Homework 10

(Due Date: Start of class on Thurs. March 22)

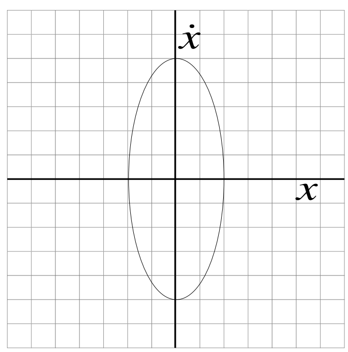
NOTE: March 22 is our second in-class exam day! You may bring TWO sides of one page of paper with your own *hand written* notes, if you like. Please read the LAST homework question first, so you know it's coming. This may require some planning on your part.

1. (a) A 4 kg mass is connected to a spring with spring constant k = 1.0 N/m. At t = 0 the mass is set into simple harmonic motion (no damping) by releasing it from rest at a point x= -1.0 m (i.e. a meter to the left of the origin). Sketch an accurate phase space plot for the oscillator. Explain your reasoning and show your work. If the direction the particle follows around the plot is ambiguous, say so, otherwise draw an arrow to show how it moves around the phase space diagram.

(b) On the phase space trajectory you have drawn, label the point Q that represents the position and velocity of the oscillator one-quarter period after t = 0. Explain your reasoning. Also, on the phase space trajectory you drew, add a second trajectory (make it "dashed" so we can tell them apart) which shows the phase space plot of a system with the *same total energy* but *smaller mass*. Explain your reasoning briefly.

(c) Now consider an elliptical phase space trajectory for a *different system*, as shown in the figure below. Assuming each unit on the horizontal axis is 10 cm, and each unit along the vertical axis is 10 cm/s, and assuming a mass m=1.0 kg, determine numerical values for the following quantities:

i) angular frequency, ii) period, iii) total energy, and iv) spring constant



2. *Practice, practice: We have noticed some difficulties in evaluating multi-dimensional integrals. Since this is one of our class learning goals, we are giving you some basic problems to practice with.*

(a) Consider a solid sphere, determined by the volume $x^2 + y^2 + z^2 \leq R^2$, with a non uniform density $\rho(x, y, z) = A|z|$. What are the units of A? Determine the total mass of the sphere in terms of A and R. *(Hints: Use spherical coordinates. Can you write z in terms of r, θ, and ϕ? Can you think of a clever use of symmetry and limits of integration to deal with that unpleasant absolute value?).*

(b) Consider a flat disk of radius R, with an areal mass density given in polar coordinates (it's flat, so we don't have any third "z" dimension) given by $\sigma(r, \theta) = Ar^2 \sin^2(\theta)$, where A is a given constant. Describe (in words, and a simple sketch) this mass density, what does it look like physically? Now, determine the total mass of the thin disk in terms of A and R.

3. Homework review! *Note: If you have perfect scores on all homeworks so far, congratulations. Just let the grader know! Otherwise...* Go back over all your old homeworks, and look over what you missed. (Note:

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solutions are always posted on CULearn) Pick at least one problem you didn't do well on, and redo it to your satisfaction. You don't need to turn in the resolved problem - instead, turn in a summary of what went wrong, and what you needed to do to fix it. Were you missing a concept? A math skill? Was it sloppiness, a lack of time, or something deeper? Try to articulate what you have learned by redoing the problem (For obvious reasons, the grader will not grade what you do here in *detail*, this question will be graded simply "credit/no credit").

4. Exam review! This question is similar to what we assigned you before Exam. 1. (Again you are required to turn this in. And again, for obvious reasons, the grader will not grade what you write in *detail*, each part will be graded simply "credit/no credit").

(a) Find or invent a plausible exam question covering material you expect to see on this exam. (Exams are cumulative, but focus on new material since the previous midterm) You might also think about what we have covered in Boas, too - can you hook that in? Write it down. Solve it. (Include your solution with your homework) (If it takes $<\approx$ 5 min, how could we have made it a little more interesting/richer/challenging? If it takes $>\approx$ 20 min, how could we scaffold/hint/simplify to get at the interesting physics, without making it tedious/grungy?) Write a brief (just a few words) summary which characterizes what content this problem covers (e.g, "Gauss law", or "Simple harmonic motion" or "Conservation of energy", etc) Finally, which of the course scale learning goals does your problem address (list them by number) See

http://www.colorado.edu/physics/phys2210/phys2210_sp12/course_goals.html

(b) Get together with at least one other person from class, and share your made-up exam question. Do theirs, and discuss with them whether you think they got the level and coverage right. To turn in to us: Write down the name(s) of the person you worked with. To show us that you really did this activity (yes, this IS a homework problem, for credit!), write down in your homework the problem of theirs that you did. (If it's really long, paraphrase)
