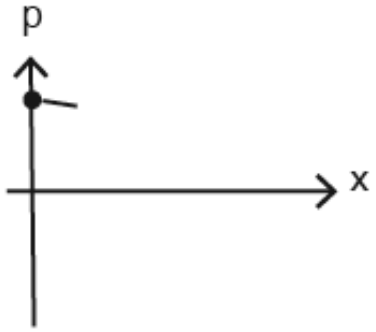
Chem 442: Homework L1 (lecture 1)

(You need to turn in the assignment marked as "**Turn in**" only; for convenience, you can do them all on the same sheets so you have the whole collection together, but the TAs will only grade the ones listed as "turn in." Do all assignments by the first lecture of the next week.)

1. Read the postulates, and if there is any weird vocabulary, look it up in the Quantum Vocabulary handout. If it's not shown there, demand in the next lecture that Prof. Gruebele add it!
Don't worry if the postulates don't make crystal-clear sense yet: that's why we are spending a whole semester on quantum mechanics!

2. Write down the classical Hamiltonian (kinetic plus potential energy) of a of a 3-D particle in a gravitational potential V(z)=mgz that depends only on height z, not on x and y. Does the kinetic energy in 3-D depend on p_x and p_y? Now write down the same Hamiltonian ignoring any kinetic energy in the x and y directions, i.e. the particle is only allowed to drop straight down, not to be thrown sideways in the gravitational field. Does the Hamiltonian depend on any other fundamental observables besides z and p_z?

Turn in 3. On an x-p_x plot (where x is now the vertical axis, not z), draw the trajectory of a marble that starts at x=0, is thrown straight up at t=0, then falls back into the hand at x=0 at t>0 later. I started the plot for you below.



Think it through carefully before drawing: right after the throw starts, the particle is still at x=0 but it has positive p_x and flies upward; eventually it slows down and stops in mid-air (p_x=? then); then it falls down and therefore has negative p_x. If energy is conserved, what is p_x when it lands in your hand again and x=0 again?

4. Draw the quantum particle on the x-p plot for the same problem as in 3, but taking into account what Gruebele said about Δx and $\Delta p \neq 0$, i.e. the quantum particle's center of mass location is not a point on the x-p plot.