1. (*Note: This problem also serves as a pos-test for* Phase space diagrams: Simple harmonic motion.)

The diagrams at right can be used to represent one full period of motion for several different types of oscillators.



For each case below, identify which diagram could be used to represent that situation. If more than one diagram could apply in a particular case, **specify them all.** If none of the diagrams apply, state so explicitly. Explain how you decided your answer in each case.

a. the phase space diagram *(*vs. *x)* for the motion of an ideal 1-D oscillator (no damping)

b. the phase space diagram *(*vs. *x)* for the motion of an underdamped 1-D oscillator

c. the phase space diagram *(*vs. *x)* for the steady state motion of a driven, damped 1-D oscillator

2. (*Note: This problem also serves as a post-test for* Damped harmonic motion: Energy loss and the quality factor.)  
  
A harmonic oscillator with mass *m* and undamped angular frequency *o* is subject to a damping force *mo**.* (Assume that all constants are positive.)

A. Write down the differential equation that governs the motion of this oscillator.

B. What can be said about the value of the parameter *o* if the above oscillator were (i) critically damped? (ii) underdamped?

C. If the quality factor of the above oscillator is equal to *Q* = 15, then determine each of the following quantities in terms of *o* and numerical constants. Clearly show all work. [*Hint:* Do *not* solve the differential equation if you don’t have to!]

i. the period **d of the damped oscillator

ii. the period *o* of the oscillator when the damping is removed

iii. the ratio of the amplitudes of two successive maxima of the damped oscillator



D. On the basis of your results above, carefully sketch a qualitatively correct phase space plot for the first cycle of the motion of the oscillator, starting at point *P.*

*(Note:* Shown for reference is the trajectory that would represent the motion of the oscillator *if* the damping were *removed.)*