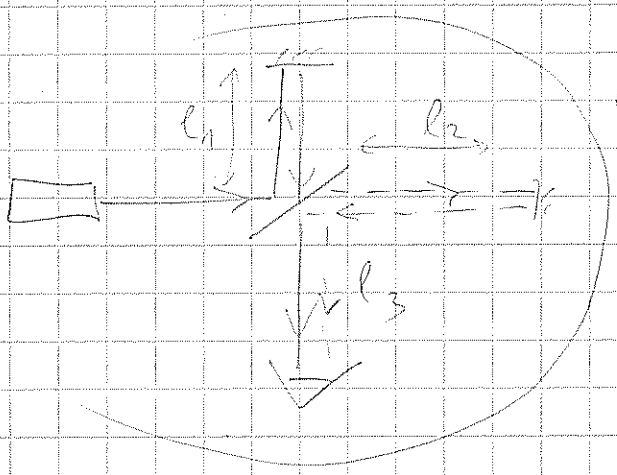
Answer of two questions, 1 & 2

Qu 1:



ASSUME:

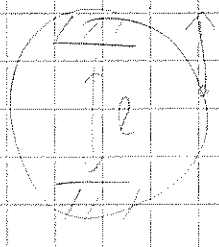
(a) moves w/ $\vec{v}$ wrt aether

(b) light moves w/ c wrt aether

- light ray 1 & 2 will spend different times (if $l_1 \neq l_2$, even if light same speed in all dirn's)
- l_3 doesn't matter (both rays travel l_3 @ same speed (orthog. same direction), so cancels out in $\Delta t = t_1 - t_2$ ($\Delta\phi = \omega \Delta t$) ↑ interference

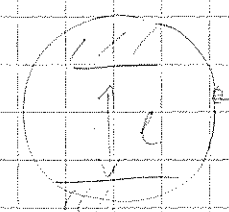
two cases 1st:

(A)



$$\Delta t_A = \frac{l}{c-v} + \frac{l}{c+v} = \frac{2lc}{c^2-v^2} \approx \frac{2l}{c}\left(1 + \frac{v^2}{c^2}\right)$$

(B) a bit trickier -- easier in rest frame of aether



$\sqrt{l^2 + v^2\Delta t^2}$

$v\Delta t$

l

light travels this

so $\Delta t_B = \frac{2}{c} \times \sqrt{l^2 + v^2 \left(\frac{\Delta t_B}{2}\right)^2}$

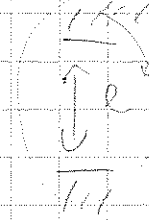
$$\Delta t_B = \frac{2l}{c} \sqrt{1 + \frac{v^2 \Delta t_B^2}{4l^2}}$$

$$\frac{c^2 \cancel{4}}{\cancel{4} l^2} \Delta t_B^2 = 1 + \frac{v^2}{4l^2} \Delta t_B^2$$

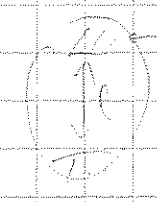
$$(\Delta t_B)^2 \left(\frac{c}{2l}\right)^2 \left[1 - \frac{v^2}{c^2}\right] = 1$$

$$\Delta t_B = \frac{2l}{c} \sqrt{1 - \frac{v^2}{c^2}}$$

$$\Delta t_B \approx \frac{2l}{c} \left(1 - \frac{v^2}{2c^2}\right)$$

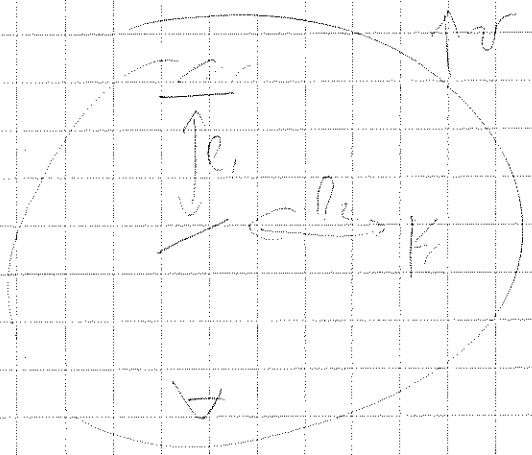


$$\Delta t_A \approx \frac{2l}{c} \left(1 + \frac{v^2}{c^2}\right)$$



$$\Delta t_B \approx \frac{2l}{c} \left(1 - \frac{v^2}{2c^2}\right)$$

Back to Michelson

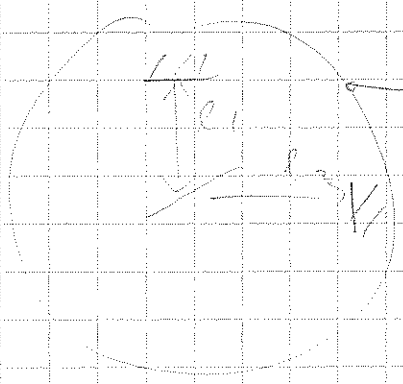


$$\Delta t = \Delta t_1 - \Delta t_2$$

A w/ l_1, B w/ l_2

$$= \frac{2l_1}{c}\left(1+\frac{v^2}{c^2}\right) - \frac{2l_2}{c}\left(1+\frac{v^2}{2c^2}\right)$$

$$\boxed{\Delta t = \frac{2(l_1-l_2)}{c} + \frac{2l_1+l_2}{c}\frac{v^2}{c^2}}$$



$$\Delta t = \Delta t_1 - \Delta t_2$$

B w/ l_1, A w/ l_2

$$= \frac{2l_1}{c}\left(1-\frac{v^2}{2c^2}\right) - \frac{2l_2}{c}\left(1+\frac{v^2}{c^2}\right)$$

$$\boxed{\Delta t = \frac{2(l_1-l_2)}{c} - \frac{l_1+2l_2}{c}\frac{v^2}{c^2}}$$

even if $l_1 = l_2$ $\quad \Delta t = \begin{cases} +\frac{3l}{c}\frac{v^2}{c^2} \\ -\frac{3l}{c}\frac{v^2}{c^2} \end{cases}$ if turn at 90° w/ each other.

if 180° - no matter