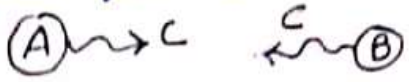
Solution Tutorial 7 Physics-I

(1) $U_{AB} = \frac{C+C}{1+\frac{C^2}{C^2}} = C$



$U_{BA} = \frac{-C-C}{1+\frac{C^2}{C^2}} = -C$ ie Velocity of light remains same.

(2) According to Newtonian mechanics, Velocity $= 0.9c + 0.9c = 1.8c$

But according to special theory of relativity

$U = \frac{U'+V}{1+\frac{U'V}{c^2}} = 0.994c$

(3) The amount of work done will be change in kinetic energy of e^-. ie $W = K_2 - K_1$, here $K_1 \& K_2$ are the kinetic energies of e^- with velocity $v_1 \& v_2$ respectively.

Here $K_1 = m_0c^2\left[\left(1-\frac{v_1^2}{c^2}\right)^{-1/2}-1\right]$ & $K_2 = m_0c^2\left[\left(1-\frac{v_2^2}{c^2}\right)^{-1/2}-1\right]$

$= 1.278 \times 10^5$ eV & $= 3.423 \times 10^5$ eV

So $W = K_2 - K_1 = 2.146 \times 10^5$ eV $= 3.434 \times 10^{-14}$ Joules

(4) Use relativistic formula of momentum

$p = mv = \frac{m_0 v}{\sqrt{1-v^2/c^2}} = \frac{(E_0/c^2)\times(0.6c)}{\sqrt{1-(0.6)^2}} = 0.383 \frac{MeV}{c}$

(5) $n=2$, $l = 0, 1$ for $l=0$, $m_l = 0 \rightarrow$ state 2S (one state)
$l=1$, $m_l = -1, 0, 1 \rightarrow$ state 2P (three state) } 4 states

Since all these (4) states have corresponding to $n=2$ so all have same energy ie $E_2 = \frac{-13.606}{n^2} = -3.4015$ eV

(6) For $2^2P_{3/2}$, $L=1$, $2S+1 = 2 \Rightarrow S = 1/2$ & $j = 3/2$

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

ie $\theta = 135°, 90°, 45°$

$S = \sqrt{S(S+1)}\hbar$ & $S_z = S\cos\theta = m_S\hbar$ & $m_S = -1/2, +1/2$, $\cos\theta = \frac{m_S}{\sqrt{S(S+1)}}$

ie $\theta = 44.7, 125.26°$

$J = \sqrt{j(j+1)}$, $J_z = J\cos\theta \rightarrow m_j = m_l \pm m_S = -3/2, -1/2, 1/2, 3/2$

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

(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 $l=1$, $j = l \pm 1/2 = 3/2$ or $1/2$
$\Rightarrow j = 5/2$ is not possible

For D state $l=2$
$j = \frac{5}{2}$ or $\frac{3}{2}$
$\Rightarrow j = \frac{7}{2}$ is also not possible