PHYS 111
HOMEWORK #4

Due : 23 Sept. 2014

Write on only one side of each sheet. To receive full credit for questions involving numerical calculations, use proper units throughout the calculations. Complete solutions and explanations are required for full credit.

Note : There will be no class (and no discussion) on Thursday 25 September.

We will neglect friction in all questions in this assignment.

1. An object is dropped from rest from a cliff of height H. It is observed that the object completes the last half of the trip in 1 second. Determine the time (in seconds) it takes the object to reach the ground and the height (in meters) of the cliff.

2. An object is launched with initial velocity v_o at an angle θ with respect to a horizontal plane and lands a distance R from the launch point. If the initial velocity is doubled, how far (in terms of R) will it land? If the launch angle is changed to 90 - θ, how far will the object land?

3. An object is launched on a level plane with initial velocity v_o at an angle θ. What must the angle θ be if the maximum height achieved by the object is equal to its range?

4. An object slides off the edge of a horizontal table that is 2 m above a level ground. If the object leaves the edge of the table with a horizontal velocity of 5 m/s, how far from the edge of the table will the object land on the ground?

5. Consider the same situation as in problem 4, except now we do not have numbers. Call the height of the table H and the speed of the object as it slides off the edge v. Derive expressions for a) the time of flight, and b) the distance from the edge of the table where the object strikes.

6. An object is launched from the edge of a cliff that is 100 m above the ground. The object has an initial velocity of 30 m/s that is directed at an angle 40 degrees with respect to the edge of the cliff. (See the figure for problem 22 on p. 95; this figure represents the general idea, except the numbers we are using here are very different). Determine :

a) The time of flight
b) The maximum height the object achieves above the ground.
c) The horizontal distance the object lands from the base of the cliff.
d) The x and y components of the velocity at the instant just before impact.
e) The magnitude of the velocity and the angle the velocity vector makes with the ground.

Five points for each part.

7. As we have discussed in class, one of the most important elements of physics is learning how to combine equations to derive new expressions. This is often useful when we can measure certain

variables, but not others. Now, consider the situation described in problem 6 (except we don' t have numbers.) The height of the cliff is H.An object is launched at an angle θ with respect to the edge of the cliff. If the object lands a distance D from the base of the cliff, show that its maximum height above the ground is given by :

$$H_{max} = H + \frac{D^2 \tan^2 \theta}{4 (H + D \tan \theta)}$$

Note that the expression does not involve velocity. This means you will have to use the relationships for projectile motion that we derived in class, and substitute appropriately for velocity.