Name: ID:

General Physics I (151)

Discussion Questions #6

Work and Energy

1. A box of mass M slides across a horizontal table. It collides with a spring, compresses the spring, and then the box-spring system rebounds. This system can be used to find the spring constant k. When the box first hits the spring it has speed v_0, and take this to be at $x = 0$.
No friction: Analyze what happens if there is no friction between the box and the table.
a) Suppose that the box comes to a stop after compressing the spring a distance L. What is the spring constant in terms of v_0, M, and L?

b) Then the spring expands, pushing the box back. When the box passes through $x = 0$, what is its speed?

With friction: Now include the effect of friction between the box and the table. Let the coefficient of kinetic friction be μ_k. With friction, the spring plus box compresses to a smaller distance l, rebounds, and will eventually stop. Hint: Use the work-energy relation, $W_{non\text{-}conservative} = \Delta PE + \Delta KE$.
c) First consider the "round trip", where the initial position is the first time the box hits the spring at $x = 0$, and the final position is when the box returns to $x = 0$ and stops. Use the above equation to find μ_k in terms of l, v_0 and g.

d) Second, consider just half the above cycle, with the initial place as in (c), but the final position where the box stops is at $x = l$. Find μ_k in terms of l, v_0, k and g.

e) Use the results of (c) and (d) to eliminate l, giving the spring constant k in terms of μ_k, v_0 and g.

2. Young Albert Jr. takes a running start at a tire swing, which is hanging at rest. He jumps onto the tire and rides it up to a height Δh above where the tire started, at which point he starts to swing back down. Assuming Albert Jr. has a mass of m_A and the tire has a mass of m_T you are asked to calculate Albert's speed right before he jumped onto the tire. You may neglect the mass of the rope.

   a) In terms of Δh, m_A and m_T, what is the speed v_{A+T} of Albert Jr. and the tire right after Albert has jumped on? What assumptions are you making and why?

   b) What is the initial speed v_A of Albert Jr. right before he jumps on the swing, in terms of v_{A+T}, m_A, and m_T? What assumptions are you making and why? Don't forget that little Albert clings to the tire, making this a totally inelastic collision.

   c) Solve for v_A in terms of Δh, m_A, and m_T.