PHYS 111
FIRST HOUR EXAM -- 2014

This is a closed book, closed note exam. All electronic devices including calculators must be stored out of sight now. Do all writing in your blue book (s) and be sure to put your name on each book you use. You may do questions in any order, but be clear which question you are answering. All questions must show complete work. There are 100 points on this test; the numbers in parentheses indicate the point value of the question. There is a list of equations at the end of the test. You will have sixty minutes to complete this exam.

1. Consider a projectile launched horizontally with an initial speed of 10 m/s from the roof of a building of height H. Ignore the effects of air friction for all parts of this question. Draw a separate graph for each part :

a) Draw a graph of the vertical velocity of the object as a function of time. (5)

b) Draw a graph of the horizontal velocity of the object as a function of time. (5)

c) Draw a graph of the acceleration of the object as a function of time. (5)

d) Draw a graph of the value of x (t) (horizontal distance from the edge of the roof) as a function of time (5)

Make sure you label your axes clearly for each graph. Provide a short (one or two sentence) explanation for the form of your graph. Indicate on each graph the value of y - intercept (i.e., what is the value of the requested parameter at t = 0). (Five points in aggregate for the explanations).

2. For each graph in problem 1 that is a straight line, what is the numerical value (including units) of the slope of each straight line? (20)

3. Consider an object launched from a point on level ground with initial velocity v_o at an angle θ to the horizon. starting with the generalized forms of the equations of motion:

$$x(t) = x_o + v_{ox} t + \frac{1}{2} a_x t^2$$

$$y(t) = y_o + v_{oy} t + \frac{1}{2} a_y t^2$$

a) Describe your coordinate system (is up positive or negative?) and provide values or symbols for x_o, y_o, v_{ox}, v_{oy}, a_x, and a_y, and then: (5)

b) Derive an expression for the time of flight of the object. (5)

c) Derive an expression for the maximum height of the object. (10)

d) Derive an expression for the range of the object. (10)

(Your answers in parts b)-d) should be in terms of v_o, θ and g.)

4. Refer to the drawing on the board. Masses m_1 and m_2 are on a frictionless inclined plane of angle θ. Mass m_1 is attached to a wall by string 1 and the two masses are connected by string 2. The system is in equilibrium (is not accelerating).

a) What are all the forces acting along the plane (i.e., in a direction parallel to the plane)? (5)

b) Write Newton' s second law for each mass in this direction (the direction along the plane). (10)

c) Determine an expression for the tension in string 1 (the upper string) in terms of the masses, θ and g. (10)

LIST OF FORMULAE AND RESULTS

$$v_{av} = \frac{\Delta x}{\Delta t} \quad (1)$$

$$v_{inst} = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} \quad (2)$$

$$a_{av} = \frac{\Delta v}{\Delta t} \quad (3)$$

$$a_{inst} = \lim_{\Delta t \to 0} \frac{\Delta v}{\Delta t} \quad (4)$$

$$x(t) = x_o + v_{ox}\, t + \frac{1}{2} a_x t^2 \quad (5)$$

$$v(t) = v_o + at \quad (6)$$

$$v_f^2 = v_0^2 + 2\, a\, x \quad (7)$$

$$\mathbf{v}_{av} = \frac{\Delta \mathbf{r}}{\Delta t} \quad (8)$$

$$a_{cent} = \frac{v^2}{r} \quad (9)$$

$$W = m\, g \quad (10)$$

$$\Sigma \mathbf{F} = m\, \mathbf{a} \quad (11)$$

$$\tan\theta = \frac{\sin\theta}{\cos\theta} \quad (12)$$

$$\sin^2\theta + \cos^2\theta = 1 \quad (13)$$

$$\sin 2\theta = 2 \sin\theta \cos\theta \quad (14)$$