J05Q.3 - Heavy Particle Passing a Hydrogen Atom

Problem

A heavy particle has a charge e and travels with velocity v on a straight trajectory with minimal distance D from the nucleus of a hydrogen atom (which you may assume to be fixed). Assume that initially the hydrogen atom is in its ground state. Moreover, $D \gg a$ (where a is the Bohr radius), and $v \gg D|E_0|/\hbar$ (with E_0 the ground state energy of the hydrogen atom). What is the probability that the electron in the hydrogen atom is in a $2p$ state after the passage of the heavy particle?