2008

EXAM I Physics 218

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

USEFUL INFORMATION

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

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

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!

1.

2.

3.

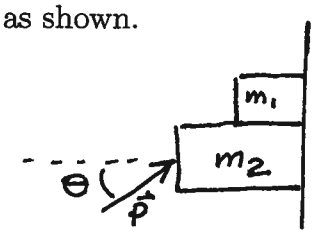
4.

1. (25 points)A motorcycle policeman spots a speeding car when it is a distance D away. At that instant the motorcycle is at rest and the car is approaching with a velocity of magnitude v_1. At that instant the motorcycle starts towards the car with a constant, unknown, acceleration, a_2, while the car reverses its electric engine so that it has a constant acceleration directed opposite to its initial velocity. The magnitude of this acceleration is a_1.

a. Find the position of the car at the instant when it reverses its direction.

b. If the policeman catches up to the car a time T_c after spotting it, what was the motorcycles acceleration?

2. (25 points) A small block of mass m_1 is placed on top of a large mass, m_2. There is no friction between the blocks. They are pushed against a wall by a constant force of magnitude P directed as shown.



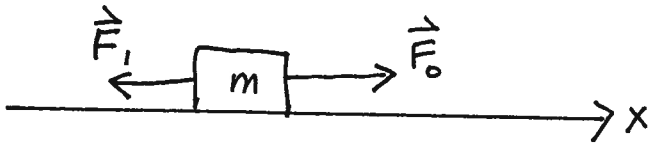
Assume the blocks remain at rest and that the wall is frictionless.

a. Isolate each of the blocks and draw the free body diagrams for them.

b. If θ, m_1 and m_2 are known, what does P have to be in order for the blocks to remain at rest? In that case what is the force exerted by the wall on each of the blocks?

c. Suppose P were such that the blocks were accelerating up the wall and there was a coefficient of friction μ between the blocks and the wall. Draw the free body diagrams for each of the blocks in this case.

3. (25 points) An object of mass m can only move along a line which is defined to be the x axis. It has only two horizontal forces acting on it as shown below:

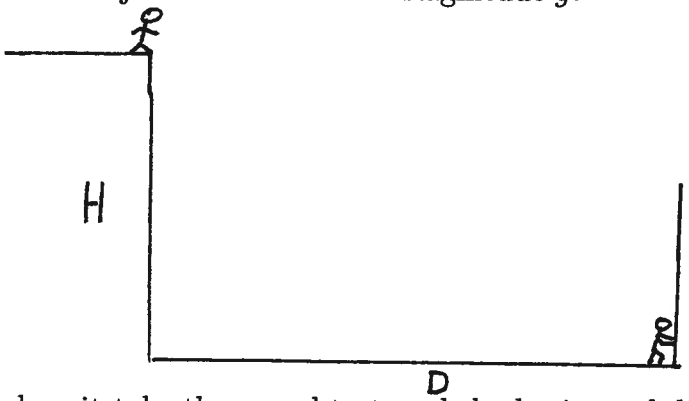


One of the forces has the constant magnitude F_0. The other force, indicated on the diagram, is unknown. The position of the object is observed to be a function of time given by

$$x(t) = \alpha t^4$$

where α is a known constant. Determine the unknown force.

4. (25 points) A terrorist is climbing a wall. She starts from rest and accelerates with acceleration αt where α is a known constant. A security guard is sitting on top of a building with height H a distance D away. He spots the terrorist and in his excitement falls off the building. By flapping his arms wildly he is able to obtain a horizontal acceleration given by βt where β is a known constant. His vertical acceleration is unaffected and is just the usual with magnitude g.



a. How long does it take the guard to travel the horizontal distance D?

b. Find the relationship that must hold between α, β, D, H, and g in order for the guard to collide with the terrorist.