

## Tutorial-7 “Physics-1, 15B11PH111” (Odd Semester 2021-22)

1. Two photons approach each other. What is their relative velocity?  
(Ans:  $c$ ) [CO1]
2. Two electrons beams travel along the same straight line but in opposite direction with velocities  $0.9c$  relative to the laboratory frame. Find the relative velocity of the electrons according to Newtonian mechanics. What will be the velocity measured by an observer moving with one of the electron beams?  
(Ans:  $1.8c, 0.994c$ ) [CO3]
3. Calculate the amount of work to be done to increase the speed of an electron from  $0.6c$  to  $0.8c$ . Given that rest energy of electron is  $0.511\text{ MeV}$ .  
(Ans:  $3.434 \times 10^{-14}\text{ Joule}$ ) [CO2]
4. Find the momentum (in  $\text{MeV}/c$ ) of an electron whose speed is  $0.600c$ . The rest mass energy of an electron is  $0.511\text{ MeV}$ . (Ans:  $0.383\text{ MeV}/c$ ) [CO2]
5. For a hydrogen atom determine the number of allowed states corresponding to the principle quantum number  $n = 2$ . Also calculate the energies of these states.  
(Ans: 4 states,  $-3.4015\text{ eV}$ ) [CO1]
6. Consider a Hydrogen atom in  $2^2P_{3/2}$  state. Find all possible orientation of  $L_z$ ,  $S_z$  and  $J_z$  vector in space, where  $L$ ,  $S$  and  $J$  are orbital, spin and total angular momentum vectors. (Ans: for  $L$ ,  $135^\circ, 90^\circ, 45^\circ$  for  $S$ ,  $44.7^\circ, 125.3^\circ$  for  $J$ ,  $140.77^\circ, 104.96^\circ, 75^\circ, 39.25^\circ$ ) [CO4]
7. The term symbol of the ground state of sodium is  $3^2S_{1/2}$  and that of its first excited state is  $3^2P_{1/2}$ . List the possible quantum numbers  $n, l, j, m_j$  of the electron in each case. Why is it impossible for  $2^2P_{5/2}$  and  $3^2D_{7/2}$  states to exist? [CO3]