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PHY422/820: Classical Mechanics

FS 2020

Exam Preparation

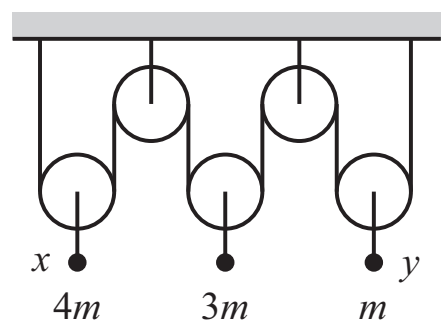
December 1, 2020

Problem P2 – Atwood Machines

Consider the Atwood machine shown in the figure, consisting of the indicated masses, several ideal pulleys and a string of fixed length l.

1. Show that the Lagrangian of the machine is given by

$$L = \frac{7}{2}m\dot{x}^2 + 3m\dot{x}\dot{y} + 2m\dot{y}^2 + mg(x - 2y), \qquad (1)$$

   where x and y are the lengths indicated in the figure. (Note that there is some flexibility in the definition of the lengths.)

2. Show that the Lagrangian is invariant under the transformation $x \to x + 2\epsilon$ and $y \to y + \epsilon$, and use Noether's theorem to compute the conserved momentum.