# PHYS 1511 Discussion Section: Week 5

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# Relevant Equations

$$\Sigma\vec{F} = \overrightarrow{F_{net}} = m\overrightarrow{a_{net}} \qquad \text{(Newton's 2nd Law)} \tag{1}$$

$$\vec{F} = \frac{Gm_1 m_2}{r^2} \qquad \text{(Newton's Law of Gravity)} \tag{2}$$

$$\overrightarrow{F_s} = \mu_{(\text{s or k})}\vec{N} \qquad \text{(Static or Kinetic Friction)} \tag{3}$$

$$a_c = \frac{v^2}{r} \qquad \text{(Centripetal Acceleration)} \tag{4}$$

$$\vec{F}_c = m\vec{a_c} = m\frac{\vec{v}^2}{r} \qquad \text{(Centripetal Force)} \tag{5}$$

# Review

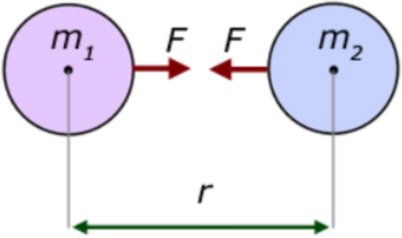
Newton's Laws:

1) An object stays at rest (or constant velocity) unless acted upon by exterior net force.

2) When a net force ($\Sigma\vec{F}$) is exerted, an acceleration $\vec{a}$ results and is given by: $\vec{a} = \frac{\Sigma\vec{F}}{m}$

3) **Whenever one object exerts a force on another, the 2nd object exerts an equal and opposite force on the first object.**

# Review




-Action-Reaction pairs

-Normal Force

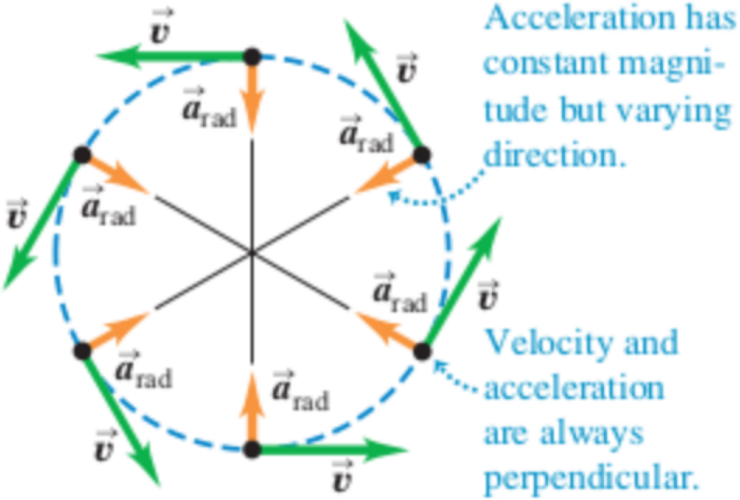
-Apparent Weight

-Friction Force

-Tension Force

-Centripetal Force/Uniform Circular Motion

# Review


Acceleration has constant magnitude but varying direction.
Velocity and acceleration are always perpendicular.
$\vec{v}$
$\vec{a}_{rad}$

# Question #1

## Force the issue

A book with mass "m" sits on a table at rest. The table is also at rest. Ignore friction. Answer the following:

a) List all the mechanical forces acting on the book

b) List all the mechanical forces acting on the table

c) Is the normal force and weight on the book an action-reaction pair?

d) Suppose a rope was tied to the book in the center and pulled just enough, so that the book would lift off the table if any more upward force is applied. List all the mechanical forces on the book now.

# Question #2

## An apparent problem

A rocket blasts off from rest and attains a speed of 45 m/s in 15 s. An astronaut has a mass of 57 kg.

(a) What is the astronaut's apparent weight during takeoff?

(b) What is the astronaut's weight while standing at rest

# Question #3

## Gravity Attraction

Synchronous communications satellites are placed in a circular orbit that is $3.6 \times 10^7$ m above the surface of the earth.
(a) What is the magnitude of the acceleration due to gravity at this distance?
(b) What is the **Linear** velocity of the satellites at this height?

G $= 6.67 \times 10^{-11}\ \frac{m^3}{kg*s}$
M$_{earth} \approx 6 \times 10^{24}$ kg
R$_{earth} \approx 6400$ km

(If you're interested, try calculating the acceleration due to gravity at the ISS! $R_{ISS} \approx 408km$ above earth)

# Question #4

## Friction holds us together

A 59kg box is sitting on floor of an elevator. The coefficient of static friction between the box and the floor is 0.4. Determine the static frictional force that acts on the box when the elevator is:
(a) Stationary
(b) Accelerating upward at 2 $m/s^2$
(c) If someone applies a force of $250N$ horizontally on the box in part (b), does it start move? What about if the elevator wasn't accelerating?

# Question #5

## Gravity of the situation

Oh no! A mad scientist suddenly turned the Sun into a black hole! Suppose the earth stopped rotating around where the sun was and began (from rest) falling toward the center of the solar system. Symbolically solve for how long would it take for the earth to enter the black hole's event horizon (the point where they collide). Write your answers in terms of:

$M_{\odot}$ - Mass of the black hole
$r_{au}$ - Distance from earth to black hole

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G - Gravitational Consant $M_\odot$ - Mass of the black hole
$R_{au}$ - Distance from earth to black hole

How much time does humanity have (in days) if $M_\odot = 2 \times 10^{30}$kg and $r_{au} = 1.50 \times 10^{11}$m and $G = 6.67 \times 10^{-11}\ \frac{m^3}{kg * s}$

# Question #6

## Amusement Physics

At an amusement park there is a ride in which cylindrical shaped chambers spin around a central axis. People sit in seats facing the axis, their backs against the outer wall. At one instant the outer wall moves at a speed of 3.2 m/s. A 83-kg person feels a 560N force pressing against their back. What is the radius of the chamber then?