How do we describe motion?

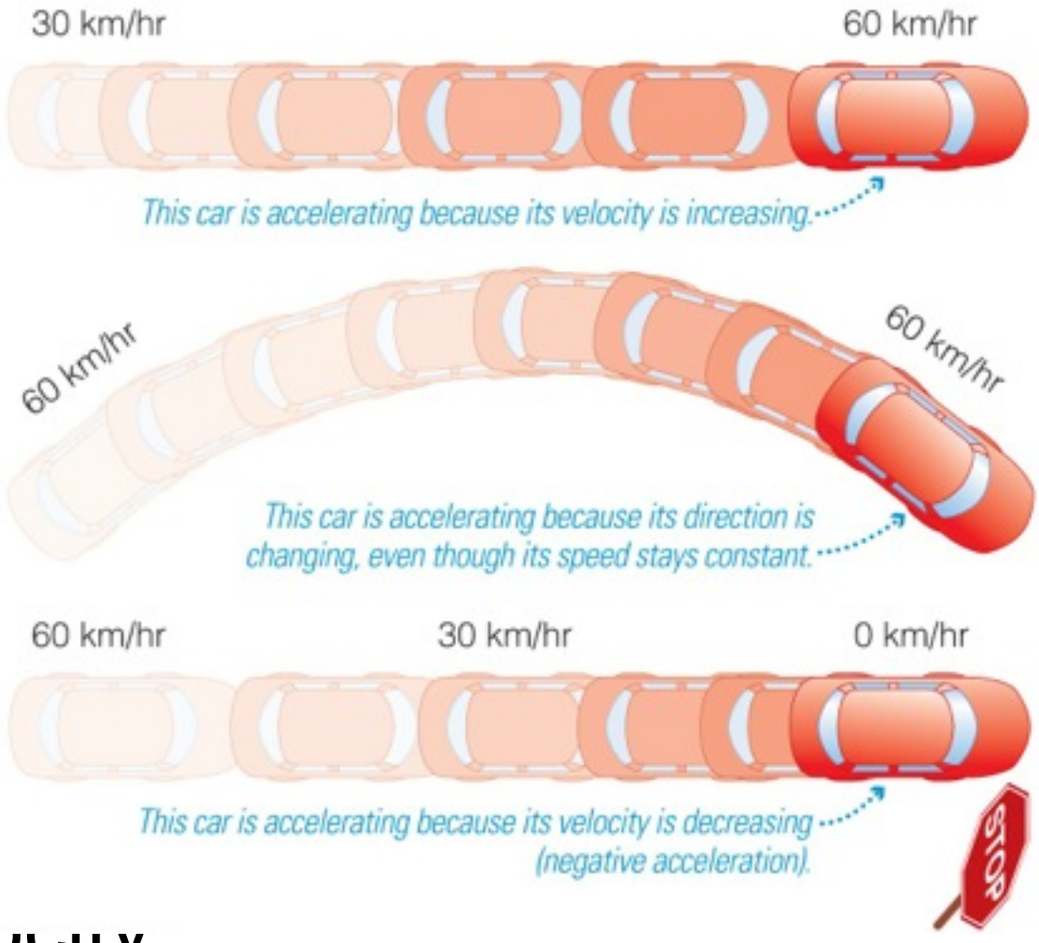
- Precise definitions to describe motion:
- **Speed:** Rate at which object moves

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

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

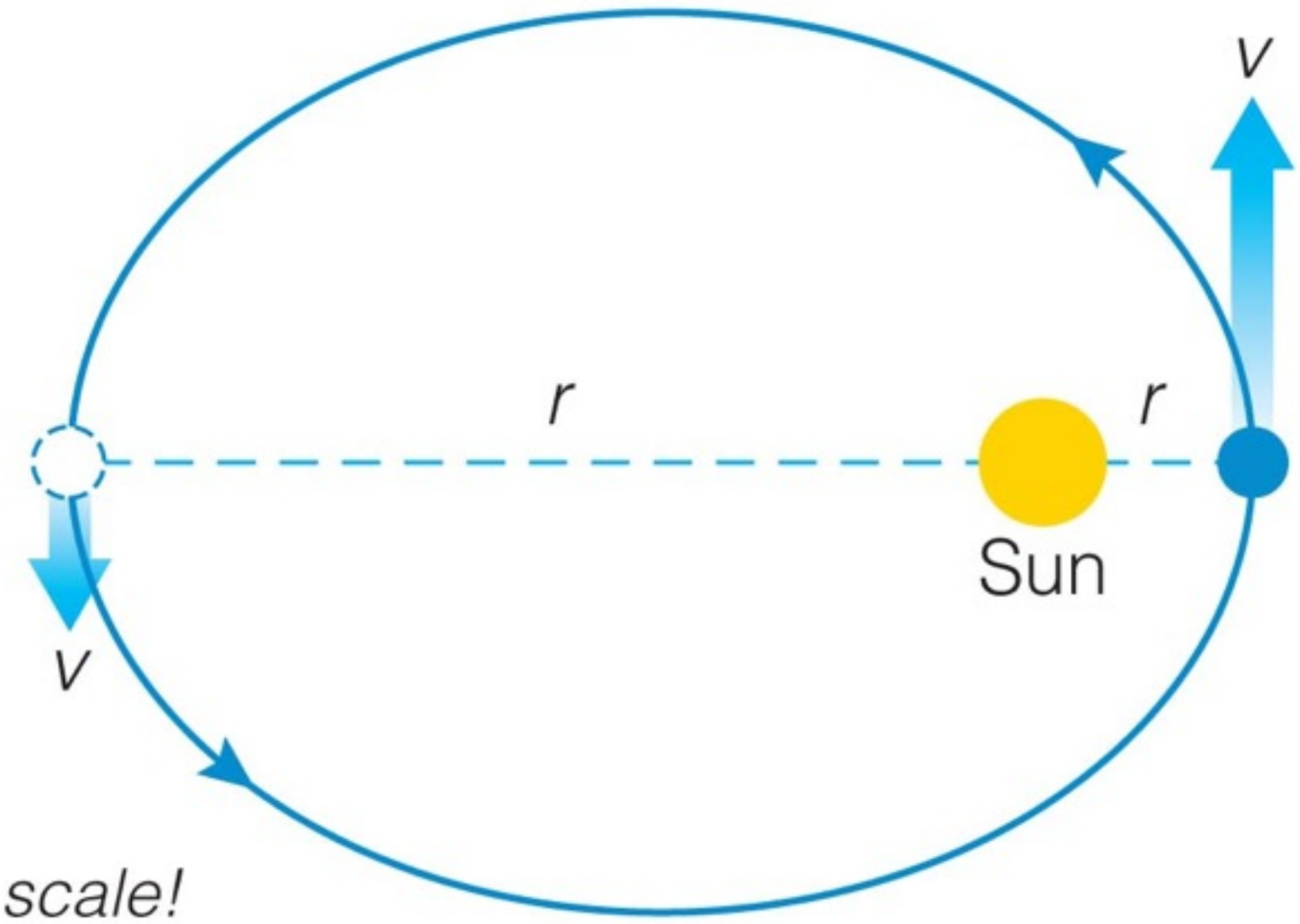
How does the force the Earth exerts on you compare with the force you exert on it?

A. Earth exerts a larger force on you.

B. You exert a larger force on Earth.

C. **Earth and you exert equal and opposite forces on each other.**

What keeps a planet rotating and orbiting the Sun?



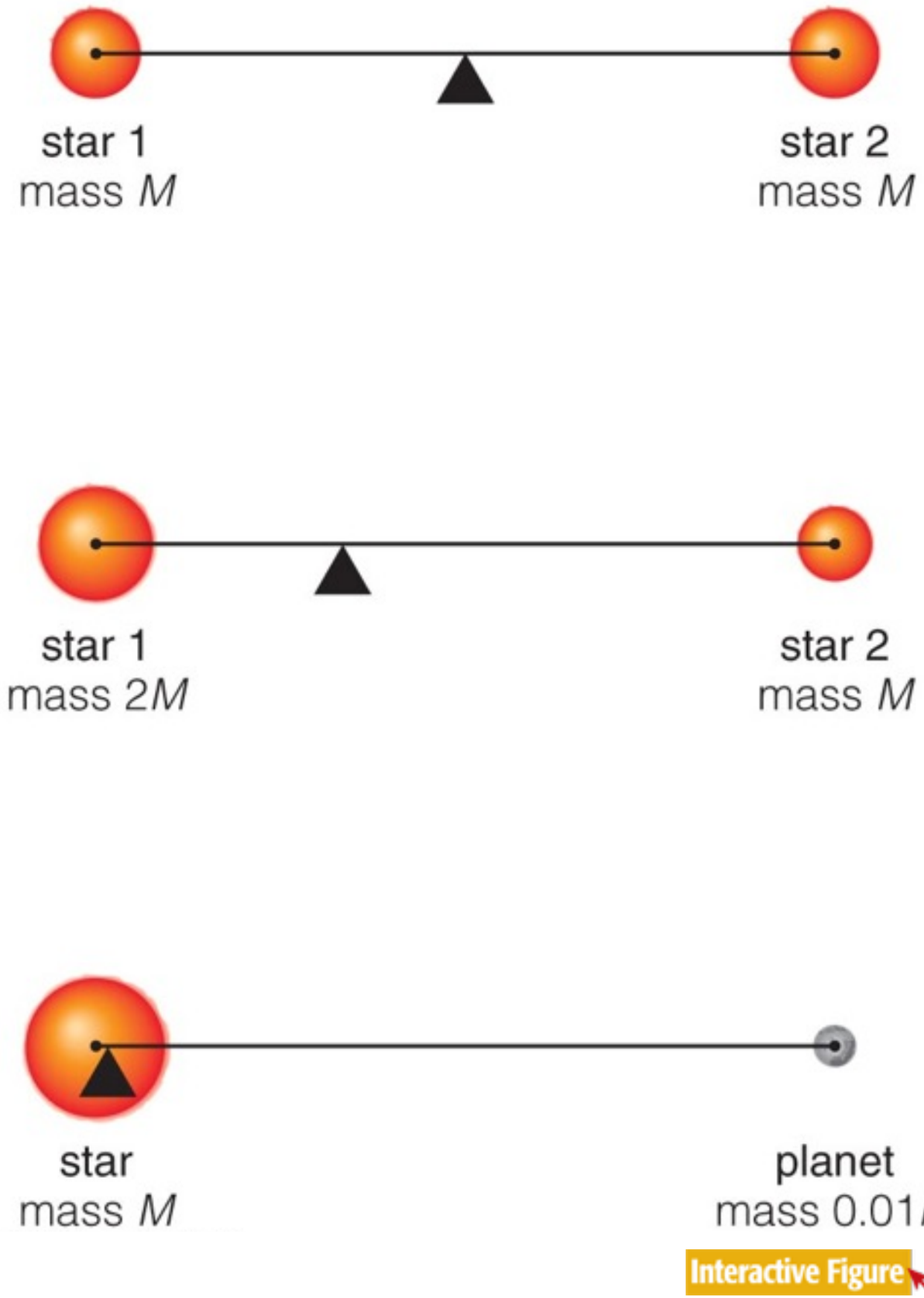
Conservation of Angular Momentum

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



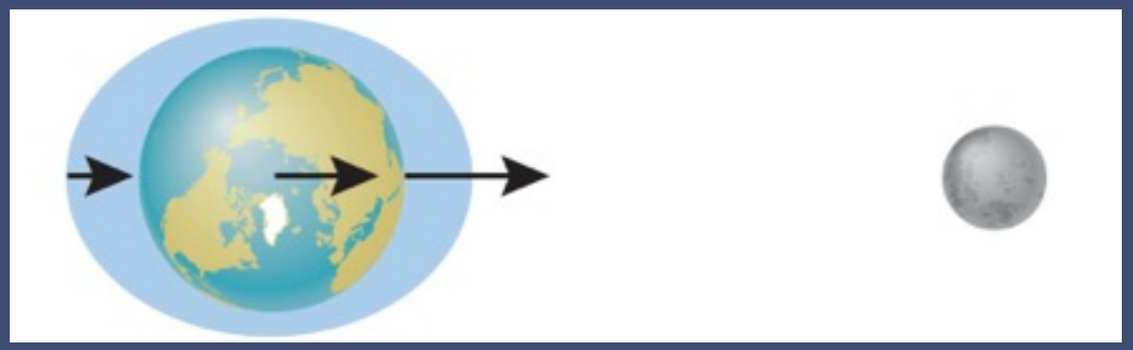
- Because of momentum conservation, orbiting objects orbit around their center of mass.

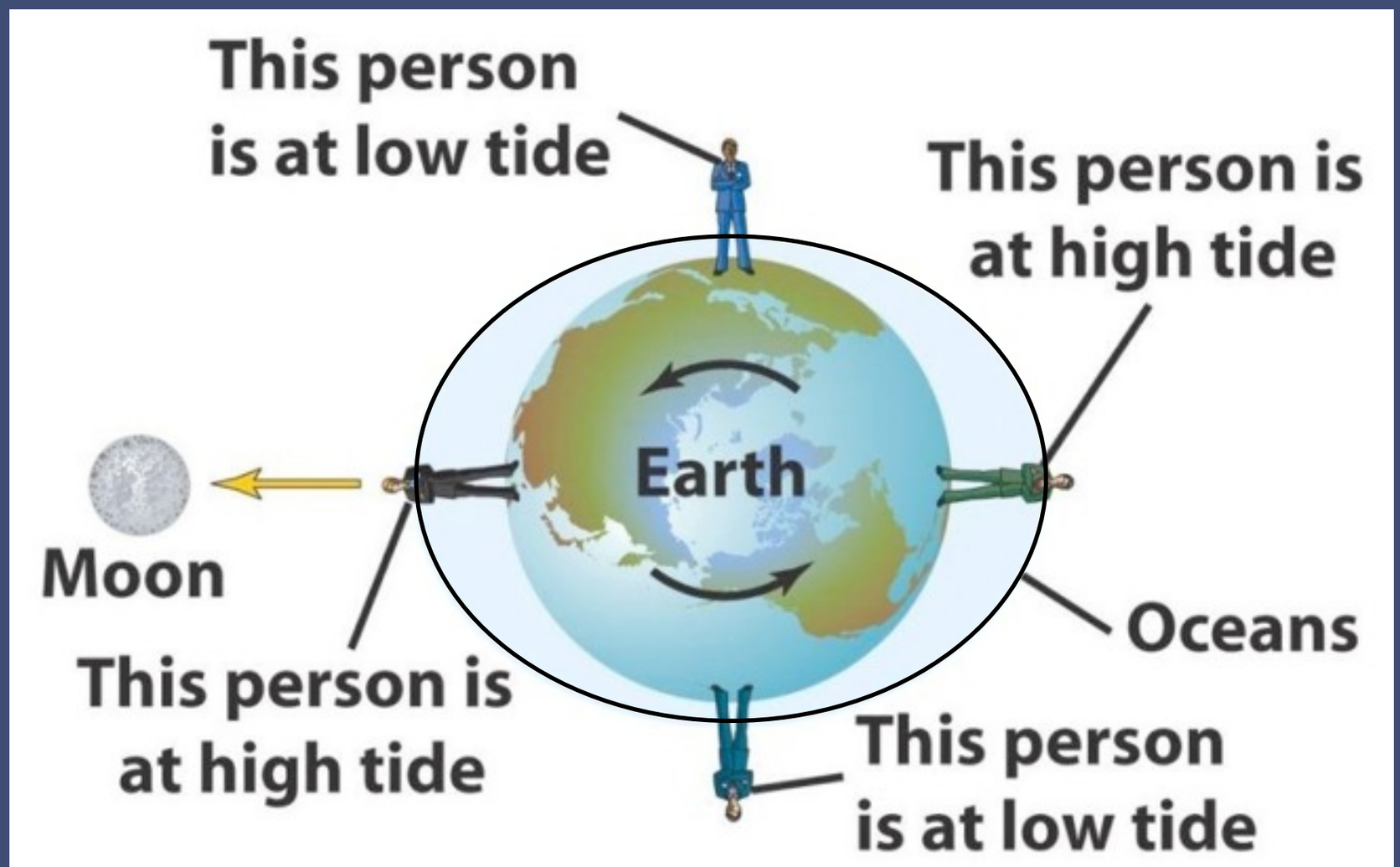
Tides

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

Tides

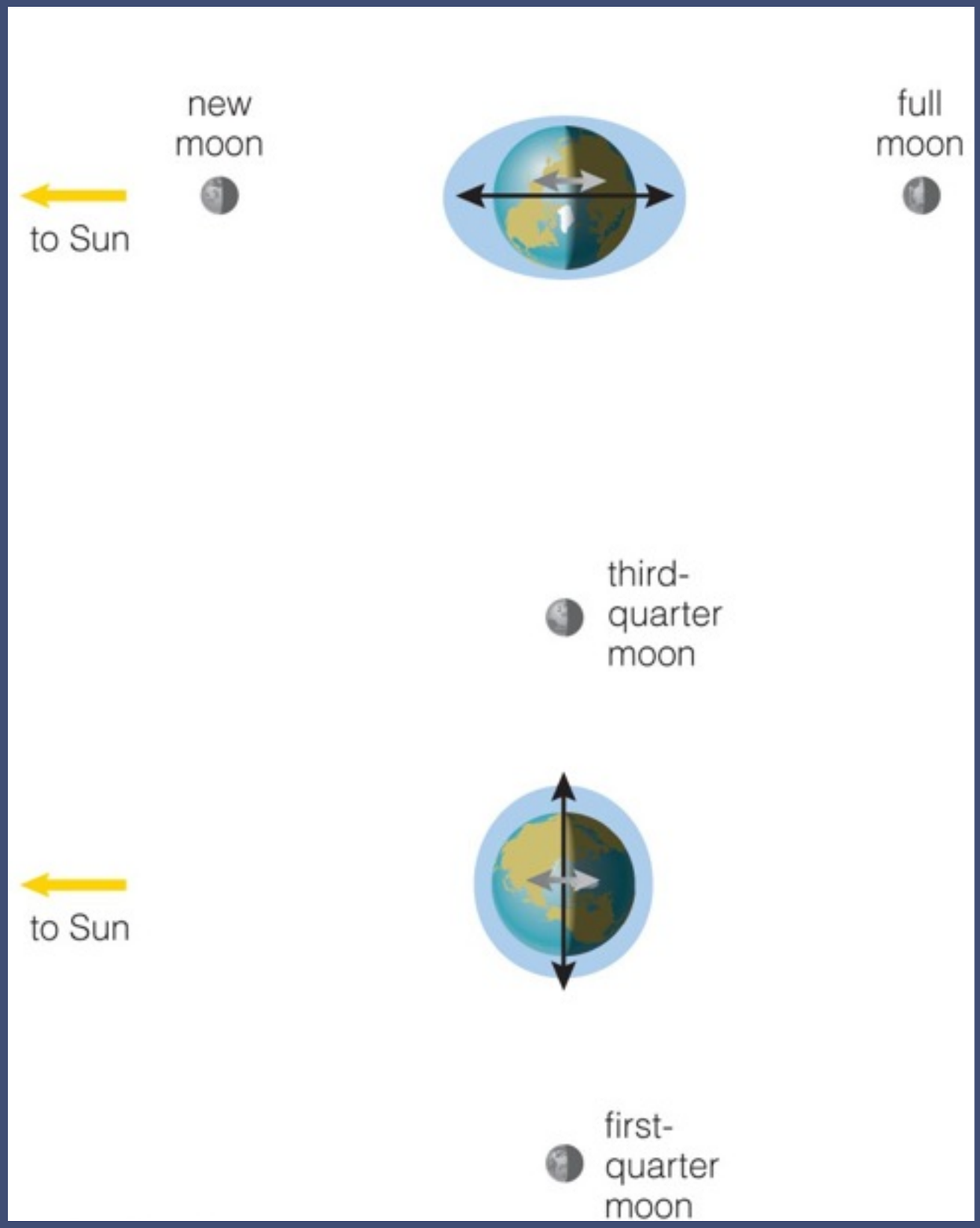
- Caused by gravity primarily of the Moon, but also of the Sun
  - –land tides (2-3 inches)
  - –ocean tides (~2 feet)



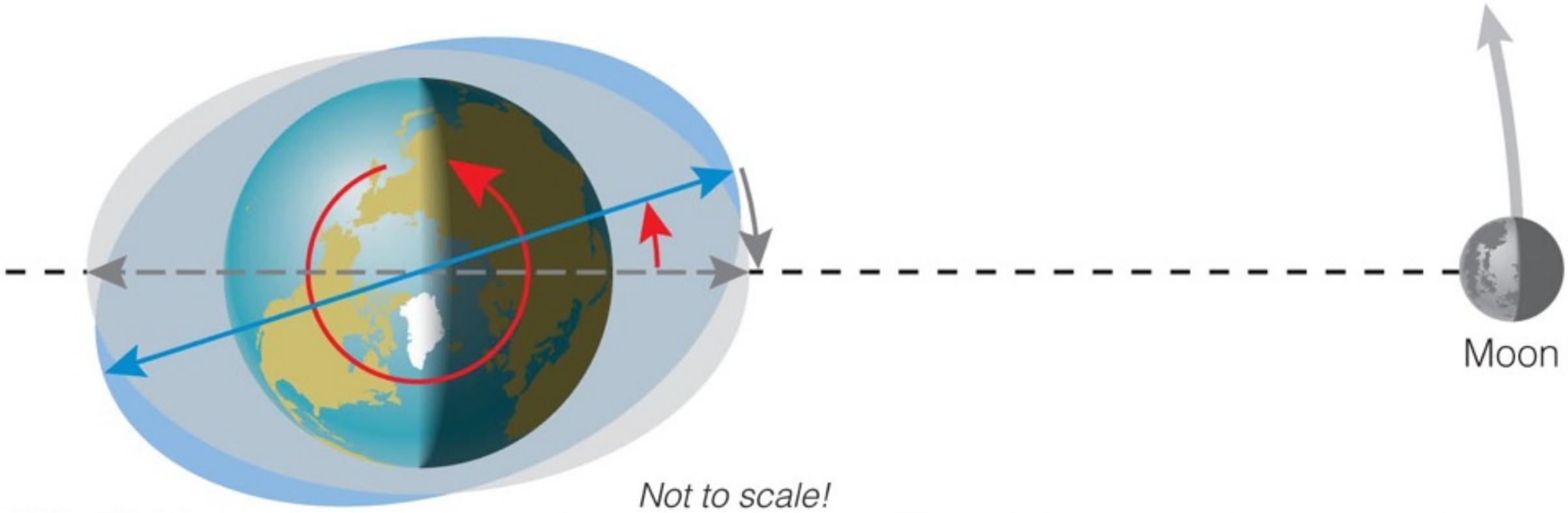


Tides

- 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).