Name KEY Student Number

Last First MI

Written Response. Show your work and/or explain your reasoning for full credit.

II. *Relativity* [26 pts]: A particle of mass m is moving at very high speeds relative to you, the observer.

A) Explain, using the equations for relativistic energy and momentum, why it is not possible for an object with mass to reach the speed of light.

$E = \frac{mc^2}{\sqrt{1-\frac{v^2}{c^2}}}$ as $v \to c$ $E \to \infty$

$p \to \infty$

IMPOSSIBLE TO SUPPLY ENOUGH ENERGY

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

B) Find the ratio of the relativistic to non-relativistic ~~energy~~ momentum of an object moving at $v=0.98c$. (Hint: little info is given because little is needed)

$p_{CLASS} = mv$

$p_{rel} = \frac{mv}{\sqrt{1-\frac{v^2}{c^2}}}$

$\frac{p_{CLASS}}{p_{rel}} = \sqrt{1-\frac{v^2}{c^2}} = \sqrt{1-(0.98)^2}$

$\frac{p_{CLASS}}{p_{rel}} = \frac{1}{5}$

C) You see the mass move a distance of 10^6 meters. What is the time it takes according to the mass m, that is, its proper time?

$\Delta t = \frac{d}{v} = \frac{10^6}{0.98(3\times10^8)}$

$\Delta t_0 = \Delta t \sqrt{1-\frac{v^2}{c^2}}$

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

$\Delta t_0 = \frac{10^6\sqrt{1-(0.98)^2}}{0.98(3\times10^8)}$

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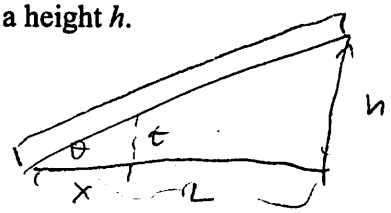
III. *Interference.* [26 pts] Two glass plates of length L are touching on one end, and on the other they are separated by a height h.



A) Write an expression for the thickness of the air between the plates, t, as a function of the distance x from the edge that is touching. Draw a picture above, clearly label your variables.

$t = mx + b$ y-int

$t = \frac{h}{L}x + 0$

$t = \frac{h}{L}x$

SIMILAR TRIANGLES

$\frac{t}{x} = \frac{h}{L} = \tan\theta$

$t = \frac{h}{L}x$

B) Explain why the edge where the two glass plates are touching would have destructive interference.

PHASE CHANGE OF π FROM REFLECTIONS, NO PHASE DIFFERENCE, SO DESTRUCTIVE

C) Using the formula from A), find the distance x to the first destructive fringe. That is, the first from the edge, not the edge itself.

USE:

$t = \frac{h}{L}x$

$2t = m\lambda \quad m = 1$

$2t = \lambda$

$t = \frac{\lambda}{2}$

$\frac{\lambda}{2} = \frac{h}{L}x$

$\boxed{x = \frac{\lambda L}{2h}}$