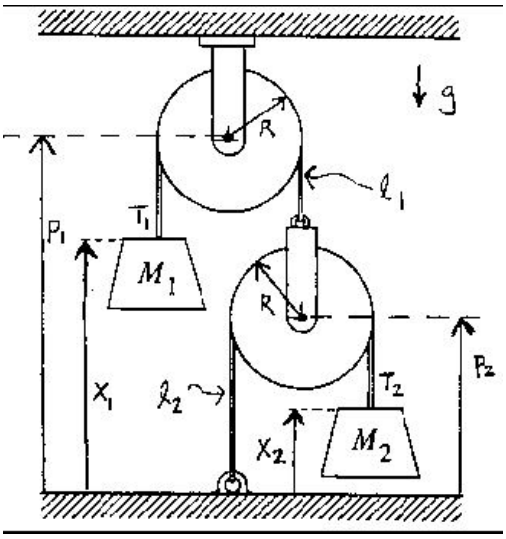
QP3



Consider the system of masses, strings and pulleys connected as shown.The strings are massless and inextensible, and the pulleys are massless and frictionless. There is a uniform gravitational field g. Note that only the lower pulley is free to move up and down. Treat the first string of length l_1 as beginning at the upper edge of m_1, going around the upper pulley, and ending at the center of the lower pulley. The second string of length l_2 is attached to the floor, goes around the lower pulley and ends at the upper edge of m_2.

a) (1 point) Write down expressions for the lengths l_1 and l_2 of the strings in terms of x_l, x_2, p_1, p_2 and the pulley radius R (consider the hook on the floor to be part of string l_2).

b) (1 point) Sketch the free-body diagram for each mass, and write down the force equations from Newton's second law. Use a_1 and a_2 for accelerations of masses m_1 and m_2, respectively.

c) (1 point) Using the results from part (a), find the relationship between a_1 and a_2. In other words, $a_1 = ka_2$, where k is a numerical constant.

d) (1 point) Write down the relationship between the tensions in the strings T_1 and T_2. In other words, $T_1 = k_2 T_2$, where k_2 is a numerical constant.

e) (1 point) Solve for a_1 and T_2 in terms for m_1, m_2 and g. If you are unable to solve parts (c) and (d), use $a_1 = -a_2$ and $T_1 = 1/3\, T_2$. (Note: there are not the correct relations).

f) (1 point) What is a_2 in the case of $m_1 = m_2$? What is the condition for zero acceleration of the masses?