

EXAM II Physics 206 2019

Last Name.....First Name.....Section Number.....

USEFUL INFORMATION

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

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

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

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

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

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

Errors on Free Body Diagrams will have serious consequences

1.

2.

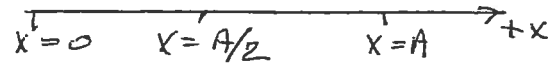
3.

4.

1. (25 points) An object of mass  $m$  is moving along the  $x$  axis having velocity to the left with magnitude  $v_1$  at  $x = A$ . The only force acting on the object is given by

$$F_x = -c_1x - c_2x^3$$

where  $c_1$  and  $c_2$  are known, positive constants. Determine whether or not this force is conservative and find the kinetic energy of the object at  $x = \frac{A}{2}$ .

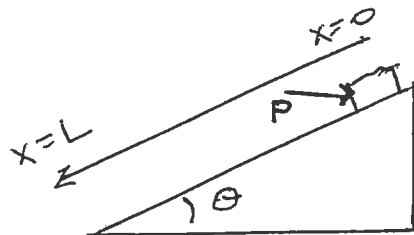


Free Body Diagram (If appropriate). Law or Definition

Application

Result

2. (25 points) A box of mass  $m$  is placed at rest on an inclined plane, known angle  $\theta$ . A known horizontal force, magnitude  $P$  is applied to the block. The coefficient of friction between the block and the plane is a function of the position on the plane given by  $\mu = \mu_0(1 + \frac{x}{L})$ . Assuming the block slides down the plane, find its velocity at the point  $x = \frac{L}{2}$ .

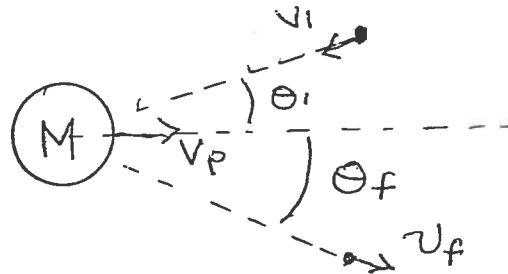


Free Body Diagram (If appropriate). Law or Definition

Application

Result

3. (25 points) In order to give a spacecraft an energy boost they use the Sling Shot Effect in which the spacecraft interacts with a planet in a what can be considered a perfectly elastic collision. This can be understood by considering the interaction of the light spacecraft,  $m_s$  with some very heavy object, mass  $M$ , where the actual force exerted by the object on the spacecraft is not specified. Assuming the heavy object continues in its original direction after the interaction, obtain enough equations so that you could solve for the magnitude of the final velocity of the spacecraft,  $v_f$ , and the final direction  $\theta_f$  given the magnitude of its initial velocity,  $v_i$ , and its initial direction,  $\theta_i$  and the magnitude of the initial velocity of the heavy object  $v_p$ .

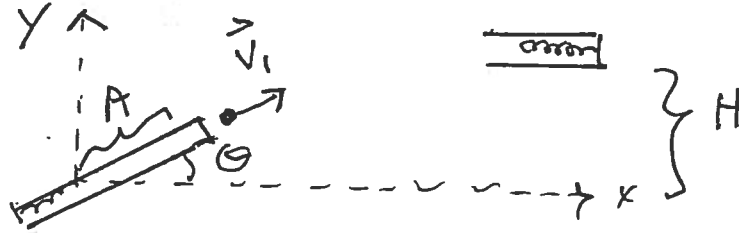


Free Body Diagram (If appropriate). Law or Definition

Application

Result

4. (25 points) A small ball of mass  $m$  is fired from a frictionless spring gun by compressing the spring, spring constant  $k_1$ , an amount  $A$ . The gun is aimed at the angle  $\theta$  as shown. At the highest point in the ball's trajectory it enters a frictionless tube which contains a spring with spring constant  $k_2$ . a.) Find the velocity of the ball when it leaves the gun. Call this velocity  $\vec{v}_1$ . b.) Find the maximum height reached by the ball. Call this height  $H$ . c.) Find the amount the second spring gets compressed. Call this distance  $B$ .



Free Body Diagram (If appropriate). Law or Definition