Name: _____

Date: _____

Collaborators: _____

(Collaborators submit their individually written assignments together)

Question:	1	2	3	Total
Points:	10	30	20	60
Score:				

Instructor/grader comments:

Dimensional analysis.

1. (10 points) **The mass of a pendant drop**

   A drop of liquid hangs from the tip of a vertical capillary tube, for example a pipette fitted with a rubber bulb, through which liquid can be slowly injected to feed the drop. If the feeding rate is slow enough, the drop grows through a sequence of equilibrium shapes with continuously increasing volume until it becomes unstable and detaches.

   Use the dimensional analysis an estimate the mass of a drop detached from a pipette of diameter a. The other relevant parameters are the acceleration of gravity g, and the surface tension σ. (σ is measured in units of force per length.)

   Give the numerical estimate for the mass of a drop of water created using a pipette of diameter of 2 mm. For the purpose of this exercise assume that $g = 10$ m/s^2 and $\sigma = 0.07$ N/m.

Normal modes

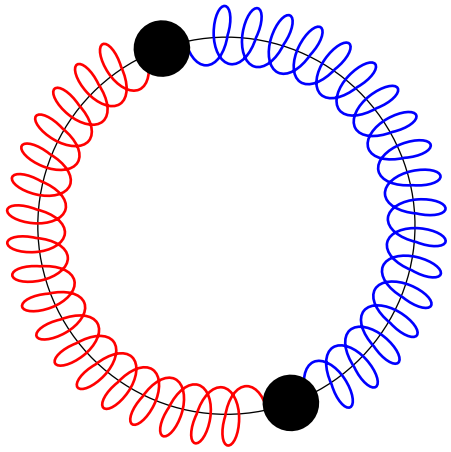
2. Two identical masses m are constrained to move along a circular horizontal frictionless rail. Two identical springs with spring constant k connect the masses as shown in Fig. 1. Find the normal modes.

   (a) (10 points) Chose two diametrically opposite arbitrary points as the equilibrium positions. Measure the displacements of masses relative to these points counterclockwise. Write the equations of motion.

   (b) (10 points) Solve two differential equations from Part (a) by adding and subtracting them first.

   (c) (10 points) Write the solutions you obtained in vector form. Describe your solutions in words.

Figure 1:



3. (20 points) A mass m is attached to two identical springs of elastic constants k and relaxed lengths zero. The other ends of the springs are fixed at two different points. (See Fig. 2.) The mass is initially at the equilibrium position in the middle of the line connecting the fixed ends of the springs. The mass is moved some distance in the direction perpendicular to the line connecting the fixed ends of the springs and released with zero initial velocity. Find the frequency of resulting oscillations.

Figure 2: