Three Practice Problems for ~Midterm Material for Practice for the Final

Physics 611

1. In a one-dimensional problem, consider a particle subject to potential energy $V(x) = -fx$, where f is a positive constant. For what physical problems might this potential be relevant?

(a) **Ehrenfest's theorem:** Determine the time derivatives of the expectation values of the position x and the momentum p of the particle.

(b) Integrate the equations you obtain part (a); compare with the classical motion.

(c) Show that $\langle(\Delta p^2)\rangle = \langle p^2\rangle - \langle p\rangle^2$ does not vary over time. Useful relation: $[AB, C] = A[B, C] + [A, C]B$.

2.

Two Hermitian operators anticommute:

$$\{A, B\} = AB + BA = 0\,.$$

Is it possible to have a simultaneous (that is, common) eigenket of A and B? Prove or illustrate your assertion. Hint: Examining $\langle a''|\,\{A, B\}\,|a'\rangle$ will be helpful.

3.

The observable A has eigenstates $|1\rangle$ and $|2\rangle$ and the hamiltonian operator is $H = C\,(|1\rangle\langle 2| + |2\rangle\langle 1|)$, where C is a constant.
(a) Derive the energy eigenstates and their eigenvalues.
(b) For a system in state $|1\rangle$ at $t = 0$, find the state vector (in Schrödinger picture) for $t > 0$ and the corresponding probability for it to be in state $|2\rangle$.
(c) What physical situation can this describe? What is then A, H and C ?