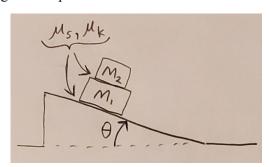
## 2) (25 points) Two blocks on a ramp

A block of mass  $M_1$  is resting on a ramp that forms an angle  $\Theta$  with the horizontal, and a second block of mass  $M_2$  rests on top of the first block, as shown in the diagram. The static and kinetic coefficients of **friction** between the two blocks and between the lower block and the ramp are  $\mu_s$  and  $\mu_k$ , respectively. For parts a-d, assume that the two blocks are sliding down the ramp together so that they have the same velocity and are not moving with respect to each other.

- a) Draw two separate free body diagrams, one for each block, showing all the forces acting on each block.
- b) What is the magnitude of the normal force acting on the lower block  $M_1$  *from the ramp*?
- c) What is the magnitude of the acceleration of the blocks?
- d) What is the minimum possible value for  $\mu_s$  given that the blocks are moving together in this way? Express your answer in terms of  $\mu_k$  and any other variables in the problem description, and as always show your work and/or justify your answer.



e) Now someone briefly pushes the upper block  $M_2$  so that it is sliding downward to the right faster than the lower block  $M_1$  after the person is no longer touching the block. What is the magnitude of the acceleration of the lower block  $M_1$ ?