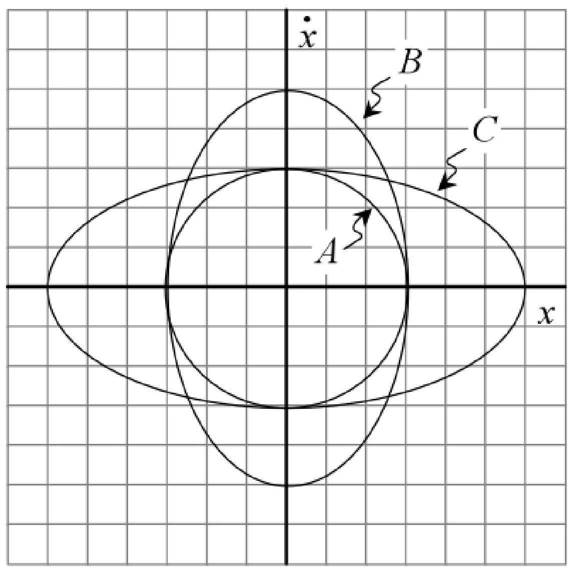
PHYS 2210 Fall 2010 Homework Set 9

Due at start of class on **Oct 28th, 2010**
Show your work!

1. (2 pt) Taylor 5.2

2. (1.5 pt) Consider the phase space plots (A, B, and C) shown below.



   (a) Could all three plots correspond to the same simple harmonic oscillator (i.e., same mass and same spring constant)? Explain why or why not.

   (b) Which pair of plots could be used to show the effect of keeping the total energy constant but increasing the spring constant (while keeping the mass constant)? Clearly indicate which plot would correspond to the larger spring constant. Explain without performing any calculations.

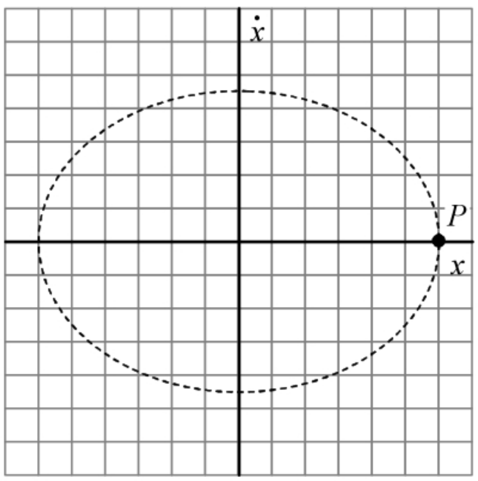
   (c) Which other pair of plots could be used to show the effect of keeping the total energy constant but decreasing the mass and keeping the spring constant fixed? Clearly indicate which plot would correspond to the smaller mass. Explain without performing any calculations.

3. (1.5 pt) The phase space trajectory of an undamped oscillator is shown below left. In the diagram, each division along the position axis corresponds to 0.1 m; along the velocity axis, 0.10 m/s.

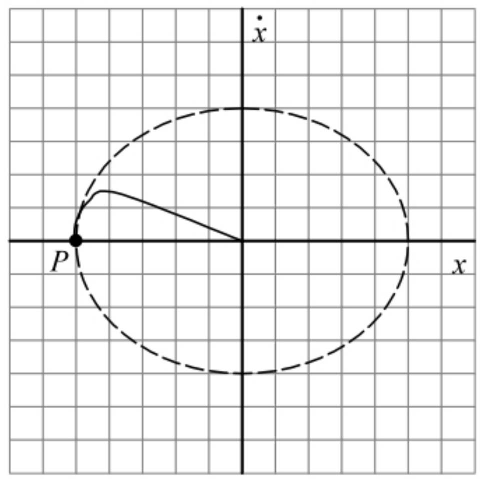
   (a) What is the angular frequency ω_0 of the undamped oscillator? Explain how you can tell.

   (b) A retarding force is now applied to the oscillator for which the damping constant is equal to $\beta = 0.069\omega_0$. By what factor does the amplitude change after a single oscillation? Show all work.

   (c) On the basis of your results above, carefully sketch the phase space plot for the first cycle of the motion of the damped oscillator, starting at point P.



(a) Figure for Problem 3



(b) Figure for Problem 4

4. (1.5 pt) Shown above right are the phase space plots for (i) a simple harmonic oscillator (dashed) and (ii) the same oscillator with a retarding force applied (solid). Point P represents the initial conditions of the oscillator in both instances. In the diagram, you may assume each division along the position axis corresponds to 0.1 m; along the velocity axis, 0.10 m/s.

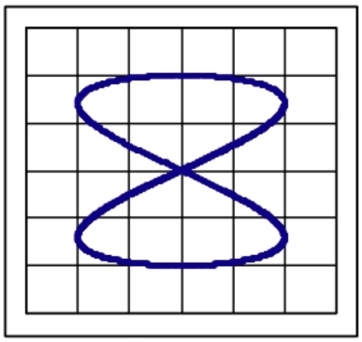
   (a) Explain how you can tell that the damped oscillator is not underdamped.

   (b) Is the damped oscillator critically damped or overdamped? Explain how you can tell.

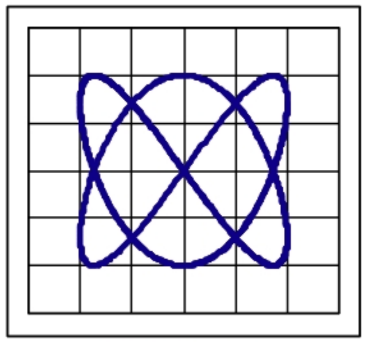
   (c) If you said in part b that the oscillator is {critically damped, overdamped}, then draw how the phase space plot would be different if the oscillator (starting at point P) were instead {overdamped, critically damped}. Explain your reasoning

5. (1 pt) Taylor 5.16

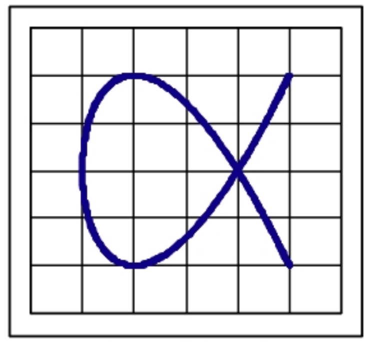
6. (1.5 pt) Consider the motion of a two-dimensional non-isotropic oscillator, in which the spring constant in x direction (k_1) is not equal to the spring constant in the y direction (k_2). Each trajectory below depicts the possible motion of a unique non-isotropic oscillator. All three oscillators, share the property that the angular frequencies ω_1 and ω_2 for the motions along the x- and y-axes are commensurate, i.e., that the angular frequencies satisfy the following relationship: $\frac{\omega_1}{n_1} = \frac{\omega_2}{n_2}$, where n_1 and n_2 are integers. For each case below, (i) determine whether ω_1 is greater than, less than, or equal to ω_2, and (ii) determine the values n_1 and n_2 that satisfy the condition. Explain.



Trajectory #1



Trajectory #2



Trajectory #3

7. (1 pt) Taylor 5.20 (Hint: Consider the slope of the decay parameter.)