Strings and Tension

PHYS 2425

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1. Conceptual Questions

A. A ball is dropped from a certain height. Ignoring air resistance, how is the work done by gravity affected by the path it takes on the way down?

It is not affected at all by the path. Only starting and ending positions matter.
B. Friction is a non conservative force. What does this mean in terms of energy transfer? Where does the energy go?

Friction loses energy to heat. This also means that the amount of work done by friction does depend on the path taken.

C. Suppose you push a sled up a rough hill. How does the work you do compare with the work that gravity does?

You will do a greater magnitude of work than gravity. You will have to do work against gravity and work against friction.

D. If friction always converts mechanical energy into thermal energy, how can a car's brakes (which use friction) make a car slow down? Does this violate energy conservation?

Your brakes will get very hot. A lot of what constitues good brake discs is actually their ability to dissipate heat faster, not necessarily slow you down faster.

2. Work and Energy Problems

1. A ball of mass m is pushed up a rough incline at θ degres relative to the horizontal axis. The block is pushed a distance L along the incline by a force applied parallel to the incline. The coeficient of friction is μ_k. How much work is done by friction? What is the minimum force to push the block up the incline at a constant speed?

The friction force becomes

$$\mu_k(mg\cos(\theta))$$

So the work done by frition is

$$W = -f_k \cdot d = -\mu_k(mg\cos(\theta)d$$

For part 2, at constant speed the net force is 0, so the applied force must balance gravity's x component and friction:

$$F = mg\sin(\theta) + \mu_k N$$

2. A block of mass m_1 sits on a rough horisontal surface with coeficient of kinetic friction μ_k. It is connected by a physics string over a massless, frictionless pullet to a hanging block m_2. The system is released from rest and the blocks move. Write an expression for the work done by friction on block m_1 after it has moved a distance d. What is the final speed v of the blocks after m_2 has dropped a distance h?

The work done by friction is $-\mu_k m_1 gd$.
For part 2, the work done by gravity in m_2 is $m_2 gL$. The work done by friction on m_1 is $-\mu_k m_1 gd$. (What about the work done by gravity on block one? What about the work done by tension?) Since we know that the work done equals the change in kinetic energy, we know

$$m_d gd - \mu_k m_1 gd = \frac{1}{2}(m_1 + m_2)v^2$$

So the final expresion for the speed is:

$$v = \sqrt{\frac{2}{m_1 + m_2}(m_2 gd - \mu_k m_1 gd)}$$