1 Day 2: Operators and Expectation Values

1. The momenumt operator is defined as:

$$\hat{p} = -i\hbar \frac{\partial}{\partial x} \tag{1}$$

   Find the eigenstates and eigenvalues for this operator.
2. A particle's wavefunction is given by:

$$\psi(x) = A(a^2 - x^2) \tag{2}$$

   for $-a \leq x \leq +a$ and $\psi(x) = 0$ elsewhere

   1. Find the normalization constant A.
   2. Find the expectation values of x, x^2, p, and p^2.
   3. Find σ_x and σ_p and verify that Heisenberg's uncertainty relation holds: $\sigma_x \sigma_p \geq \frac{\hbar}{2}$