



- New WebWork posted. Due Monday morning.
- No physics tea today. SCRP talks in Ford 122.
- Test 1 two weeks from today
- Polling: `rembold-class.ddns.net`

News of the Day: Cassini no more





Say an orbiting planet lost some of its mass in a process that kept its angular momentum constant. Potential effects could be:

- A. The planet slowing down but staying the same distance away from the Sun
- B. The planet moving closer to the Sun but staying the same speed
- C. The planet moving further from the Sun but staying the same speed
- D. None of the above



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Our Wobbly Planet



- Just like a spinning top, Earth has a bit of a wobble
- Relative to the celestial sphere, the direction of our North Pole oscillates every 26 000 yrs
- “North Star” changes!





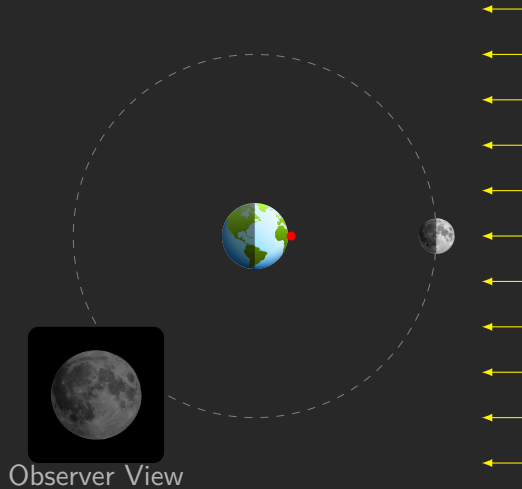
Two obvious observations we are interested in explaining:

- Why do we see the Moon going through phases?
- What causes eclipses?

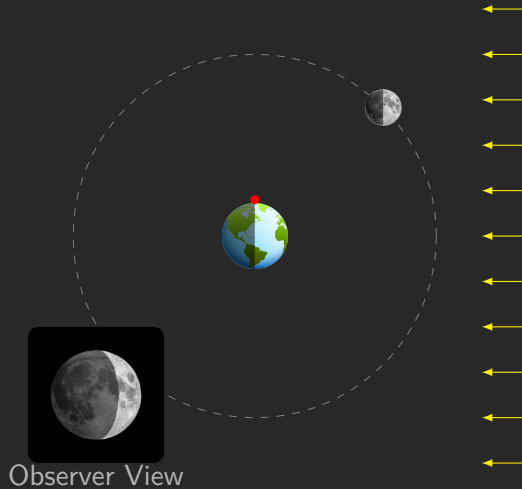


- Moon orbits Earth in 27.3 d
- Lunar Phases repeat every 29.5 d
 - Difference due to Earth moving about the sun during this time
- Sunlight hits Earth and Moon at same angle because the Sun is so far away
- Moon's phase is also closely related to its rising and setting times
- The Man in the Moon is always watching
 - We always see the same face of the moon

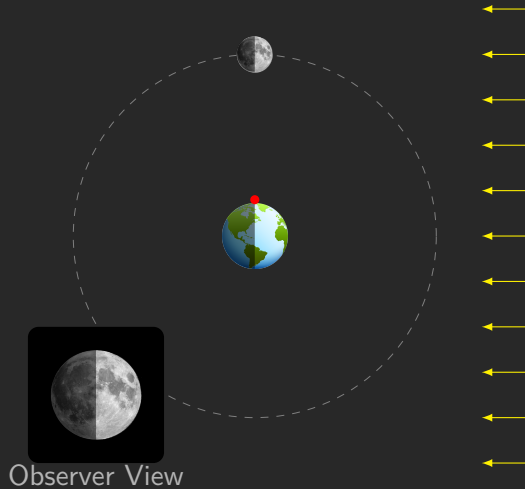
It's just a phase



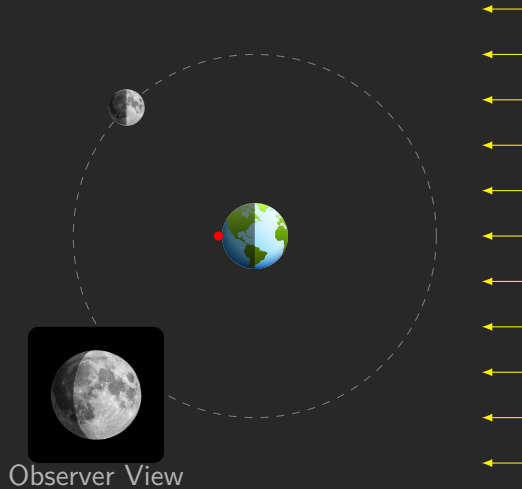
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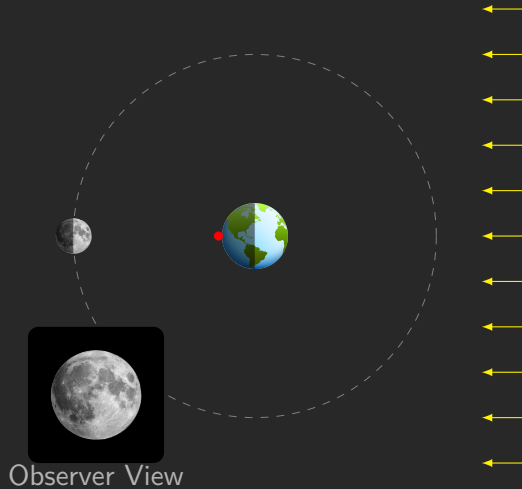
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Wax on, Wane off



- Waxing - the moon is becoming more full
 - Visible afternoon/evening
- Waning - the moon is becoming less full
 - Visible late night / morning
- In Northern Hemisphere:
 - Light on Right \Rightarrow waxing
 - Opposite in Southern Hemisphere

Waxing Moons



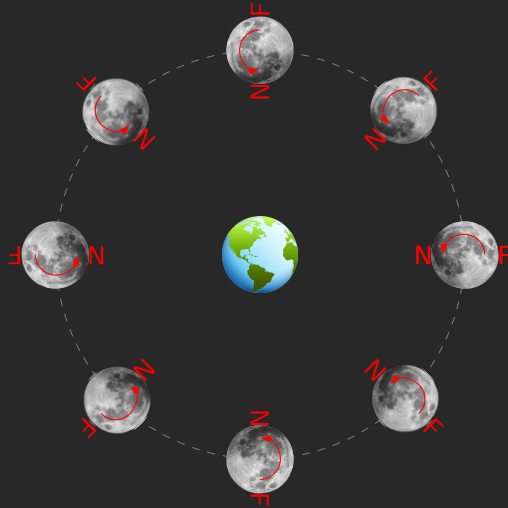
Don't Turn Your Back!



Why do we only see one side of the moon?

- If the moon did not spin as it orbited us, we'd see all parts of the moon
- If the moon spun either quickly or slowly, we'd see all parts of the moon
- But if it spun *jussst riighht*...

Synchronous Spinning





In truth, we actually can see upwards of 60% of the Moon's surface over a year

- Libration describes this oscillating wobble
- Libration in longitude due to the Moon's orbit not being perfectly circular
- Libration in latitude due to the Moon's tilt (similar to Earth's seasons!)
- Diurnal libration do to an observer getting two different perspectives from each side of the Earth daily





Imagine you built yourself a lovely house on the surface of the moon. One day you are talking to your mom back on Earth and she mentions that it is a lovely full moon tonight. From your vantage point on the moon, what is Earth's phase?

- A. New
- B. Waxing
- C. Full
- D. Waning



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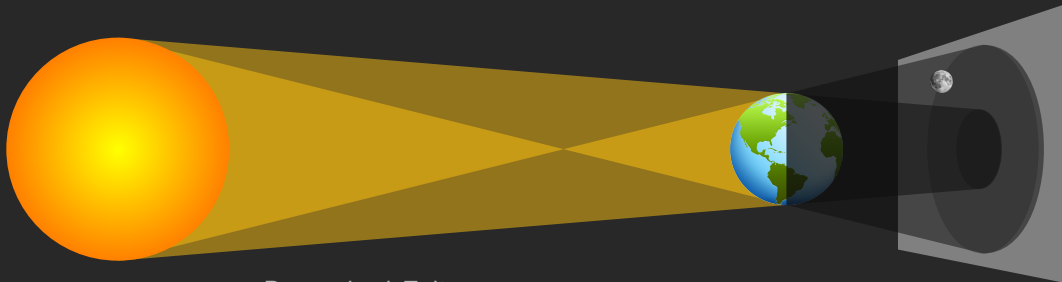
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Lunar Eclipse Facts



- Lunar eclipses can *only* occur when the Moon is full!
 - Otherwise the Earth isn't between the Moon and the Sun
- Lunar eclipses can be penumbral, partial, or total, depending on what part of the shadow overlaps the moon
- Note that anyone on Earth sees the same eclipsed Moon (assuming its night)

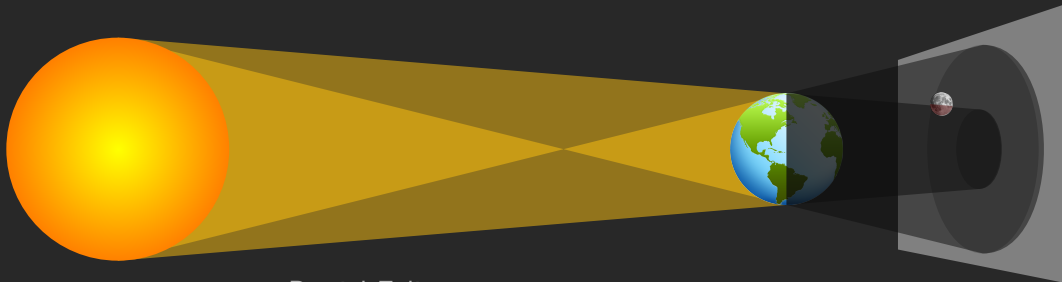


Penumbral Eclipse

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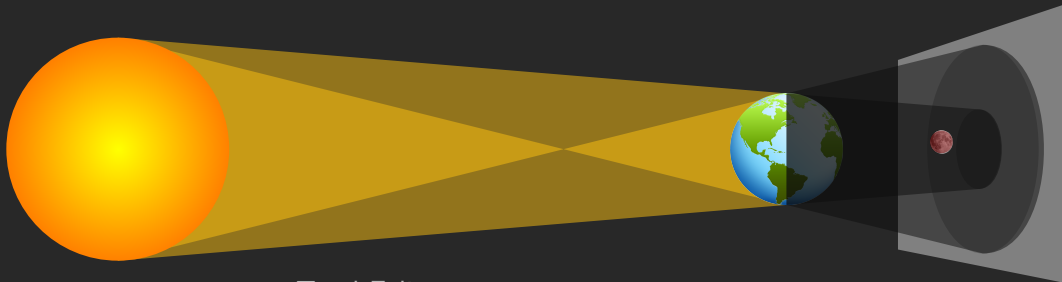


Partial Eclipse

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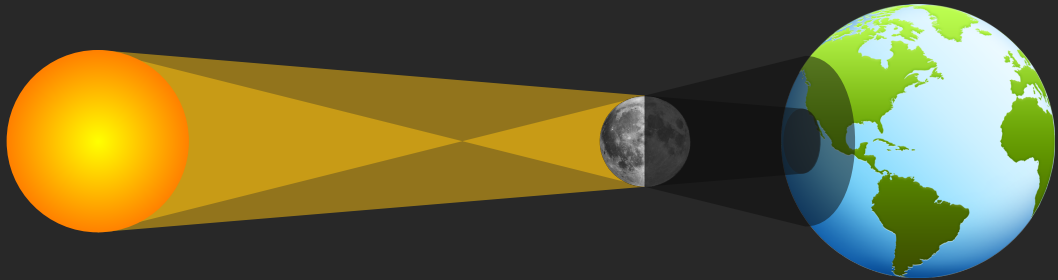
Total Eclipse



Solar Eclipses Facts



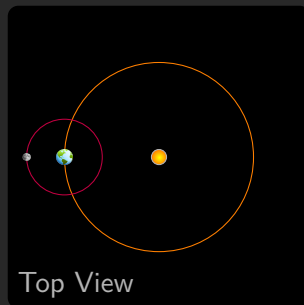
- Moon casting shadow onto the Earth
- Solar eclipses can only occur when the Moon is new!
- Solar eclipses can be partial, total, or annular
- Note that only select portions of the Earth observe the eclipsed Sun!



Why not eclipses every month?



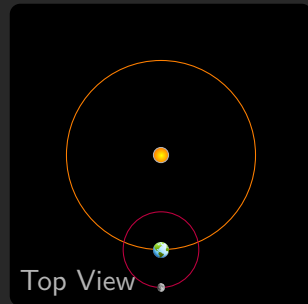
- The Moon's orbit is tilted 5° to the ecliptic
- Results in two seasons each year when eclipses can happen



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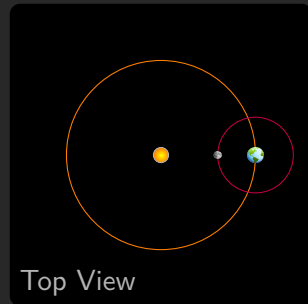
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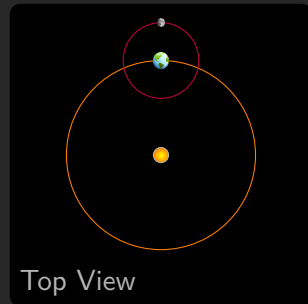
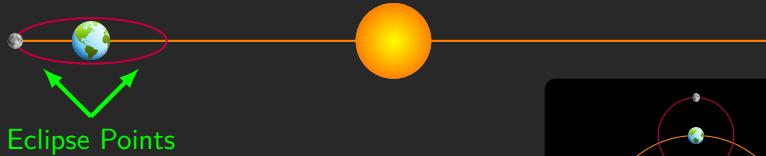
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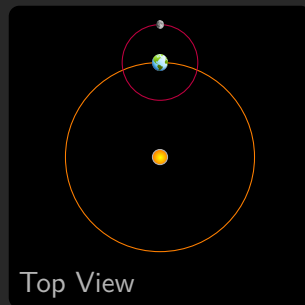
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Eclipse Conditions

An eclipse can only occur when:

- There is a full moon (lunar eclipse) or new moon (solar eclipse)
- The Moon is at or near one of its two ecliptic crossing points



The Saros Cycle



- Ecliptic crossing points slowly move around the Moon's orbit
 - Put's potential eclipse seasons about 173 days apart
- Combine with lunar cycle to get one eclipse about every 18 years, 11 days, and 8 hours.
 - Called the **Saros Cycle**
- Can predict *when* an eclipse will occur but not where or what type

