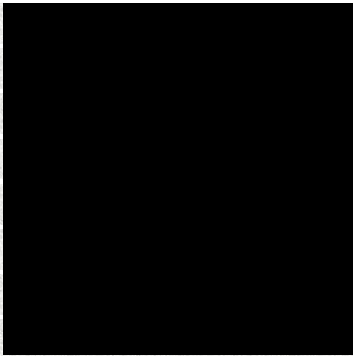


# The Lunar Cycle



- The image to the left is a time-lapse sequence of the moon taken over the course of one month
- **1 Lunar Cycle is about 29.5 days**
- Name four things you see changing in this image
  - Phase (illuminated part)
  - Size
  - Shadows
  - Wobble

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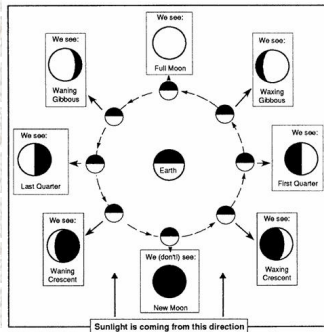
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## Phases

- At any time, half of the Moon's surface is illuminated, half is dark
- As the Moon orbits the Earth, our **perspective** of that illuminated surface changes
- Different phases
  - **New moon** = we see no light from the moon
  - **Full moon** = we see the entire disk illuminated
  - **Quarter moon** = we see half the disk illuminated
  - **Crescent moon** = we see less than half illuminated
  - **Gibbous moon** = we see more than half illuminated




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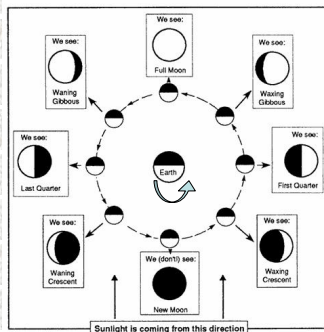
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## Phases

- Over the course of a month, the moon will appear to grow and shrink
  - From new Moon to Full Moon, the illuminated fraction of the Moon is **growing**, and these phases are called **waxing**
  - From full Moon to new Moon, the illuminated fraction of the moon is **shrinking**, and these phases are called **waning**
- Also notice that the full moon will always be up during the night, the new moon (can't see it) is up during the day
  - What part of the day or night is a last (or 3rd) quarter moon visible?




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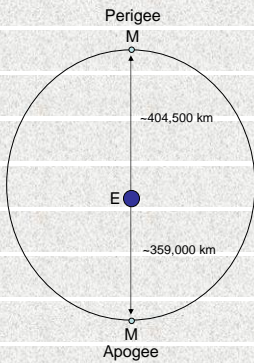
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## Apparent Size of the Moon

Another horribly not to scale picture!



- Like all orbits in the solar system, the Moon's orbit around the Earth is not a perfect circle, but an ellipse
- Because of this, the Moon is sometimes closer, and sometimes farther away
- The point in its orbit where the Moon is closest to the Earth is called **apogee**, the point where it is farthest away is called **perigee**
- This change in distance causes the moon to appear to change size over the course of a month

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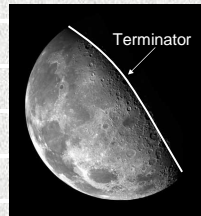
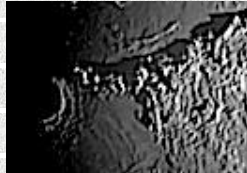
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## Shadows on the Surface

- Details on the lunar surface come into sharper relief under the right lighting conditions
- Sunlight that hits the lunar surface directly causes few or no shadows, while a glancing angle of sunlight creates very long shadows
- The **terminator** (make Steve do an Arnold Schwarzenegger impersonation) is the dividing line between the illuminated and non-illuminated part of the Moon
  - The craters along the terminator show the greatest detail since the sun is not shining directly into them




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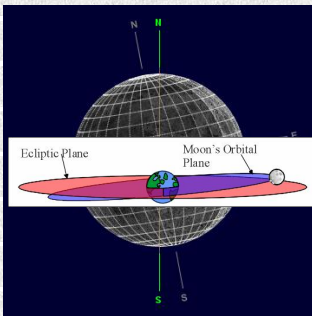
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## The Moon's Wobble - Libration



- The apparent wobble of the moon has multiple causes
- The elliptical orbit of the moon causes it to slightly speed up and slow down over the month
  - This lets us see a little more of the leading edge and trailing edge as it changes orbital speed
- The moon's orbit around the Earth is tilted slight (~5°) relative to the Earth's path around the Sun
  - This lets us see a little more of the northern or southern edge of the moon depending on the time of month

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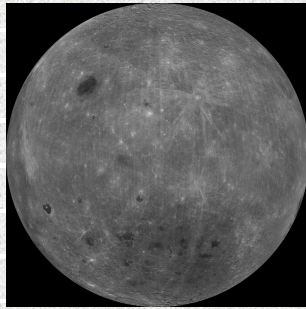
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## Synchronous Rotation

- Why do we always see the same side of the moon?
  - The Earth and the Moon have 'synched' up, meaning that the time it takes for the Moon to go around the Earth is equal to the time it takes for the Moon to spin once on its axis
- The far side of the moon has been photographed by satellites and lunar astronauts




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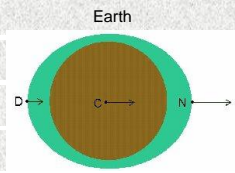
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## Tides



N = Nearest to Moon  
C = Center of Earth  
D = Most Distant from Moon

- The moon also has a significant effect on the Earth and its oceans
- The strength of gravity is determined by the distance between objects
  - The nearest side to the Moon feels the most gravity
  - The most distant side feels the least gravity
- This causes the Earth (especially the liquid oceans) to bulge, creating two high tides and two low tides per day

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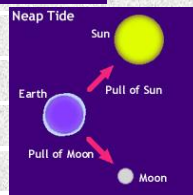
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## Spring and Neap Tides

- The Sun also has an effect on the tides of Earth's oceans
- When the Sun and the Moon are aligned with Earth (full moon and new moon), the Sun's gravity distorts the bulges even further, creating **spring tides** (very extreme low/high tides)
- When the Sun and the Moon are at a right angle with the Earth (1st and 3rd quarter moons), the Sun's pull and the Moon's pull somewhat cancel each other, creating **neap tides** (very weak low/high tides)




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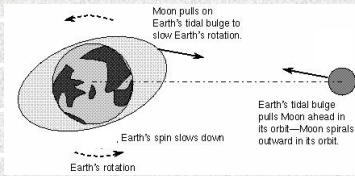
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## Tidal Drag

- The Earth spins on its axis faster than the Moon orbits the Earth
  - This causes the ocean's bulge to always slightly lead the Moon
- The Moon still pulls on this bulge, causing the Earth's rotation to gradually slow over time
  - In the past, the day was much shorter and the Moon was much closer



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## How Do We Know?

- Where do we get the proof that the rotation of the Earth has slowed over time?
- Some species of coral record daily and seasonal changes in their layers (much like how you can use tree rings to find a tree's age)
  - Daily changes mark the day-night cycle of the Earth
  - Seasonal changes mark the length of the year
- Fossilized coral from 10's of millions of years ago show a pattern which indicates the average day was shorter (about 22 hours)

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