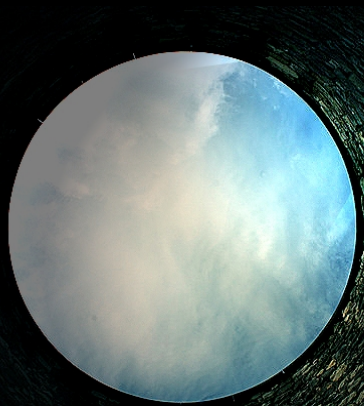
CAPTAIN BOOTSIE BEAR'S
AND
MARVIN THE MARTIAN'S



GUIDE TO THE MOON

Moon Guide Courtesy
of
NASA
and
Captain Bootsie Bear's Magic Time Portal To Adventure
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DID YOU KNOW?

- The distance From Earth is 363,301 kilometers (225,745 miles).
- The radius of the moon is 1,738 kilometer (1,080 miles), the diameter is 3476 kilometers (2,160 miles).
- Total weight: of the moon is 74 sextillion kilograms (81 Quintillion Tons).
- The surface temperature during the day is 134 iC (273i F), and at night is - 153i C (244i F)
- Gravity at the surface of the moon is 1/6 that of the Earth
- The Orbital speed of the moon is 3680 km per hour (2,287 mph).
- It would take 135 days to drive by car (@70 mph) to the moon
- It takes 60 to 70 hrs flying time to get to the moon by rocket.
- The age of the oldest rock collected is 4.5 Billion years old.
- The rocks collected by Apollo weigh 382 kg (842 pounds).
- The moon's widest craters are 225 km (140 miles) in diameter.
- The moon's deepest craters are 4,500 meters (15,000 ft.)
- The moon's highest mountains are 5,000 meters (16,000 ft)

- From Earth, we always see the same side of the moon.
- The lunar day (or the time from sunrise to sunrise) on the moon is approximately 708 hours
- On July 20, 1969, Neil Armstrong became the first human being to set foot on the Moon.
- The moon is actually moving away from earth at a rate of 1.5 inches per year.
- The surface area of the moon is 37,932,000 square km (14,658,000 square miles) or 9.4 billion acres.
- Only about 59 percent of the moon's surface is visible to us here on earth.
- The moon is not round, but egg shaped with the large end pointed towards earth.
- The earth rotates about 1000 mph. By comparison, the moon rotates about 10 mph.
- If you weigh 120 pounds, you would weigh only 20 pounds on the moon.
- The moon has no atmosphere or clouds.
- Its surface is scarred from hundreds and thousands of meteors that have struck it over billions of years.
- Moon soil is called regolith.

- There are no active volcanoes on the moon.
- "Moonquakes" are millions of times less powerful than earthquakes.
- The spacecrafts Clementine and Lunar Prospector found evidence for water on the Moon
- There are two high tides and two low tides every day on every beach on Earth, because of the moon's pull.
- Only 12 people have ever walked on the surface of the moon.
- People have not gone to the moon since 1972.
- From 1972 to present only four spacecraft orbited the moon, Clementine, Hiten, Lunar Prospector and Smart-1.
- The Clementine spacecraft discovered evidence of ice at the Moon's south pole.
- Some people believe that moonlight causes insanity. "Don't stare at the moon. You'll go crazy."
- The word "lunatic" comes from when doctors thought that the insane were "moonstruck."
- The ancient Chinese greeted solar eclipses by using noisemakers and by shooting arrows toward the heavens.

- The Moon's orbit is inclined 5 degrees from the Earth's ecliptic.
- The face of the Moon is marked by regions, called mare, Latin for "sea". A name given by Galileo who thought the dark featureless areas were bodies of water. We now know them to be basalt (a type of lava) filled impact basins.
- The Moon's magnetic field is 100 to 1000 times weaker than the Earth's
- The sidereal month is the average period of revolution of the moon around the earth in reference to a fixed star, equal to 27 days, 7 hours, 43 minutes in units of mean solar time.
- The cause of moon phases is that from the Earth we see the part of the Moon that is illuminated by the Sun from different angles as the Moon traverses its orbit. So the appearance depends on the position of the Moon with respect to the Sun (as seen from the Earth). Because the Earth orbits the Sun, it takes the Moon extra time (after completing a sidereal month, i.e. a full circle) to catch up and return to the same position with respect to the Sun. This longer period is called the synodic month

QUESTIONS YOU ALWAYS WANTED ANSWERED BY ASTRONOMER DR. CATHY IMHOFF OF THE SPACE TELESCOPE SCIENCE INSTITUTE.

How did the moon form?

- We think that the moon and Earth formed at about the same time, back when our whole solar system was formed. Earth was forming from many chunks of rock and icy material. Possibly a big chunk hit the new Earth and knocked loose a big piece, which became the moon.

How hot and cold does it get on the moon?

- As you may have learned, the moon doesn't have any air around it. The air that surrounds our earth acts as a nice blanket to keep us warm and comfy! But the moon, since it doesn't have this blanket, gets much colder than the earth — and much hotter than the earth. On the side of the moon that the sun is shining on, the temperature reaches 260°Fahrenheit! That is hotter than boiling. On the dark side of the moon, it gets very cold, -280° Fahrenheit.

What is the surface of the moon like?

- The surface of the moon has about two inches of dust. Much of this dust has fallen to the moon from the spaces between the planets over the last several billions years. It probably feels pretty soft. You can see this in some pictures taken by the astronauts of their footprints on the moon.

How many holes are in the moon?

- We call those holes "craters." They are the places where many years ago meteors hit the surface of the moon and put dents into it. There are thousands of big craters, but even more little ones. There are probably millions of little craters on the moon! Some are only an inch or so across.

Why does the moon have big rocks?

- The moon is made up of various kinds of rocks. These rocks are fairly similar to the rocks on earth. But on earth, we have wind and rain that help wear the rocks down into sand and dirt. There is no air or wind on the moon, so the rocks don't get worn down as they do on the earth.

How many moons are there all together?

- Earth has only one moon. If you count all the moons around all the planets in our solar system, there are 61 (Earth has one, Mars has two, Jupiter has 16, Saturn has 18, Uranus has 15, Neptune has 8, and Pluto has one). There may be more that we haven't discovered yet!

Why does the moon change its shape (as in full, half, and quarter moon)?

- The bright part of the moon is the part that the sun is shining on. This is like daytime on earth. The dark part is in shadow, like night on earth. Now the moon goes around the earth once every 29 days (approximately).

- At new moon, the moon and the sun are on the same side of Earth. We see the part of the moon that is in shadow, so the moon is dark. Then the moon moves around in its orbit. At first quarter, it has gone one-fourth of the way around Earth. Now we can see part of the moon that is sunlit, but part still in shadow. Note that if the sun is setting in the west, the bright part of the moon is on the side toward the sun and the dark part is away.

- About a week later, the moon has moved halfway around its orbit. Now it is on the opposite side of Earth, away from the sun. Now we see only the sunlit side — that is the full moon. Note that if the sun is setting in the west, the moon is just rising in the east.

- About a week later, the moon has moved now three-fourths of the way around in its circle around Earth. Once again only part of the moon is sunlit and part is dark. Now you can see the moon in the morning, and note that once again the sunlit side is on the side towards the sun, and the shadow side away. Another week and we are back to the new moon.

- It's easier to demonstrate if you have a ball to represent the moon and a flashlight for the sun. Have someone stand several feet away, holding the flashlight so it shines on the ball. Hold the "moon" ball and slowly turn around, watching the moon go around you (you are Earth). Do you see the moon's phases?

What is a lunar eclipse? What is a solar eclipse?

- 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. During a solar eclipse, our moon moves between us (on Earth) and the sun and blocks the sunlight. During a lunar eclipse, Earth 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 dark. Other kinds of eclipses happen too. For instance if you were standing on the surface of Jupiter (kind of hard, but we can imagine) you might see one of its moons eclipse the sun!

How come we can sometimes see the moon during the day?

- The reason that you don't see the stars during the day is that the sky is too bright. Sunlight scatters around in the air and makes the sky look bright blue. But if you had a telescope and pointed it at a bright star you could still see it during the day! The stars are still there, just hard to see. The moon is bright enough that we can see it during the day or night. It orbits Earth once every 29 days. So during some of that time, it is easiest to see during the day and sometimes during the night.

Does the moon really have volcanoes?

- Yes, the moon has some volcanoes. But as far as I know they are all "dead" volcanoes that have not erupted for millions of years. Most of the craters on the moon are from the surface being hit by asteroids and comets billions of years ago. The moon is a very "quiet" place. There is no air or water to erode the surface, and there are no earthquakes or volcanoes to change the surface. Only the smallest rocks may still hit the surface. So it has not changed much in billions of years! Probably the biggest changes recently are the footprints from the astronauts that visited the moon about 30 years ago!

Does it ever rain or snow on the moon or the other planets of our solar system?

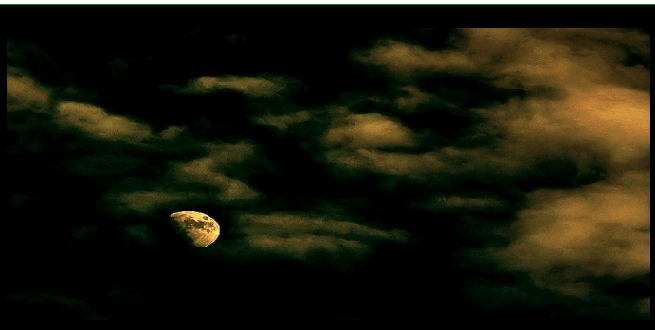
- **To have rain or snow, we need to have water and an atmosphere of some kind. The moon has no atmosphere, so it has no weather at all! Mars has only a very thin atmosphere but it does have weather. Strong winds can blow up big dust storms. Pictures from the Mariner spacecraft show that sometimes thin frost forms on the surface of the planet. Sometimes just after Martian dawn, we see an icy fog rising from the craters! I believe that it is too cold for rain, but frost and icy fogs have definitely been seen. And of course, Mars has polar caps of frozen water and carbon dioxide ("dry ice"). Perhaps it snows at the polar caps. The atmosphere of Venus is very thick and very hot. There is a little water in its clouds, but I don't believe it ever rains. Mercury has no atmosphere. The outer planets — Jupiter, Saturn, Uranus, Neptune, and Pluto — are extremely cold. Their atmospheres are mostly made up of methane, ammonia, nitrogen, and stuff like that. There are probably some ice crystals in their atmospheres too, but they probably just blow around in the strong winds. So there might be a sort of "snow" but not very much like what we are used to on Earth.**

Is there really water on the moon?

- **Water that would be found on the moon may have existed from the days when our solar system was formed. Comets that may have hit the moon could also be a source of water. Generally we think water, that was part of the moon as it formed, would have probably evaporated away. Water from comets would have evaporated too. However, the area where Clementine found the possible signature of water is at the very cold south pole of the moon, in a dark, cratered area where the sun never shines. So it seems possible that the water (or ice) has survived there. We are hoping that other observations can be made with other satellites that can confirm whether this is really water on the moon. If so, it would be a great help for manned space travel in the solar system!**

Can you plant something on the moon?

- **You could plant something, but it would die. There is no atmosphere (it needs carbon dioxide) and no water. The sunlight would burn it during the lunar day, and in the nighttime it would freeze. I don't know if the soil would provide the nutrients that it would need, because it is just rock dust; there are no organic components that earth plants need to fix nitrogen, and so on. Life on earth is very special and very precious!**



If there is no weather or atmosphere on the moon, then where does the ice come from?

- We think that the ice on the moon came from comets! Comets are made up of mostly ice with some rocks and dirt mixed in. We think that most of the water on the earth probably came from comets that crashed into the earth when the earth was very, very young. The ice on the moon may have come the same way. Most of the water on the moon evaporated away a long time ago. But the ice at the South Pole stayed there because it is very, very cold and is in a dark area where the sun never shines.

Is the moon moving away from Earth?

- Yes, it is! But it is moving only about an inch farther away each year.

Do you think it is possible that the moon was once a star and is now a black dwarf?

- No, I don't think so. The moon is way too small in mass (too little material) to have ever been a star.

Why are parts of the moon called seas?

- Galileo was responsible for naming the major features on the moon. You may know that he was the first person to study the night sky using a telescope. He thought the dark, smooth areas were seas, and called them "maria" (Latin for seas; "mare" is the singular). For instance, the first Apollo landing occurred in Mare Tranquilitatis (the Sea of Tranquility). Of course we know now that there are no seas. The "seas" look flat from ancient lava flows. But the names stayed.

If a man was walking on the moon and he picked up a rock and threw it really hard, would it go past the moon's atmosphere?

- The gravity on the surface of the moon is one-sixth of Earth's, so the astronaut could certainly throw that rock a lot farther. Did you know that one of the Apollo astronauts took a golf club to the moon and hit a golf ball a really long way? Even so, the gravity is strong enough that the ball or rock would not go into orbit or leave the moon. But it would go six times as far.

How long would it take to fly in a 747 to the moon?

- Of course we know that this can't happen, because there is no air and a plane couldn't fly fast enough to escape the earth's gravity. But we can pretend. A 747 airplane normally flies at about 400 miles per hour. The moon is about 250,000 miles away. So if we divide 250,000 by 400, we find that the plane would take 625 hours — or 26 days — to fly to the moon! Boy that would be a looong trip! Twenty-six days of eating airline food — yuck!

In a spaceship, how long does it take to get to the moon?

- It depends on how fast the spaceship can travel. When the Apollo astronauts went to the moon, it took about two days.

What is "the man in the moon"

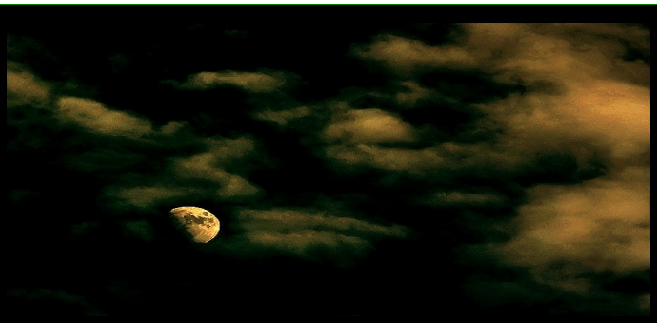
- Have you looked at the moon and noticed the dark patches? Some people think that they make the moon look like it has two eyes and a big smile. The next time the moon is nearly full, it would be a good time to look in the early evening at the moon and see if you can see the "face." In other cultures people see different things on the moon. The Japanese people talk about the rabbit on the moon. I have looked at the moon and seen the "rabbit" too — it looks like a rabbit is walking up the left side of the moon. You might want to look for the rabbit too.

How did the moon get its name?

- The moon is something that even the cavemen must have seen and given a name to. Maybe something like "big light in the sky at night when the sun isn't around." According to my dictionary, the Old English word for the moon was mona. In Latin it was mensis. In Greek it was mene (mee-nee). The words moon and month come from the same roots. That is probably because a month was originally measured by the phases of the moon. It takes 29.5 days for the moon to go from full moon to full moon. But there have been many changes to the calendar since that was true, so now months are a little longer and people don't pay too much attention to the phases of the moon anymore.

In what year will man be able to live on the moon?

- Right now NASA has no immediate plans to send a human back to the moon. NASA scientists and engineers have been studying how to live on the moon, so it is probably possible. But so far, no plans.

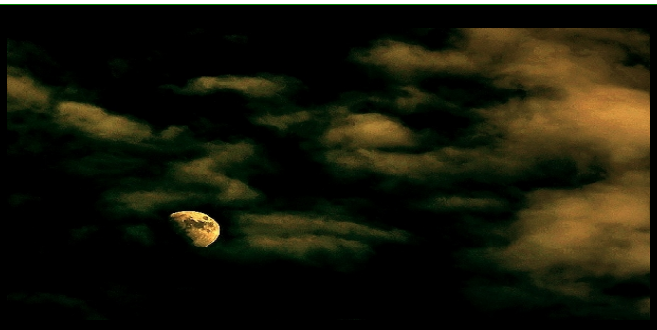


If we are going to have space probes on the moon, should they be on the light or dark side of the moon?

- Some people talk about the Dark Side of the moon as if it is a specific place, but this isn't correct. As the moon orbits Earth, different parts are in sunlight or the dark at different times. It takes roughly 29 days for the moon to circle Earth. Since it keeps the same side toward Earth, this means that the moon turns once every 29 days. This is hard to visualize, but you can try it with a ball (for the moon) and a flashlight (for the sun, and you as Earth), perhaps with some help from your teacher. This is also why the moon has phases.

- When the astronauts went to the moon, they wanted to be on the side facing Earth so they could communicate with us, and also they wanted to be in the sunlight so they could see and also get power to their solar arrays. So they went around the full moon. They stayed only a few days. If they had stayed for two weeks, they would have ended up in the dark during the new moon!

- If we sent a space probe, we would have to decide where to put it based on what kind of studies it would be doing. For instance, if you wanted to study radio waves from the stars, you might want to be on the far side of the moon so you wouldn't get any interference from Earth's TV and radio waves. But you would also have to set up a communications relay station so you could communicate with the probe.



Why does the moon affect the tides?

- **The moon actually CAUSES the tides. If there were no moon, we would have no tides. The tides arise due to the pull of the moon's gravity. On the side of Earth nearest the moon, the moon's gravity is the strongest and it pulls up the water slightly (high tide). On the side of Earth furthest from the moon, the moon's gravity is the weakest and the water can move a little away from the moon (which is also high tide). This also affects Earth itself. During high tide Earth rises by an inch or two, not enough for us to notice.**

How come the moon reflects the sun's light and things on earth (like rocks) don't reflect the sun's light?

- **Actually everything DOES reflect sunlight. If something doesn't reflect light, it looks completely black. There aren't many things like that around. If you stand outside in the sunlight, you are seeing because the sun's light is bouncing off of everything and your eyes see that light. When you are inside, you see things because the light from the lamps or the fluorescent lights bounces off things in the room**

THOUGH OUR MOON ADVENTURE IS AT AN END.....
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