1. (25 points) An object only moves along the x-axis. Its velocity is given by

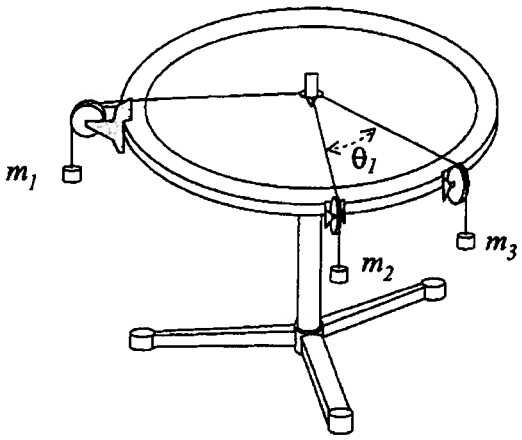
$$v_x(t) = \alpha t + \beta t^2$$

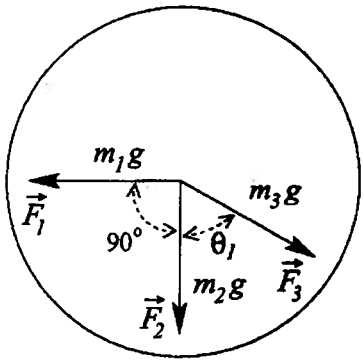
where α and β are known constants.

a. What is the object's acceleration?

b. How far does it travel between the times $t = 1$ sec and $t = 2$ sec?

2. (25 points) In a physics lab three known masses, m_1, m_2, and m_3, have been hung from a small ring in the positions shown. θ_1 is a known angle. In order for the ring to remain in static equilibrium, in other words not to move, a fourth mass m_4, is to be hung from the ring.





Top View

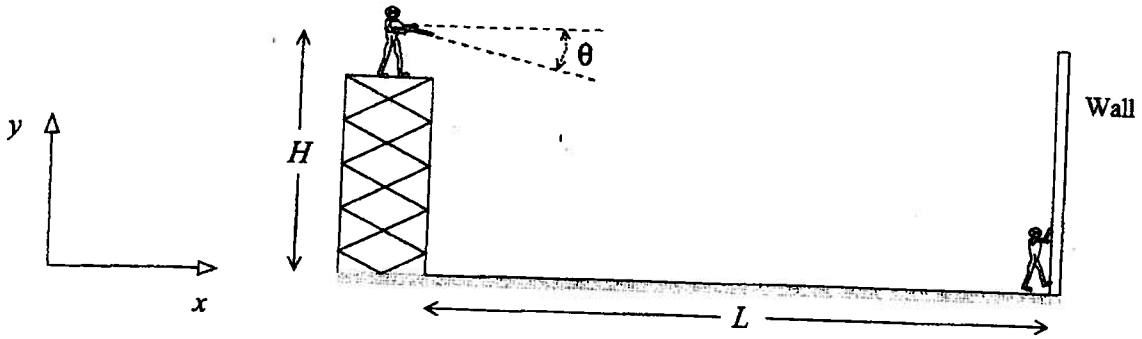
a. Draw a coordinate system and express the forces $\vec{F}_1$, $\vec{F}_2$, and $\vec{F}_3$ in terms of their components.

b. What would the components of the force exerted by the fourth mass have to be for static equilibrium?

3. (25 points) You are a guard in a prison for very nasty criminals. Your guard tower is H above the ground. At a time $t = 0$ you spot a bad guy starting to climb a wall a distance L away from the tower. He starts from rest at the ground and climbs with a constant vertical acceleration, a_c. You immediately launch a rocket propelled grenade which you aim at an angle θ below the horizontal as shown. The grenade has an initial velocity of magnitude v_1 and its acceleration is given by the vector

$$\vec{a}_G = \alpha \vec{i} + \beta t \vec{j}$$

where α and β are known constants and the effects of gravity on the grenade are included in this acceleration.

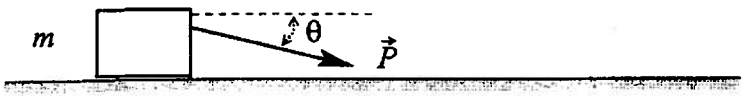


a. Find the bad guy's position as a function of time.

b. Find the grenade's position as a function of time.

c. What is the condition for the grenade to hit the bad guy? (Not in words, equations please.)

4. (25 points) A block of mass m is at rest on a frozen pond. There is no friction. In addition to the other forces there is a constant force of magnitude P applied to the block at the angle θ shown.



a. What will be the block's acceleration?

b. If the ice breaks when the force exerted on it exceeds F_c what is the largest value that P can have so that the ice does not break?

c. If there were a coefficient of friction μ between the block and the ice, what would the acceleration of the block be for a given P and θ?