EXAM III Physics 218 2015

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:

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

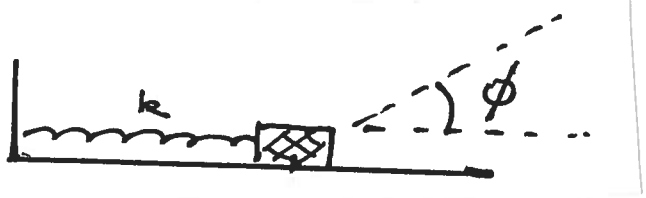
and

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

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

1. (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 at rest on a frictionless surface. It is attached to a spring with spring constant k. In an instantaneous explosion it explodes into two pieces. The heavier piece, mass $\frac{2}{3}m$, goes off at a known angle ϕ as shown. (Its motion is in the plane of the paper.) The lighter piece goes off to the left, compressing the spring and the maximum amount the spring gets compressed is given to be A. Find the velocities of the two pieces just after the explosion.

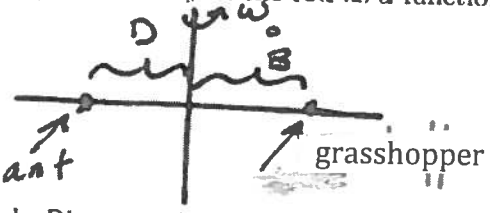


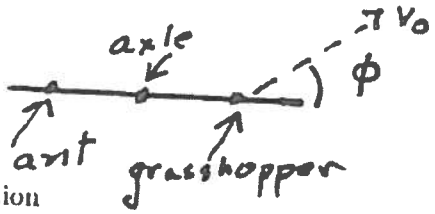
Free Body Diagrams (If appropriate). Law or Definition

Application

Result

3. (25 points) A rod of length S has moment of inertia I_R about its center. The rod is free to rotate about a vertical axle through its center. An ant of mass m_1 sits on the rod at the position shown and a grasshopper of mass m_2 is at the position shown a distance B from the axle.The entire system is set rotating about the axle with angular velocity ω_0. At $t = 0$ the grasshopper is frightened and jumps off horizontally in the direction shown with velocity of magnitude v_0. The ant then, at $t = 0$, begins to move so that its distance from the axle is given by $D - ct$ where c is a constant. What will be the angular velocity of the rod as a function of time?





Free Body Diagrams (If appropriate). Law or Definition

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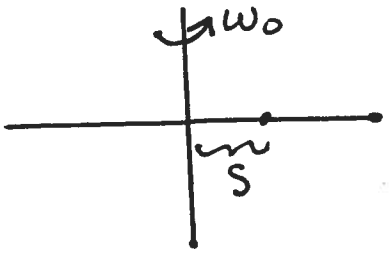
4. (25 points)A small bead can slide without friction on a horizontal rod. The rod rotates in a horizontal plane about a vertical axle at a constant angular velocity ω_0. At $t = 0$ the bead is a distance S from the axle.You are told that the distance of the bead from the axle is given by $Se^{\beta t}$, where β is an unknown constant. Find the value of β and find the torque about the axle exerted on the bead.



Free Body Diagrams (If appropriate). Law or Definition

Application

Result