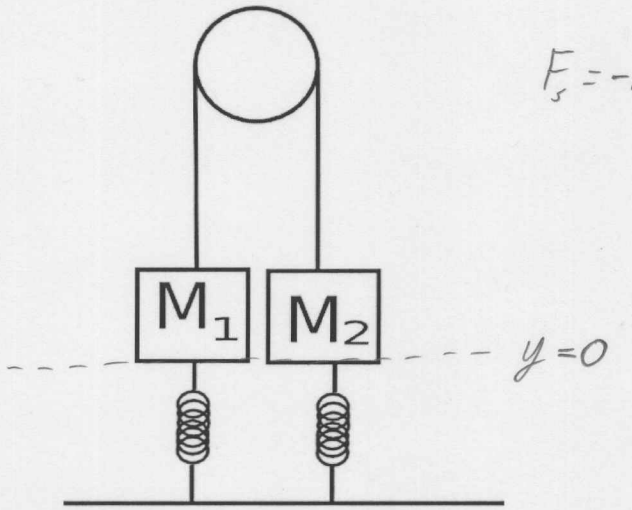
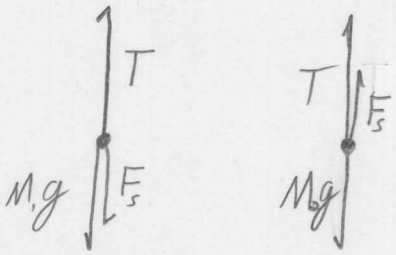
Force Problems

The contraption below is an atwood machine with springs attached between the ground and each of the weights. The spring on M_1 has a sprint constant k_1. The spring on M_2 has a spring constant k_2. When the weights are at the same level, as in the picture, the springs are in equilibrium.

Find an expression for the displacement from equilibrium of M_1 in terms of M_2, k_1, and k_2.





$T - M_1g + F_s = 0$ $\qquad$ $T - M_2g + F_s = 0$

Leave these signs as plus
Let the displacement take care of the sign

So: $T - M_1g - k_1y_1 = 0$ $\qquad$ $T - M_2g - k_2y_2 = 0$

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Now: If M_1 moves up, M_2 moves down by the same amount. Displacements are equal and opposite.

$$y_1 = -y_2$$

So, replace $-y_2$ with y_1

$$\cancel{T} - M_1 g - k y_1 = \cancel{T} - M_2 g + k_2 y_1$$

and solve for y_1

$$g(M_2 - M_1) = y_1 (k_1 + k_2)$$

$$\boxed{y_1 = \frac{M_2 - M_1}{k_1 + k_2} g}$$