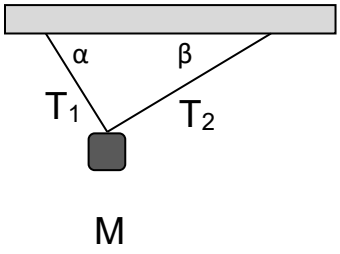
Physics 1135 Homework #5: Newton's 1st and 2nd law

For each problem, begin by drawing a fully labeled free-body diagram and follow the Recipe for Force Problems.

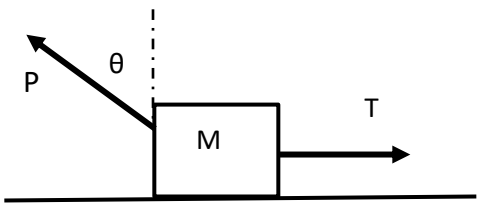
1. Apparent weight. A superhero of mass 75 kg stands on a bathroom scale in an elevator. Find the reading on the scale if the elevator
a) moves upwards at constant speed of 3 m/s.
b) moves downwards at constant speed of 3 m/s.
c) moves upwards and speeds up at a rate of 3 m/s^2.
d) moves upwards and slows down at a rate of 3 m/s^2.
(Note: the equation for the apparent weight is NOT a stating equation and must be derived from Newton's 2nd law.)

2. A box of mass M is suspended from two ropes that make angles of α and β with the horizontal as shown in the figure. The box is at rest. Derive an expression for the magnitudes of the tensions T_1 and T_2, respectively, in terms of system parameters.



3. A magic medallion is suspended from a string inside a compartment of the Hogwarts Express which is running straight Eastwards on horizontal tracks.
a) Draw a free-free body diagram for the medallion if the train is moving at constant speed.
b) Draw a free-body diagram for the medallion if the train is speeding up with constant acceleration. Indicate acceleration and the direction of the net force.
c) Calculate the angle the string makes with the vertical if the train accelerates at a constant rate from rest to 20 m/s in 10 seconds.

4. Two people are tugging on a crate of mass M that is on a frictionless horizontal floor, as shown in the figure. One person pulls with a constant force of magnitude P that is directed an angle θ with respect to the vertical. The crate always remains in contact with the surface. The other person pulls with a horizontal force of magnitude T to the right.



a) Derive an expression for the crate's acceleration.
b) Derive an expression for the normal force.
c) Find the value of T for which the crate will move at constant speed.