

EXAM III Physics 218 2012

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

USEFUL INFORMATION

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

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

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

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

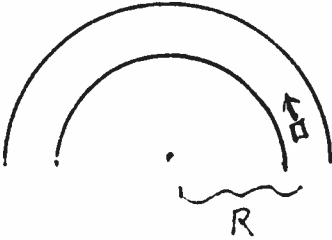
$$F_x = -\frac{\partial U}{\partial x} \quad F_y = -\frac{\partial U}{\partial y}$$

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

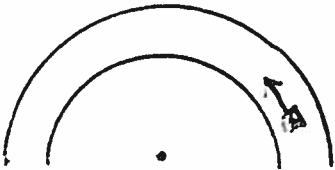
- 1.
 - 2.
 - 3.
 - 4.
-

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

2. (25 points) At a flat, circular curve, radius R , in the road, the sign says "Maximum Speed V_{max} ". If a car is to travel at this maximum constant speed without slipping, what must be the coefficient of friction between the car and the road?

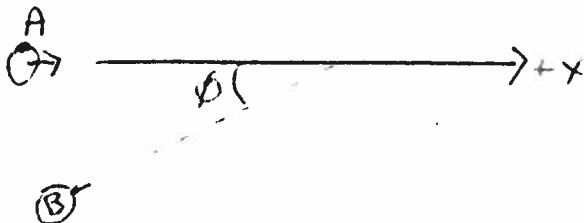


Given this coefficient of friction, suppose at a time defined to be $t = 0$ the car had velocity of magnitude $\frac{V_{Max}}{2}$ and was given a constant angular acceleration, c_1 about the center of the curve. Obtain a single equation that could be solved for the time at which the car begins to slip off the road in terms of R , g , V_{Max} and C_1 .



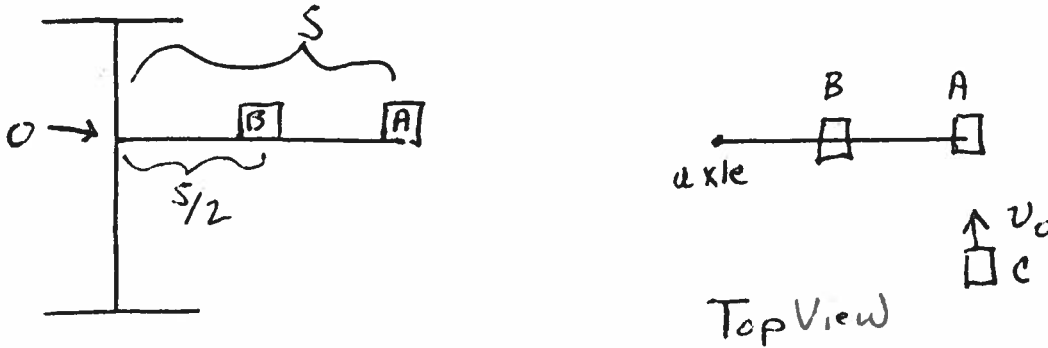
Find the torque about the center of the curved road for **each** force acting on the car.

3. (25 points) Molecule A, with mass M_A , moves along the $+x$ axis with velocity of magnitude V_A . It collides with a molecule B with mass M_B which was moving with velocity of magnitude V_B at an angle ϕ with the x axis. The two molecules stick together after the collision. Find the velocity of the new molecule after the collision.



How much kinetic energy was gained or lost in the collision?

4. (25 points) (Ignore gravity in this problem.) A vertical axle is free to rotate. A massless rod is attached to the axle, as shown, and block A, with mass m_A and block B with mass m_B are attached to the rod as shown. A third block, block C with mass m_C is shot at block A with horizontal velocity of magnitude v_0 :



- a. What will be the angular velocity about axle of block A if block C sticks to it?
- b. What will be the angular velocity of block A about the axle if block C bounces straight back off it with a velocity of magnitude $\frac{v_0}{2}$?
- c. (Bonus) Find the angular velocity of block A about the axle if block C sticks to it but instead of being massless the rod had moment of inertia I , about the point O?