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Lab 6: Energy

PHYS 2305

Pre-lab Assignment

Question Pre-1: In Section 1.3, you will consider the gravitational potential, kinetic, and total mechanical energy of a cart moving down an inclined ramp in a cart-Earth system. (Refer to Figure 6.2). Define the gravitational potential energy to be zero when the cart is at the bottom of the ramp. Write an expression for the gravitational potential energy of the cart-Earth system in terms of the cart's mass m , the cart's position along the inclined ramp x , and the angle of the ramp θ .

Gravitational Potential Energy:

$PE = mgh$ → h is the height after x distance on ramp

$$\sin \theta = \frac{h}{x}$$

$$PE = mgx \sin \theta$$

Question Pre-2: In the situation described in Question Pre-1, how will the kinetic energy, gravitational potential energy, and total mechanical energy behave over time as the cart rolls down the inclined ramp? (For each type of energy, answer if it decreases, increases, or stays the same.) Explain.

* Since there's no friction present in the system, the total mechanical energy will remain constant. Initially, we assume at distance x the cart is at rest.

$$TE = PE + KE$$

$$TE = mgx \sin \theta + 0$$

* when the cart rolls down the KE will increase

$$KE = \frac{1}{2}mv^2$$

x is the distance

$$KE = mgx \cos \theta$$

$$v^2 = 0 + 2(g \cos \theta)x$$

the cart moves

$$PE = mgx \sin \theta - mgx \cos \theta$$

Question Pre-3: Assume a spring has an unstretched length x_0 . Write an expression for the elastic potential energy of the spring in terms of the position of the end of the spring x and its spring constant k .

$$\text{Elastic PE} = \frac{1}{2} k x^2$$

$$U = \frac{1}{2} k (x - x_0)^2$$

Pre-lab Assignment

Question Pre-1: In Section 2.2, you will consider the gravitational potential, kinetic, and total mechanical energy of a cart moving down an inclined ramp in a cart-spring system. Refer to Figure 2.1. Define the gravitational potential energy to be zero when the cart is at the bottom of the ramp. Write an expression for the gravitational potential energy of the cart as a function of the cart's position along the inclined ramp, and the cart's mass.

Question Pre-4: Describe how you will measure the spring constant k in Section 2.2. Measurement of the Spring Constant.

$$\text{Since } U = \frac{1}{2} k x^2$$

$$k = 2 \frac{U}{x^2}$$

Question Pre-2: In the situation described in Question Pre-1, how will the kinetic energy, gravitational potential energy, and total mechanical energy behave over time as the cart rolls down the inclined ramp? For each type of energy, answer if it decreases, increases, or stays the same. Explain.

As the cart rolls down the inclined ramp, its gravitational potential energy decreases, its kinetic energy increases, and its total mechanical energy remains constant.

To measure the spring constant k , you can use the following method: Attach a spring to a fixed support and a mass. Measure the displacement x of the mass from its equilibrium position for various forces F applied to it. Plot F versus x . The slope of the resulting linear graph is the spring constant k .

Another method to measure k is to use the conservation of energy. Attach a spring to a fixed support and a mass. Pull the mass down a distance x and release it. Measure the maximum height h that the mass reaches. The elastic potential energy stored in the spring is converted into gravitational potential energy at the maximum height. Set $\frac{1}{2} k x^2 = mgh$ and solve for k .