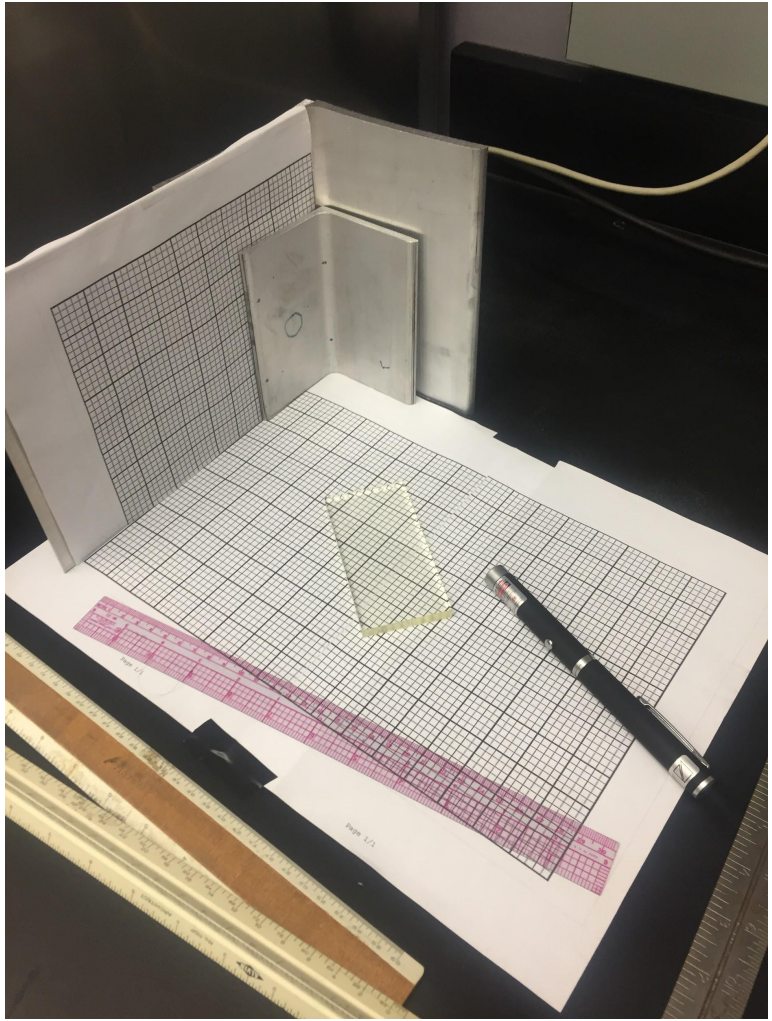
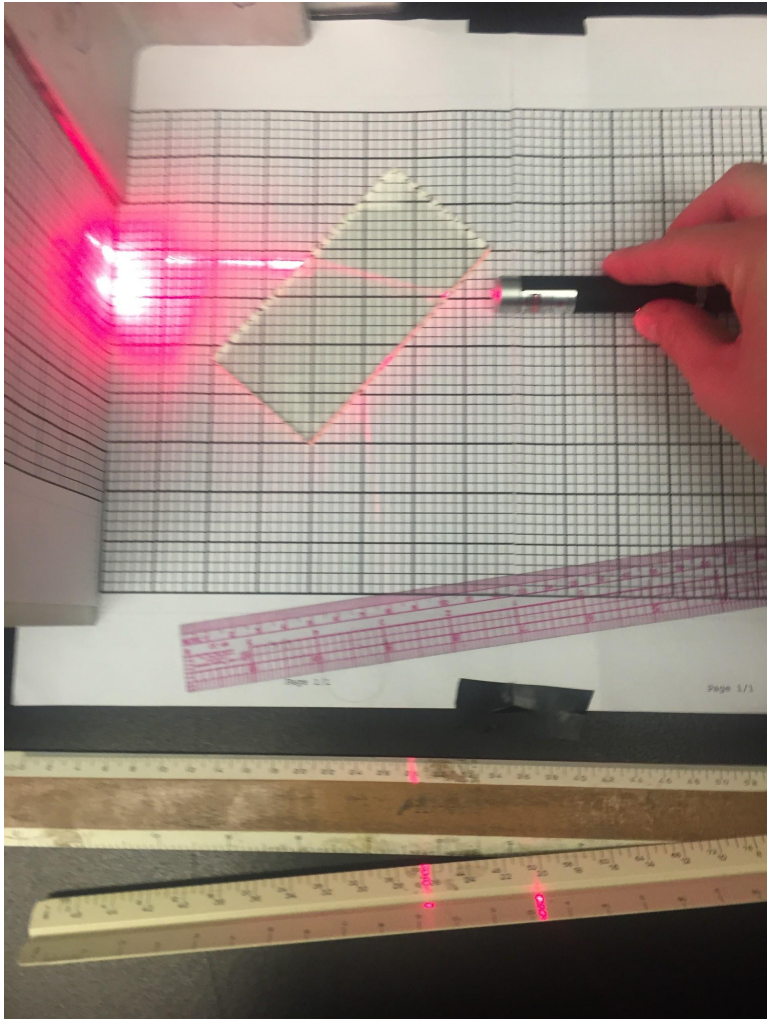
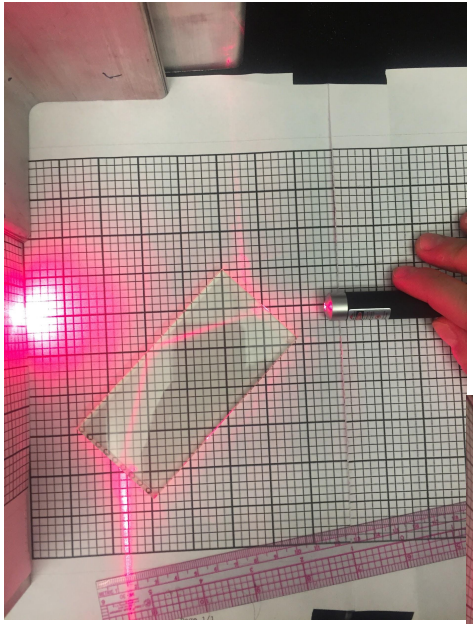
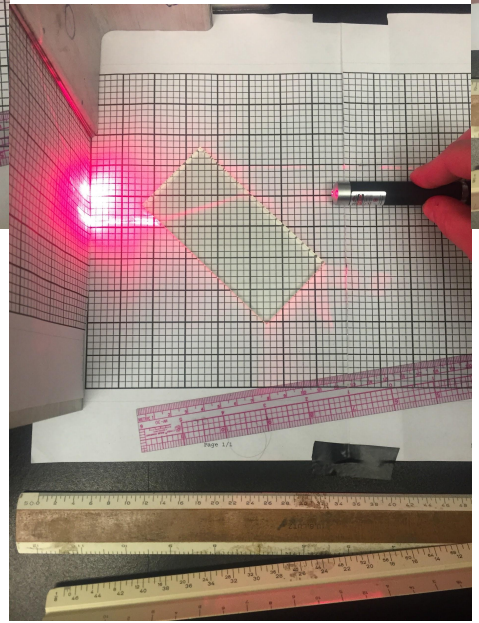
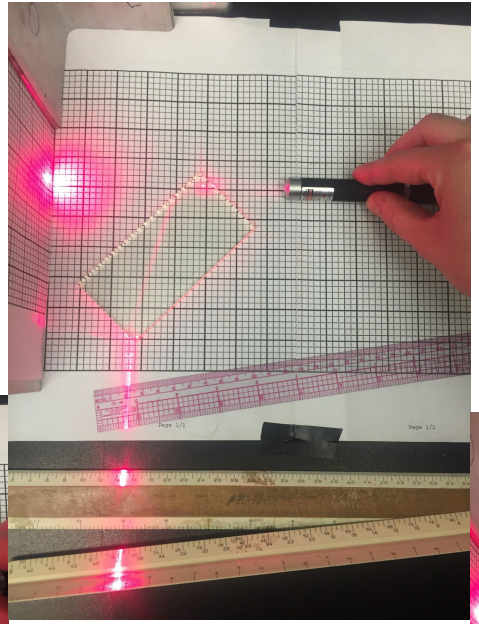
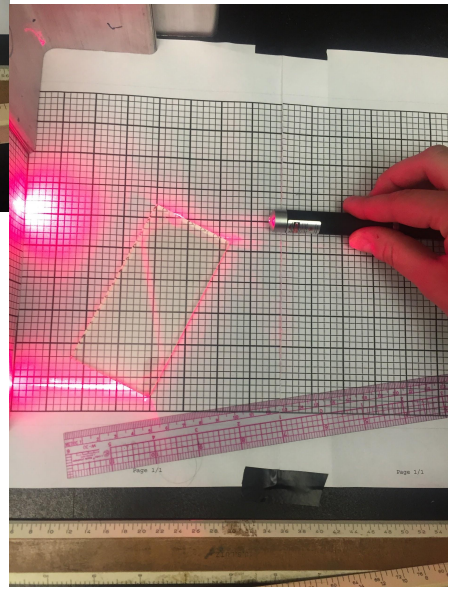




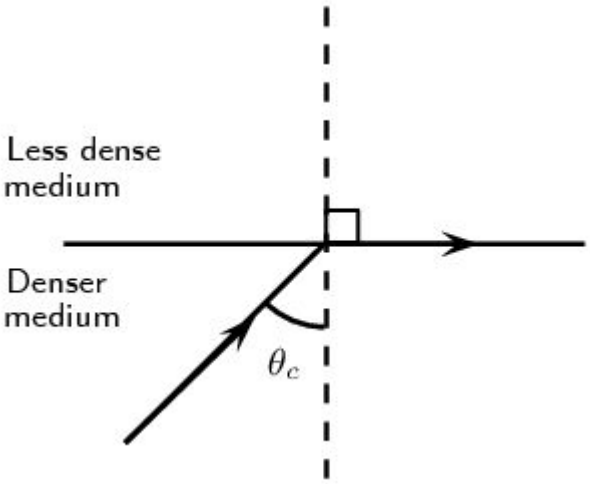


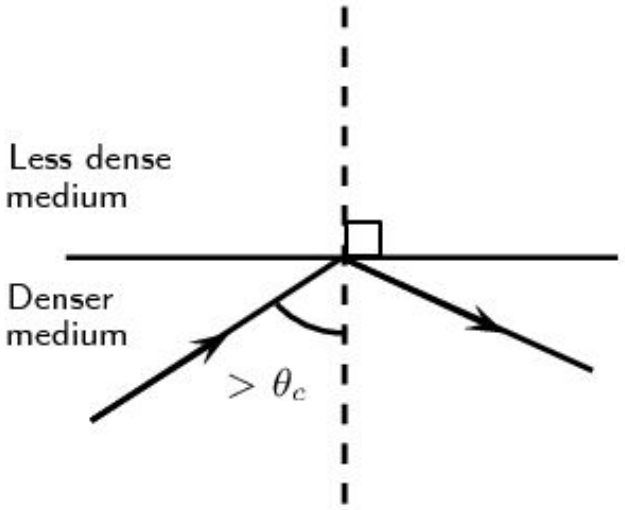






The Critical Angle



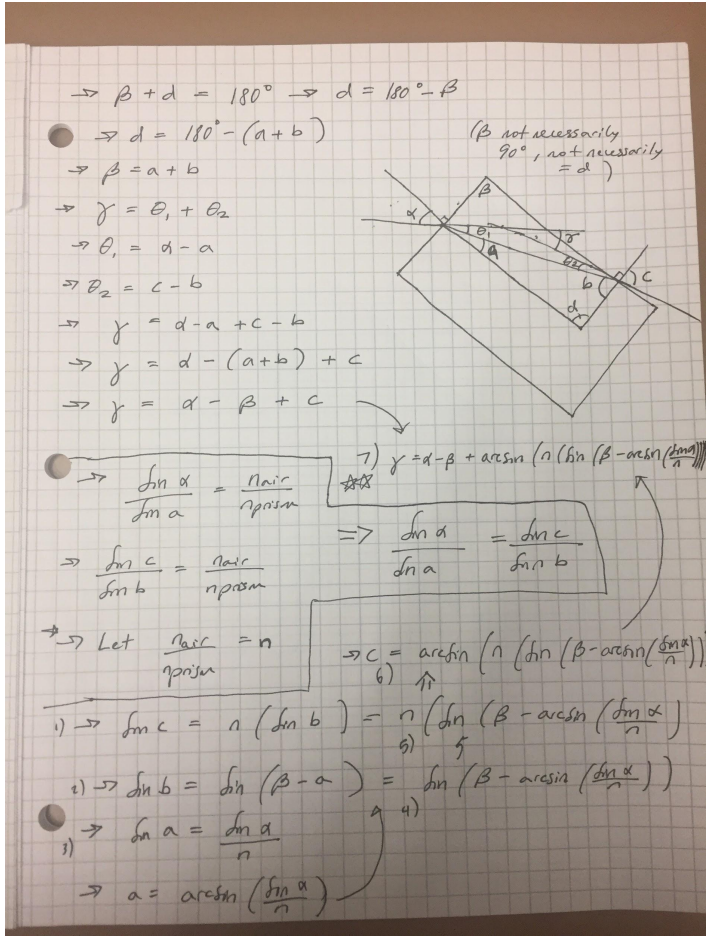


https://www.siyavula.com/read/science/grade-11/geometrical-optics/05-geometrical-optics-07

Index of Refraction (1)

$\gamma = \alpha - \beta + \arcsin(n(\sin(\beta - \arcsin((\sin\alpha)/n))))$

$n = \sqrt{(\sin^2\alpha + \sin^2(\gamma + \alpha))}$



$\rightarrow \alpha = \gamma + c$

$\rightarrow \gamma = \alpha - c$

$\rightarrow \alpha - c + b = \gamma$

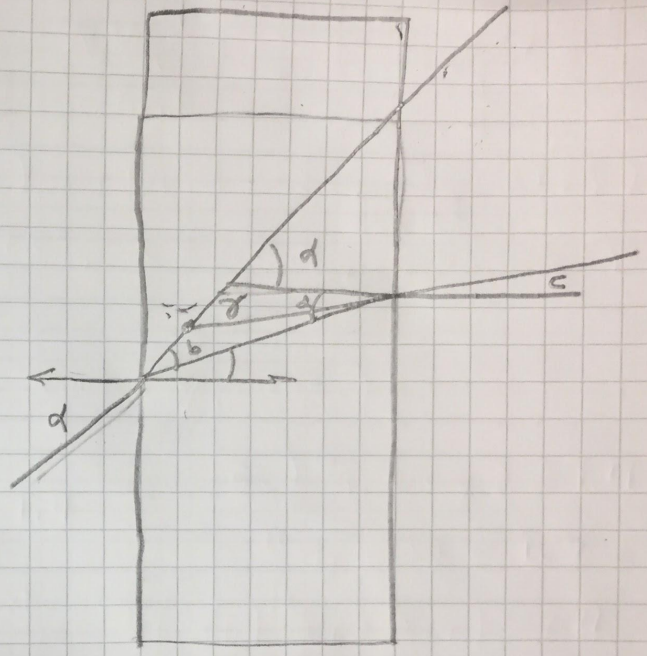
$\rightarrow \gamma = \alpha + b - c$

$\rightarrow \alpha = b + \alpha$

$\rightarrow \dfrac{\sin \alpha}{\sin(\alpha - b)} = n = \dfrac{\sin c}{\sin \alpha}$

$\rightarrow \dfrac{\sin \alpha}{\sin c} = \dfrac{\sin(\alpha - b)}{\sin \alpha} = \dfrac{\sin(b + \alpha - b)}{\sin \alpha} = 1$

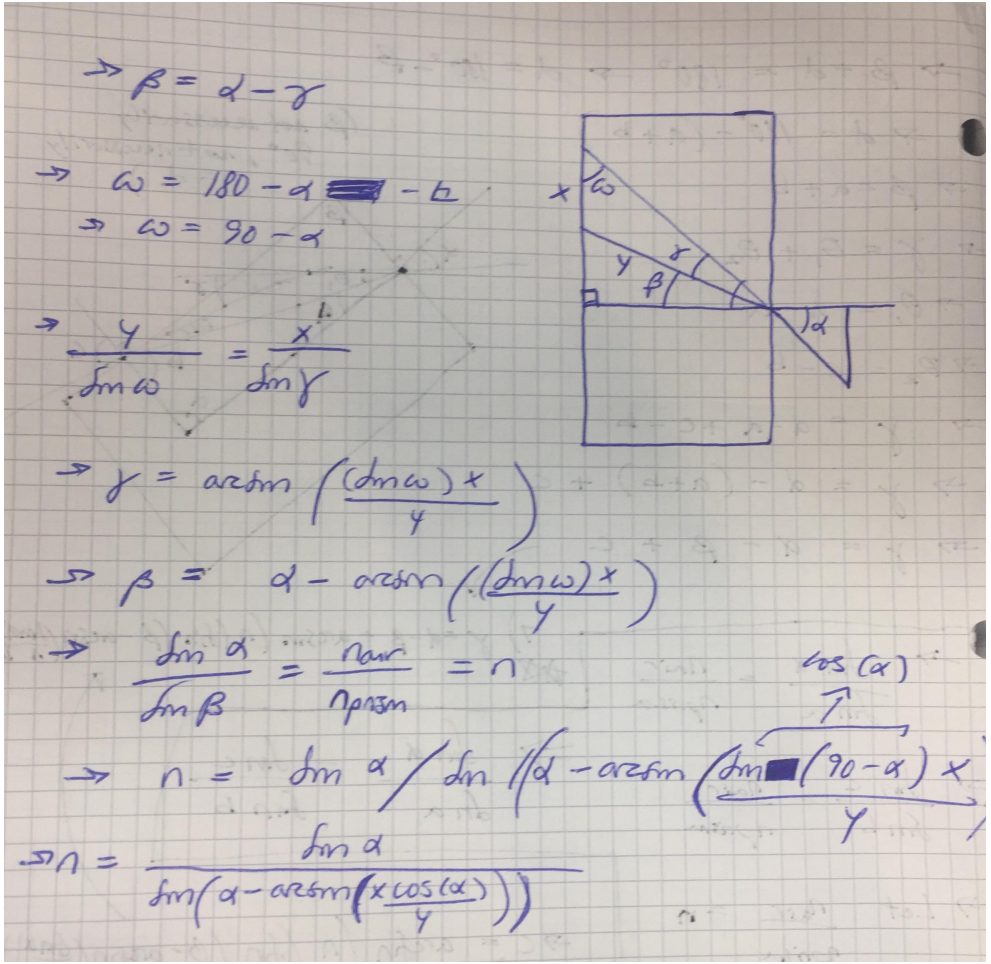
$\rightarrow \alpha = c \quad \because \gamma = 0$



The index cannot be calculated using the first equation when the laser is shone through the body of the prism rather than across the angle

Index of Refraction (2)

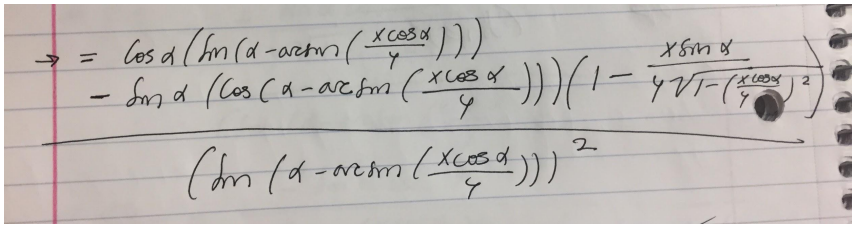
- n = (sin α)/(sin(α - arcsin(x(cosα)/y)))
- n = (sinα)/(sinβ)

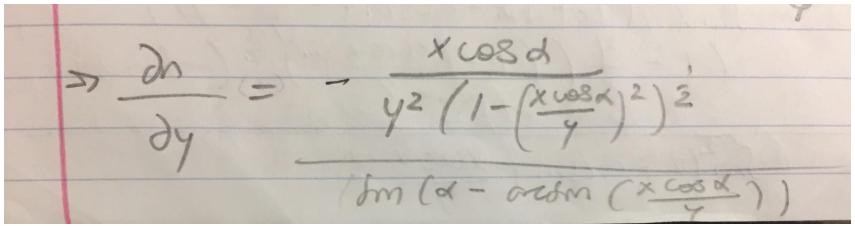


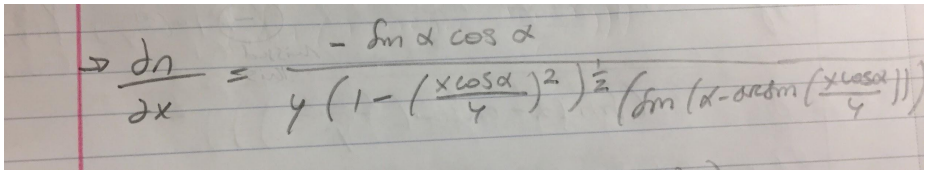
Measurements and Equations (2)

https://docs.google.com/spreadsheets/d/1Txx-vV3wgf3GK_qlBFUmlLhNHIcuCy1psQFxUU7tCow/edit#gid=1868993415

- $n = (\sin\alpha)/(\sin(\alpha - \arcsin(x(\cos\alpha)/y))$
- $n = (\sin\alpha)/(\sin\beta)$
- $\delta n(\alpha,x,y) = \sqrt{((\partial n/\partial\alpha)\delta\alpha)^2 + ((\partial n/\partial x)\delta x)^2 + ((\partial n/\partial y)\delta y)^2}$
- $\partial n/\partial\alpha =$



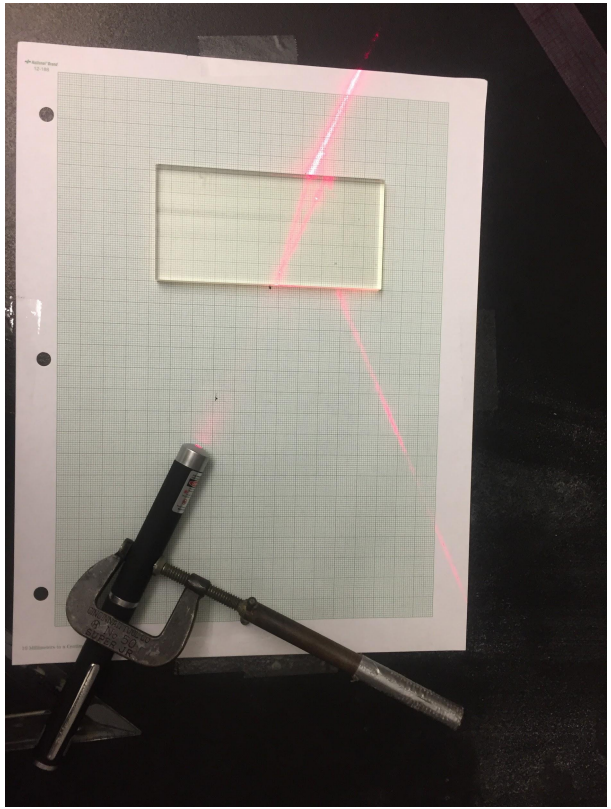


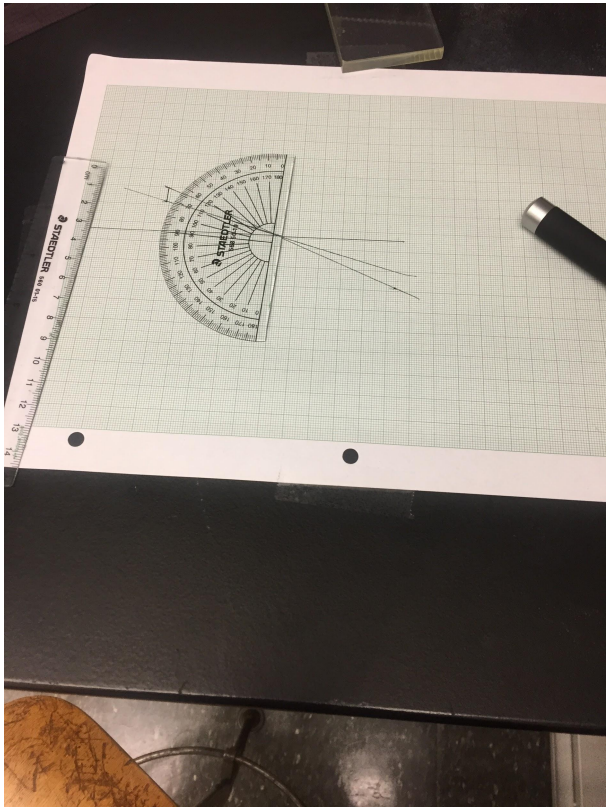


Original Measurement Approach

- Measuring while the laser was on
- Using original graph paper as reference
- Taking whole laser width as systematic error with additional random error
- Taking each measurement of 4 values as a set
- Problems:
  - Beam lifted up and put down to be able to see angles - eventually propped it up instead
  - Laser wouldn’t stay on
  - Prism and laser easily inadvertently moved
  - Protractor placed on top of prism - additional error from perspective
  - Small protractor, beam covers multiple degrees
  - Beam refracted through transparent ruler and protractor
  - Estimated error of +/- .2 for n

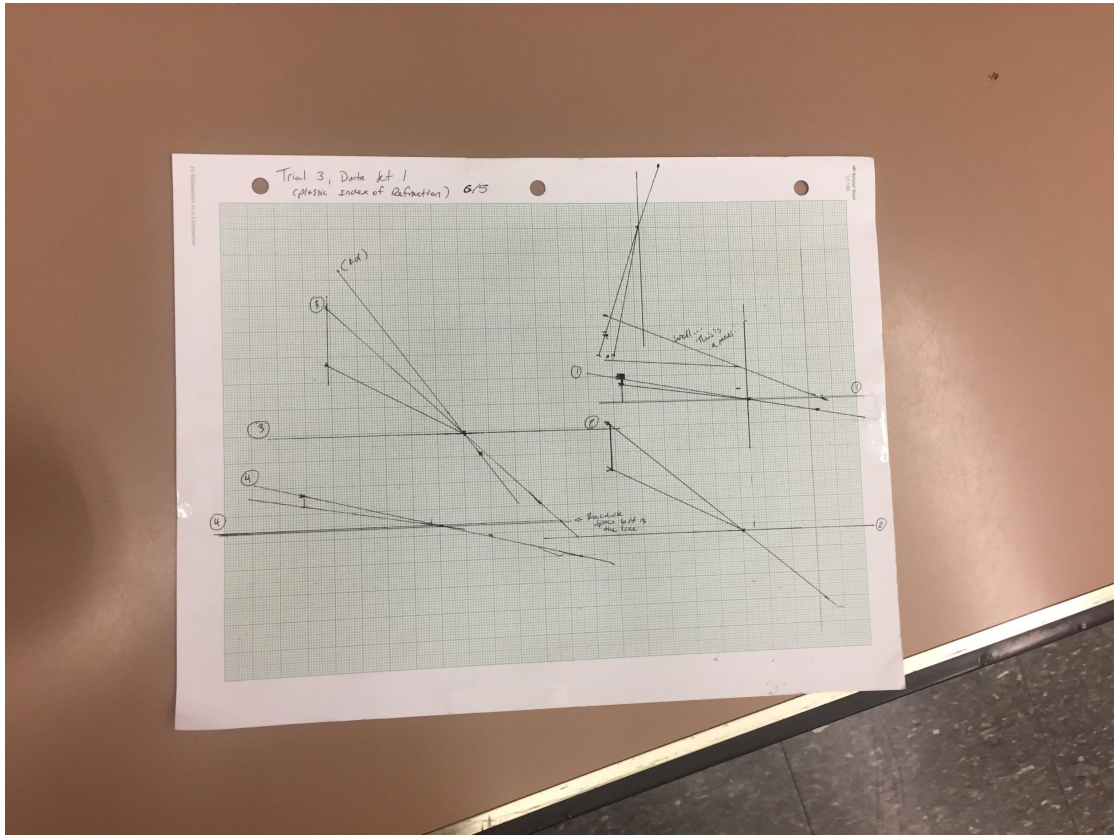
New Approach





New Approach

- Marking the location of the beam and measuring afterwards
- Using more precise graph paper
- Estimating the position of the edge of the laser beam (set 1) and then the center of the laser beam (set 2) as the point of measurement
- Taking each measured value independently
- Problems:
  - Protractor
  - Lines and points contribute to possible systematic error
  - Still error of .06+ for n
  - Data doesn't agree -> error underestimated



New Approach

https://docs.google.com/spreadsheets/d/1Txx-vV3wgf3GK_qlBFUmlLhNHIcuCy1psQFxUU7tCow/edit#gid=1346628582