

Print your name **neatly**:

Last name:

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First name:

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Sign your name: _____

Your instructor: _____ Your section: _____

Please fill in your Student ID number (UIN): _ _ _ _ - _ _ _ - _ _ _ _ _

IMPORTANT

Read these directions carefully:

- There are 4 problems totalling 100 points. Check your exam to make sure you have all the pages. Work each problem on the page the problem is on. You may use the back. If you need extra pages, I have plenty up front.
- Each problem with its associated figure is self explanatory. If you *must* ask a question, then come to the front, being as discrete as possible so as not to disturb others.
- **Indicate what you are doing!** We cannot give full credit for merely writing down the answer. **Neatness counts!** I will give generous partial credit **if** I can tell that you are on the right track. This means you must be *neat* and organized.

USEFUL INFORMATION

$$\text{If } f(x) = kx^n \quad \text{then } \frac{df}{dx} = nkx^{n-1}$$

$$\text{If } f(x) = kx^n \quad \text{then } \int f(x)dx = \frac{1}{n+1}kx^{n+1} + C$$

Grading:					
	Problem 1	Problem 2	Problem 3	Problem 4	TOTAL

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

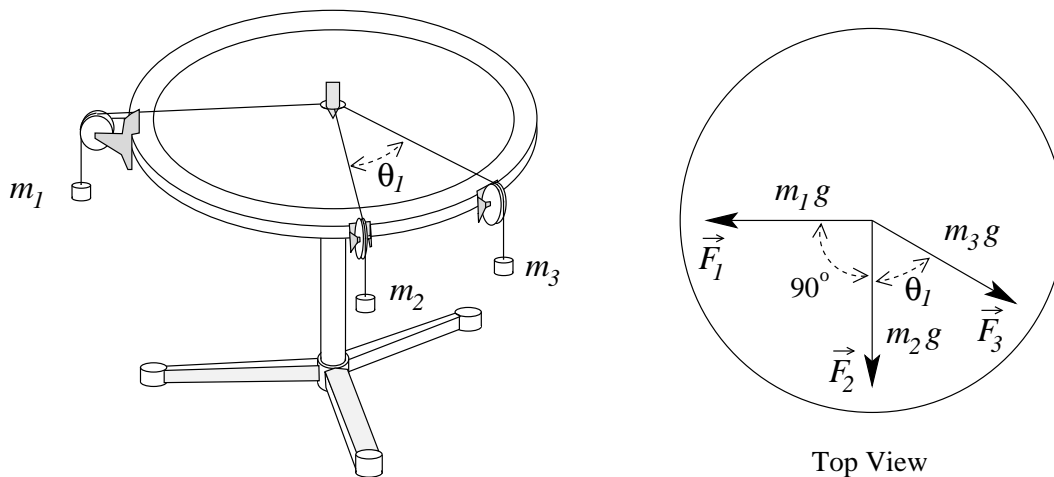
$$v_x(t) = \alpha t + \beta t^2$$

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.



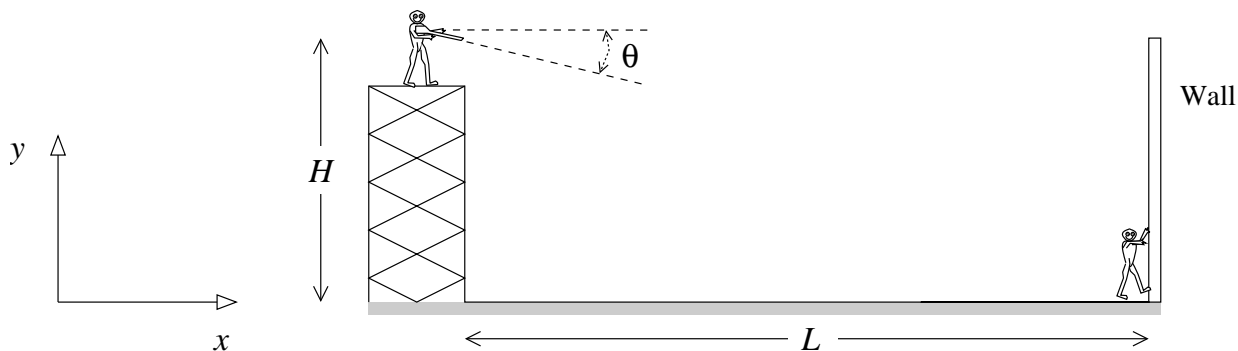
- a. Draw a coordinate system and express the forces \vec{F}_1 , \vec{F}_2 , and \vec{F}_3 in terms of their components.

- 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

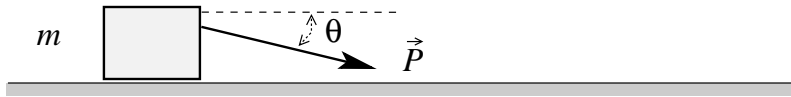
$$\vec{a}_G = \alpha \vec{i} + \beta t \vec{j}$$

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



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