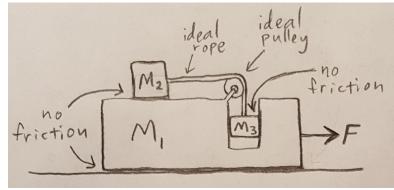
4) (25 points) Pedagogical machine

A "pedagogical machine" consists of a large block of mass M_I that is resting on a horizontal frictionless surface with two other masses, M_2 and M_3 , connected to each other by an ideal rope that passes over an ideal pulley that is attached to the large block, as shown in the diagram. M_2 can slide horizontally on the top of the large block, and M_3 can slide vertically with respect to the large block. You may neglect friction on all surfaces in this entire problem.

- a) If a constant external force F pointing to the right in the diagram is applied to the large block of mass M_1 so that the hanging mass M_3 does not accelerate upward or downward, then what is the tension in the rope? Express your answer in terms of any combination of M_1 , M_2 , M_3 , and any relevant physical constants.
- b) In that case, what is the magnitude of the acceleration of the block M_2 ? Express your answer in terms of any combination of M_1 , M_2 , M_3 , and any relevant physical constants.



- c) In that case, what is the magnitude of the external horizontal force F being applied to the large block M_1 ? Express your answer in terms of any combination of M_1 , M_2 , M_3 , and any relevant physical constants. (hint: Note that the rope exerts forces on both the pulley and the two smaller blocks.)
- d) For the rest of this problem, consider the case in which there is NO external horizontal force acting on the Pedagogical machine. What is the *direction* and *magnitude* of the acceleration of the large block M_l ?
- e) In that case, what is the tension in the rope?