

How do we describe motion?

- Precise definitions to describe motion:
- **Speed:** Rate at which object moves

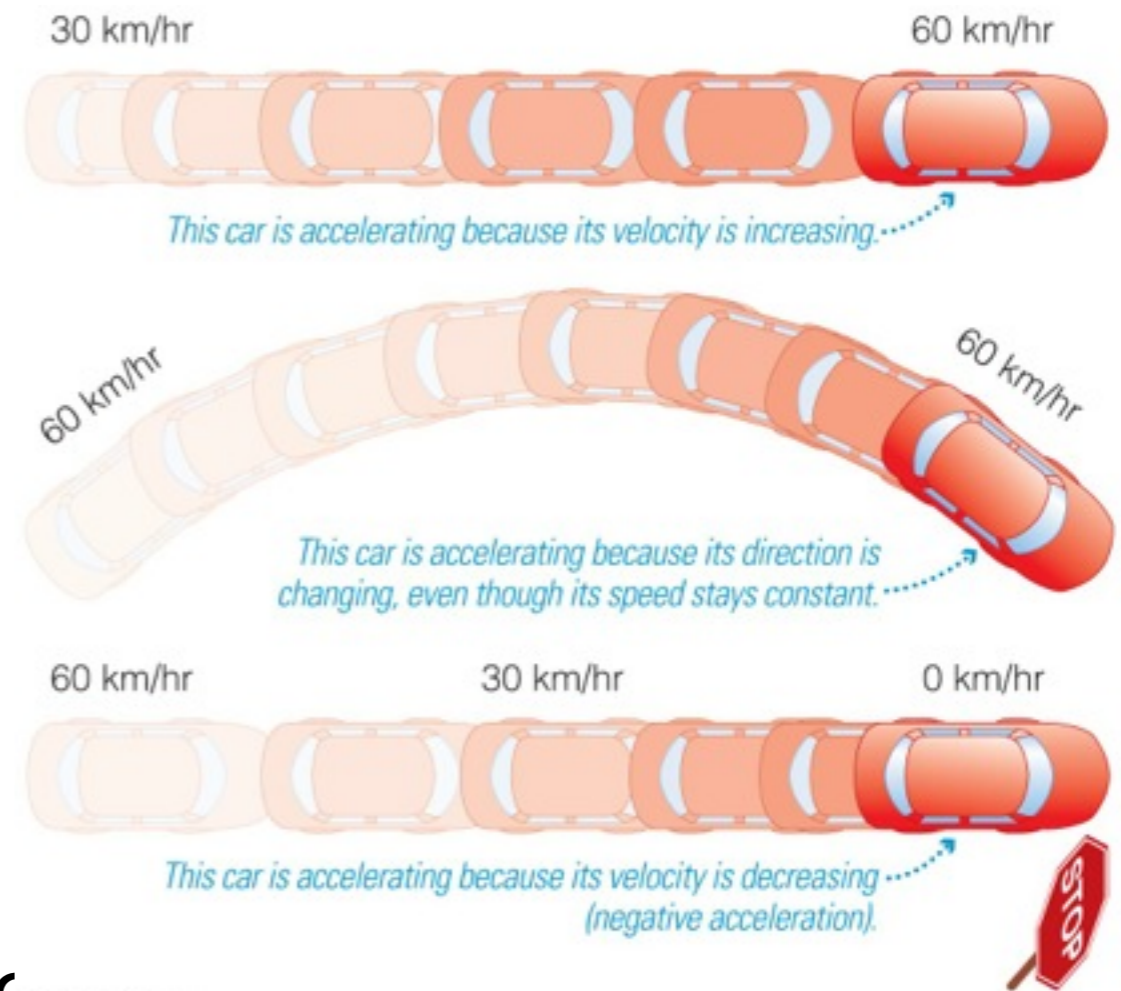
$$\text{speed} = \frac{\text{distance}}{\text{time}} \left(\text{units of } \frac{\text{m}}{\text{s}} \right)$$

Example: 10 m/s

- **Velocity:** Speed and direction

Example: 10 m/s, due east

- **Acceleration:** Any change in velocity
units of speed/time (m/s^2)



Thought Question

For each of the following is there a net force? Y/N

1. A car coming to a stop
2. A bus speeding up
3. An elevator moving up at constant speed
4. A bicycle going around a curve
5. A moon orbiting Jupiter

Thought Question

For each of the following is there a net force? Y/N

1. A car coming to a stop: Y
2. A bus speeding up: Y
3. An elevator moving at constant speed: N
4. A bicycle going around a curve: Y
5. A moon orbiting Jupiter: Y

Thought Question

On the Moon:

- A. My weight is the same, my mass is less.
- B. My weight is less, my mass is the same.
- C. My weight is more, my mass is the same.
- D. My weight is more, my mass is less.

Thought Question

On the Moon:

- A. My weight is the same, my mass is less.
- B. **My weight is less, my mass is the same.**
- C. My weight is more, my mass is the same.
- D. My weight is more, my mass is less.

Thought Question

How does the force the Earth exerts on you compare with the force you exert on it?

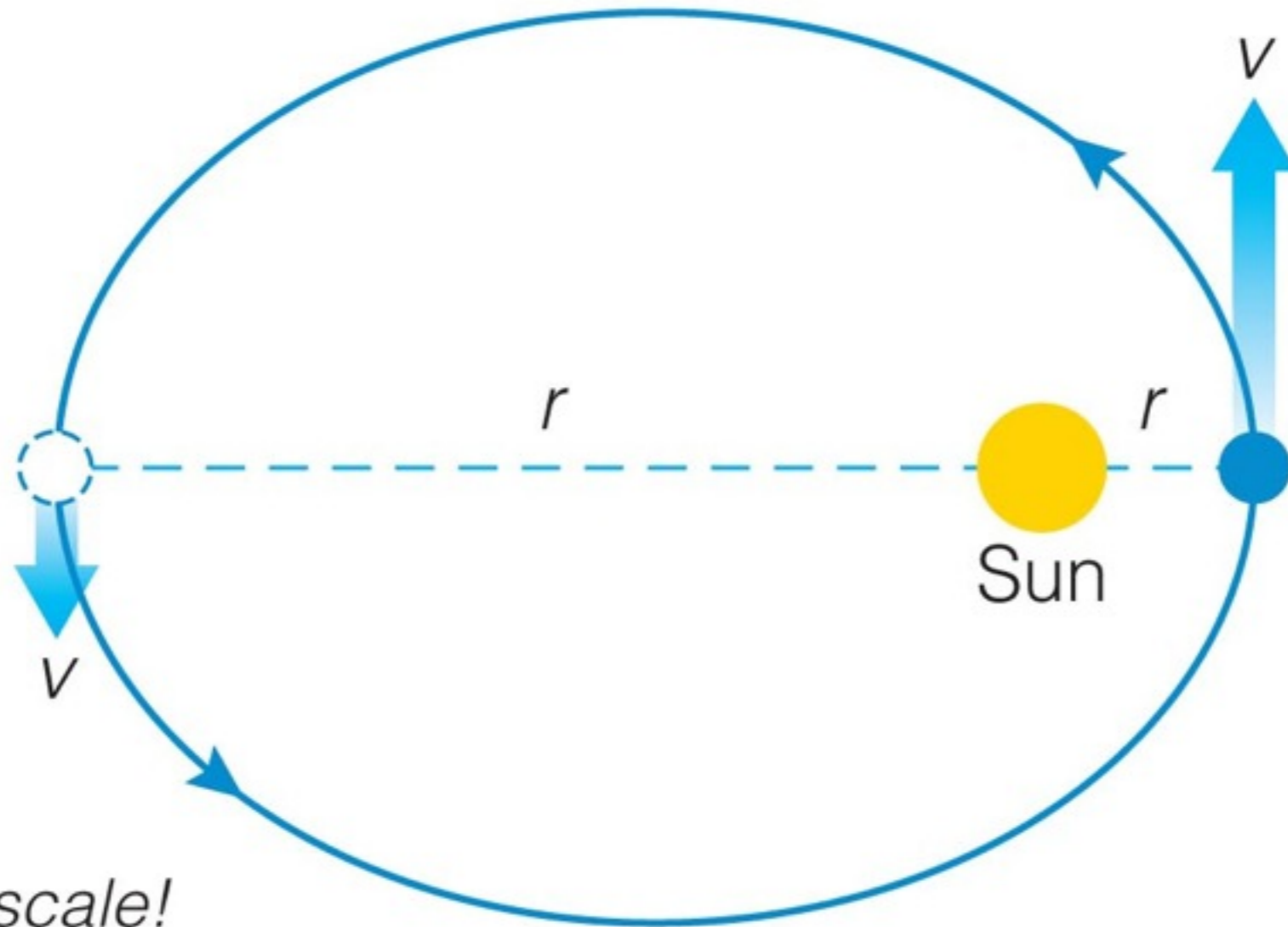
- A. Earth exerts a larger force on you.
- B. You exert a larger force on Earth.
- C. Earth and you exert equal and opposite forces on each other.

Thought Question

How does the force the Earth exerts on you compare with the force you exert on it?

- A. Earth exerts a larger force on you.
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- C. Earth and you exert equal and opposite forces on each other.**

What keeps a planet rotating and orbiting the Sun?

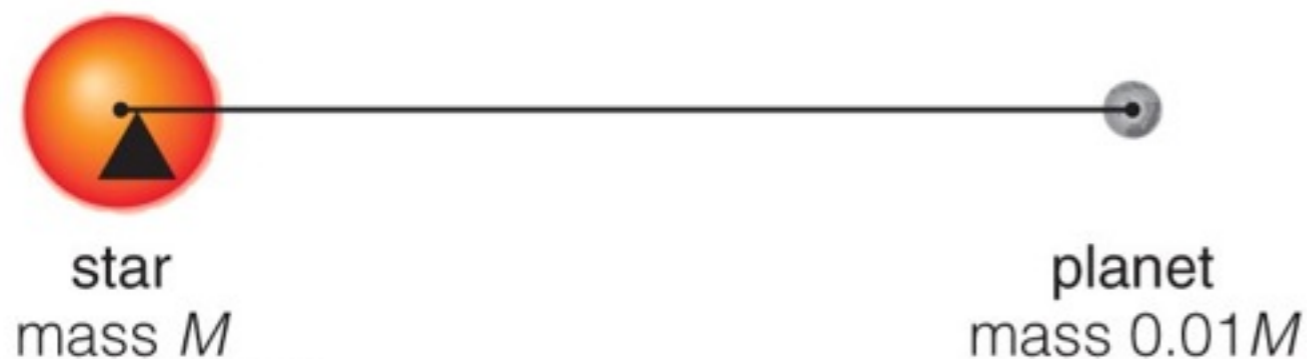


Conservation of Angular Momentum

Angular momentum = mass x velocity x radius

- The angular momentum of an object cannot change unless an external twisting force (torque) is acting on it.
- Earth experiences no twisting force as it orbits the Sun, so its rotation and orbit will continue indefinitely.

Center of Mass



Interactive Figure 

- Because of momentum conservation, orbiting objects orbit around their center of mass.

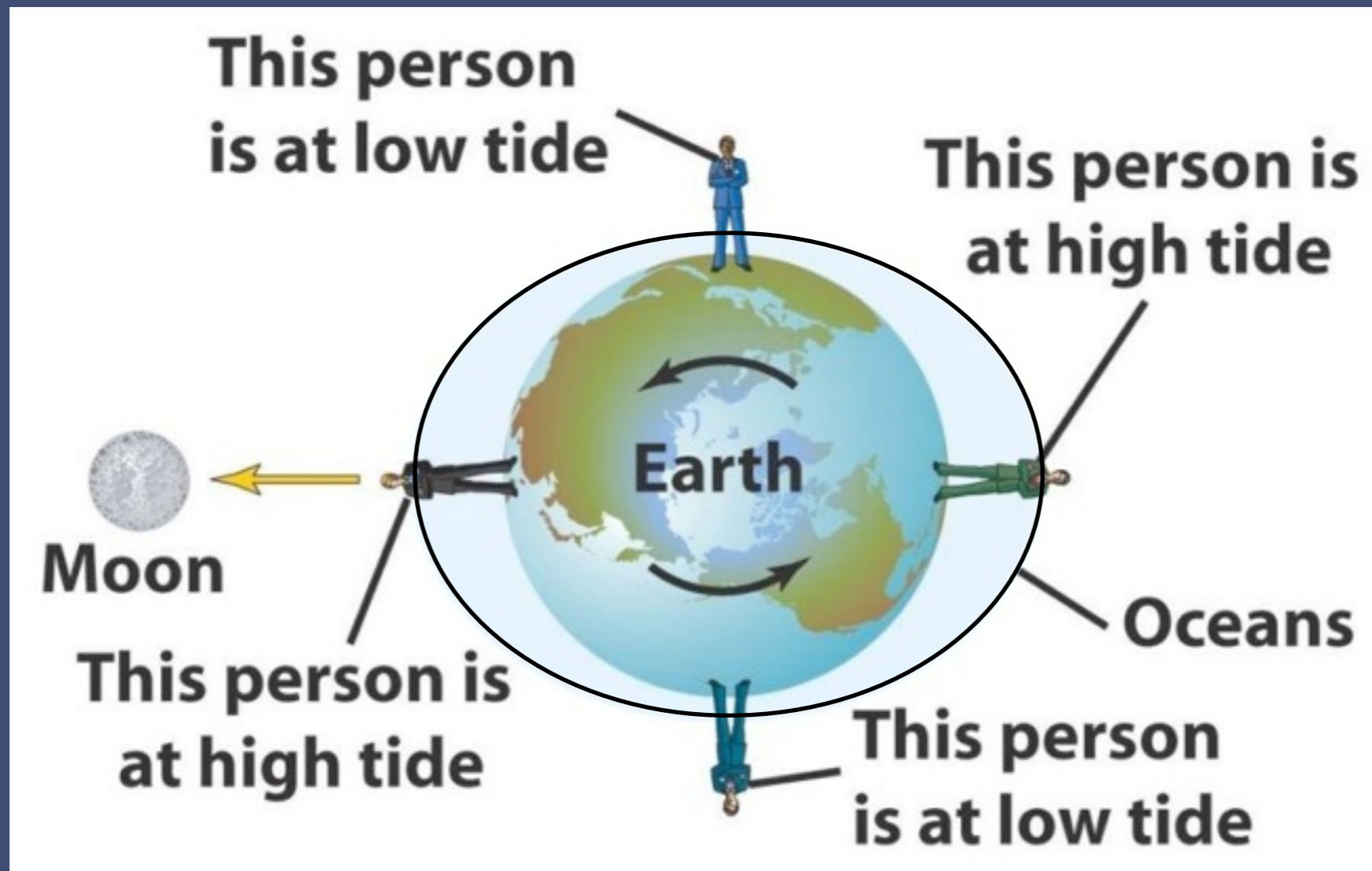
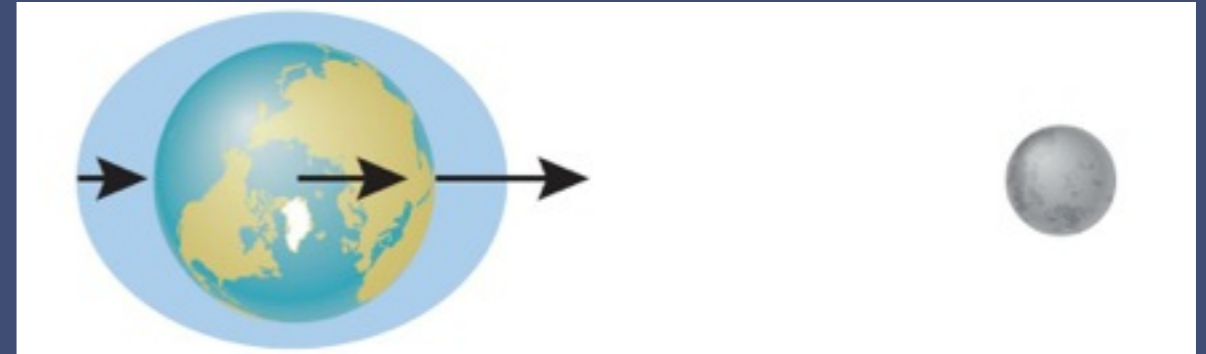
Tides

- 2 “low” tides & 2 “high” tides each day



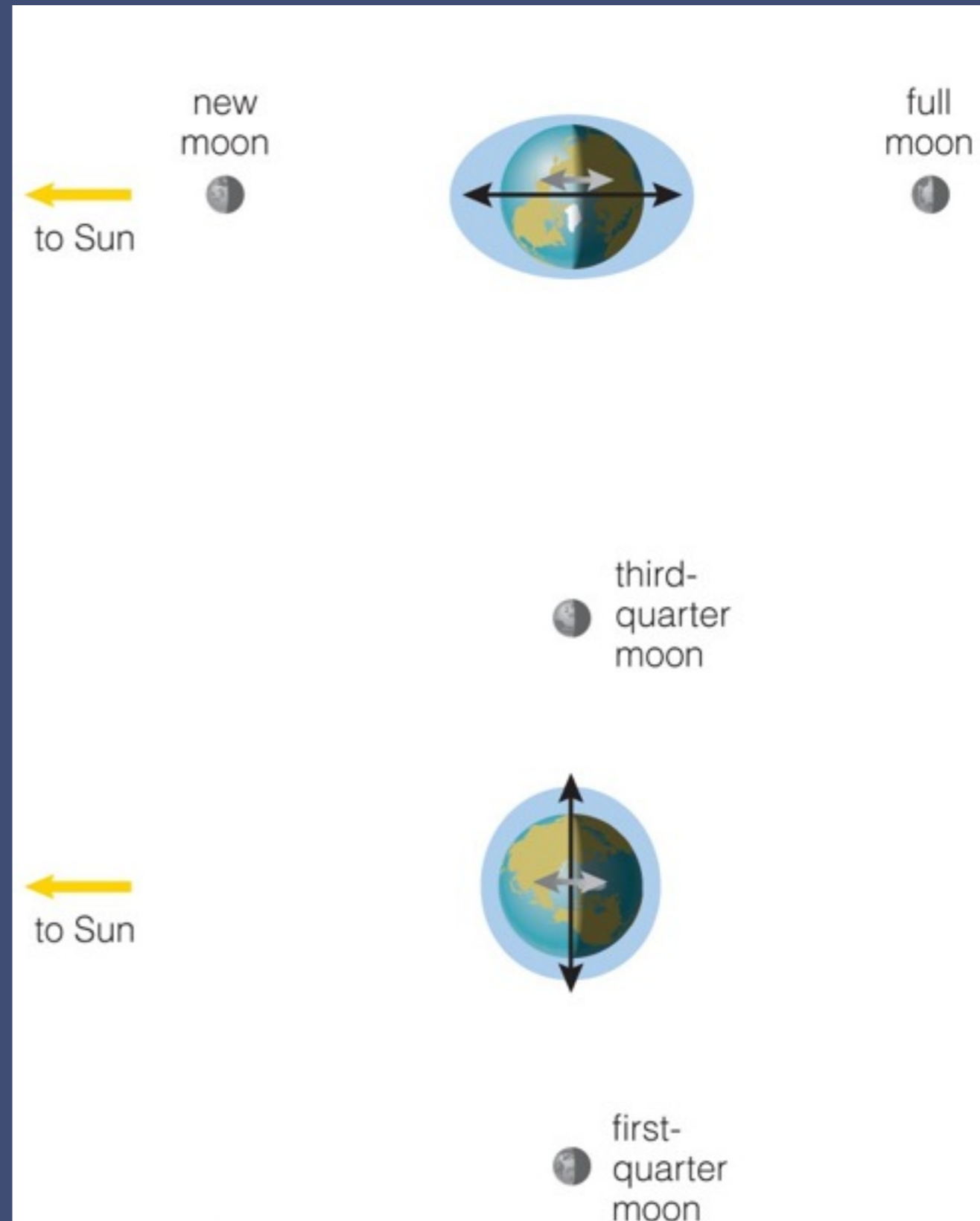
Tides

- Caused by gravity primarily of the Moon, but also of the Sun
 - land tides (2-3 inches)
 - ocean tides (~2 feet)

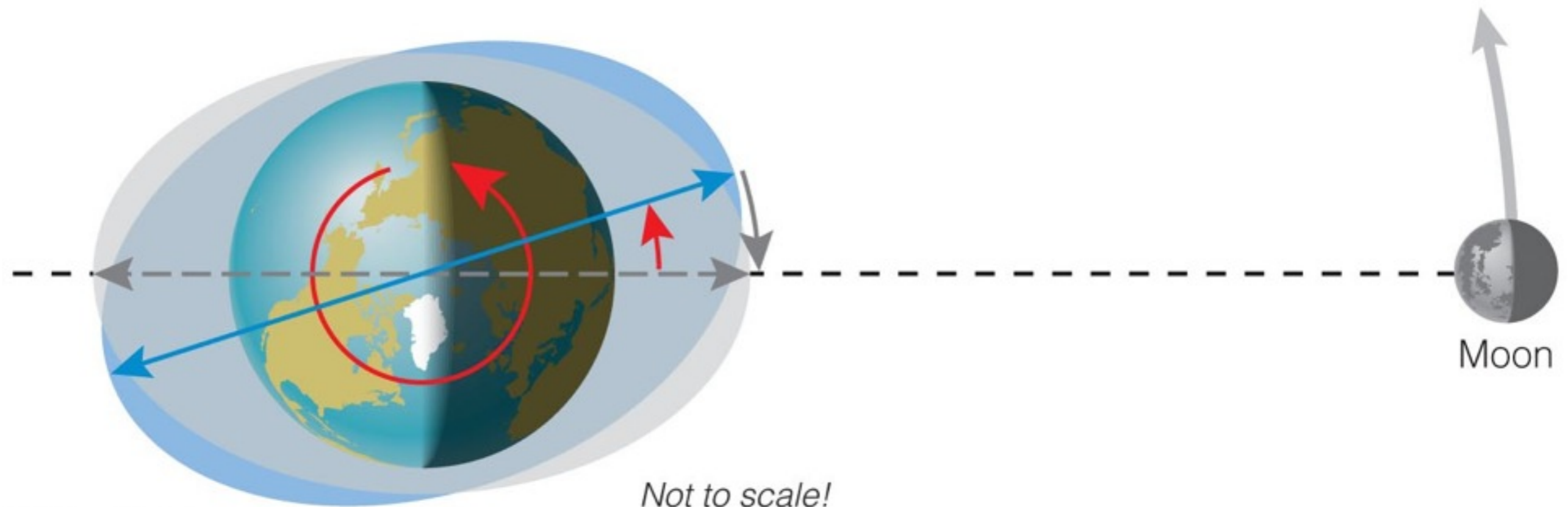


Tides

- Spring Tide
 - most extreme tides
 - Moon & Sun work together
 - Around full & new Moon
- Neap Tides
 - smallest tides
 - Moon & Sun work in opposition
 - 1st & 3rd quarter Moons



Tidal Friction



- Tidal friction gradually slows Earth's rotation (and makes the Moon get farther from Earth).