

**Class 10: Seasons, Moon Phases & Tides**



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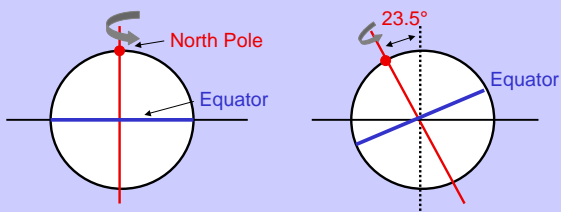
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**What is the reason for seasons?**



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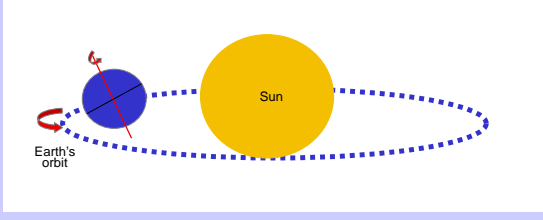
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## The Reason for Seasons



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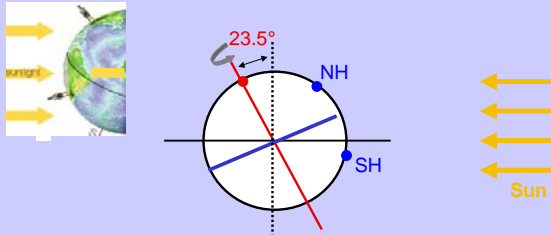
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## The Reason for Seasons



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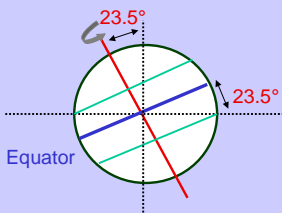
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## The Tropics



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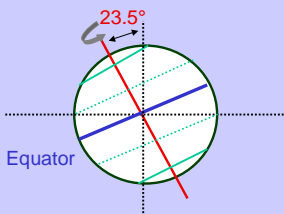
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## Arctic and Antarctic Circles




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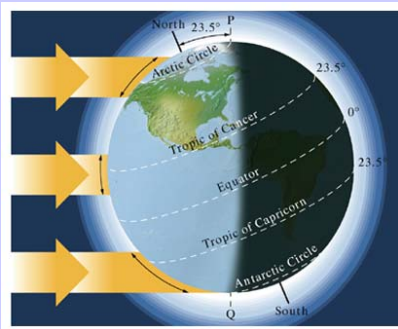
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## Seasons Review




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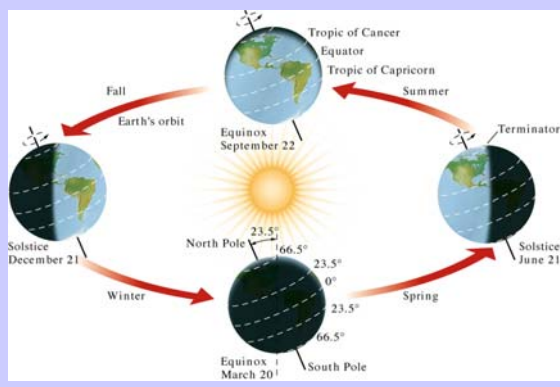
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## Seasons Review




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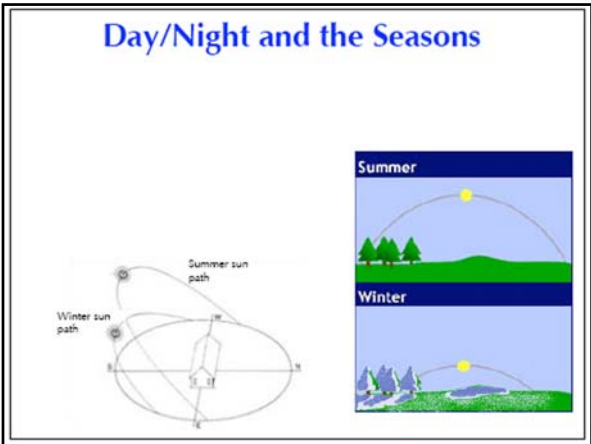
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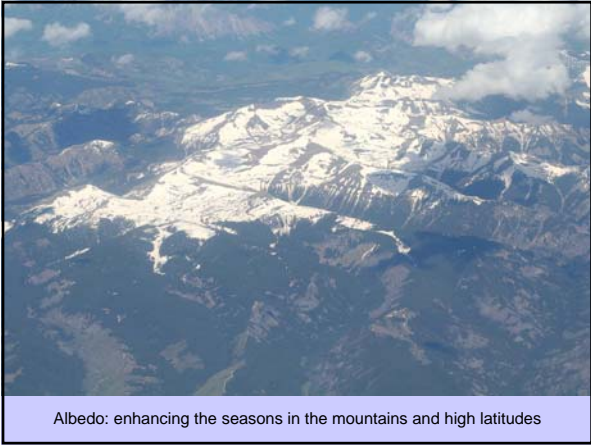
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diameter ca. 1/4 E  
 volume ca. 1/50 E  
 mass ca. 1/80 E  
 density 3.33 (E 5.5)  
 gravity on surface ca. 1/6 E  
 inclination of orbit to ecliptic 6.6  
 synodic month 29.5 d  
 sidereal month 27.3 d  
 perigee/apogee 0.88

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### The Moon

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### Exploring the Moon

**1959: Luna 2, 3 (USSR)**  
**1964: Ranger 7 (US)**  
**1966: Luna 10 (USSR)**  
**1969-1972: Apollo 11, 12, 14, 15, 16, 17 (US)**  
**1996: Clementine (US)**  
**1998: Lunar Prospector (US)**

Astronaut Eugene Cernan, Apollo 17

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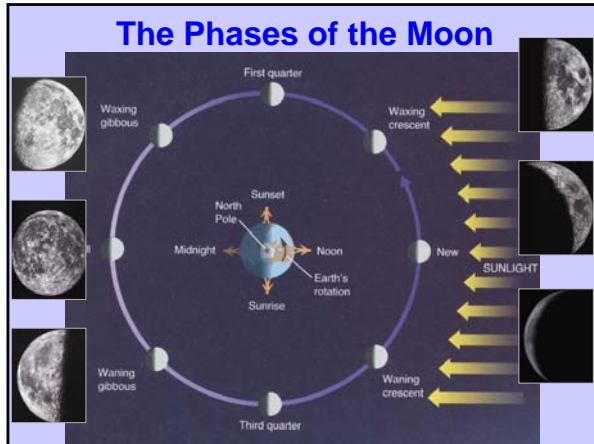
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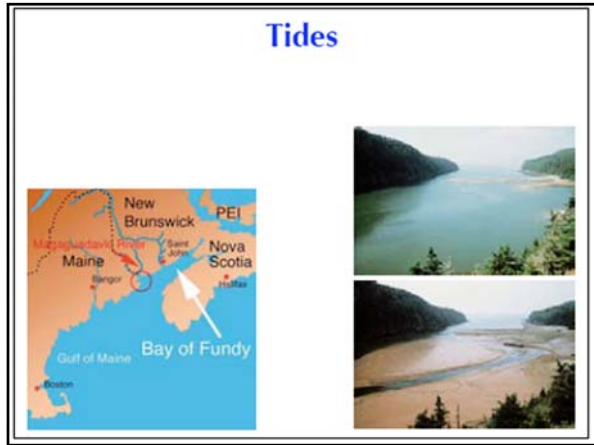
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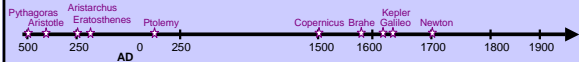
## Newton's Laws & Earth Tides

### Isaac Newton (1642 - 1727 A.D.)

- used the ideas of Kepler and Galileo (remember?)
- Laws of Motion ( $F = ma$ )
- Universal Law of Gravitation ( $F \sim M/r^2$ )
- laws explain nearly all mechanical motions on Earth and throughout the universe



Newton's apple troubles




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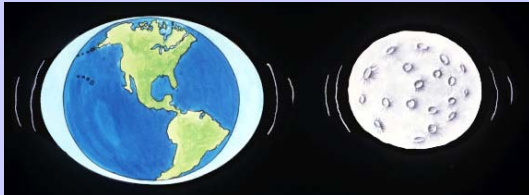
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## Tides




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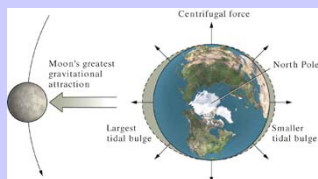
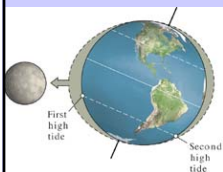
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## Tides




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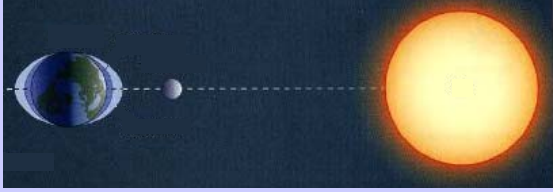
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## Tides



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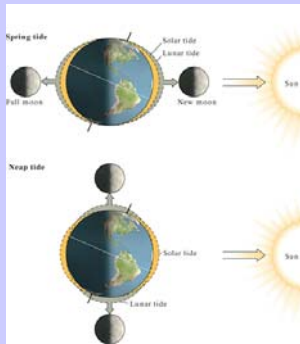
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## Tides: The Moon and Sun



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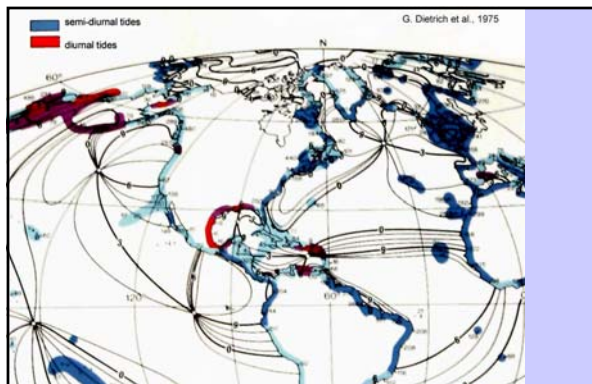
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In reality, there is no tidal bulge going around the Earth. Instead, there are rotating wave systems.

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## Eclipses



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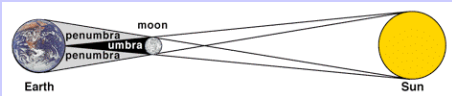
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## Solar Eclipses



How do they happen?

- Moon moves in between Sun and Earth, blocks sunlight
- Only from within the tiny area where the dark **umbra** touches the earth will you see the sun completely covered and witness a total eclipse.
- From anywhere in the grey **penumbra**, you will see some part of the sun shining from behind the moon. The penumbra is the area of partial eclipse.



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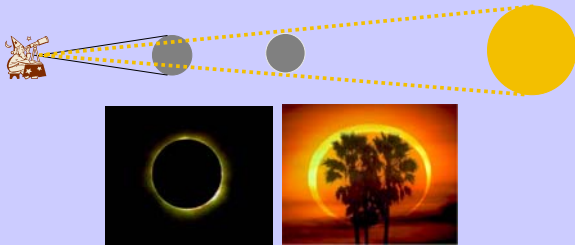
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## Solar Eclipses



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