EXAM II Physics 218

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

USEFUL INFORMATION

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

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

$$If \quad f(x) = kx^n \qquad \int f(x)dx = \frac{1}{n+1}kx^{n+1} + C$$

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

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

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

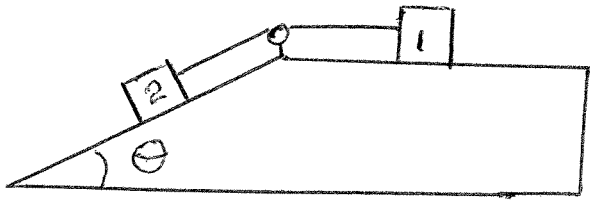
1.

2.

3.

4.

1. (25 points)Two blocks with masses, m_1 and m_2, are connected by a massless, unstretchable rope as shown below. There is a coefficient of friction μ_1 between the surface and block 1 and a coefficient of friction μ_2 between the surface and block 2. At $t = 0$ block 2 is started with an initial velocity of v_0 down the plane.



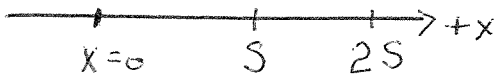
a. Draw the free body diagram for each block.

b. Find the tension in the string and the acceleration of each block.

2. (25 points) A small object of mass m is placed on the frictionless surface. There are two forces, $\vec{F}_1$ and $\vec{F}_2$, acting on the object that have components only in the x direction, given by

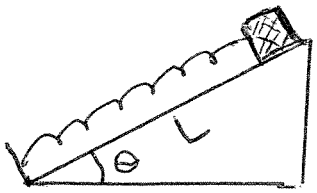
$$F_{1x} = \frac{c_1}{x^2} \qquad \textit{and} \qquad F_{2x} = c_2(1 - \frac{x}{S})$$

with c_1 and c_2 positive and S is the point shown. The object is placed at rest at the point $x = S$.



How do c_1 and c_2 have to be related in order for the object to move to the right to the point $x = 2S$ and then begin moving to the left?

3. (25 points) A spring is placed as shown at the bottom of a frictionless inclined plane which has the angle θ. The spring does not follow Hooke's Law but, instead, the magnitude of the force exerted by the spring is $F_{Spring} = k_1 x + k_2 x^3$. Here k_1 and k_2 are known, positive constants and x is the amount the spring is stretched or compressed. As usual a compressed spring pushes.



The length of the plane is L and the uncompressed length of the spring is also L. A projectile of mass m is placed against the spring which is compressed by the amount A. The projectile is then released from rest.

a. Find the potential energy function for the force exerted by the spring.

b. Find the velocity of the projectile when it reaches the top of the inclined plane.

c. Find H, the maximum height the projectile will reach above the end of the plane.

4. (25 points) An object of mass m is placed at rest at the point $x = 0$ on a horizontal table and, at time $t = 0$, a horizontal force is applied to it given by $F_x = c_1 t$ where c_1 is a known positive constant. The coefficient of friction between the table and the object is μ.

a. If the friction force is ignored what will be the object's velocity in the x direction when it reaches the point $x = A$?

b. If the friction force is not ignored find the object's velocity in the x direction as a function of time.