

For these questions, use the simulation “Superposition states in an infinite square well” in the QuVis HTML5 collection.

[www.st-andrews.ac.uk/physics/quvis/simulations\\_html5/sims/SuperpositionStates/SuperpositionStates.html](http://www.st-andrews.ac.uk/physics/quvis/simulations_html5/sims/SuperpositionStates/SuperpositionStates.html)

1) Have a play with the simulation for a few minutes getting to understand the controls and displays before answering these questions.

2) a) Explain what the slider does.

b) Make sketches of the probability density for a superposition state to show what effect, if any, the sign of the slider has on the probability density.

c) Make sketches giving examples of special slider values for which the wavefunction is particularly simple.

3) a) How is the expectation value of position represented in the simulation graph?

b) Add the expectation value of position into your sketches from questions 2b and 2c. Using these sketches, explain how this quantity is defined.

4) a) Sketch a time-dependent probability density at *one* instant in time. Explain how you can see just from the shape of the curve that this probability density is time-dependent. (Consider what the curve looks like if the probability density does not depend on time.)

b) Does the probability of finding the particle in a small interval around  $L/4$  depend on time if the probability density depends on time? Explain using sketches.

5) Make two sketches illustrating a time-dependent probability density for which the expectation value does not depend on time. Explain from your sketches how you know that the expectation value of position is time-independent.

6) a) Explain what is meant by the oscillation frequency of the probability density.

b) How does the oscillation frequency of the probability density depend on the two energies in the quantum state? Come up with a graph depicting this relation.

c) What is the ratio of the oscillation frequencies for the three different input states shown in the simulation? Explain your answer.