

## PHY114 S09 Problem Set 10

S. G. Rajeev

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1. Two protons, each having a speed of  $0.945c$  in the laboratory, are moving toward each other. Determine (a) the momentum of each proton in the laboratory; (b) the total momentum of the two protons as measured in the laboratory and (c) the momentum of one proton as seen by the other proton.
2. What is the wavelength of a neutron ( $m = 1.67 \times 10^{-27}$  kg) traveling at  $8.5 \times 10^4$  m/s?
3. Show that if an electron and a proton have the same nonrelativistic kinetic energy, the proton has the shorter wavelength.
4. An electron has a de Broglie wavelength  $\lambda = 6.0 \times 10^{-10}$  m. (a) What is its momentum? (b) What is its speed? (c) What voltage was needed to accelerate it to this speed?
5. An Excited hydrogen atom could, in principle, have a diameter of 0.10 m. What would be the value of  $n$  for a Bohr orbit of this size? What would its energy be?
6. Assume hydrogen atoms in a gas are initially all in their ground state. If free electrons with kinetic energy 12.75 eV collide with these atoms, what photon wavelengths will be emitted by the gas?
7. What fraction of a sample of  ${}^{68}_{32}\text{Ge}$ , whose half-life is about 9 months, will remain after 2.0 years?