EXAM III Physics 218

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

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

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

DO NOT WASTE TIME DOING ARITHMETIC

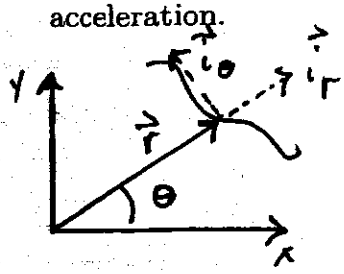
1

2

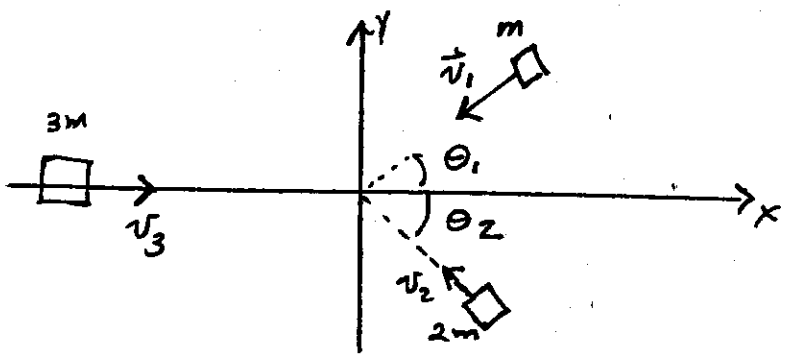
3

4

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

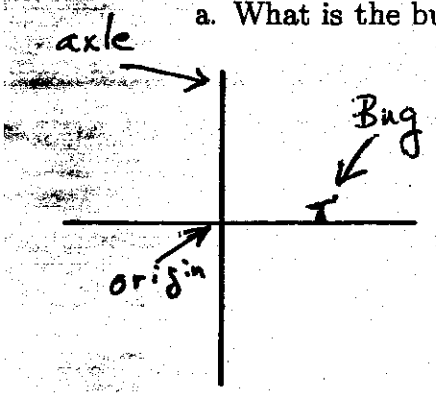


2. (25 points)Three blocks are sliding on a frictionless table. One, with mass m, has a known velocity of magnitude v_1 in the direction given by the known angle θ_1. The second, mass $2m$, has an unknown velocity of magnitude v_2 in the direction given by the known angle θ_2. A third block, mass $3m$, has a velocity of known magnitude v_3 and moves along the +x axis. The three blocks collide at the origin, stick together and go off together along the +x axis with the unknown velocity U.. What was the original velocity of the second block and what is the magnitude of the final velocity?



3. (25 points) A massless, thin rod is pivoted about an axle through its center. The rod can rotate in the horizontal plane. At time $t = 0$ the rod is given a push so that it rotates with angular velocity ω_0 about the vertical axle. A tiny bug, mass m, is initially a distance D from the axle. The ant begins to walk along the rod so that his distance from the axle is given by $D + k_1 t^2$ where k_1 is a known constant. **PLEASE!! After you have found a quantity, give it a symbol and use the symbol in later calculations. Do not keep writing lengthy expressions.**

a. What is the bug's angular momentum, about the origin, as a function of time?



b. What is the force exerted on the bug by the rod?

c. What is the torque about the origin exerted on the bug by the rod?

5 points d. OPTIONAL BONUS If the rod was not massless but had a moment of inertia I about its center, what would be the bug's angular momentum as a function of time? Use the back of the preceeding problem if you need more space.

4. (25 points) Suppose in another galaxy, far, far away, the gravitational force between the Sun, mass m_s, and a planet, mass m_p, had the magnitude

$$F = K\frac{m_s m_p}{r^4}$$

where r is the distance from the sun to the planet and K is a constant. The force is attractive so that the force on the planet points towards the sun.

a. If the planet is to circle the sun at a distance R, what does its angular velocity have to be?

b. If the planet is somehow moved from R to $2R$, what will be the change in its gravitational potential energy?