

EXAM III Physics 218 2011

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

USEFUL INFORMATION

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

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

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

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

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

$$\vec{L} = \vec{r} \times \vec{p} \quad \vec{\tau} = \vec{r} \times \vec{F} \quad I = \sum m_i r_i^2$$

1.

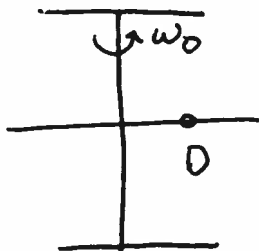
2.

3.

4.

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

2. (25 points) A massless, thin rod is pivoted about an axle through its center. The rod can rotate in the horizontal plane. A tiny bug, mass m , is initially a distance D from the axle. The rod is given an initial angular velocity ω_0 . The bug begins to walk away from the axle at the constant rate c . Neglect gravity.
- a. What will be the bug's velocity as a function of time while it walks towards the end of the rod?

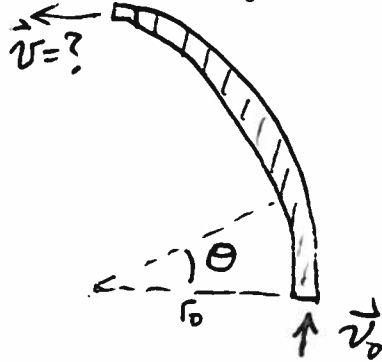


- b. What is the torque exerted by the rod on the bug as a function of time while it walks towards the end of the rod? (You must clearly show how you arrive at your answer.)

(Bonus 5 points) What would the bug's velocity be as a function of time if instead of the rod being massless it had moment of inertia I about the axle?

3. (25 points) An atom oxygen of mass m_1 is moving with velocity of magnitude v_1 and smashes into a molecule of hydrogen, mass m_2 which is at rest. What will be the velocity of the water molecule formed? The water molecule travels some distance at this constant velocity. If this moving water molecule then splits up into its original two parts, with the oxygen having kinetic energy K_1 and the hydrogen having kinetic energy K_2 , what will be the directions of velocities of the oxygen and hydrogen after the breakup? (When you have a sufficient number of equations so that you could solve for the unknowns, finish the rest of the test before spending time on algebra.)

4. (25 points) A truck of mass m traveling at velocity with magnitude v_0 , as shown, comes to a curve in the flat road. It is not a circular curve but instead the radius is given by $r = r_0(1 + \sin \theta)$. Here r_0 is known and θ is defined in the figure. By using his brakes or his accelerator he travels around the curve keeping the time rate of change of θ at the constant value $\frac{v_0}{r_0}$.



- a. Find the truck's velocity as a function of θ and evaluate the velocity when the truck reaches the end of the curve.

- b. Find the total force that the road must exert on the truck as a function of θ