AP Physics
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Free-Body Diagrams

A free-body diagram is a representation of an object with all the forces that act on it. The external environment (other objects, the floor on which the object sits, etc.), as well as the forces that the object exerts on other objects, are omitted in a free-body diagram. But any force that acts on the body from an external agent or interaction must be included in the free-body diagram.

The four forces to consider are:

Gravity ($\mathbf{F_g}$), Applied ($\mathbf{F_a}$), Normal ($\mathbf{F_n}$), Friction ($\mathbf{F_f}$)

Free-body diagrams are important because they allow us to analyze an object in isolation without distractions and to determine or predict its motion based on the action of those forces.

Part 1: Drawing the Free-Body Diagram

Step 1: Draw a box and place an **m** inside to represent the object's mass. Be sure to preserve the physical orientation of the object when you draw the box. Think about the forces that act on the object. What types of forces are they and in what direction do they act on the object? If the case includes more than one mass, be sure to distinguish the masses using subscripts.

Step 2: Draw coordinate axes that are oriented along the direction of motion and indicate the positive direction with a + sign. The directions on these will serve to determine if a force will be positive or negative in Newton's 2nd Law equation.

Step3: Attach an arrow to the box; one for each force that acts on the object. Each arrow must show the correct direction of the force and must also have a symbol that indicates the type of force it is: $\mathbf{F_g}$ (Gravity/Weight), $\mathbf{F_n}$ (Normal), $\mathbf{F_a}$ (Applied), $\mathbf{F_f}$ (Friction). Be certain to use different subscripts for forces of the same type but which have different values.

Step 4. Apply trigonometry and/or Pythagorean Theorem to resolve any forces that are at an Angle. Label the force components appropriately with **x** and **y** subscripts.

Step 5: Next to the mass, but not attached to it, draw arrows with symbols (**a** and **v**) to show the direction of the object's velocity and acceleration along each axis.