1. **Screened Potential**: Consider a particle of mass $\mu$ in the central force potential

$$ V(r) = -\frac{e^2}{r} \quad \text{for } 0 < r < R $$

$$ = -\frac{e^2}{r} \exp(-\lambda(r-R)) \quad \text{for } R < r < \infty \quad (0.1) $$

This potential differs from the Coulomb potential only in the region $r > R$, where the Coulomb force is screened. The difference becomes negligible when $\lambda \to 0$. Consider this difference as a perturbation and calculate the first-order correction to the energy of the ground state of the hydrogen atom.

2. **Relativistic Harmonic Oscillator**: A particle of mass $\mu$ moves in a one-dimensional harmonic oscillator potential $V(x) = \frac{1}{2}\mu \omega^2 x^2$. Allowing for relativistic effects, the kinetic energy is $T = E - \mu c^2 = \sqrt{\mu^2 c^4 + p^2 c^2} - \mu c^2 \simeq \frac{p^2}{2\mu} - \frac{p^4}{8\mu^2 c^2}$. Treating the $p^4$ term as a perturbation, calculate the first-order shift in the ground state energy.

3. Problems 17.2.5, 17.2.7 and 17.3.2 in Shankar’s book.