Hints: Assignment 3

1. As a check on your answer, compare it with the time-dependence of expectation values we computed in class.

2. In the second part of the question Sakurai is asking you to find the general solution of the Schrödinger equation with the given Hamiltonian.

5. Expand out the commutators (and just use the eigenvectors) to get the left hand side. Compute the commutators with the given Hamiltonian to get the right hand side.

11. Don't forget, the state vector does not change in time in the Heisenberg picture. You already know the Heisenberg operators for the oscillator.

20. It is easiest to define the stationary states via their components in the position basis – the energy eigenfunctions. These eigenfunctions should be everywhere continuous.

22. This is a standard undergraduate problem. The presence of the delta function implies a boundary/matching condition at $x = 0$ which specifies a discontinuity in the first derivative of the stationary states.

25b. Show that when $\rho > \rho_a$ the vector potential can be taken to be

$$\vec{A} = \frac{B\rho_a^2}{2\rho}\hat{e}_\theta, \quad \rho > \rho_a,$$

where $\hat{e}_\theta$ is a unit vector in the direction of increasing cylindrical angle. You will want to solve the eigenvalue problem using cylindrical coordinates.

36. Recall that the spectrum of the oscillator Hamiltonian was completely determined by commutation relations.