Gravity

9/28/2009

Opening Discussion

- http://www.youtube.com/watch?v=xMXk5Y7Gv6Y
- Have you seen anything interesting in the news? What did we talk about last class?
- Midterm results with Mars lecture:
  - A : 25, B : 18, C : 14, D : 5, F : 4
- http://lcross.arc.nasa.gov/impact.htm

Minute Essays

- Do you use more energy moving faster?
- The bomb dropped on Hiroshima converted roughly 600 mg to energy.
- Exposure to a microwave.
- Finding practice problems.
- Do you have to be able to convert energies?
- Neutron stars and conservation of angular momentum.

Skating

- Most rinks sell skates. These were from www.lowpriceskates.com.
- You can get light-up wheels.
- To learn take the class in the spring.
- I prefer quads over blades.
- I have been skating since I was 3, and regularly for about 4-5 years now.

Coke Can Example

- Let's quickly work out the answers for the last minute essay related to the chemical energy in a can of coke, 150 Cal=630,000 J:
  - How high you have to climb to have that much gravitational potential energy?
  - How fast do you have to be moving the have that much kinetic energy?
  - If you climb that high and jump, how fast will you be moving when you hit the ground?

Newton's Law of Gravity

- Gravity is a force. It's strength is proportional to the masses of the objects and inversely proportional to the square of the distance between them.

$$F_g = G\frac{M_1 M_2}{d^2}$$

- $G=6.67*10^{-11}$ [$m/(kg*s^2)$]
- Objects fall at the same rate because if you combine this with f=ma the mass of the falling object cancels.

Newton vs. Kepler

- Newton's law produces Kepler type motion, but it is more general.
  - Moons, asteroids, etc. have elliptical orbits.
  - Orbits are conic sections. Unbound orbits can be parabolic or hyperbolic.
  - Bodies orbit their mutual center of mass.
  - More general form of Kepler's 3rd law:

$$p^2 = \frac{4\pi^2}{G(M_1 + M_2)} a^3$$

Understanding Orbits

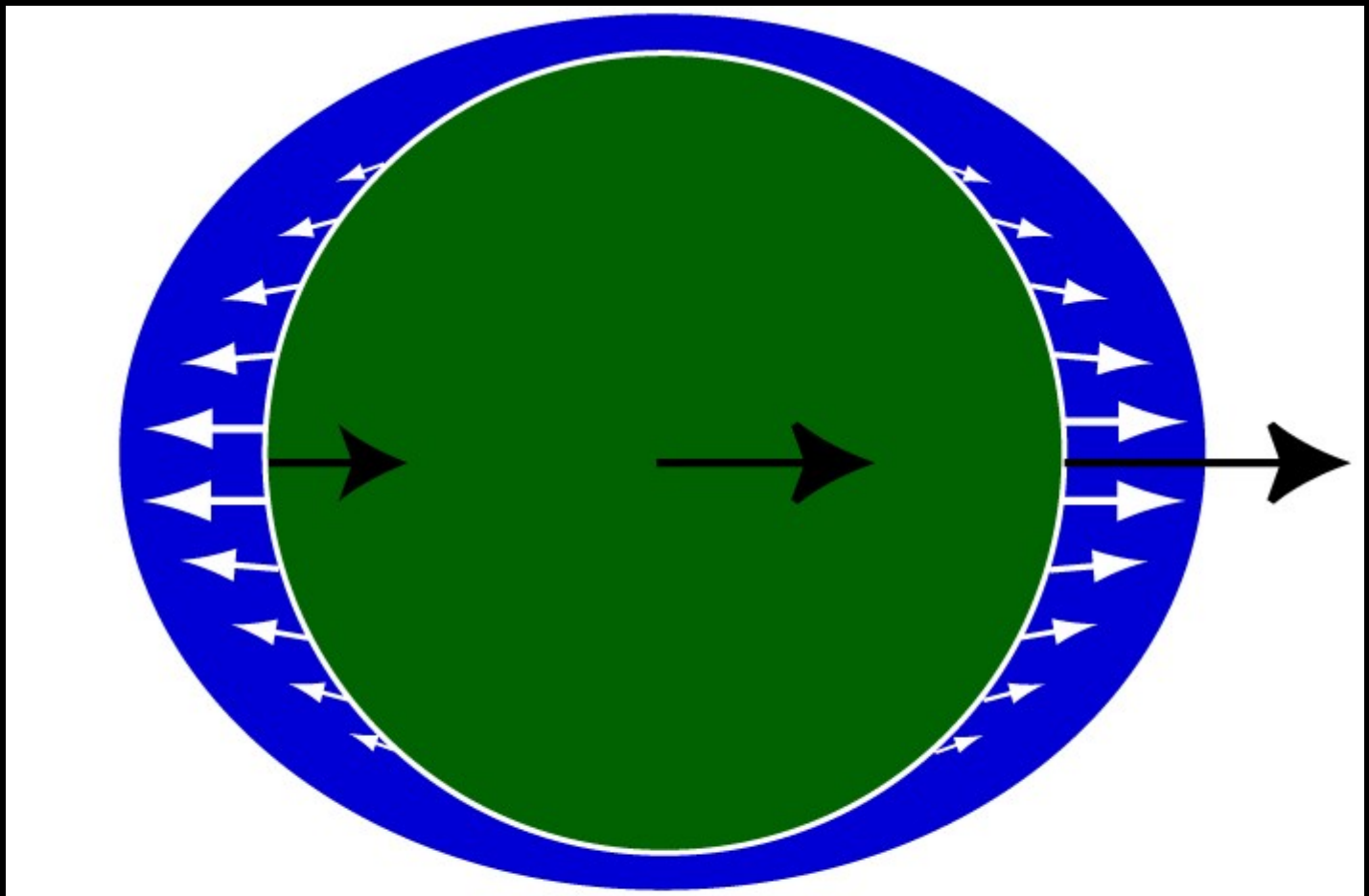
- Gravitational Potential Energy (Newton version)

$$E_{grav} = -G\frac{M_1 M_2}{d}$$

- Orbits don't change on their own, but they can be altered by outside forces.
  - Gravitational encounters.
  - Atmospheric drag.
- Escape Velocity

$$v_{escape} = \sqrt{\frac{2GM}{R}}$$

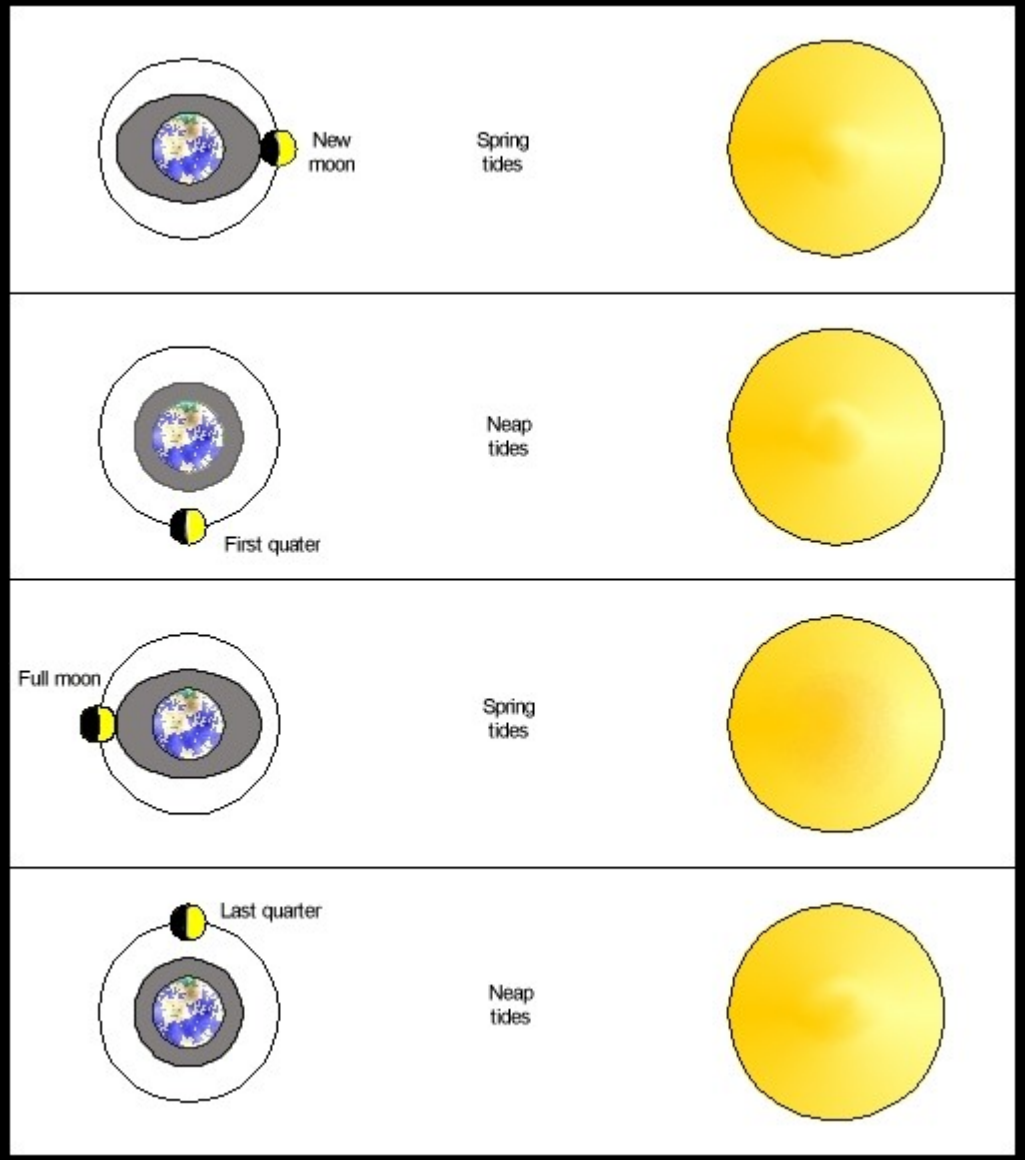
Tides



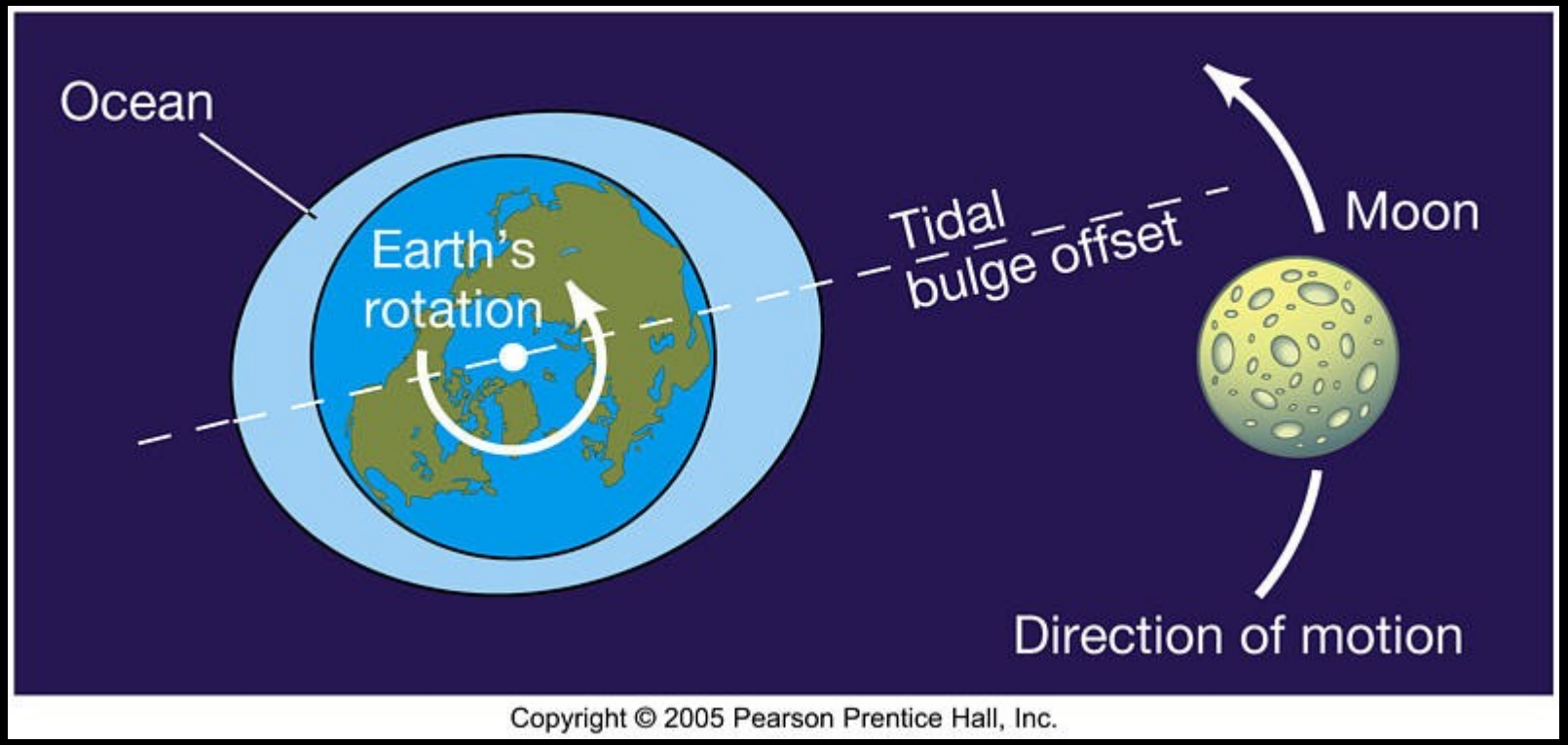
Black arrows: Gravitational force due to Moon.
White arrows: Net differential force relative to centre of the Earth - the tide-raising force.

Spring and Neap Tides

- Sun and Moon both raise tides.
- Moon's are twice as large because it is closer.
- Spring tides are when they add. Neap tides are when they cancel.
- About 12 hours and 50 minutes between high tides.



Tidal Friction



Centrifugal Force and Circular Orbit Velocity

- Objects want to move in a straight line. When a force causes an object to move on a curved path, we often describe it's tendency to want to go straight as a pseudo-force can centrifugal force.

$$F_c = \frac{mv^2}{r}$$

- Setting centrifugal force equal to gravitational force gives the circular orbit velocity.

$$v_{circular} = \sqrt{\frac{GM_1}{d}}$$

Minute Essay

- That concludes our discussion of mechanics for this class. What questions do you have?
- Quiz #3 is at the beginning of next class.
- Reading quiz will close on Wednesday.