SM 355 TMA01

1) a) The angular momentum of the electron is quantized in units of $h/2\pi$ ie $L_n = n\hbar$, where $\hbar = h/2\pi$. Put $n=1$ (the ground state), then $L = \hbar$ as stated

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b) $KE = \frac{m_e c^2}{\sqrt{1-v^2/c^2}} - m_e c^2$

ie total energy − rest mass energy

If KE = rest mass energy

$$m_e c^2 = \frac{m_e c^2}{\sqrt{1-v^2/c^2}} - m_e c^2$$

$$2 = \frac{1}{\sqrt{1-v^2/c^2}}$$

$$\sqrt{1-v^2/c^2} = \frac{1}{2}$$

$$1 - \frac{v^2}{c^2} = \frac{1}{4}$$

$$\frac{v^2}{c^2} = \frac{3}{4} \Rightarrow v = \frac{c\sqrt{3}}{2}$$

$$\lambda_{DB} = \frac{h}{p} = \frac{h}{m_e v/\sqrt{1-v^2/c^2}} = \frac{h\sqrt{1-v^2/c^2}}{m_e v}$$

$$= \frac{h\sqrt{1-3/4}}{m_e c\sqrt{3}/2} = \frac{h/2}{m_e c} \times \frac{2}{\sqrt{3}} = \frac{h}{m_e c\sqrt{3}}$$

but $\lambda_c = \frac{h}{m_e c}$

$$\lambda_{DB} = \frac{h}{m_e c} > \frac{1}{\sqrt{3}} = \frac{\lambda_c}{\sqrt{3}}$$

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so the statement on the paper is wrong

c) No this statement is wrong. The Frank Hertz experiment involves electrons being accelerated through a voltage which is adjustable. As the voltage is increased for certain voltages, the current drops dramatically. The reason is that the kinetic energy of the electrons produced by the accelerating voltage matches with the difference between energy