1) Two equal-strength delta-function potentials are placed a distance 2a apart, \( V(x) = -g[\delta(x+a) + \delta(x-a)] \). (a) Derive the eigenvalue equation for symmetric (even parity) bound states. Under what conditions is there at least one symmetric bound state? Are there ever more than one symmetric bound state?

2) Harmonic Oscillator. A harmonic oscillator is initially in the state:
\[
|\psi(0)> = \frac{1}{\sqrt{2}}|0> + \frac{i}{\sqrt{3}}|1> - \frac{1}{\sqrt{3}}|3>
\]
At time \( t \), measurements are made. (a) What are the average values \(<H>\), \(<X>\) and \(<P>\)? (b) What are \(<X^2>\) and \(\Delta X\)? (c) At time \( t_1 \) a measurement is made and it is found that \( x < 0 \). After this, at time \( t_2 \), energy is measured. What is \( P(E_0) \)?

3) Harmonic Oscillator. \( H = \frac{p^2}{2m} + \frac{1}{2}m\omega^2x^2 \). The initial state is:
\[
|\psi(0)> = \frac{1}{\sqrt{3}}|0> + \frac{i}{\sqrt{3}}|1> - \frac{1}{\sqrt{3}}|2>
\]
Measurements are made at time \( t \). (a) What are \(<H>\), \(<X>\) and \(<P>\)? (b) What is \(<X^2>\)? Using \(<H>\) and \(<X^2>\), compute \(<P^2>\). What is \(\Delta X\) \(\Delta P\)?

4) Harmonic Oscillator. \( H = \frac{p^2}{2m} + \frac{1}{2}m\omega^2x^2 \). A system in the ground state is measured at time \( t = 0 \) and it is found that \( x > 0 \), collapsing the wave function. (a) What are \( P(n=0) \), \( P(n=1) \) and \( P(n=2) \)? (b) What are \(<H>\), \(<X>\) and \(<P>\)?

5) Harmonic Oscillator. \( H = \frac{p^2}{2m} + \frac{1}{2}m\omega^2x^2 \). At \( t = 0 \) the state is:
\[
|\psi(0)> = \frac{1}{2} |0> + \frac{i}{\sqrt{2}} |1> - \frac{1}{2} |2>
\]
At time \( t \), measurements are made. (a) What is the average energy, \(<H>\)? (b) What are the average position, \(<X>\), and momentum, \(<P>\). Compute these and verify that they satisfy their classical relationship. (c) A measurement is made at \( t = t_1 \) and it is found that \( E < 2\omega \). Use the collapsed state to find the probability that \( x > 0 \) at a later time, \( t_2 \).