Phases and motion of the Moon

Homework review

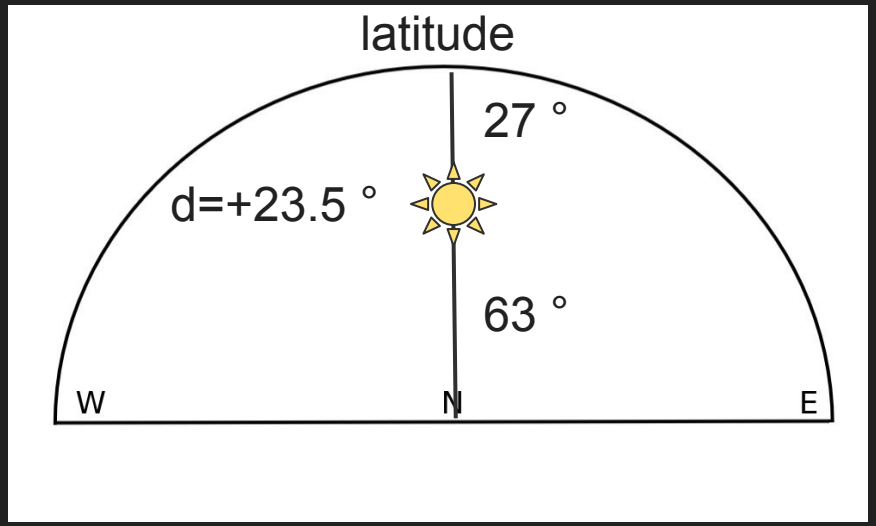
- If you didn’t include your work in your submission, then resubmit with your work attached for credit.
- Come to office hours for points back.

Homework review

5. Suppose you go on a trip to an undisclosed island. Using your knowledge of Astronomy, you realize that you can calculate the latitude of your location. If the date is 21 June, and the Sun is $63\ ^\circ$ above the northern horizon at noon, what is your latitude?

Homework review

5. Suppose you go on a trip to an undisclosed island. Using your knowledge of Astronomy, you realize that you can calculate the latitude of your location. If the date is 21 June, and the Sun is 63 ° above the northern horizon at noon, what is your latitude?



Homework review

9. Find the orbital speed of Mars using Kepler's Laws. Mars orbits at a distance of 1.523 AU from the Sun.

Homework review

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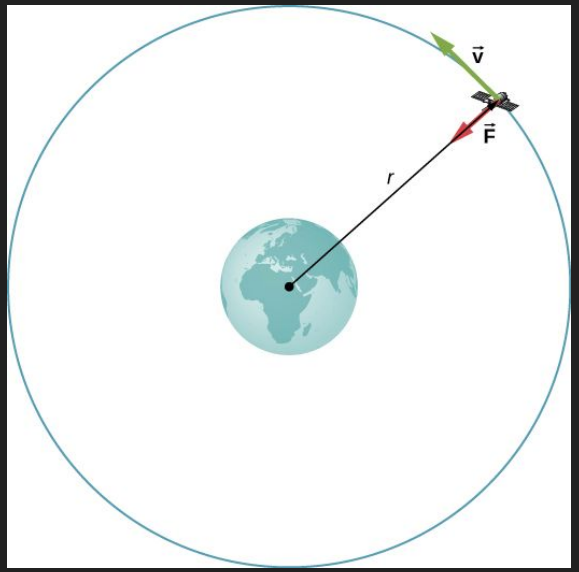
9. **Find the orbital speed of Mars using Kepler's Laws. Mars orbits at a distance of 1.523 AU from the Sun.**



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When poll is active respond at **PollEv.com/nikhilpatten355**

Send **nikhilpatten355** to **22333**

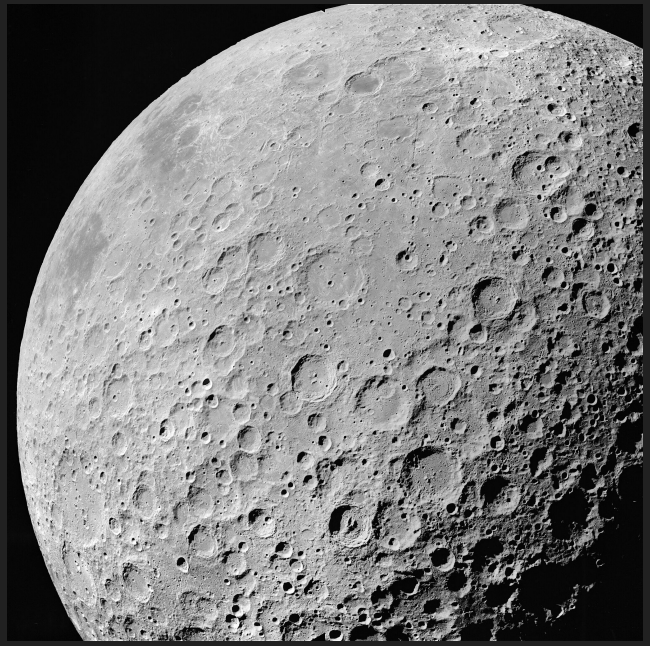
Poll everywhere

results

Surface of the Moon

- Lunar surface has distinctive bright and dark zones.
- These correspond to the highlands and the maria.
- The Moon shows evidence of past volcanic activity.
- The Moon also shows extensive impact cratering.

Surface of the Moon



- Lunar highlands (heavily cratered).

Surface of the Moon

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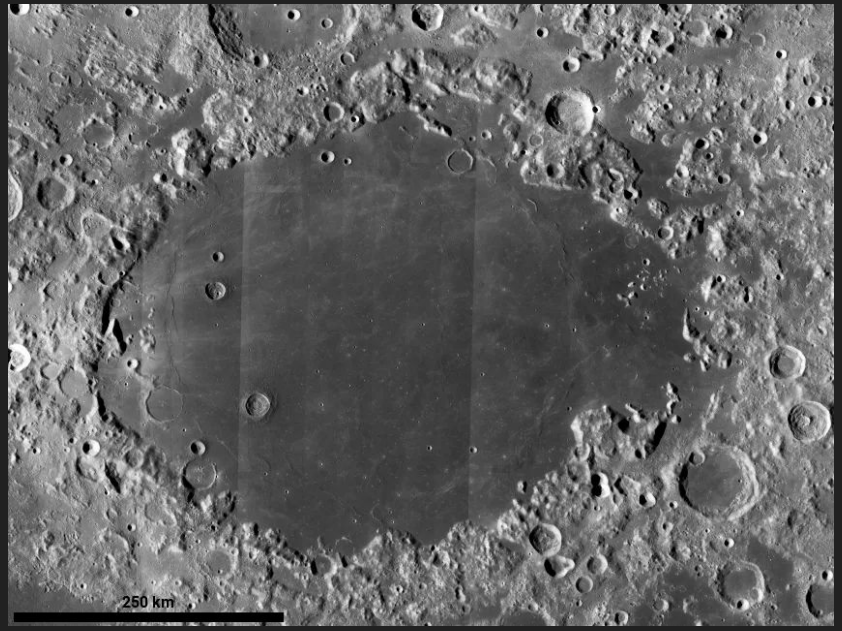

- Lunar maria (less craters).
- Maria formed from flowing lava that has cooled.

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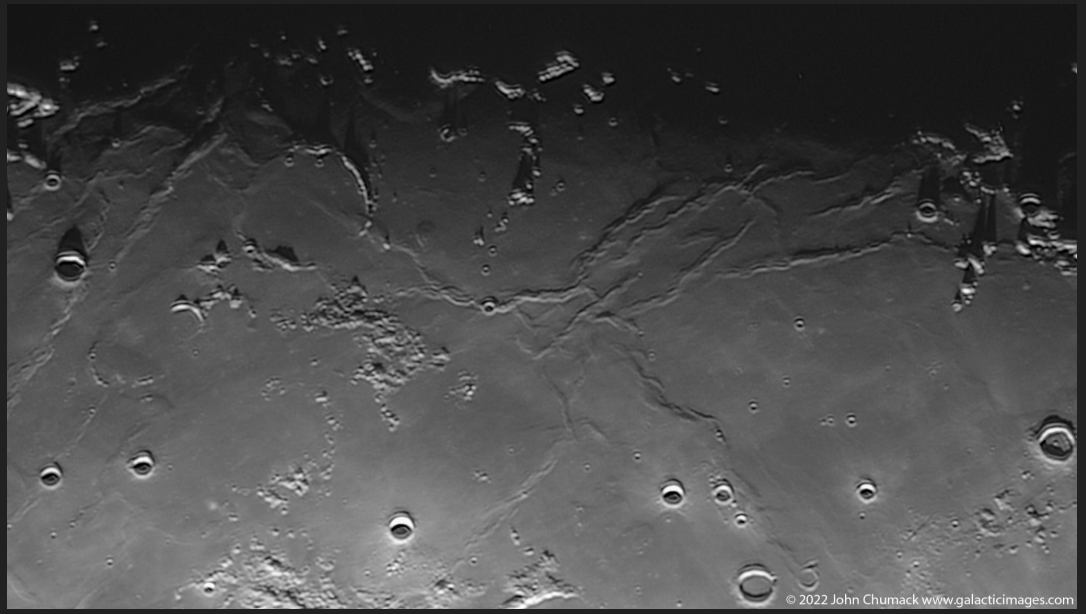
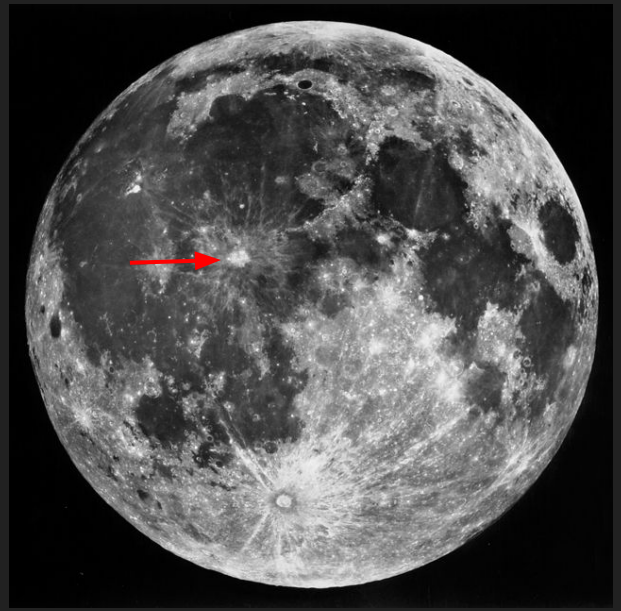
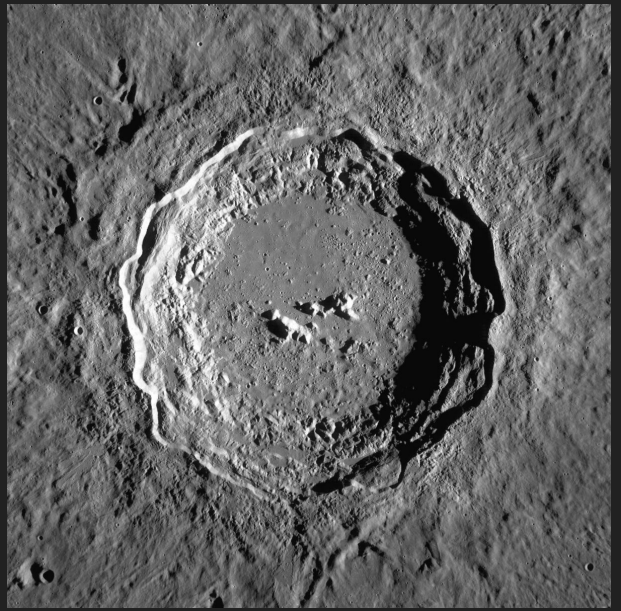


- Wrinkle ridges (maria).

Surface of the Moon

- Copernicus crater.





Surface of the Moon

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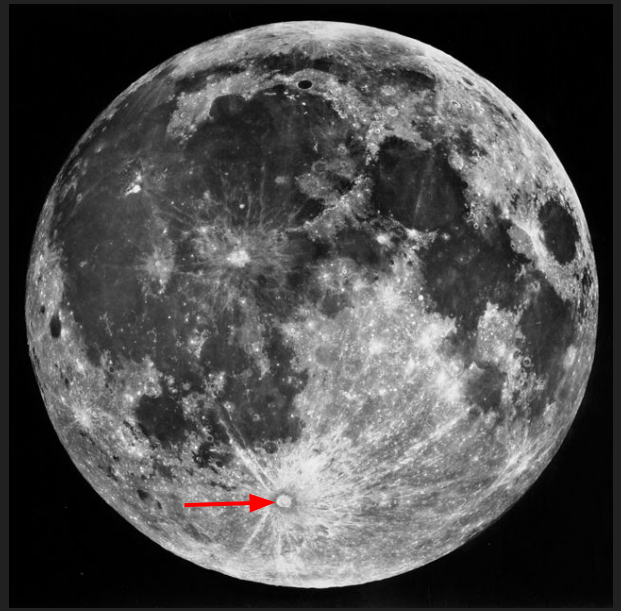
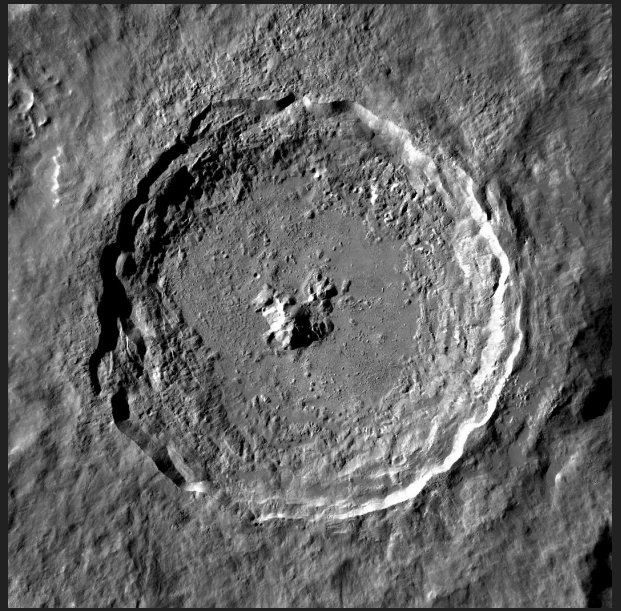
- Tycho crater.





Lunar cycle

- Solar month— time it takes the Moon to complete one revolution with respect to the Earth and Sun.
- One lunar cycle marks the solar month.
- 1 Lunar cycle = 29.5 Earth days

Lunar cycle

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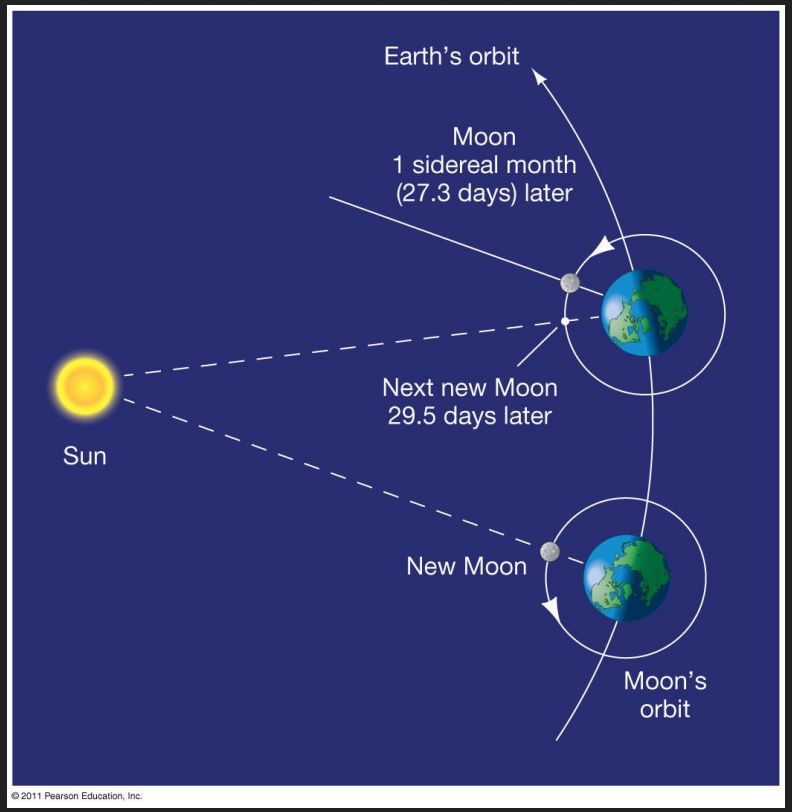
Lunar cycle

- Sidereal month— time it takes the Moon to complete one revolution with respect to the celestial sphere.
  - Problem 6 on homework 2
- 1 sidereal month = 27.3 Earth days

Lunar cycle


Earth's orbit
Moon
1 sidereal month
(27.3 days) later
Next new Moon
29.5 days later
Sun
New Moon
Moon's
orbit
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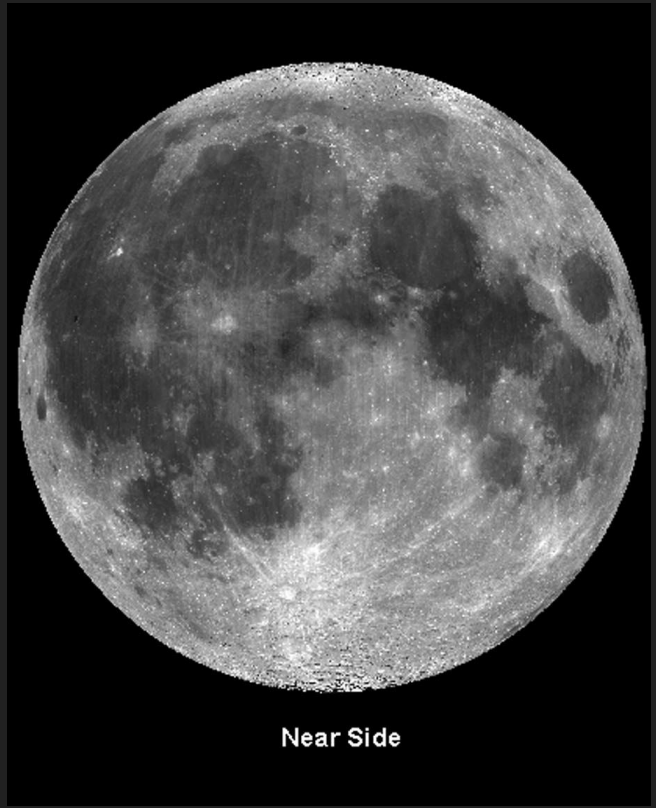
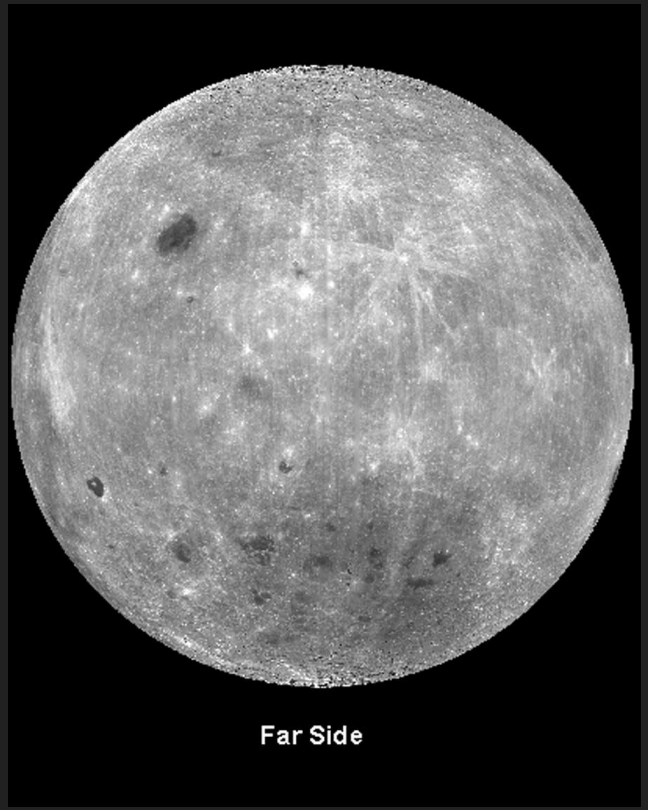
Rotation of the Moon

- The Moon’s rotational rate is synchronized with its orbital period.
- 1 full rotation every 27.3 Earth days.
- The side face of the Moon faces Earth at all points in its orbit.
- Earth-facing side —> “Near side.”
- Earth-opposite side —> “Far side.”

Rotation of the Moon



Rotation of the Moon



Tides

- Side facing Earth feels stronger attraction from Earth.
- Known as tidal forces.
- Tidal forces can synchronize rotation with orbital period.

Tides

Tides

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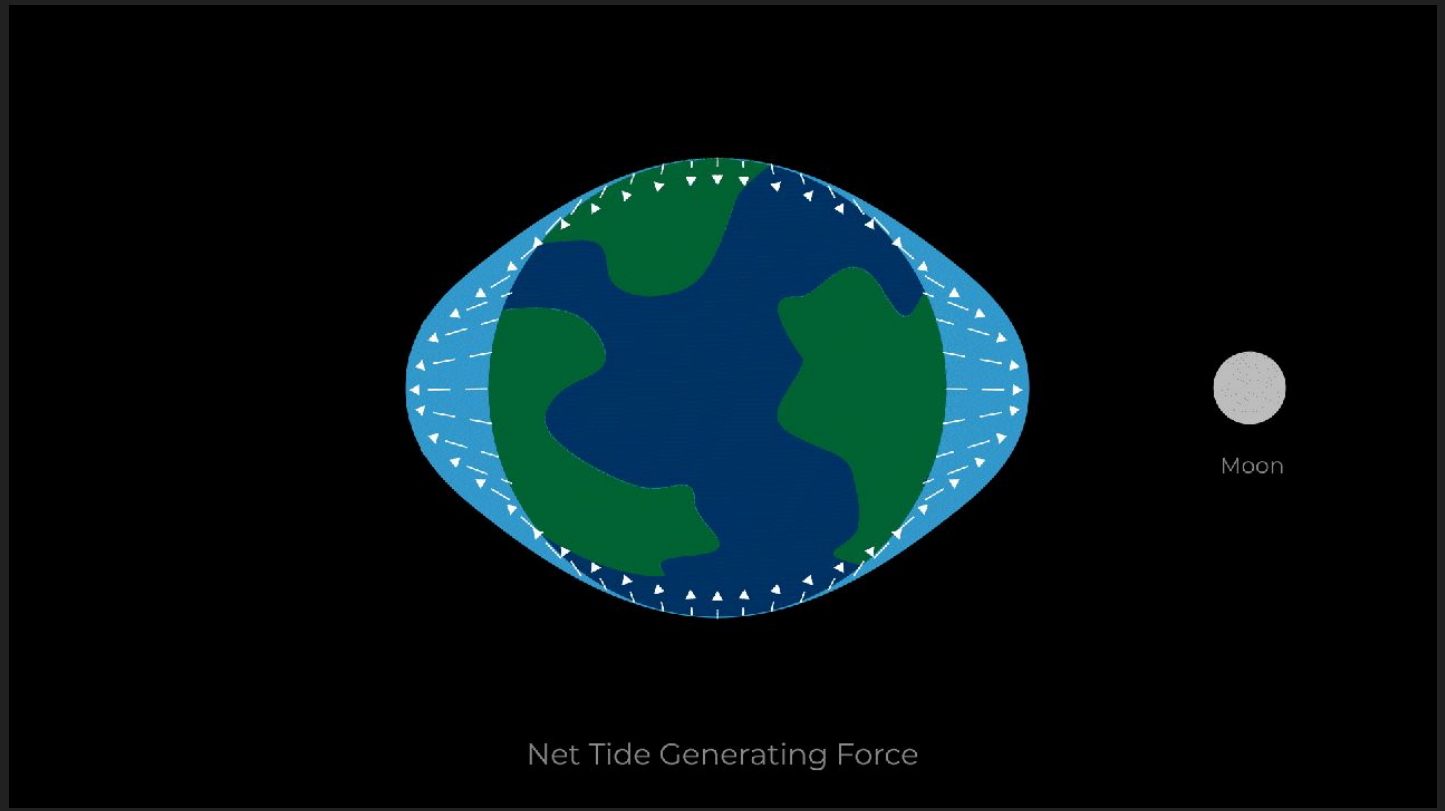

Tides

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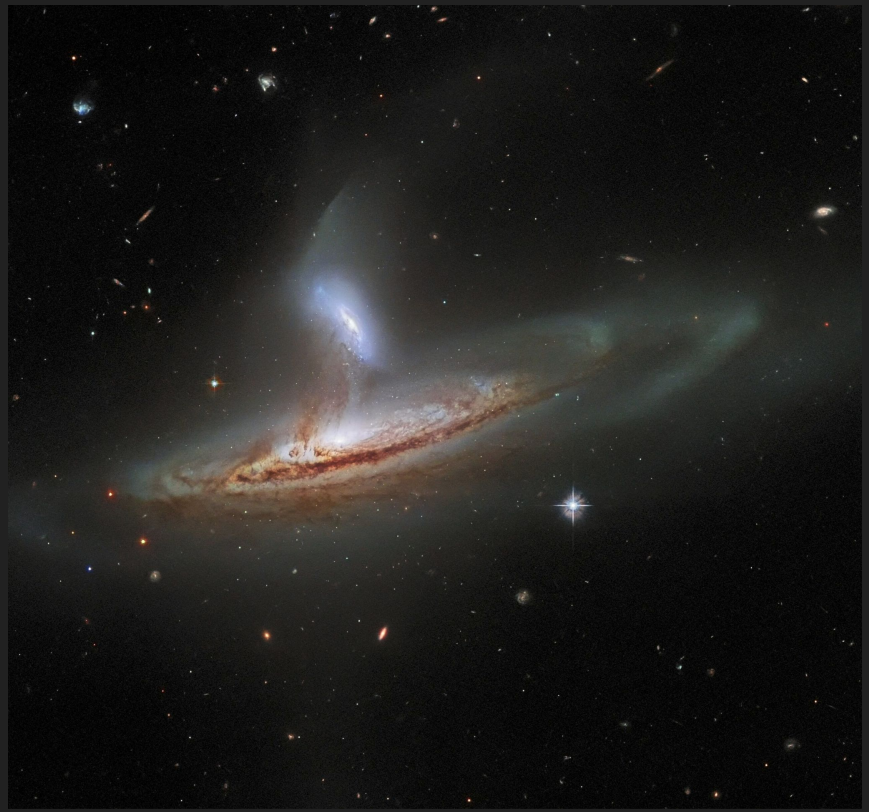

Tides

- Moon is tidally locked to the Earth.
- The Earth is not tidally locked to the Moon.
- The Earth's rotational rate has evolved with time.
  - 600 million years ago (Mya), Earth's day was 21 hours.
- Angular momentum from Earth's rotation deposited into the Moon's orbit.
  - The Moon is getting further away from the Earth.

Question

1. If the Earth's day is increasing at a rate of 24 microseconds per year (24×10^{-6} seconds per year), calculate the time required for the Earth's rotation to synchronize with the Moon's orbit (27.3 days).

    a. 1.37 million years b. 42.3 billion years c. 98.2 billion years

Question

The Earth's day is increasing at a rate of 24×10^{-6} seconds yr^{-1}. Today, Earth's rotational period is 1 days. To find the time it would take for the Earth's rotational period to equal the Moon's orbital period (27.3 days), use the definition of rate of change.

$$\text{rate} = \frac{\text{final} - \text{initial}}{\text{time}}$$

In this case, we are given the rate $r = 24 \times 10^{-6}$ seconds per year. We also have the final and intial rotational periods, $P_2 = 27.3$ days and $P_1 = 1$ days. Find the time, in years.

$$r = \frac{P_2 - P_1}{t}$$
$$t = \frac{P_2 - P_1}{r}$$

Be mindful of units.

$$t = \frac{P_2 \text{ (days)} - P_1 \text{ (days)}}{r \text{ (seconds year}^{-1}\text{)}}$$
$$t = \frac{(P_2 - P_1) \text{ (days} \cdot \text{year)}}{r \text{ (seconds)}}$$
$$t = \frac{(P_2 - P_1) \text{ (days} \cdot \text{year)}}{r \text{ (seconds)}} \times \frac{60 \text{ seconds}}{1 \text{ min}} \times \frac{60 \text{ min}}{1 \text{ hour}} \times \frac{24 \text{ hours}}{1 \text{ day}}$$
$$t \text{ (years)} = \frac{(P_2 - P_1) \text{ (days)}}{r \text{ (seconds per year)}} \times 86400$$

$$\boxed{t = 9.468 \times 10^{10} \text{ years}}$$

Announcements

- Lab today (STEM 180)
- Homework 2 assigned today, due Friday, 11:59 PM

Next time

- Phases and motion of the Moon