For these questions, use the simulation "The Bohr model of the hydrogen atom" and work through the simulation, including the step-by-step exploration (click on the "Step-by-step Exploration" tab).

1) Assume the hydrogen atom electron is in a state with quantum number $n = 10$.
a) For this case, write down the radius of the Bohr orbit r_{10} in units of the Bohr radius a_0 and the total energy E_{10}.
b) Sketch the orbit. Show the de Broglie standing wave in your sketch. Indicate the wavelength of the standing wave in your sketch.
c) Calculate the wavelength of the standing wave in units of the Bohr radius a_0.

2) a) Using the simulation, determine qualitatively how the de Broglie wavelength changes with increasing quantum number n.

b) Confirm this result to part a) quantitatively by deriving a relation between the wavelength λ_n and the quantum number n. Start by determining the length of the orbit in terms of the quantum number n.

c) Using the de Broglie relation between wavelength and momentum, explain how this result relates to a classical (incorrect) model of an electron that orbits a proton in a circular orbit. No calculation is required.

3) Name successes of the Bohr model of the hydrogen atom, and some problems with the Bohr model that were then overcome by modern quantum theory.