1. (4 p)
Show that in stationary state perturbation theory, if the Hamiltonian can be written as
\[ H = H_0 + H' \]
with \( H_0 \phi_0 = \varepsilon_0 \phi_0 \), then the correction \( \Delta E_0 \) is given by
\[ \Delta E_0 \approx \langle \phi_0 | H' | \phi_0 \rangle \]  
(1)

2. (5 p)
A particle of mass \( m \) moves one-dimensionally in the oscillator potential \( V(x) = \frac{1}{2}m\omega^2 x^2 \).
In the nonrelativistic limit, where the kinetic energy \( T \) and the linear momentum \( p \) are related by \( T = \frac{p^2}{2m} \), the ground state energy is well known to be \( \frac{1}{2}\hbar\omega \).
Allow for relativistic corrections in the relation between \( T \) and \( p \) and compute the ground state level shift \( \Delta E \) to order \( 1/c^2 \).
Hint: The relativistic kinetic energy is given as \( T \equiv E - mc^2 \), where \( E \) is the total energy.