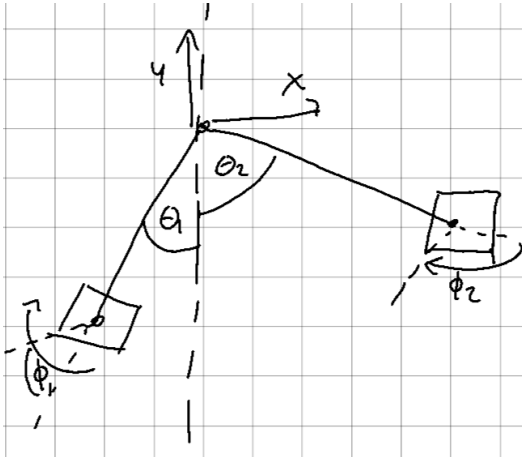


# ME314 Project Proposal - S. Morton

I'd like to design a final project program based around the Bolas, or Clacker Balls. When we model this system as 2 square blocks at the end of two independent strings, there are 4 state variables:  $\theta_1, \theta_2, \phi_1, \phi_2$ , where  $\theta$  are the angles of the strings from the central axis and  $\phi$  are the angles of rotation of the masses themselves. [this deviates somewhat from the original toy, which has fixed masses]. This is illustrated below.



Energy is added to the system by the user, who can drag around the top loop of the Bolas to make the balls swing more energetically. This will be done using interactions with a GUI made in Tkinter, which I have used before in prior CS courses.

Requirements for the project:

- involve at least two bodies and be more than 2 but not more than 5 degrees of freedom (unless something makes the extra degrees of freedom straight forward);**
  - 2 bodies: the two Bolas on their strings
  - Degrees of freedom:  $\theta_1, \theta_2, \phi_1, \phi_2, x_{\text{loop}}, y_{\text{loop}}$
- include rotational inertia in at least one body;**
  - Accounted for in rotations and revolutions of each ball
- include impacts; done**
- include some sort of external forcing (but this could be friction—not necessarily control forces/torques).**
  - External forcing provided by user's click+and+drag; potential for damping
- be planar; we will be limiting ourselves to projects in 2D; done**
- animate the resulting simulation to show that it “works”;**
  - Animation will reflect real-time changes to system energy via forced Euler-Lagrange equations.
  - Gameplay will be limited to a period of time of ~30 seconds, after which plots of the energy of the system over time will be plotted.
- no spheres—anything like a “ball” must be modeled as a polygon (typically a triangle or rectangle) so that impacts have some sort of nontrivial updates. - done**

Frames used to compute equations of motion:

- Frame S will be at a fixed location on screen
- Frame P will be at the top loop of the Bolas
- Frames E1, E2 will be at the ends of the strings
- Frames B1, B2 will be the frames associated with the center of each Bola as it rotates.