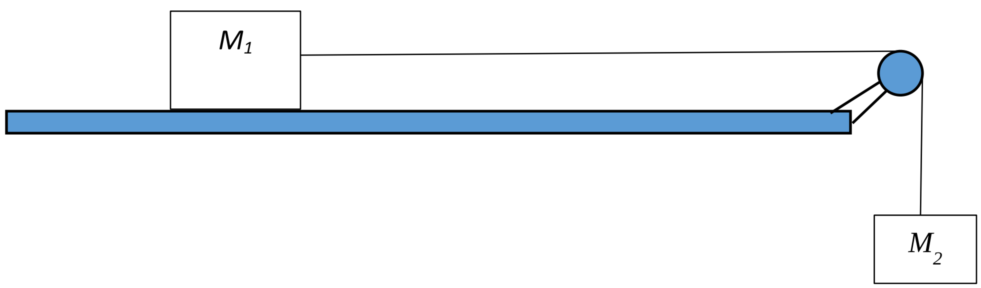
PRACTICE PROBLEMS with answers

Forces, motion, and friction

In ALL of these practice problems, you should make the following simplifying assumptions. The masses of all strings are so small compared to other masses that they can be ignored (we can pretend that the strings are massless). The masses of all pulleys and the friction forces in all pulleys are so small that they can be ignored (we can pretend that the pulleys are massless and frictionless). The acceleration of objects in freefall is given by $g = 9.80\ \frac{m}{s^2}$

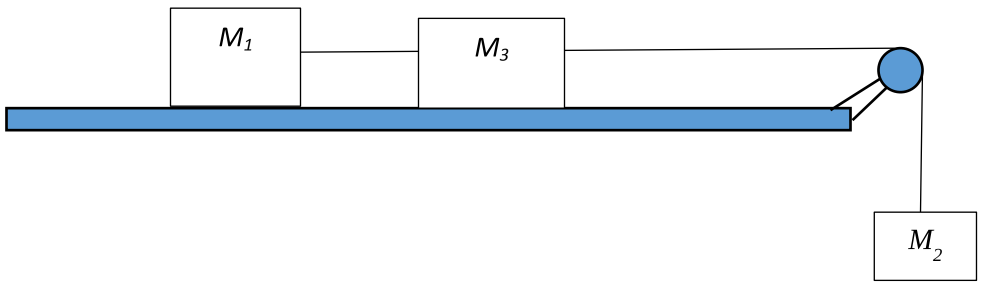
1) A block (block 2) of mass $m_2 = 1.3\ kg$ hangs from the end of a (massless) string which runs over a (massless frictionless) pulley. The other end of the string is connected to another block (block 1) of mass $m_1 = 2.2\ kg$ on a horizontal *frictionless* table. The situation is shown below.



   a) Assuming that block 1 is sliding to the right (toward the pulley), find the acceleration of block 1. (3.6 m/s^2)
   b) Assuming that block 1 is sliding to the right (toward the pulley), find the tension in the string. (8.0 N)
   c) Sarah repeats this experiment but she gives block 1 a push to the left, so now it is sliding to the left (away from the pulley). Find the acceleration of block 1 (after Sarah has stopped pushing it but while it is still sliding to the left). (3.6 m/s^2)
   d) As above in part c, block 1 is sliding to the left (away from the pulley). Find the tension in the string (after Sarah has stopped pushing it). (8.0 N)

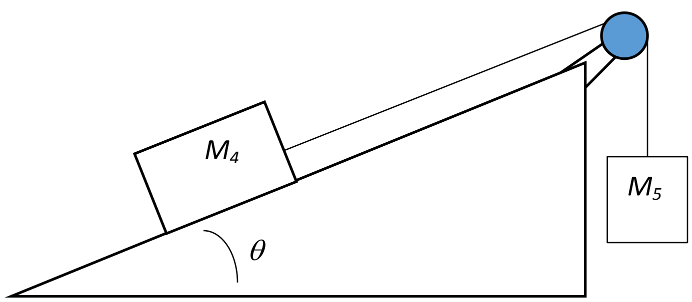
2) The situation is the same as in problem #1, but now there is friction between block 1 and the table. The coefficient of kinetic friction between the table and block 1 is $\mu = 0.20$.
   a) Assuming that block 1 is sliding to the right (toward the pulley), find the acceleration of block 1. (2.4 m/s^2)
   b) Assuming that block 1 is sliding to the right (toward the pulley), find the tension in the string. (9.6 N)
   c) Sarah repeats this experiment but she gives block 1 a push to the left, so now it is sliding to the left (away from the pulley). Find the acceleration of block 1 (after Sarah has stopped pushing it but while it is still sliding to the left). (4.9 m/s^2)
   d) As above in part c, block 1 is sliding to the left (away from the pulley). Find the tension in the string (after Sarah has stopped pushing it). (6.4 N)

3) A block (block 2) of mass $m_2 = 1.3\ kg$ hangs from the end of a (massless) string which runs over a (massless frictionless) pulley. The other end of ***that*** string is connected to another block (block 3) of mass $m_3 = 1.2\ kg$ on a horizontal *frictionless* table. Block 3 is connected to ***another string*** which is connected to another block (block 1) of mass $m_1 = 2.2\ kg$ on a horizontal *frictionless* table. The situation is shown below.



a) Assuming that block 1 and block 3 are sliding to the right (toward the pulley, with the same velocities and accelerations), find the acceleration of block 1. (2.7 m/s^2)
b) Assuming that block 1 is sliding to the right (toward the pulley), find the tension in the string that connects block 1 to block 3. (6.0 N)
c) Find the tension in the string that connects block 3 to block 2. Notice that your answers to parts b and c should be different. (9.2 N)

4) A block (block 5) of mass $m_5 = 2.3\ kg$ hangs from the end of a (massless) string which runs over a (massless frictionless) pulley. The other end of the string is connected to another block (block 4) of mass $m_4 = 6.1\ kg$ on a surface inclined at an angle of $\theta = 27°$ above the horizontal. The situation is shown below.



a) Assuming there is no friction between block 4 and the inclined plane, find the acceleration (magnitude and direction!) of the acceleration of block 5. (0.55 m/s^2 up!)
b) Assuming there is no friction between block 4 and the inclined plane, find the tension in the string. (24 N)
c) Now assume there is friction between block 4 and the plane with a coefficient of kinetic friction $\mu = 0.20$. Assuming that block 4 is sliding down the plane (that is the direction of velocity) find the acceleration of block 5. (0.72 m/s^2 down!)
d) Under the same assumptions as in part c, find the tension in the string. (21 N)