**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.
2. A boy is pushing a box across the floor at a steadily increasing speed.
3. A bicycle is speeding up down a hill.
4. You slam on your car brakes while going downhill, and skid to a halt.
5. You toss a rock straight up into the air – while you are still holding/throwing/touching the rock.
6. You toss a rock straight up into the air – right after the rock leaves your hand.
7. You toss a rock straight up into the air – after the rock has reached its’ highest point and is now falling straight down.
8. 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.
9. 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).
10. 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?
2. 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?
3. 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?
4. 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.

300

450

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?