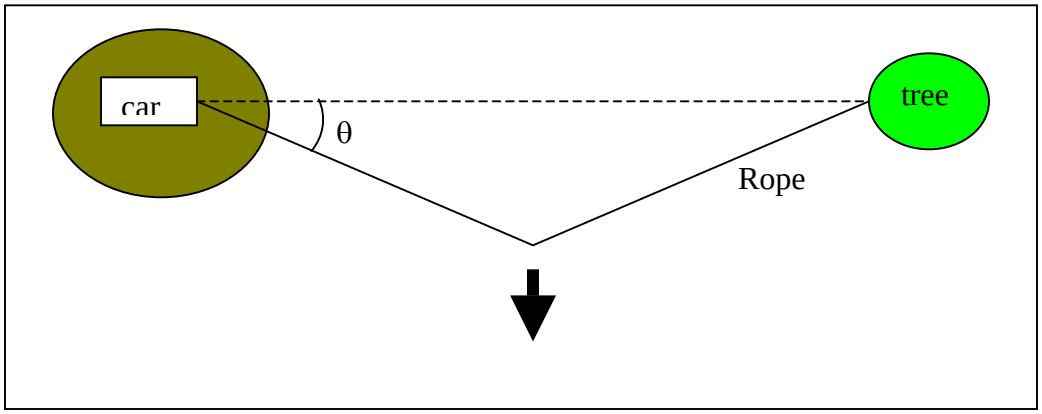
Physics 206a

Homework Assignment V
due February 9, 2007

1. A bird flies at a constant velocity of $11\frac{m}{s}$ in a direction 17° North of West. The bird has a mss of $2.7kg$. The air exerts a drag force on the bird with a magnitude of $F_d = 5N$. Treating North as the $\hat{y}$ direction and East as the $\hat{x}$ direction
   a. Draw a free body diagram of the bird (since this is a *3-d* problem, it would be wise to draw two different free body diagrams: one a top view and one a side view).
   b. Give explicit values for all of the external forces acting on the bird. Express these in terms of the unit vectors.
2. A rocket is launched at an angle of 33° relative to the horizontal. It has a mass of $7kg$. Consider its mass to be constant (this is usually not a good approximation for rockets, but we'll go with it this time). Its initial speed is $v = 72\frac{m}{s}$ and its engine exerts a constant force (after providing whatever was necessary to give it its initial velocity) of $\vec{F}_R = 13N\hat{x} + 5N\hat{y}$. Neglect air resistance.
   a. What maximum height will it reach?
   b. How long after launch will it strike the ground?
   c. How far from its launch position will it be when it strikes the ground?
   d. What will its velocity be when it strikes the ground?
   e. What will its speed be when it strikes the ground?

3. A car is stuck in a mud puddle. A man wishes to pull the car out by tying a rope to a tree and to the car. He pulls at the middle of the rope. It requires a force of 10,000 Newtons to free the car from the mud. The man is capable of applying a maximum force of 1000 Newtons. What is the maximum angle θ for which the car will move?



4. A block of mass *m* sits on an incline at angle θ. The coefficient of static friction, μ_s, between the block and the incline is 0.4. Find the "angle of repose" of the block. That is, the maximum angle at which the block will not slip.

5. A pair of frictionless pulleys is used in combination as shown below. The pulley combination is used to lift a safe which has a mass of 175 kg. (Hints: a) You can't push on a rope! b) The tension in a rope is the same everywhere along its length provided there is no friction in the pulleys, the pulleys are massless, and the mass of the string is negligible, all of which are valid approximations in this case.) Note: The pulleys rotate freely within brackets. The safe is suspended from a bracket and one end of the rope is attached to the other bracket.

   a. Draw a free-body diagram indicating all relevant forces on the safe.

   b. What is the force that someone needs to exert on the rope to lift the safe? Justify your answer by reference to forces indicated on your diagram.