Quantum Mechanics

Sample Exam for Second Examination

1 An Ammonia molecule starts out in state "down". What is the probability that it is found "down" at time t? Use the notation and results in the textbook, section 5.5.

2 Evaluate $\Im m\{\langle \hat{x}\hat{p}\rangle\}$ for any state $|\psi\rangle$. ($\Im m\{z\}$ means the imaginary part of z. So if $z = x + iy$, where x and y are real, then $\Im m\{z\} = y$.)

3 Suppose operators $\hat{A}$ and $\hat{B}$ obey $[\hat{A}, \hat{B}] = c\hat{B}$, where c is a number. If $|a\rangle$ is an eigenstate of $\hat{A}$ with eigenvalue a, show that $\hat{B}|a\rangle$ is an eigenstate of $\hat{A}^3$, and find its eigenvalue.

4 A "Lorentzian" wavepacket has
$$\psi(x) = \frac{A}{x^2 + \gamma^2}e^{ikx},$$
where γ and k are fixed parameters.

    a. What is the normalization constant A?

    b. What is the mean kinetic energy?

What materials (books, notes, web sites, etc.) did you consult while taking this exam?