2011

EXAM II Physics 218 2011

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

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

DO NOT WASTE TIME DOING ARITHMETIC

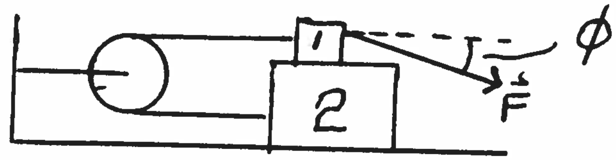
1.

2.

3.

4.

1. (25 points) Block 1, of mass m_1 is placed at rest on block 2, mass m_2. It is attached by a massless, unstretchable string to block 2 through a pulley. The pulley is massless and frictionless and just changes the direction of the tension in the string. The coefficient of friction between the blocks is μ_1 and the coefficient of friction between block 2 and the table is μ_2. A unknown force $\vec{F}$ is applied which acts in the direction shown and has unknown, positive magnitude.



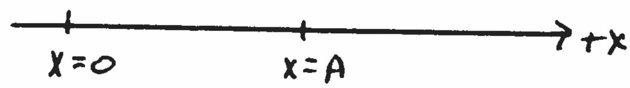
a. Draw the free body diagrams for block 1 and block 2.

b. Suppose the force $\vec{F}$ is known and large enough to cause the blocks to move. Obtain a sufficient number of equations so that you could solve the equations for the tension in the string.

2. (25 points)This is a one-dimensional problem. You need not concern yourself with the y direction.

An object of mass m is placed at the point $x = 0$ on a horizontal table and given a velocity of magnitude v_1 to the right. The object is repelled from the origin by some mysterious force which has magnitude $\alpha x + \beta x^5$ where α and β are known constants. The coefficient of friction between the table and the object is μ.

a. How fast will the object be moving when it reaches the point $x = A$?



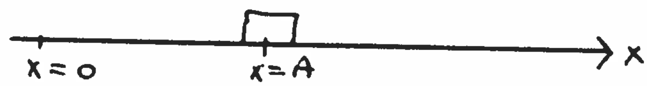
b. Suppose instead of the mysterious force being a function of position it was given by $F_x = \alpha t + \beta t^5$ where α and β are known constants. If it is given the velocity to the right of magnitude v_1 at $t = 0$, how fast would it be going at a given time T.

3. (25 points) In a famous Physics 218 experiment it was discovered that a real spring doesn't totally follow Hooke's Law. However, instead of having $F_x = -kx$ where x is the amount stretched and the spring is unstretched at $x = 0$, the actual force exerted by the spring is approximately given by $F_x = -k_1 x$ for $x < S$ and $F_x = -k_2(x - S) - k_1 S$ for $x \geq S$. Here k_1, k_2 and S are known constants.

a. Given this force suppose a block of mass m starts at $x = 0$ with a velocity v_1 to the right on a frictionless table. Determine how far it would go before turning around if v_1 is so small that the block does not go beyond $x = S$.

b. Given this force suppose a block of mass m starts at $x = 0$ with a velocity v_1 to the right on a frictionless table. Determine how far it would go before turning around if v_1 is large enough so that the block does go beyond $x = S$. (No Algebra!)

4. (25 points) A block of mass m is placed at rest on a frictionless table at the point $x = A$. It can only move along the $+x$ axis. In addition to gravity and the force exerted by the table there are two other forces acting on the block. One of these forces is given by $\vec{F_1} = c_1\vec{i}$ and the second is given by $\vec{F_2} = (-c_2 x + \frac{c_3}{x^3})\vec{i}$. Here c_1, c_2 and c_3 are known positive constants.



a. Find the potential energy function for the force $\vec{F}_1$.

b. Find the potential energy function for the force $\vec{F}_2$.

c. If $c_3 = 0$ where will the block have its maximum velocity, assuming the constants are such that it begins to move to the right?