

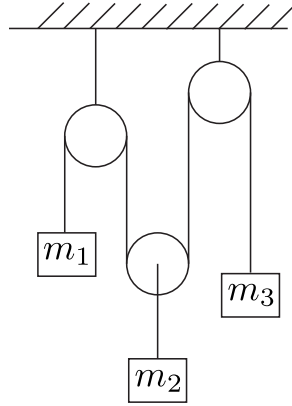
Aug. 2020 CM Prelim

UC Merced

Attempt only 2 out of the 3 problems

1. Consider an object (with mass m) that is coasting horizontally (positive x direction) subject to a drag force $f = -\alpha\sqrt{v}$, where v is the speed and α is a constant.
 - (a) Write down Newton's second law for this object and solve for the velocity with $v(t = 0) = v_0$.
 - (b) Sketch the behavior of v as a function of time and find at what time t the object stop moving.
 - (c) If the object falls under the same type of drag along the vertical direction, find its terminal velocity.

2. A set of pulleys and weights are assembled, as shown in the following figure.
- (a) Write down the Lagrangian of the system.
 - (b) Write down the Euler-Lagrange equation.
 - (c) Find the acceleration of m_1 , m_2 , and m_3 , respectively.



3. You determine that a particle is subjected to a mysterious force $\vec{F} = b^2(-x + 4x^3/a^2)\hat{x}$, where a and b are constants.
- (a) What are the units of a and b ? Now, determine $U(x)$ assuming $U(0) = 0$ and sketch it. (Sketch means hand-drawn, not plotted with Mathematica. Include all features you consider interesting in your sketch, including e.g. zero crossings, behavior at large x , “scales” of your axes, etc)
 - (b) Find the equilibrium points, if any, and determine if they are stable or unstable.
 - (c) Qualitatively explain the motion of an object in this force field released from rest at $x = 0.3a$. Then, qualitatively explain the motion of an object in this force field released from rest at $x = 0.6a$