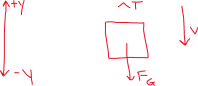
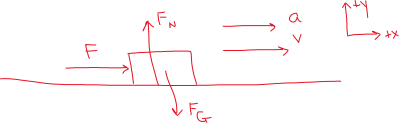
**Free Body Diagrams**

* Friction is NOT negligible.
* Draw all forces acting on the object, in the direction of the force.
* Label each force with a variable, not a number.
* Draw the x-y axis you have chosen for your problem.
* Indicate direction of displacement, velocity, and/or acceleration.
* If any forces are not along either the x or y axis, you may find it helpful to also draw the components of those forces.

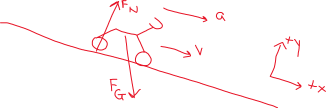
1. A heavy crate is being lowered straight down at constant speed by a steel cable.



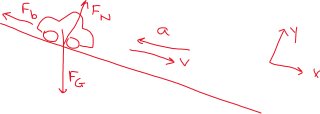
1. A boy is pushing a box across the floor at a steadily increasing speed.



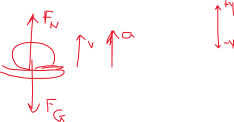
1. A bicycle is speeding up down a hill.



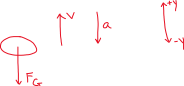
1. You slam on your car brakes while going downhill, and skid to a halt.



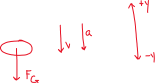
1. You toss a rock straight up into the air – while you are still holding/throwing/touching the rock.



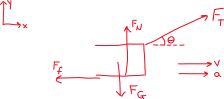
1. You toss a rock straight up into the air – right after the rock leaves your hand.



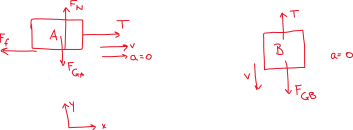
1. You toss a rock straight up into the air – after the rock has reached its’ highest point and is now falling straight down.



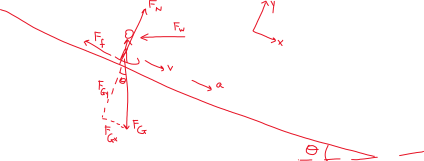
1. You are pulling a heavy box across a rough floor, using a rope that is connected to the box, pulling upward at a 30° angle.



1. Two heavy boxes are connected by a rope. Box A is sliding along a rough table, and the rope connecting Box A to Box B is on a pulley, so that Box B is hanging down off the side of the table. Box B is moving down toward the floor at a constant speed, and there is no slack in the rope (it is taut).



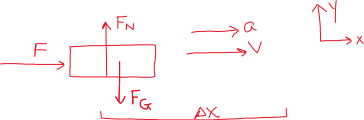
1. A skier is going down a 30° slope. There is a horizontal headwind blowing in the skier’s face. Friction is small but not zero.



**Force and Motion Problems**

1. A 25 kg couch is pushed across the floor with a constant horizontal force of 7 N for 3 s.
   1. If it starts from rest, what is its’ final speed?
   2. How far did you push it?

**Qualitative Representation**



**Variables and Equations**

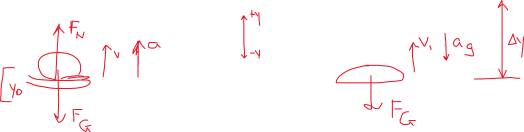
**Solution (remember, show your reasoning and math)**

**Reasonability check?**

This is a very small force, and even for a small couch like this, it is reasonable that it would only move about 1.25m, which is around 4 feet.

1. When throwing a rock vertically upward, my hand moves through a distance of about 1.2 m before the rock leaves my hand. The 0.95 kg rock reaches a maximum height of about 23 m above my hand. What was the average force that my hand exerted on the rock?

**Qualitative Representation**



**Variables and Equations**

**Solution (remember, show your reasoning and math)**

**when it leaves the hand**

**Reasonability check?**

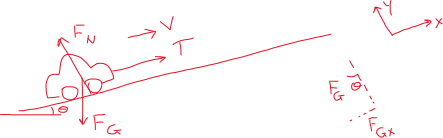
In order to a throw a rock this high, it will require a reasonable amount of force, even if exerted over a 1.2 meter distance.

Note: this problem is vaguely worded enough, that if you solved this using the height after it leaves the hand as 23 – 1.2 meters, I would have accepted your work on an exam.

1. A car with a weight of 15000 N is being towed up a 20° smooth hill at a constant velocity. The tow rope is rated for a maximum of 6000 N of tension. Will the tow rope break?



**Qualitative Representation**



**Variables and Equations**

**will it break? T = ?**

**a = 0**

**Solution (remember, show your reasoning and math)**

**This is smaller than the maximum tension the rope is rated for, so the rope will not break.**

**Reasonability check?**

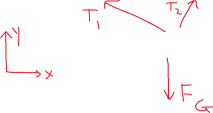
**Because the hill is a low incline, gravity isn’t working against us TOO much, so this is plausible.**

1. A barrel is hung with two ropes as shown below. Find the force each rope puts on the barrel. The barrel has a mass of 50 kg. Solve for the tension in each rope.

**Qualitative Representation =**

450

300



**Variables and Equations**

**8 m/s2**

**Solution (remember, show your reasoning and math)**

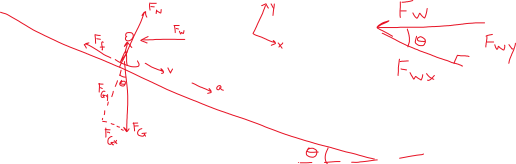
**= 358.7 N**

**Reasonability check?**

**In order to hang a 50 kg weight using 2 cables, having two cables each bear a substantial fraction of the weight is to be expected.**

1. A skier is going down a 30° smooth slope. There is a horizontal headwind blowing in the skier’s face.. If the skier starts with a 15 m/s velocity down the hill, and the slope length is 100 m, what will her final velocity be?

**Qualitative Representation**



**Variables and Equations**

**Solution (remember, show your reasoning and math)**

**Reasonability check?**

**It’s a lot harder to use intuition to check to see if this is a reasonable answer! However, we can see that unless the wind to mass ratio is bigger than 6.95, we will be speeding up. This means for a 75 kg human (around 150 pounds) that the wind would need a force of over 520 N to stop our skier. This makes our answer at least plausible, even if you don’t like still having variables in your answer.**