

37. If kinetic energy is not conserved, some of the neutron's initial kinetic energy is used to excite the hydrogen atom. The least energy that the hydrogen atom can accept is the difference between the first excited state ( $n = 2$ ) and the ground state ( $n = 1$ ). Since the energy of a state with principal quantum number  $n$  is  $-(13.6\text{ eV})/n^2$ , the smallest excitation energy is  $13.6\text{ eV} - (13.6\text{ eV})/(2)^2 = 10.2\text{ eV}$ . The neutron does not have sufficient kinetic energy to excite the hydrogen atom, so the hydrogen atom is left in its ground state and all the initial kinetic energy of the neutron ends up as the final kinetic energies of the neutron and atom. The collision must be elastic.