



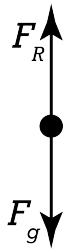
Flipping Physics Lecture Notes:

AP Physics C: Dynamics Review (Mechanics)

- Newton's 1st Law: When viewed from an inertial reference frame, an object at rest will remain at rest and an object in motion will remain at a constant velocity unless acted upon by a net external force.
 - An inertial reference frame is where the acceleration of the reference frame zero.
 - A non-inertial reference frame is where the acceleration of the reference frame is not zero.
 - Also called the "Law of Inertia".
 - Inertia is the tendency of an object to resist acceleration.
- Newton's 2nd Law: $\sum \vec{F} = m\vec{a}$ on the equation sheet it is $\vec{a} = \frac{\sum \vec{F}}{m} = \frac{\vec{F}_{net}}{m}$.
- Newton's 3rd Law: $\vec{F}_{12} = -\vec{F}_{21}$
- $\sum \vec{F} = m\vec{a} \Rightarrow \text{newtons, } N = \frac{kg \cdot m}{s^2}$
- The basic forces with which we begin dynamics:
 - Force of Gravity also called Weight. $F_g = mg$
 - The force of gravity is caused by the interaction between the object and the planet.
 - The force of gravity is always down.
 - The acceleration due to gravity, g, here on planet Earth is +9.81 m/s².
 - Sometimes the symbol is W.
 - The force of gravity acts on the center of gravity of the object. (Which is the same as the center of mass in a constant gravitational field like the one we live in.)
 - Force Normal, F_N : A pushing force caused by a surface.
 - The force normal is normal to (perpendicular to) the surface.
 - The force normal is always a push. (Never a pull. A surface can't "pull".)
 - The force normal acts on the contact point between the two surfaces.
 - Force of Tension, F_T : The force caused by a rope, cable, wire, string, etc.
 - Always in the direction of the rope, cable, wire, string, etc.
 - Always a pull. (Never a push. You can't "push" with a rope.)
 - Sometimes the symbol is T.
 - Force Applied, F_a : The force of one object pushing or pulling on another object.
 - Force of Friction, F_f : The force caused by the interaction between two surfaces.
 - With regards to the direction of the Force of Friction. F_f always:
 - is parallel to the surface.
 - opposes motion (opposes sliding between the two surfaces)
 - is independent of the direction of the Force Applied.
 - General formula on the equation sheet: $|\vec{F}_f| \leq \mu |\vec{F}_N|$
 - Static friction is when the two surfaces do NOT slide relative to one another.
 - $\vec{F}_{sf} \leq \mu_s \vec{F}_N$ & $\vec{F}_{sf_{max}} = \mu_s \vec{F}_N$
 - Kinetic friction is when the two surfaces DO slide relative to one another.
 - $\vec{F}_{kf} = \mu_k \vec{F}_N$
 - The coefficient of friction, μ , is an experimentally determined, dimensionless number which depends on the materials of the two interacting surfaces.

- General range is 0 – 2:
 - However, μ can get up to 4 in extreme circumstances.
 - $\mu_s > \mu_k$ (For the same two interacting materials.)
- Free Body Diagrams or Force Diagrams. The five steps are ...
 1. Draw the Free Body Diagram(s).
 2. Break forces in to components.
 3. Redraw the Free Body Diagram(s).
 4. Sum the forces.
 5. Sum the forces (in a direction perpendicular to the direction in step 4).
 - Only forces are drawn in Free Body Diagrams.
 - When on an incline we will often break the force of gravity in to it's parallel and perpendicular components and sum the forces in the parallel and perpendicular directions. $F_{g_{\perp}} = mg \cos \theta$ & $F_{g_{\parallel}} = mg \sin \theta$
 - Always draw the Free Body Diagram without braking forces into components first and then redraw the Free Body Diagram. These are specific instructions from The AP CollegeBoard!
 - When summing the forces you must identify:
 - Positive directions, especially for pulleys!
 - Which object(s) you are summing the forces on.
 - Which direction you are summing the forces in.
 - You can only sum the forces on multiple objects at the same time if they all have the same acceleration.
- Translational equilibrium.
 - Translational motion simply means moving from one location to another.
 - Translational Equilibrium means the net force acting on the object is zero, $\sum \vec{F} = 0$.
 - An object in translational equilibrium is not accelerating.
 - $\sum \vec{F} = 0 = m\vec{a} \Rightarrow \vec{a} = 0$.
 - The object moves with a constant velocity or is at rest.
- The Drag Force or the Resistive Force, F_R : The force caused by the interaction of an object and the fluid the object is moving through.
 - Sometimes the symbol is R or F_D .
 - Opposite the direction of motion of the object.
 - For “small” objects moving at “slow” speeds, $\vec{F}_R = -b\vec{v}$.
 - The resistive force equals the negative of, b, the proportionality constant times the velocity of the object.
 - For all other objects (and more generally applicable), $\vec{F}_R = \frac{1}{2} D \rho A v^2$.
 - D is the Drag Coefficient of the object, has no dimensions, is experimentally determined, and depends on the shape and surface texture of the object.
 - ρ is the density of the medium through which the object is moving.
 - A is the cross sectional area of the object normal to the direction of motion.
 - v is the velocity of the object.

- Terminal velocity is when an object moving through a fluid has reached translational equilibrium. Force example an object which is falling downward in the Earth's atmosphere has a free body diagram with the force of gravity down and the resistive force up.



- $$\sum F_y = F_R - F_g = ma_y \Rightarrow \frac{1}{2}D\rho Av^2 - mg = ma_y \Rightarrow a_y = \frac{\frac{1}{2}D\rho Av^2 - mg}{m} = \frac{D\rho Av^2}{2m} - g$$
 - In other words, in the absence of air resistance, $a_y = -g$!!!
- With $a_y = 0 \Rightarrow 0 = \frac{D\rho Av^2}{2m} - g \Rightarrow \frac{D\rho Av^2}{2m} = g \Rightarrow v_{terminal} = \sqrt{\frac{2mg}{D\rho A}}$

- Note: This equation is only true for "an object which is falling downward in the Earth's atmosphere". A rocket moving upward will have a different equation for terminal velocity because the free body diagram is different.