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Physics

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Free Body Diagram (FBD) One Pager

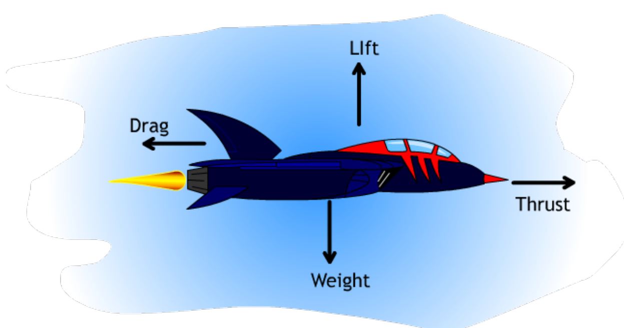
A Free Body Diagram (FBD) is a tool used to sole problems with multiple forces acting on a single body.

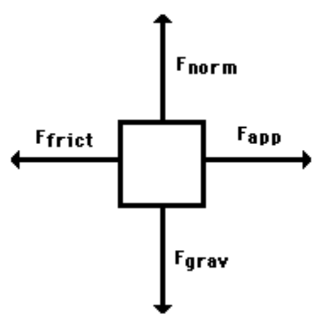
Tips when using the Free Body Diagram

1. Identify the force acting on a body

2. Identify the direction of each acting force and draw vectors representing the forces
3. Create a pair of equations from a free body
4. Do the math. This usually involves systems of equations

Pictures

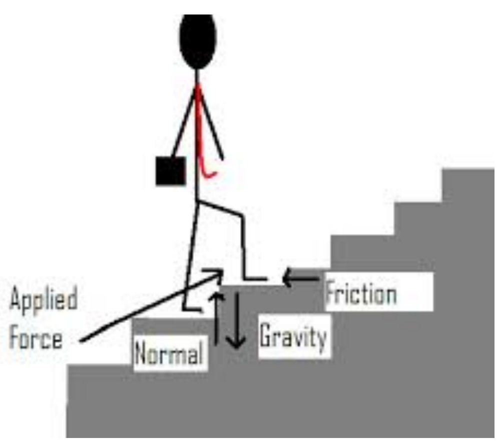




Formulas

Equation	Name	Direction	Notes
$F_g = mg$	Gravity; weight	Downwards (towards center of the Earth).	$g = 9.8\ \text{m/s}^2$ on the Earth
F_N	Normal force	Perpendicular (i.e. normal) to the surface.	Equal to whatever force is needed to prevent the object from falling through the floor. Use the FBD recipe to find F_N.
F_T	Tension	In direction of the rope or string (away from the object).	Is either given already, or needs to be found via the FBD recipe.
$F_s = kx$	Spring force (Hooke's law)	Opposite to the direction of x	x is indicates how much the spring is compressed or stretched, and $x = 0$ if it's not stretched or compressed at all. k is called the spring constant.
$f_k = \mu_k F_N$	Kinetic friction	Opposite to the direction of the velocity	μ_k is the coefficient of kinetic friction and F_N the normal force.
f_s	Static friction	Parallel to the surface, but the exact direction depends on what is needed to prevent object from moving.	Equal to whatever force is needed to prevent object from moving. However, the max value of f_s is: $f_{s,\max} = \mu_s F_N$ with μ_s the coefficient of static friction and F_N the normal force.
$F_G = G\dfrac{m_1 m_2}{r^2}$	Gravitational force	From center of one mass towards the center of the other	Use this equation instead of $F_g = mg$ when the r is approximately the radius of the Earth or larger (i.e. for planets and such).
$F_B = \rho_f V_s g$	Buoyancy force	Upwards	ρ_f is the density of the fluid, and V_s the part of the volume of the object that is submerged. When an object of mass m is floating, $F_B = \rho_f V_s g = mg$.

Example



Practice Problems

1. A book is at rest on a tabletop. Diagram the forces acting on the book.
2. A girl is suspended motionless from the ceiling by two ropes. Diagram the forces acting on the combination of girl and bar.
3. An egg is free-falling from a nest in a tree. Neglect air resistance. Diagram the forces acting on the egg as it is falling.
4. A flying squirrel is gliding (no wing flaps) from a tree to the ground at constant velocity. Consider air resistance. Diagram the forces acting on the squirrel.
5. A rightward force is applied to a book in order to move it across a desk with a rightward acceleration. Consider frictional forces. Neglect air resistance. Diagram the forces acting on the book.