PHYS 321 TEST1

<1.1>

a. 1900, Plank suggest that “energy is radiated and absorbed in quantities divisible by discrete energy element” when he tried to solve “black body radiation” problem introduced by Kirchhoff 1859

b. 1905, Einstein postulated that light itself consist of individual quanta and explained photoelectric effect (1839)

c. Compton effect

<1.2>

a. $t = \frac{26.4 year \cdot c}{0.99c} = 26.67 year$

b. $\gamma = \frac{1}{\sqrt{1-(0.99)^2}} = 7.09$

$$t' = \frac{t}{\gamma} = 3.76 year$$

<1.3>

No.

$E = \gamma mc^2$, $p = \gamma mv$, where $\gamma \to \infty$ as $v \to c$.

<1.4>

a. $E_m = E_1 + E_2$, $\overrightarrow{p_m} = \overrightarrow{p_1} + \overrightarrow{p_2}$

$$\Rightarrow \quad E_m = (m_1^2c^4 + p_1c^2)^{\frac{1}{2}} + (m_2^2c^4 + p_2c^2)^{\frac{1}{2}} ,$$

$$\overrightarrow{p_m} = p_1\hat{j} + p_2\hat{i}$$

Then $E_m^2 = m^2c^4 + |p_m|^2 c^2$

$$[(0.25+4)^{\frac{1}{2}} + (1+2.25)^{\frac{1}{2}}]^2 = 3.86^2 = m^2c^4 + 6.25$$

M=2.94Gev/ c^2

b. $v = \frac{pc^2}{E} = \frac{2.5}{3.86} = 0.65$ c

<2>

a. $W = \hbar\omega = \frac{\hbar 2\pi c}{\lambda}$

$$\lambda = \frac{\hbar 2\pi c}{W} = 652nm$$

b. $K = \hbar\omega - W = \frac{\hbar 2\pi c}{\lambda} - W = 2.48 - 1.9 = 0.58$ eV

<3>

$\Delta p = m\Delta v = m \times 43 \times 5\%$,

also, $\Delta p \Delta x \geq \frac{\hbar}{2}$

so , $\Delta x \geq \frac{\hbar}{2 \times 43 \times 5\% \times m}$

$\Delta x_{baseball} \geq \frac{\hbar}{2 \times 43 \times 5\% \times 0.15} = 1.64 \times 10^{-34} m$

$\Delta x_{electron} \geq \frac{\hbar}{2 \times 43 \times 5\% \times 9.1 \times 10^{-31}} = 2.6 \times 10^{-5} m$

<4>

a. $\hbar\omega = \hbar 2\pi f = \Delta E = E_3 - E_1 = hcR(\frac{1}{1} - \frac{1}{9}) = 13.6eV \times \frac{8}{9} = 12.09eV$

$f = \frac{12.09eV}{2\pi\hbar} = 3.1 \times 10^{15} Hz$

b. upper limit = $hcR(\frac{1}{1} - \frac{1}{\infty}) = 13.6eV$

lower limit = $hcR(\frac{1}{\infty} - \frac{1}{\infty}) = 0$