Astro 301/ Spring 2005

(46690)

Introduction to Astronomy

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TAs: Nick Sterling & Nairn Baliber

MWF 12-1 W-3.502

Lecture 8+9+10; MWF Feb 7,9,11

Announcements/L8

- http://www.as.utexas.edu/~sj/a301-sp05.html

- First Homework assignment : pick it up today. Also online

- Quiz: pick up your quiz if you did not do so on Friday.

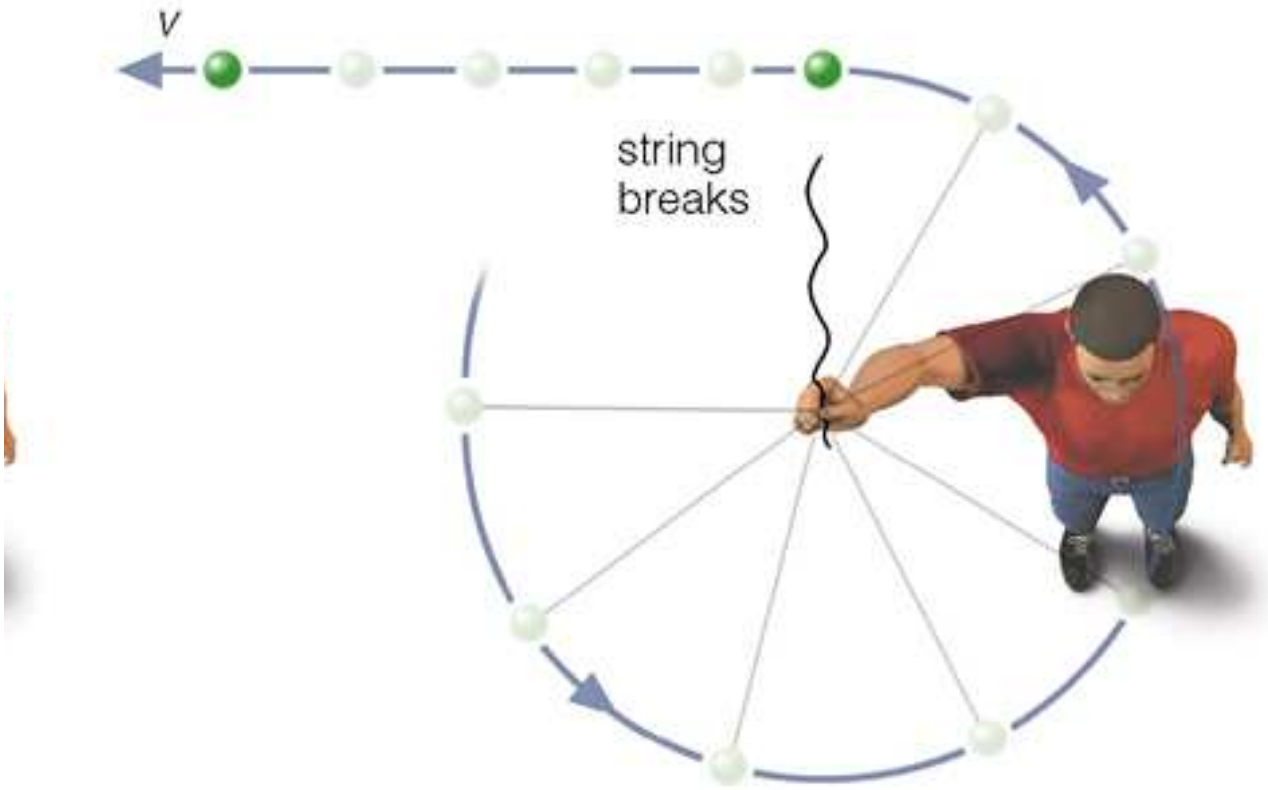
- Quiz: If your grade is below 44%, please come by during office hours for help, discussions, Q&A. We are here to help!

Fundamental Concepts

See class notes

- Fundamental concepts
- Force
- Vector and Scalar quantities : velocity vs speed, mass vs weight
- Newton's laws of motion
- Mass, weight, volume, momentum
- Conservation laws: Energy, Momentum
- The four fundamental forces
- Newton's Universal Law of Gravitation
- Conservation laws: Angular Momentum

Speed vs. Velocity

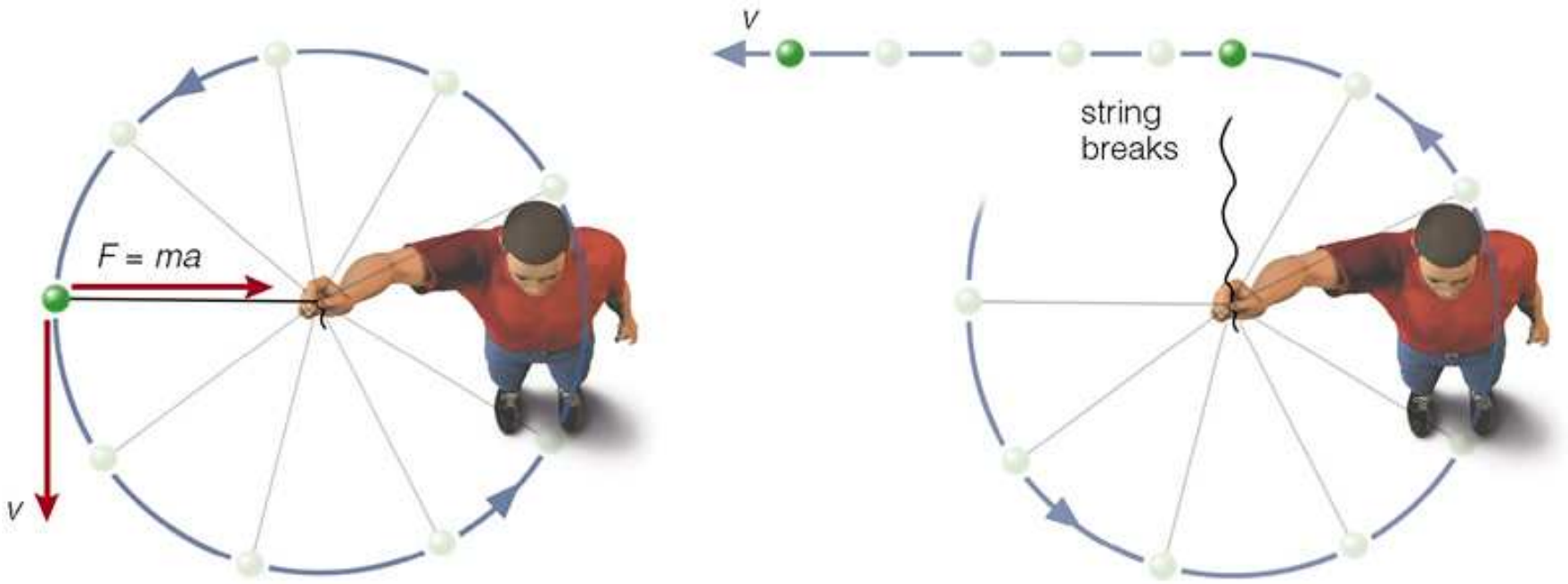


- Velocity ***v*** = both size and direction à changes as object moves in a circle
- If string breaks, force =0, object flies off along a tangent at constant ***v***

Newton's Laws of Motion

Force ***F*** = m ***a***

Newton's Laws of Motion

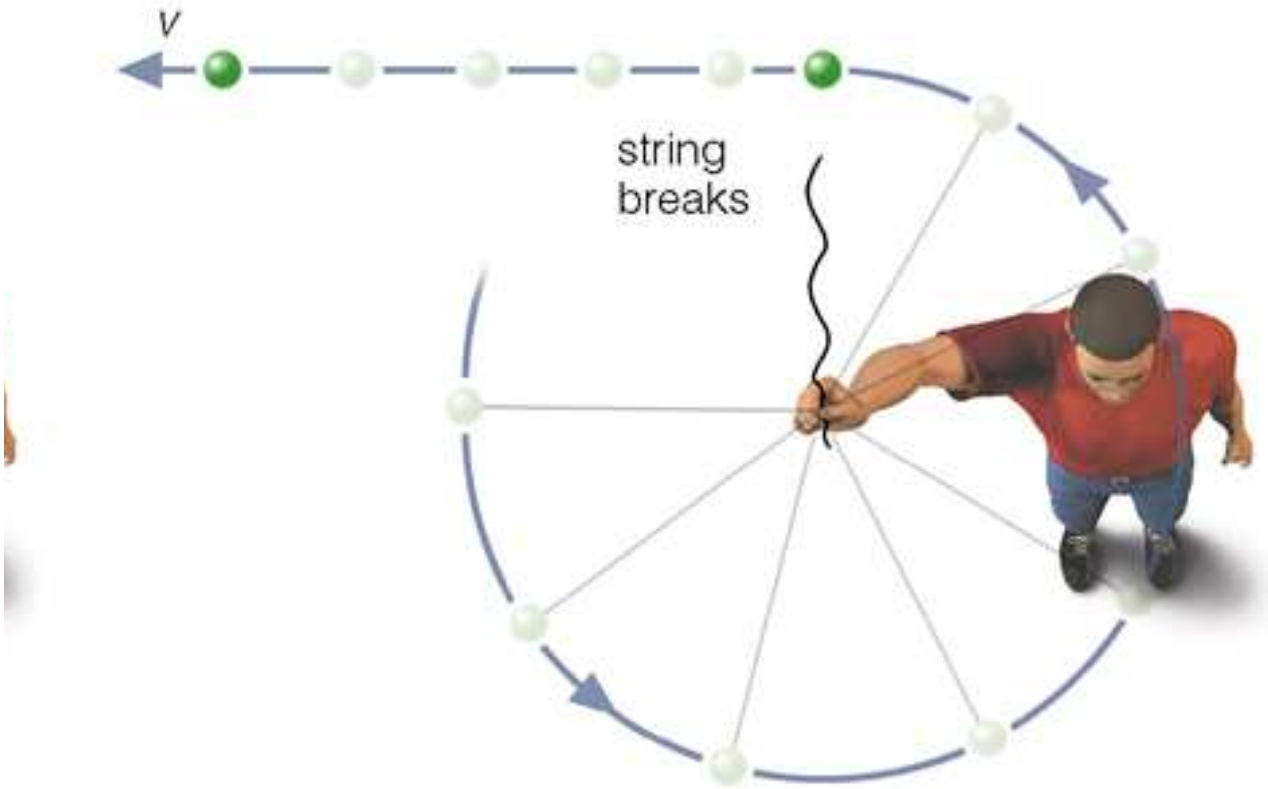


- Velocity ***v*** = both size and direction à changes as object moves in a circle
- Force ***F*** changes ***v*** continuously
- If string breaks, force =0, object flies off along a tangent at constant ***v***

Newton's Laws of Motion

A rocket is propelled upward by a force equal and opposite to the force with which gas is expelled out its back.

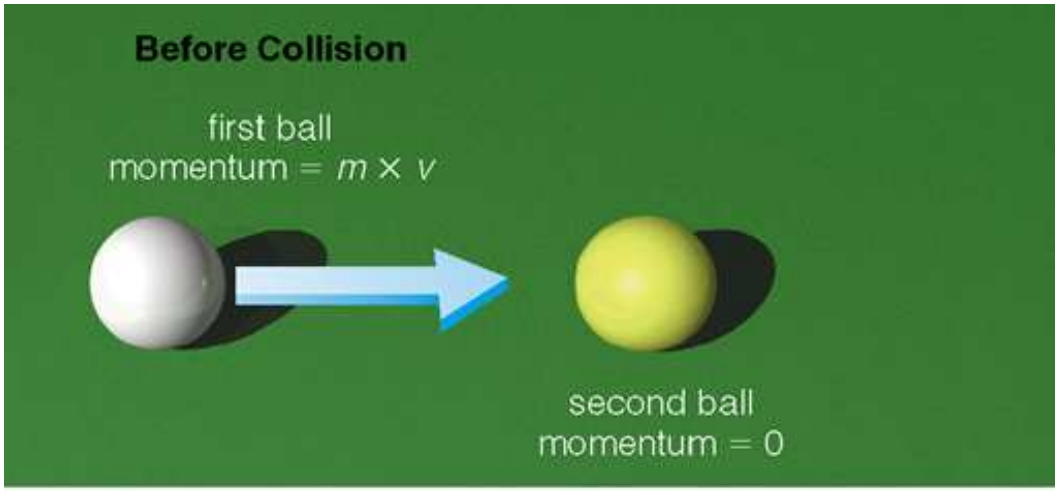
Momentum



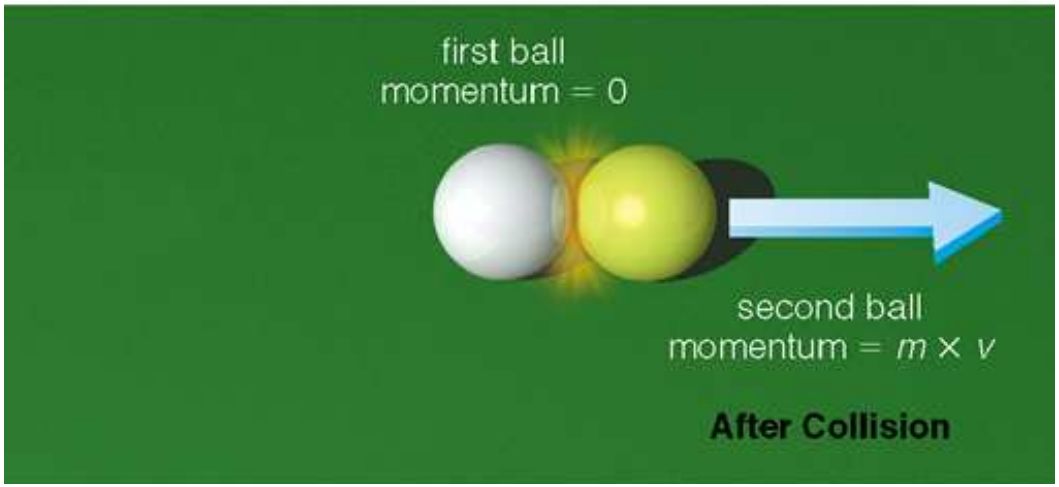
Velocity ***v*** = both size and direction à changes as object moves in a circle

Momentum ***p*** = m ***v*** in kg m s^{-1} à changes as object moves in a circle

Conservation of momentum



The collision transfers momentum from the first ball to the second ball.



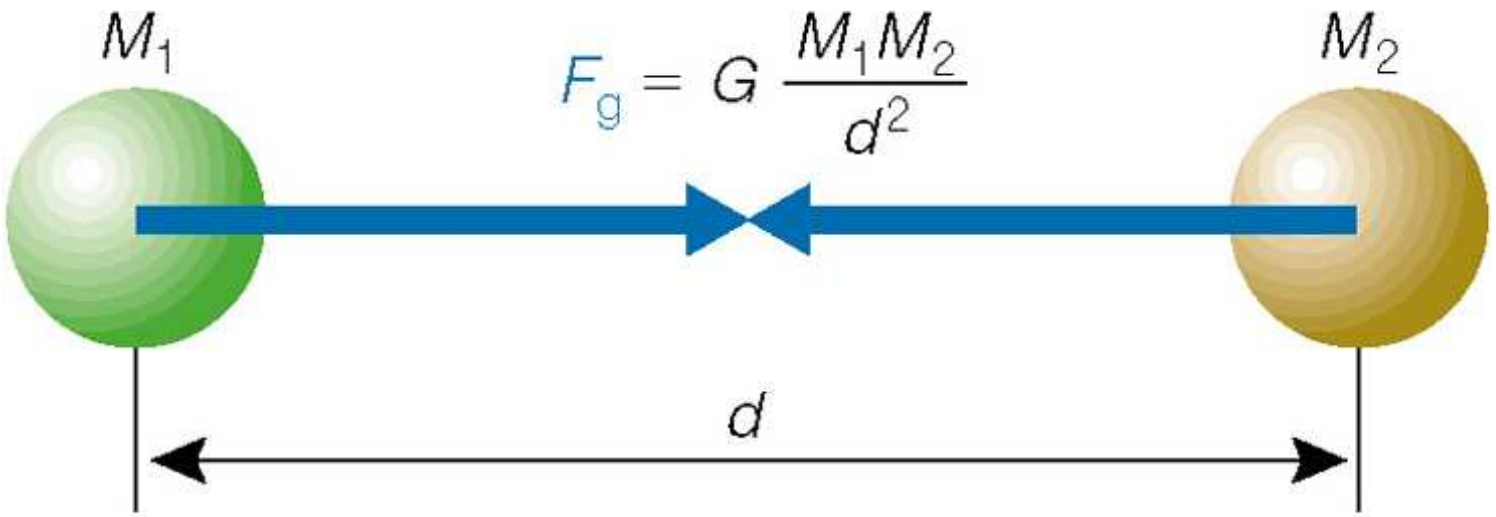
Conservation of Momentum

A rocket is propelled upward by a force equal and opposite to the force with which gas is expelled out its back.

Momentum given to gas by rocket is equal and opposite to momentum given by gas to rocket

$$M_{rocket}\ \boldsymbol{v}_{rocket} = -\ M_{gas}\ \boldsymbol{v}_{gas}$$

Four Fundamental Forces in Nature



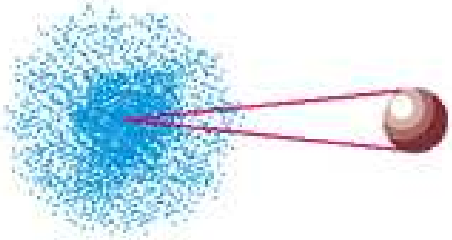
Gravitational, electric, and magnetic forces are inverse square law forces

F prop to $1/d^2$

Four Fundamental Forces in Nature

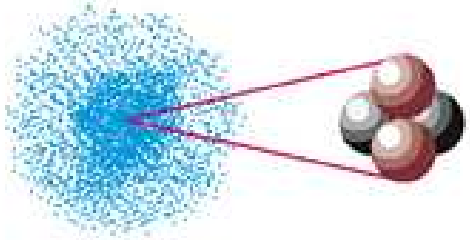
atomic number 5 number of protons
atomic mass number 5 number of protons 1 neutrons

Hydrogen (^{1}H)



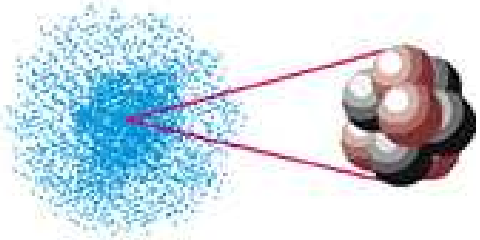
atomic number 5 1
atomic mass number 5 1
(1 electron)

Helium (^{4}He)



atomic number 5 2
atomic mass number 5 4
(2 electrons)

Carbon (^{12}C)



atomic number 5 6
atomic mass number 5 12
(6 electrons)

The number of electrons in a neutral atom equals its atomic number.

Atoms consist of

- a nucleus made of protons (+ve charges) and neutrons (neutral)
- a ‘cloud’ of electrons (-ve charges) orbiting the nucleus

Momentum vs Angular Momentum

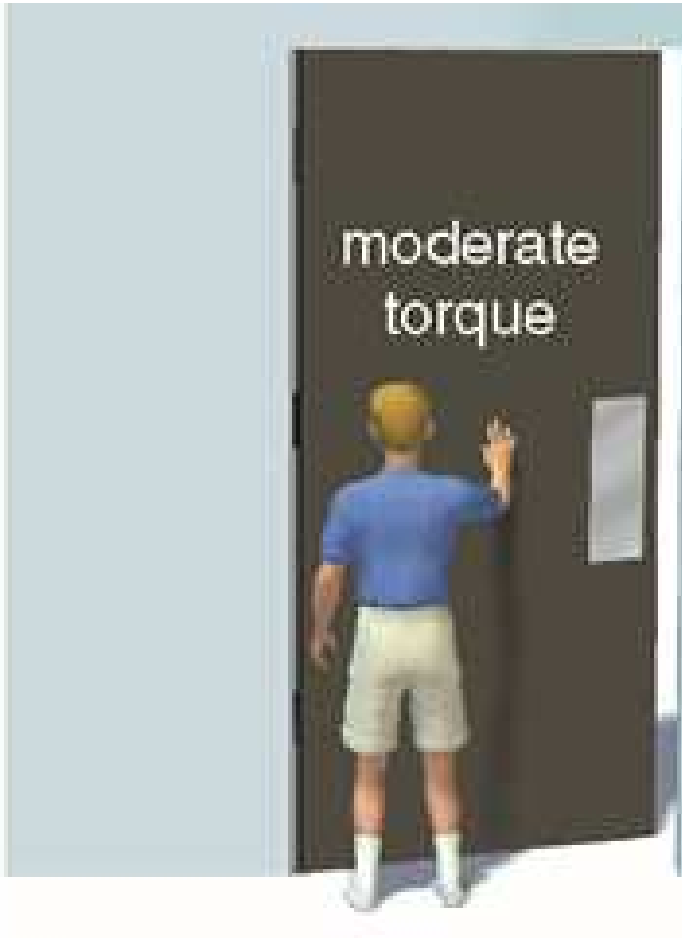
Momentum is associated with translational motion

$\boldsymbol{p} = M_{gas}\ \boldsymbol{v}_{gas}$

Angular momentum is about axis of rotation

$\boldsymbol{L} = M_{gas}\ \boldsymbol{r}\ \boldsymbol{v}_{gas}$

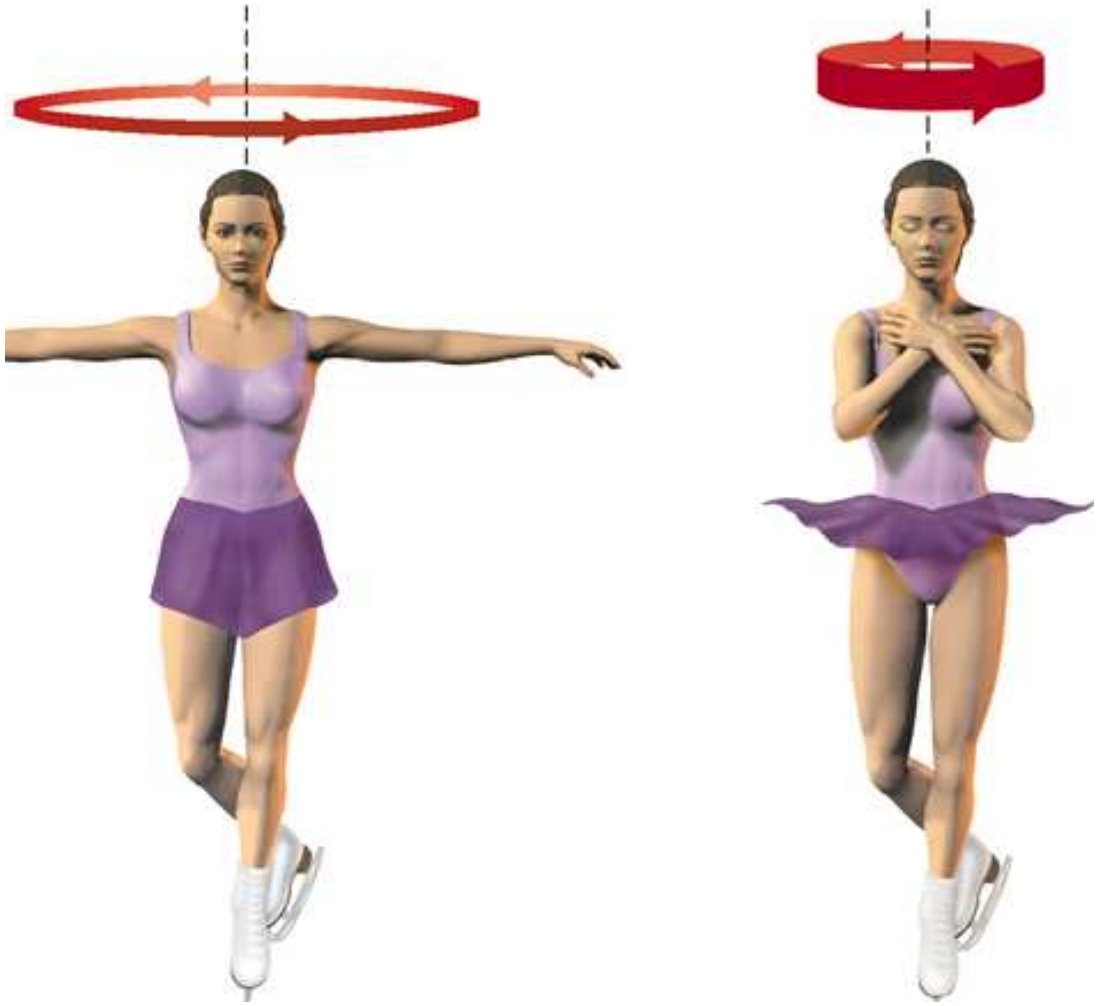
Momentum vs Angular Momentum
Force vs Torque



Angular momentum of door = ***L*** = ***r*** M ***v***

Torque on door = twisting force about rotation axis (door hinge) = ***r F***

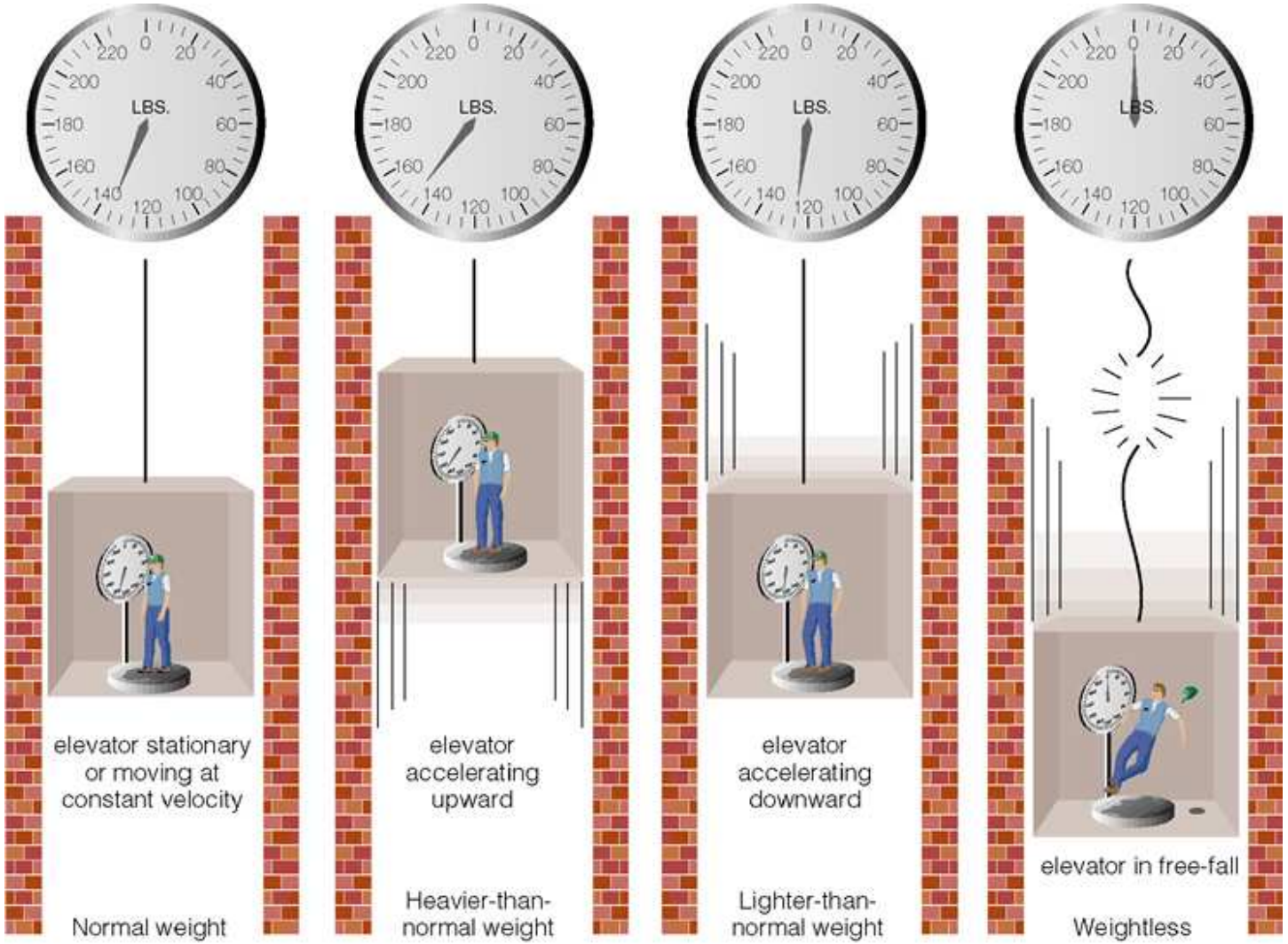
Conservation of Angular Momentum L



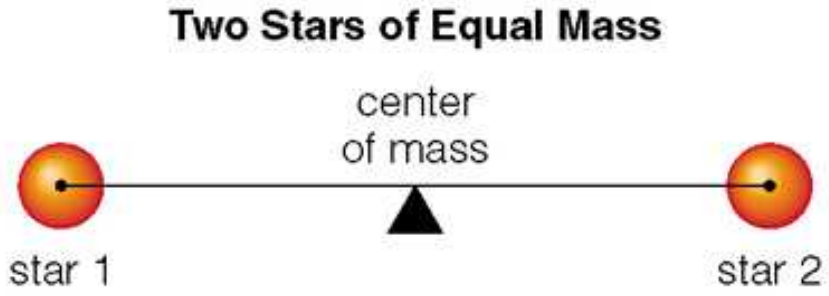
Angular momentum of ice-skater = ***L*** = ***r*** M ***v***

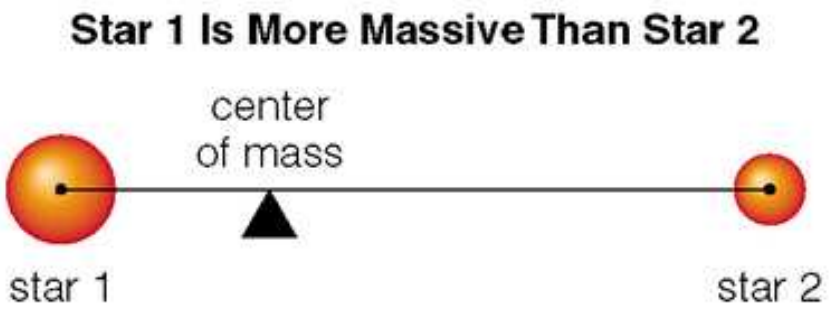
Net Torque on ice-skater = 0 à ***L*** is conserved

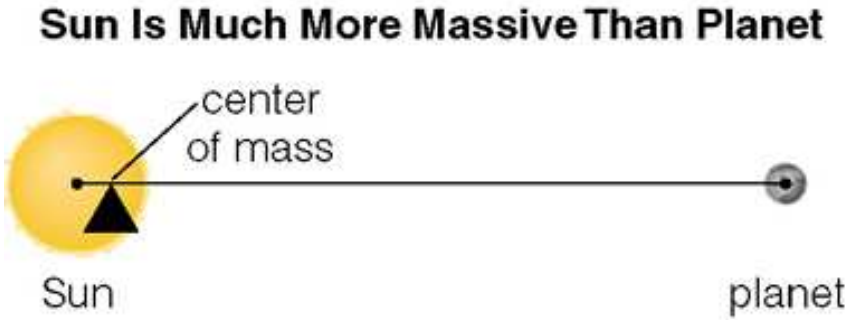
Mass, Weight, Apparent Weight and Weighltessness



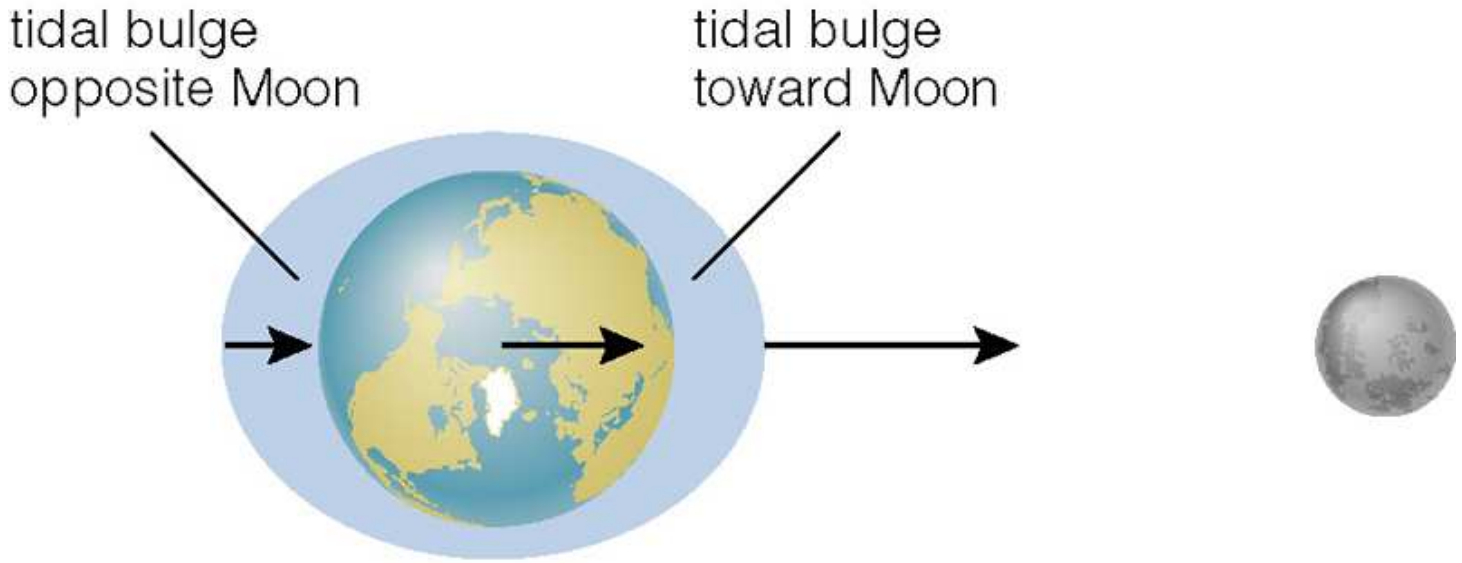
Center of Mass of 2 (orbiting) Bodies







Tides: Motion of Earth & Centripetal vs Gravitational forces

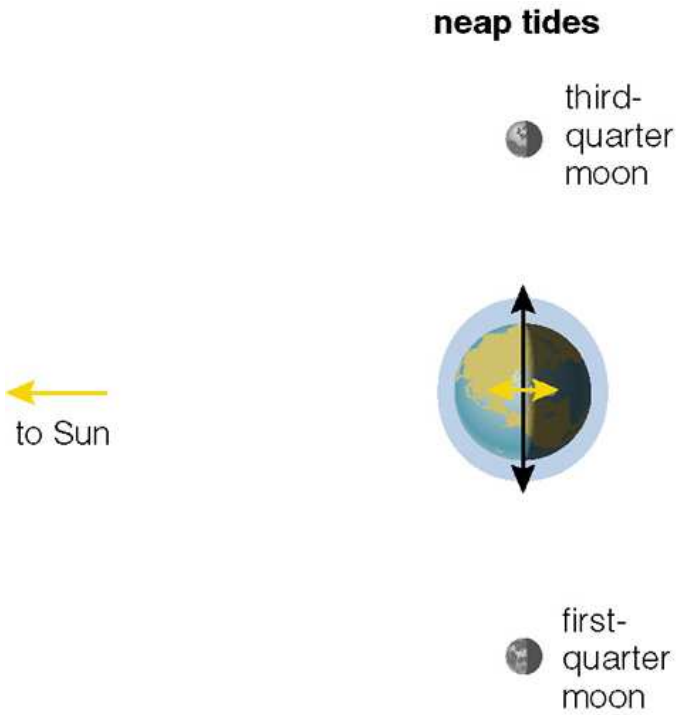


Not to scale! The real tidal bulge raises the oceans by only about 2 meters.

Why do we get tidal bulges of about same magnitude on both sides of Earth?

Why do we get 'high' tides twice a day?

Spring and Neap Tides



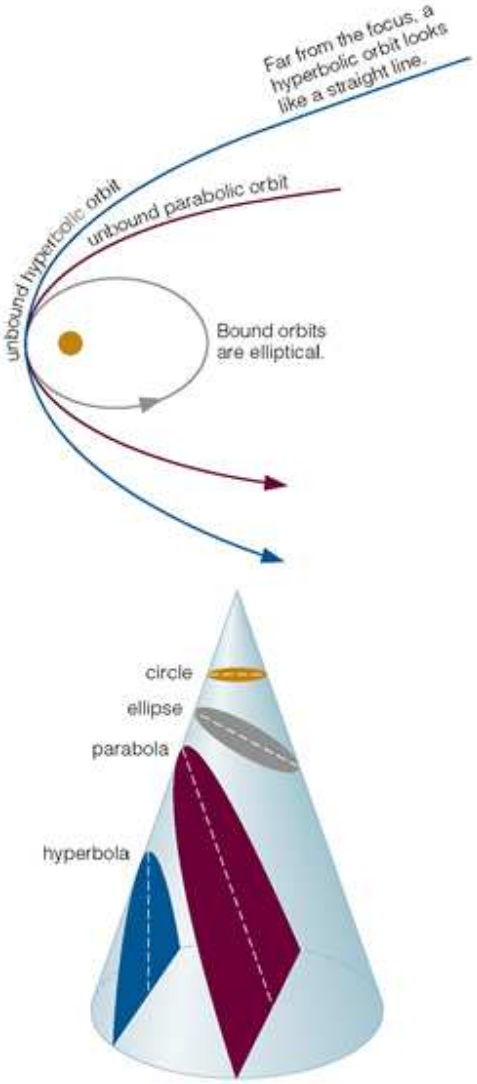
- Spring tides:

At new and Full moon, tidal forces from Moon and Sun reinforce each other leading to enhanced tides

- Neap tides

Force from Sun perpendicular to Moon's force on E\

Newton's laws of gravity : Explain + Generalise Kepler's laws



- Orbital paths allowed by law of gravity
  ellipses, hyperpolas, parabolas

- Ellipses = only orbits that are bound