Recognizing and Interpreting Free-Body Diagrams

Adapted from Minds on Physics Activity #50:
Recognizing and Interpreting Free-Body Diagrams

Goals:

- ✓ To learn what a free-body diagram is.
- ✓ To learn the properties of a correct free-body diagram.
- ✓ To learn how to distinguish between correct and incorrect free-body diagrams.

Free-Body Diagrams:

- ✓ A free-body diagram shows all the forces acting on a single, isolated body.
- ✓ Only forces should be entered on a free-body diagram.
- ✓ The body must be isolated (a free body.)
- ✓ Indicating all of the forces acting on a single body makes it possible to discuss and determine the behavior of that body without referring to any of the objects exerting the forces.
- ✓ When drawing a free-body diagram, we draw a point to represent the body. Sometimes we draw a square around the point to represent the body.
- ✓ The point (and possible square) should be drawn away from any other illustrations or diagrams.
- ✓ On your free-body diagram, show each force on the object as an arrow. The direction of the arrow should be the same as the direction of the force. Whenever possible, the length of the arrow should be roughly proportional to the size of the force.
- ✓ All arrows representing forces begin at the point.
- ✓ Each force in the diagram should be clearly labeled.

Forces we will label on FBDs:

Gravity (weight)	W
Normal	N
Tension	T

Spring	S
Air Resistance (drag)	D
Friction	f

Common Forces:

Force (Symbol)	*Short Description*	*When is this force present?*
Normal (N)	The force that one object exerts on another by pushing on it. The direction is directly away from the surface that exerts the force and perpendicular to the surface.	Whenever two objects are touching.
Tension (T)	The force that a string, cable, cord, or rope exerts on an object pulling on it. The direction is always parallel to the string and way from the object being pulled.	Whenever a string is attached and taut (rather than slack.)
Gravitational/weight (W)	The attractive forces that objects exert on each other due to their masses.	Whenever two objects both have non-zero mass.
Drag (d) (air resistance, water resistance)	The force that air (or another fluid) exerts to oppose the motion of an object moving relative to it. The direction is opposite the relative motion of the object and the air.	Whenever an object moves through the air, or when there is wind.
Static Friction (f_s)	The force that one object exerts on another to prevent it from sliding across it. The direction is parallel to the two surfaces in contact.	Whenever there is non-zero normal force and when the objects would slide without the force.
Kinetic Friction (f_k)	The force that objects exert on each other when they are sliding across each other. The direction is opposite the relative motion of the two objects.	Whenever there is a non-zero normal force and a non-zero coefficient of kinetic friction.

Note that there are only three forces that do not require contact. They are the exception to the rule:

- ✓ Gravitational
- ✓ Electric
- ✓ Magnetic