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PHYSICS Tutorial - 7

Q.1. $U_{AB} = \frac{C+C}{1+\frac{C^2}{C^2}} = C$

$U_{BA} = \frac{-C-C}{1+\frac{C^2}{C^2}} = -C$ i.e., velocity of light remained same

Q.2. According to newtonium mechanics, velocity $= 0.9C + 0.9C$
$= 1.8C$

According to special theory of relativity $U = \frac{U'+V}{1+\frac{U'V}{C^2}}$

$U = 0.994\,C$

Q.3. The amount of work done will be changed in kinetic energy of e^- i.e. $W = K_2 - K_1$, here $K_1 + K_2$ are the kinetic energies of e^- with velocity $v_1 + v_2$ respectively.

$K_1 = m_0c^2\left(\left(1-\frac{v^2}{c^2}\right)^{-1/2}-1\right)$, $K_2 = m_0c^2\left(\left(1-\frac{v_1}{c^2}\right)^{-1/2}-1\right)$

$= 1.278\times10^5$ eV $K_2 = 3.423\times10^5$ eV

$W = K_2 - K_1 = 2.145\times10^5 eV = 3.434\times10^{-14}$ J

Q.4. Use relativistic formula of momentum.

$p = mv = \frac{m_0v}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{(E_0/c^2)\times0.6c}{\sqrt{1-(0.6)^2}} = 0.383\ \frac{MeV}{c}$

Q.5. $n=2$, $l=0,1$ for $L=0$, $m_L=0$ → state 2s (one state)
" $L=1$, $m_L=-1,0,1$ → 2p (Three state)

since all these 4 states (1+3) have corresponding to $n=2$ & all have same energy i.e. $E_2 = \frac{-13.606}{n^2}$

$E_2 = -3.4015$ eV

Q.6. $2^2P_{3/2}$, $L=1$, $2S+1 = 2 \rightarrow S = 1/2$ & $J = 3$

$L = \sqrt{l(l+1)}$ & $L_z = L\cos\theta = m_l$, $m_l = -1, 0, +1$

$\cos\theta = \frac{m_l}{\sqrt{l(l+1)}} \Rightarrow \theta = 135°, 90°, 45°$

$S = \sqrt{s(s+1)}$ & $S_z = S\cos\theta = m_s$, $m_s = -1/2, +1/2$

$\cos\theta = \frac{m_s}{\sqrt{s(s+1)}} \Rightarrow \theta = 44.7°, 125.26°$

$J = \sqrt{J(J+1)}$, $J_z = J\cos\theta = m_j$; $m_j = m_l + m_s$

$= -3/2, -1/2, 1/2, 3/2$

$\cos\theta = \frac{m_j}{\sqrt{j(j+1)}} \Rightarrow \theta = 140.77°, 104.96°, 75°, 39.25°$

Q.7. $3^2S_{1/2} \Rightarrow n = 3, l = 0, j = 1/2, m_j = \pm 1/2$

$3^2P_{1/2} \Rightarrow n = 3, l = 1, j = 3/2, m_j = \pm 1/2, \pm 3/2$

$n = 3, l = 1, j = 1/2, m_j = \pm 1/2$

for P state $l = 1$, $j = 5/2$ is not possible.

for D state $l = 2$, $j = 7/2$ is not possible.