1. In a one-dimensional problem, consider a particle subject to potential energy \( V(x) = -fx \), where \( f \) is a positive constant. For what physical problems might this potential be relevant?

   (a) **Ehrenfest’s theorem:** Determine the time derivatives of the expectation values of the position \( x \) and the momentum \( p \) of the particle.

   (b) Integrate the equations you obtain part (a); compare with the classical motion.

   (c) Show that \( \langle (\Delta p)^2 \rangle = \langle p^2 \rangle - \langle p \rangle^2 \) does not vary over time. Useful relation: \([AB, C] = A[B, C] + [A, C]B\).

2. Two Hermitian operators anticommute:

\[
\{A, B\} = AB + BA = 0.
\]

Is it possible to have a simultaneous (that is, common) eigenket of \( A \) and \( B \)? Prove or illustrate your assertion. Hint: Examining \( \langle a| \{A, B\} |a'\rangle \) will be helpful.

3.

The observable \( A \) has eigenstates \(|1\rangle\) and \(|2\rangle\) and the hamiltonian operator is \( H = C (|1\rangle\langle 2| + |2\rangle\langle 1|) \), where \( C \) is a constant.

   (a) Derive the energy eigenstates and their eigenvalues.

   (b) For a system in state \(|1\rangle\) at \( t = 0 \), find the state vector (in Schrödinger picture) for \( t > 0 \) and the corresponding probability for it to be in state \(|2\rangle\).

   (c) What physical situation can this describe? What is then \( A, H \) and \( C \)?