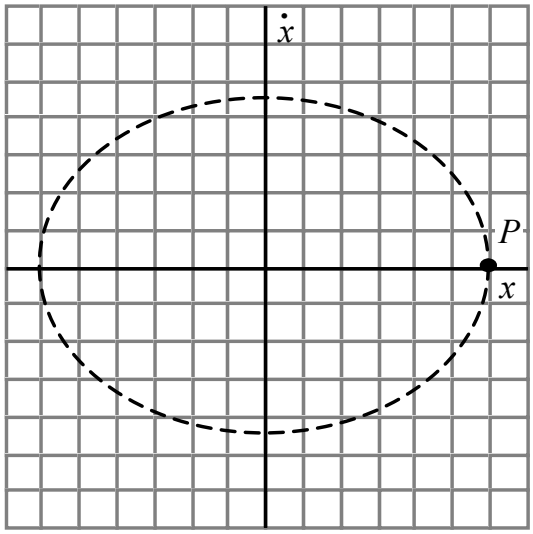
Homework: Phase space diagrams: Damped harmonic motion Name _____

1. The phase space trajectory of an undamped oscillator is shown below right. 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_o of the undamped oscillator? Explain how you can tell.



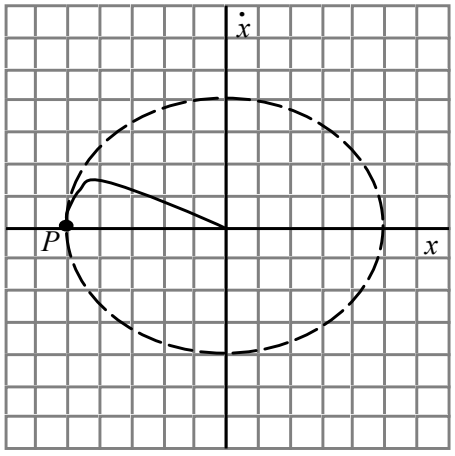
   A retarding force is now applied to the oscillator for which the damping constant is equal to $\gamma = 0.069\omega_o$.

   b. 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*.

2. Shown below 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.

   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.