

EXAM I Physics 218

Name.....Section Number.....

USEFUL INFORMATION

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

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

For the **SPECIAL CASE:**

CONSTANT ACCELERATION IN ONE DIMENSION

$$x(t) = \frac{1}{2}a_c t^2 + v(0)t + x(0).$$

Do Not Spend Too Much Time on Algebra!

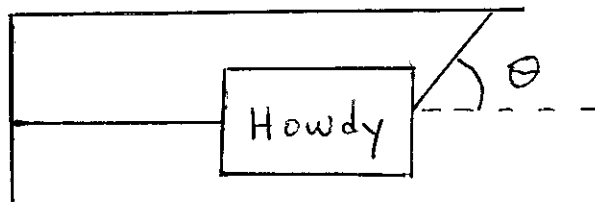
1a. (10 points) An object moves along the x-axis so that its position is given by

$$x(t) = k_1 t^5 + k_2 t^2 + c_1 t + c_2.$$

Here k_1 and k_2 are known constants and c_1 and c_2 are unknown. The velocity of the object is measured at the known time $t = T_A$ and found to have the value w . The position is measured at $t = 0$ and found to have the value D .

Determine c_1 and c_2 and the object's acceleration.

1b. (15 points) A sign, having known mass M is to be attached to the ceiling and a wall by two thin wires as shown:



Each wire has essentially zero mass and can not be stretched. One wire is horizontal and the other is at the angle θ . Find the tension in each of the wires. (The tension is the force that the wire exerts on the sign.)

2. (25 points) A rocket travels along a straight, vertical line. Starting at the time defined to be $t = 0$, at a point defined to be the origin, its vertical velocity is observed to be

$$v(t) = -k_1 t^2 + k_2 t$$

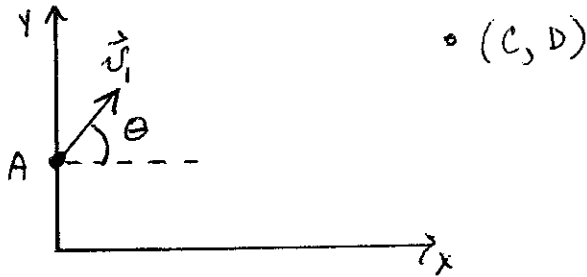
where k_1 and k_2 are known, positive constants. What will be the rocket's maximum height?

3. (25 points) A robot has been programmed so that it has an acceleration given by

$$\vec{a} = 0\vec{i} - \beta t\vec{j}$$

in the coordinate system below. Here β is a known constant. The robot is to be placed at the point $x = 0, y = A$ at $t = 0$ and given some initial velocity, \vec{v}_1 , so that it can pick up some object at the point $x = C, y = D$. (Here A, C , and D are known.)

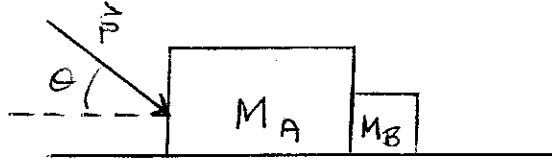
- a. What is the robot's position as a function of time?



- b. What must be the magnitude of the robot's initial velocity if it leaves the initial point at the known angle θ as shown?

4. (25 points) Two boxes are at rest on a frictionless table. There is no friction between the two boxes. The box with mass M_B will be crushed if a force is applied to it that has a magnitude greater than the known value T_C . A force of magnitude P is to be applied to the first block, mass M_A , at the fixed, known angle θ .

a. (20 points) What is the largest value that P can have without the second box being crushed?



b. (5 points) Find the maximum value that P can have without crushing the box if now the surface of the table is such that there is a coefficient of friction μ between the table and first box, M_A , but all other surfaces are still frictionless.