ANALYSIS OF FORCES

Newton's first and second laws deal with the total of all the forces exerted on a specific object, so it is very important to be able to figure out what forces there are. Once you have focused your attention on one object and listed the forces on it, it is also helpful to describe all the corresponding forces that must exist according to Newton's third law. We refer to this as “analyzing the forces” in which the object participates.

A barge is being pulled along a canal by teams of horses on the shores. Analyze all the forces in which the barge participates.

force acting on barge	force related to it by Newton’s third law
ropes’ forward normal forces on barge	barge’s backward normal force on ropes
water’s backward fluid friction force on	barge’s forward fluid friction

barge	force on water
planet earth’s downward gravitational force on barge	barge’s upward gravitational force on earth
water’s upward “floating” force on barge	barge’s downward “floating” force on water

Here I've used the word “floating” force as an example of a sensible invented term for a type of force not classified on the tree in the previous section. A more formal technical term would be “hydrostatic force.”

Note how the pairs of forces are all structured as “A's force on B, B's force on A”: ropes on barge and barge on ropes; water on barge and barge on water. Because all the forces in the left column are forces acting on the barge, all the forces in the right column are forces being exerted by the barge, which is why each entry in the column begins with “barge.”

Often you may be unsure whether you have missed one of the forces. Here are three strategies for checking your list:

1. See what physical result would come from the forces you've found so far. Suppose, for instance, that you'd forgotten the “floating” force on the barge in the example

above. Looking at the forces you'd found, you would have found that there was a downward gravitational force on the barge which was not canceled by any upward force. The barge isn't supposed to sink, so you know you need to find a fourth, upward force.

2. Whenever one solid object touches another, there will be a normal force, and possibly also a frictional force; check for both.
3. Make a drawing of the object, and draw a dashed boundary line around it that separates it from its environment. Look for points on the boundary where other objects come in contact with your object. This strategy guarantees that you'll find every contact force that acts on the object, although it won't help you to find non-contact forces.

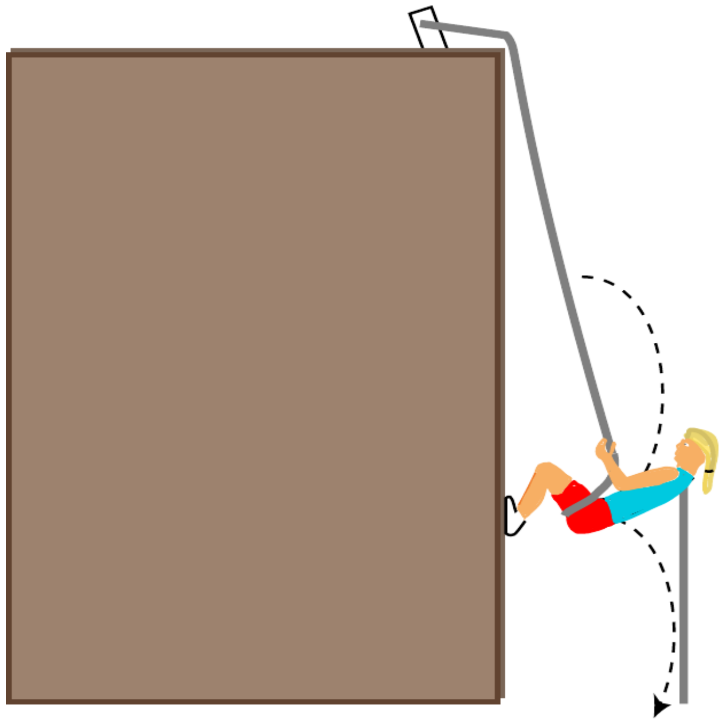
The following is another example in which we can profit by checking against our physical intuition for what should be happening.

As shown in the figure below, Cindy is rappelling down a cliff. Her downward motion is at constant speed, and she takes little hops off of the cliff, as shown by the dashed line. Analyze the forces in which she participates at a moment when her feet are on the cliff and she is pushing off.

force acting on Cindy	force related to it by Newton's

	third law
planet earth’s downward gravitational force on Cindy	Cindy’s upward gravitational force on earth
ropes upward frictional force on Cindy (her hand)	Cindy’s downward frictional force on the rope
cliff’s rightward normal force on Cindy	Cindy’s leftward normal force on the cliff

The two vertical forces cancel, which is what they should be doing if she is to go down at a constant rate. The only horizontal force on her is the cliff's force, which is not canceled by any other force, and which therefore will produce an acceleration of Cindy to the right. This makes sense, since she is hopping off. (This solution is a little oversimplified, because the rope is slanting, so it also applies a small leftward force to Cindy. As she flies out to the right, the slant of the rope will increase, pulling her back in more strongly.)



I believe that constructing the type of table described in this section is the best method for beginning students. Most textbooks, however, prescribe a pictorial way of showing all the forces acting on an object. Such a picture is called a free-body diagram. It should not be a big problem if a future physics professor expects you to be able to draw such diagrams, because the conceptual reasoning is the same. You simply draw a picture of the object, with arrows representing the forces that are acting on it. Arrows representing contact forces are drawn from the point of contact, noncontact forces from the center of mass. Free-body diagrams do not show the equal and opposite forces exerted by the object itself.

Source:
http://physwiki.ucdavis.edu/Fundamentals/03._Conservation_of_Momentum/3.2_Force_In_One_Dimension