For these questions, use the simulation "Probability density and probability current" in the QuVis HTML5 collection.
www.st-andrews.ac.uk/physics/quvis/simulations_html5/sims/ProbabilityCurrent/ProbabilityCurrent.html

1) Have a play with the simulation for a few minutes, getting to understand the controls and displays. Note down three things about the displayed quantities that you have found out.

2) Write down the relation between $|\psi|^2$ and j.
Using the "Stop" button, sketch the probability density $|\psi|^2$ and the probability current j for a fixed time t_0.
Sketch qualitatively the probability density a small time step later into your graph of $|\psi|^2$.
Explain your reasoning.

3) There are times when the probability current is zero everywhere within the well. What does this imply for the the probability density? Explain your reasoning.

4) The particle in the simulation is in an equally weighted superposition of the ground state and the first excited state of an infinite well, with

$$\psi(x,t) = \frac{1}{\sqrt{2}}\sqrt{\frac{2}{L}}\left(\sin\left(\frac{\pi x}{L}\right)\exp\left(-\frac{iE_1 t}{\hbar}\right) + \sin\left(\frac{2\pi x}{L}\right)\exp\left(-\frac{iE_2 t}{\hbar}\right)\right).$$

Show that the probability current for this wave function is

$$j(x,t) = \frac{\hbar\pi}{mL^2}\left(\sin\left(\frac{2\pi x}{L}\right) cos\left(\frac{\pi x}{L}\right) - 2\sin\left(\frac{\pi x}{L}\right) cos\left(\frac{2\pi x}{L}\right)\right) sin\left(\frac{(E_2 - E_1)t}{\hbar}\right).$$

5) Which of the Challenges did you find most difficult and why? Explain how you solved this challenge. If none of the Challenges were difficult, choose the one you found most interesting and explain how you solved it.