EXAM III Physics 206 2019

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)In another galaxy, far, far away, a small moon, mass m, travels in a circle of radius r about the fixed Sun. The force exerted by the Sun on the moon is not the usual force of gravity. It is attractive and has magnitude

$$|\vec{F}| = c\frac{m}{r^4}$$

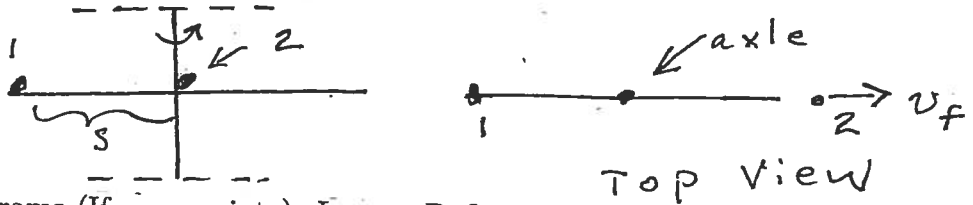
where c is a constant and r is the distance between the Sun and the moon. Find the total energy, kinetic plus potential, for the moon as a function of r.

Free Body Diagrams (If appropriate). Law or Definition

Application

Result

3. (25 points) A massless, horizontal rod of length $2S$ is free to rotate about a vertical axle as shown. There are two small objects on the rod. Object 1 has mass m_1 and is fixed at the end of the rod. Object 2 has mass m_2 and is at rest next to the axle. The axle is given an angular velocity ω_0. At a time defined to be $t = 0$, object 2 begins to move along the rod so that its distance from the axle is given by ct where c is a known constant. **a.** What will be the angular velocity of the rod as a function of time? **b.** What will be the angular velocity of the rod at the instant when object 2 reaches the end of the rod? **c.** If object 2 leaves the rod when it reaches the end, with a velocity of magnitude v_f parallel to the rod, what will be the angular velocity of the rod after the object leaves?



Free Body Diagrams (If appropriate). Law or Definition

Application

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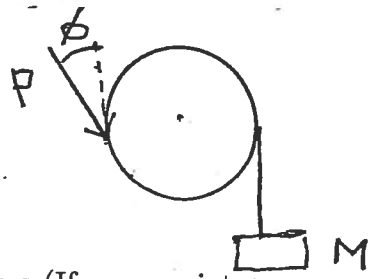
4. (25 points)A block of mass M is suspended by a massless, unstretchable rope from the pulley as shown. The pulley rotates freely about a fixed horizontal axle. The rope moves around the pulley without slipping. The pulley has a moment of inertia about its center of I and a radius R. A constant force of magnitude P is applied to the pulley as shown at the known angle ϕ. What will be the acceleration of the block, assuming it moves down? If the hanging mass is released from rest at $t = 0$, what will be the angular velocity of the pulley as a function of time?



Free Body Diagrams (If appropriate). Law or Definition

Application

Result