# EXAM III Physics 218 2014

Last Name.....First Name.....Section Number.....

## USEFUL INFORMATION

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

$$If \quad f(x) = kx^n \qquad \int_A^B f(x)dx = \frac{1}{n+1}k(B^{n+1} - A^{n+1})$$

$$\int_{\vec{r}_1}^{\vec{r}_2} \vec{F}_{tot} \cdot d\vec{r} = \frac{1}{2}mv^2(\vec{r}_2) - \frac{1}{2}mv^2(\vec{r}_1)$$

If $\vec{F}$ is conservative:

$$\int_{\vec{r}_1}^{\vec{r}_2} \vec{F} \cdot d\vec{r} = -[U(\vec{r}_2) - U(\vec{r}_1)]$$

and

$$F_x = -\frac{\partial U}{\partial x} \qquad F_y = -\frac{\partial U}{\partial y}$$

$$\vec{L} = \vec{r} \times \vec{p} \qquad \vec{\tau} = \vec{r} \times \vec{F}$$

1.

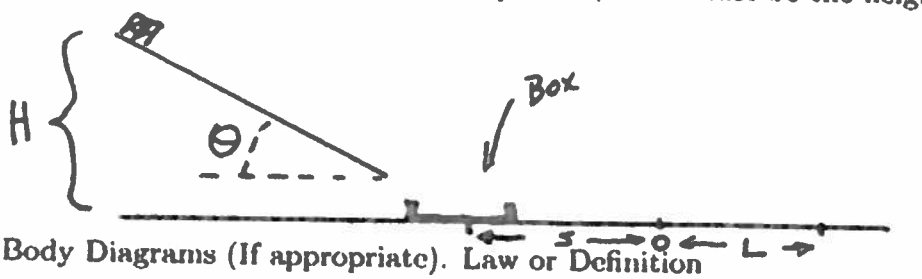
2.

3.

4

1. (25 points)Derive the expressions for the $\vec{i}_r$ and $\vec{i}_\theta$ components of the velocity and acceleration.

2. (25 points)A small block of mass $m$ is released from rest on a frictionless track. At the bottom of the track it goes into a box of mass $M$. The box, with the block, moves along a frictionless surface a distance $S$. Starting at the point marked 0 there is friction between the box and the surface with coefficient of friction $\mu$. If the box is to stop right at the point a distance $L$ from the point 0, what must be the height $H$?

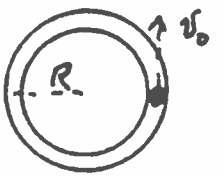



Free Body Diagrams (If appropriate). Law or Definition

Application

Result

3. (25 points) A small object of mass $m$ slides around in a horizontal, frictionless, circular tube of radius $R$. The object is given an initial velocity $v_0$ at the point shown. At some later time, defined to be $t = 0$, some strange force starts to act on the object The force is always directed opposite to the object's velocity and has known constant magnitude $c$ as long as the object is moving. Consider only the time while the object is moving. Starting at $t = 0$ find the object's angular momentum about the center of the circular path as a function of time. Show that the general relationship between torque and angular momentum is satisfied for this specific motion.

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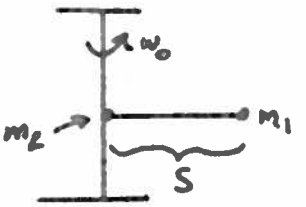
4. (25 points)A vertical axis is free to rotate. A massless, horizontal rod is attached to the axle as shown. There are two small objects attached to the rod. One of the objects has mass $m_1$ and is fixed at the end of the rod. The other, with mass $m_2$, starts right at the point where the rod is attached to the axle. The axle is given an angular velocity $\omega_0$. At a time defined to be $t = 0$ the object with mass $m_2$ moves towards the second object so that its distance from the axle is $c_1 t$ where $c_1$ is a known constant. Find the force that the rod exerts on the **fixed** object, as a function of time, during the time from $t = 0$ until the objects are in contact.




Free Body Diagrams (If appropriate). Law or Definition

Application

Result