and an adventurous volunteer transforms the project into a manned mission, the story quickly turns into an international race to the Moon. In his usual spooky, futuristic vision, Verne chose the site for his fictional Moon launch: a place called Tampa, Florida—the launch site of the Apollo, nearly one hundred years later....

H. G. Wells, *The First Men in the Moon*

The 1901 publication of H. G. Wells' "The First Men In the Moon" is more than a fanciful first flight of humans to the Moon. The two freelance adventurers, propelled into space by the invention of an antigravitational substance, explore deep *into* the Moon—and find more than geological wonders. Inhabiting the sublunarian world is a race of insect-like beings, a culture where individuals, much less important than the society as a whole, are physically altered to fit the role of their social class. Of course, nothing like that would ever happen on Earth....

Mythical Moon

All over the world, many cultures have legends and stories about the Moon. Here are two of them.

Coyolxauhqui

Coyolxauhqui was the Moon goddess of the Aztecs. She was the ruler of the star gods, and a powerful magician. When her mother became pregnant in a shameful way, Coyolxauhqui killed her. The unborn fetus, Huitzilopchtli, the Sun god, sprang forth and killed Coyolxauhqui, then tossed her head into the sky, which became the Moon.

Mawu

The supreme god to the Fon people in West Africa is Mawu, the Moon goddess, the goddess of night, joy, and motherhood. Mawu, seen as an old mother who lives in the west, brings cooler temperatures to the African world. Mawu and her partner, Liza, the god of day, together created the world.





Soma

In Hindu mythology, Soma, the god of the Moon, rides through the sky in a chariot pulled by white horses. The Moon is the storehouse of the elixir of immortality, which only the gods can drink. The waning of the Moon is said to happen as the gods drink away the elixir

Rona

Rona was Tide Controller in Maori myth, daughter of the sea god Tangaroa. One night as Rona carried a bucket of water, the Moon slipped behind a cloud and it became dark. Rona tripped on a root and became upset, speaking unkind words about the Moon. The Moon heard her, snatched her up, and placed a curse on the Maori people. Many today see a woman with a bucket in the Moon, and it is said that when Rona upsets her bucket, it rains.

Anningan

The Moon god of some Inuit people of Greenland is Anningan. Anningan continually chases his sister, Malina, the Sun goddess, across the sky. As he chases her he forgets to eat, and becomes thinner and thinner. Finally, each month, he disappears for three days to satisfy his hunger and returns replenished to begin the chase again.

Tsuki-Yoma

In the oldest Japanese religion, Shinto, Tsuki-Yomi was the Moon god. Born of the right eye of the being Izanagi, Tsuki-Yomi originally lived in the Heavens with his sister, the Sun goddess Amaterasu. One day, Amaterasu sent her brother as a representative to the goddess of food, Uke Mochi. Uke Mochi celebrated the visit by making him a wonderful meal created from her mouth and nose. Tsuki-Yomi was so disgusted that he killed her. This made Amaterasu so angry that she never wanted to see her brother again, and so day and night are separated.

Artemis

The Greek Moon goddess was Artemis, twin sister of the Sun god Apollo, and daughter of Zeus and Leto. A hot-tempered pair, Artemis and Apollo killed most of the children of Niobe, who insulted their mother by comparing his children to the twins of Sun and Moon. Artemis was also the goddess of the hunt.



How Does the Moon Affect You?

When the Greek king Lycaon played a trick on the god Zeus, the god of gods turned him into a wolf. "Lycanthropy"—the affliction of being transformed into an animal--is named after Lycaon, who started the whole thing.

Tales of lycanthropy are found in many cultures around the world, and one thing most of them have in common is that the Moon is the cause of the transformations.

An 18th Century psychologist described these effects: "The desire to run comes upon them. They leave their beds, jump out of a window, and plunge into a fountain. After the bath, they come out covered with dense fur, walking on all fours, and commence a raid over fields and meadows, through woods and villages, biting all beasts and human beings that come their way. At the approach of dawn, they return to the spring, plunge into it, lose their furry skins, and again regain their deserted beds."