Hint and changes: Physics III, Problem set 0, problems 2 (e) & (f)

The hints I gave for problems 2(e) and (f) before were not very illuminating. So, here's what I really meant to say in the hints, and in fact, let's even change these two questions.

Changes: We'll combine problems 2 (e) and (f) into **one problem**. In this problem, your goal still is to calculate the energy lost when the two blocks come and stick together (i.e. change in kinetic energy just before and after Fig. 2 (c) in the original problems set 0 handout). More specifically, **show that the energy lost due to the two blocks sticking to each other is $T_0 L$ Where does this energy go? If this is true, then is the total energy of the system not conserved after all?**.

Hint: Look at the figure below. Imagine two scenarios. The scenario depicted at the top of the figure corresponds to the process described in our original problem. Let's call this "scenario 1". The scenario depicted at the bottom of the figure shows an alternate process. In this alternate process, the two blocks are intially touching each other. Let's call this "scenario 2". Initially, all four blocks (two in Scenario 1, and the other two in scenario 2) are all at the same initial position (as you can see in the figure, they're all lined up). Your hand grabs the rope (shown as the "dot" in the figure below) and pull the blocks with a constant force T_0. Let's say X is the total distance your hand travels in Scenario 1, just before the two blocks collide with each other and stick. Then the horizontal distance that the two blocks travel in scenario 1 must be $X - L$ as shown in the figure. Now, in scenario 2, your hand moves by a different amount $(X - L)$ for the two blocks in scenario 2 to line up with the position of the 2 blocks in scenario 1 (at the instant that the blocks in Scenario 1 collide). What is this distance that your hand moves in scenario 2? How much work did you hand put in, in scenario 1? How much work did your hand put in, in scenario 2? Now, to finish off the argument, can you justify why the velocity of the two blocks in scenario 1 (just after the two blocks collide) must be the *same* as the horizontal velocity of the 2 blocks in scenario 2? (i.e. why is the work done by the vertical component of force in scenario 1 irrelevant just after the collision of the two blocks? It may help you to think about the fact that the work W done by force $\vec{F}$ over displacement $\vec{d}$ is $W = \vec{F} \cdot \vec{d}$ (dot product)).

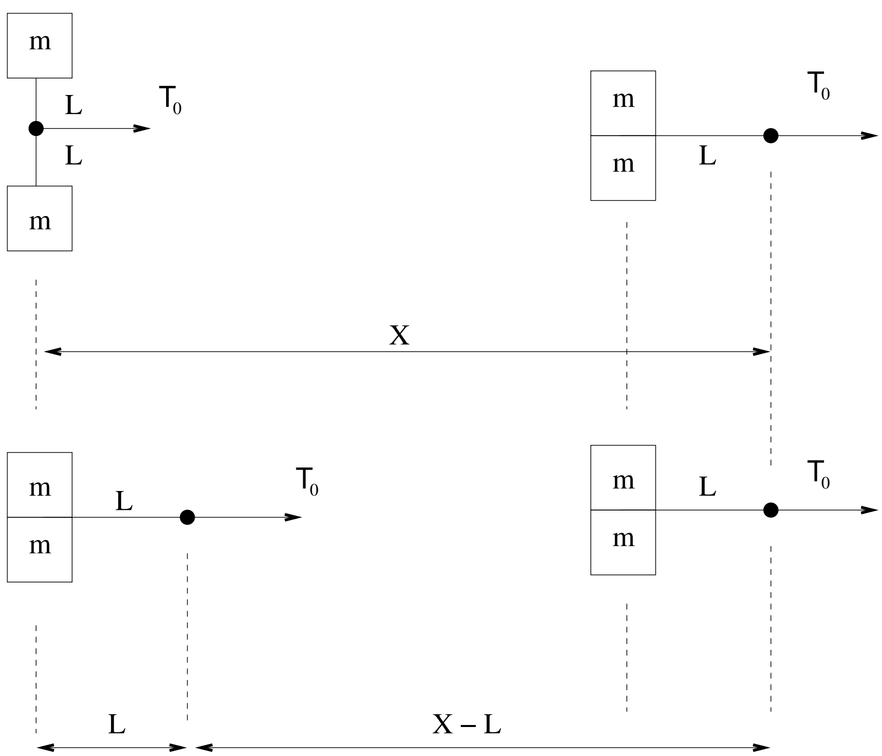

FIG. 1: Top: Scenario 1. Bottom: Scenario 2.