PHY180F ASSIGNMENT 4 2005
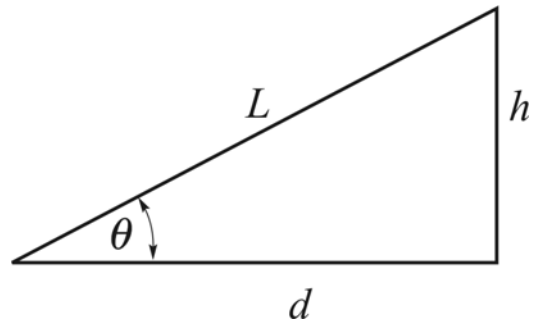
Due When: Thursday October 13 by 4:00 P.M.
Due Where: In your tutor's drop box in the basement of the Physics building (tower) opposite the elevators.

The first two questions are taken from last year's final exam. The level of difficulty of these two questions is what you should expect on the upcoming test (October 17).

1) A cannon is firing artillery shells at an enemy. The angle of elevation $\boldsymbol{\theta}$ of the barrel of the cannon and the initial speed **v** of the artillery shells cannot be varied. Enemy soldiers on the ground can just reach a distance **X** from the cannon without being hit. Enemy aircraft are told that they will not be hit if they fly at an altitude of at least $\frac{1}{4}$**X**. Take the origin to be at the cannon.
   a) Showing your work, derive the angle $\boldsymbol{\theta}$.
   b) An enemy aircraft flies just low enough to be hit by an artillery shell. Determine the velocity of the artillery shell in terms of the unit vectors $\hat{\mathbf{r}}$ and $\hat{\boldsymbol{\theta}}$ (cylindrical coordinates), where $\hat{\mathbf{r}}$ and $\hat{\boldsymbol{\theta}}$ are defined by the position vector $\vec{\mathbf{r}}$ from the origin to the point where the aircraft is hit.

2) An object is sliding down a frictionless plane. The length of the plane is given by **L**, the vertical and horizontal projections are given by **h** and **d** respectively and the angle of inclination is $\boldsymbol{\theta}$.
   a) If an object starts from rest, find the time **t** for the object to slide down the entire plane in terms of the given quantities.
   b) If the angle $\boldsymbol{\theta}$ is varied and only the vertical projection **h** remains constant, find the minimum time for the object to travel the length of the plane in terms of quantities which do not vary.
   c) If the angle $\boldsymbol{\theta}$ is varied and only the horizontal projection **d** remains constant, find the minimum time for the object to travel the length of the plane in terms of quantities which do not vary.

3) Serway, Chapter 5; Number 54

4) Serway, Chapter 10; Number 46