1. A mass \( m = 250 \text{ g} \) on a spring \( k = 6 \text{ N/m} \) is damped with a factor of \( \beta = 0.1 / \text{sec} \) (underdamped).

   (a) Take the initial conditions to be \( x(0) = 0.5, v(0) = 0 \).
   Make a phase space plot and a “normalized” state space plot for the oscillator.

   (b) Repeat part (a) for \( \beta = 5.0 / \text{sec} \) (overdamped).

2. A double physical pendulum is made of uniform bars that are connected to each other end to end as shown in the figure. Let \( x_1, y_1, x_2, \) and \( y_2 \) be the coordinates of the center of mass of each bar with the origin taken to be the pivot point.

   Find the Lagrangian in terms of \( \theta_1 \) and \( \theta_2 \), measured with 0 degrees being down. Then find the equations of motion and solve them for three cases:

   (a) Move both pendula to 10 degrees and release them from rest.

   (b) Move both pendula to 30 degrees and release them from rest.

   (c) Move both pendula to 80 degrees and release them from rest.

   The following information is given:
   \( m = 350 \text{ g} \) is the mass of each rod.
   \( d = 40 \text{ cm} \) is the length of each rod.
   \( MI = 0.05 \text{ kg m}^2 \) is the moment of inertia of each rod when rotated about its center of mass.

3. Take the same problem as problem 35.2, but compare the solutions for two cases with very similar initial conditions:

   (a) Move both pendula to 80 degrees and release them from rest.

   (b) Move both pendula to 81 degrees and release them from rest.

   (c) Compare the evolution of the two cases.