Video Lecture #1 – The Introduction to the Modern Physics Lecture (No Lecture notes)

Video Lecture #2 – What is Light? An explanation of The Michelson Morely Experiment: The Search for The Aether

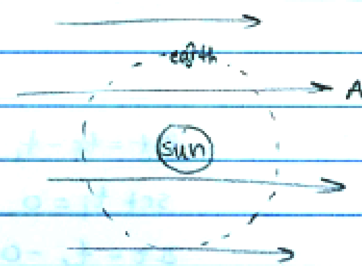
Thank You, Stephanie Hong, for these notes.

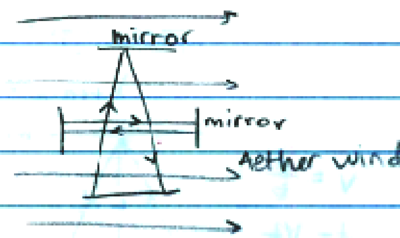
What is light?
- particle or wave

Aether: medium for light

1801: Thomas Young's Double Slit Experiment
↳ proved light is a wave

1887: Michelson-Morely Interferometer





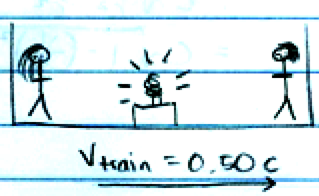
↳ proved that there is no aether
↳ proved $c = 3.00 \times 10^8 \frac{m}{s}$ no matter who measures it

Light is EM waves
- Alternating E & B fields
- the only known self-propagating wave.

Video Lecture #3 – Introduction to the Relativity of Simultaneity

train car

The Relativity of Simultaneity

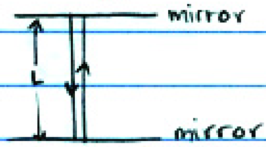


1905: Albert Einstein

- special theory of relativity

Time Dilation

- Light clock



$d = 2L$

$v = \frac{d}{t} = \frac{2L}{t}$

$t = \frac{2L}{v}$

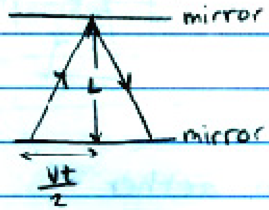
$t_0 = \frac{2L}{c}$

- t_0 : proper time: time measured w/ a single clock @ rest in the frame in which the events take place.
- put light clock on train

$V_{train} = V$ (to the right)

$v = \frac{d}{t}$

$d = vt$



$d = 2H \Rightarrow H = ?$

$a^2 + b^2 = c^2$

$\left(\frac{vt}{2}\right)^2 + L^2 = H^2$

$H = \sqrt{\left(\frac{vt}{2}\right)^2 + L^2}$

$\Delta t = t_f - t_i$

set $t_i = 0$

$\Delta t = t_f - 0$

$\Delta t = t_f = t$

$d = 2H = 2\sqrt{\left(\frac{vt}{2}\right)^2 + L^2}$

$V = \frac{d}{t} \Rightarrow t = \frac{d}{v} = \frac{2\sqrt{\left(\frac{vt}{2}\right)^2 + L^2}}{c}$

$t = \frac{2}{c}\sqrt{\left(\frac{vt}{2}\right)^2 + L^2}$

$t^2 = \frac{4}{c^2}\left(\left(\frac{vt}{2}\right)^2 + L^2\right)$

$t^2 c^2 = 4\left(\frac{v^2 t^2}{4} + L^2\right)$

$t^2 c^2 = v^2 t^2 + 4L^2$

$t^2 c^2 - v^2 t^2 = 4L^2$

$t^2 (c^2 - v^2) = 4L^2$

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

$t = \frac{2L}{[\sqrt{c^2 - v^2}]}$ → $\sqrt{c^2 - v^2} = \frac{c}{c}\sqrt{c^2 - v^2}$

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

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

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

$t = \frac{2L}{c\sqrt{1 - \left(\frac{v}{c}\right)^2}}$

$t = \frac{1}{\sqrt{1 - \left(\frac{v}{c}\right)^2}}\left(\frac{2L}{c}\right)$

$\boxed{t = \gamma t_0}$

$\boxed{\gamma = \frac{1}{\sqrt{1 - \left(\frac{v}{c}\right)^2}}}$

Video Lecture #5 – A Twin Paradox Example - A Time Dilation Problem

Twin Paradox

- twin on ship
- $V_{ship} = 0.95c$

ship time

- 10.0 years away earth
- 10.0 years back to earth

↳ how old are each of you?

- A: twin = 20.0 y.o.

$$\gamma = \frac{1}{\sqrt{1-(\frac{v}{c})^2}} = \frac{1}{\sqrt{1-(\frac{0.95c}{c})^2}} = \frac{1}{\sqrt{1-0.95^2}} = 3.20256$$

$$t = \gamma t_0 = (3.20256)(20.0) = 64.0512 \text{ y.o.} = \text{you}$$

Video Lecture #6 – A Discussion of the Consequences of The Special Theory of Relativity

Length contraction

↳ $L = \frac{L_0}{\gamma}$

↳ $E_0 = mc^2 \Rightarrow$ rest energy

↳ $E = \gamma E_0$

Limits $v \Rightarrow c$

- when $v = c$, $\gamma = \frac{1}{0}$

$$\gamma = \frac{1}{\sqrt{1-(\frac{v}{c})^2}}$$

- when $v \Rightarrow c$ (a little smaller), $\gamma \Rightarrow \infty$
- c is the universal speed limit.

Video Lecture #7 – A Discussion of the Consequences of The Special Theory of Relativity

Length contraction

↳ $L = \frac{L_0}{\gamma}$

↳ $E_0 = mc^2$ ⇒ rest energy

↳ $E = \gamma E_0$

Limits $v \Rightarrow c$

- when $v = c$, $\gamma = \frac{1}{0}$

  $\gamma = \frac{1}{\sqrt{1-(\frac{v}{c})^2}}$

- when $v \Rightarrow c$ (a little smaller), $\gamma \Rightarrow \infty$
- c is the universal speed limit.

Video Lecture #7 – A Discussion of Black Holes, How to Find Them and Spaghettification (no lecture notes)

Video Lecture #8 – A Discussion of our Galaxy, The Universe and How Insignificant We Are (no lecture notes)