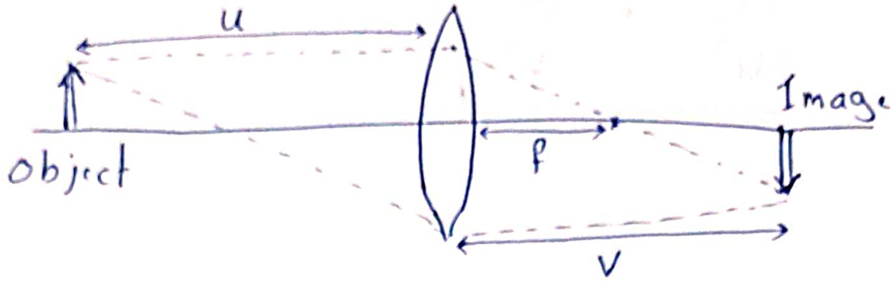
Exp 5: Focal Length of a Convex Lens



$$\frac{1}{f} = \frac{1}{u} + \frac{1}{V}$$

$$\Rightarrow \boxed{\frac{1}{V} = -\frac{1}{u} + \frac{1}{f}}$$

f: (focal length)
If the object is placed at infinity ($u = \infty$) $\Rightarrow$ the image will be formed at f ($V = f$)

$y = m x + b$: معادلة الخط المستقيم

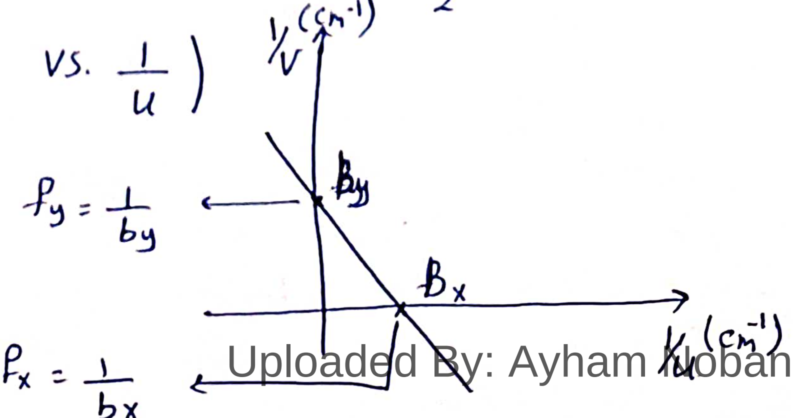
$\rightarrow y = \frac{1}{V}$, $x = \frac{1}{u}$ $\Rightarrow$ $m = -1$, $b = \frac{1}{f}$

Let $\frac{1}{u} = 0$ $\Rightarrow$ $b_y = \frac{1}{f_y}$ (y_{-int} (القطع الصادي))

Let $\frac{1}{V} = 0$ $\Rightarrow$ $b_x = \frac{1}{f_x}$ (X_{-int} : القطع السيني)

$\Rightarrow$ Theoretically $f_y = f_x$, Experimentally f_y may differ from f_x because of errors $\Rightarrow$ $f = \frac{f_x + f_y}{2}$

plot y vs. x ($\frac{1}{V}$ vs. $\frac{1}{u}$)



* To find the uncertainty:

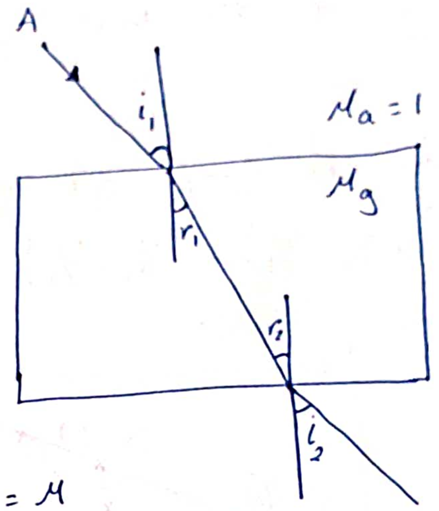
$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

$$\boxed{\frac{\Delta f}{f^2} = \frac{\Delta u}{u^2} + \frac{\Delta v}{v^2}}$$

Exp: 6 Index of Refraction (معامل انكسار الضوء)

Index of refraction (μ) $= \dfrac{\text{speed of light in vacuum}}{\text{speed of light in medium}} = \dfrac{c}{v}$

* The refractive index is a measure of how much bending will occur for the light.



Snell's law:

$\mu_a \sin(i) = \mu_g \sin(r)$

$\rightarrow \boxed{\sin(i) = \mu \sin(r)}$

$y = m x + b \rightarrow m = \mu$

$b = 0$

To find $\Delta\mu$:

$$\mu = \frac{\sin(i)}{\sin(r)}$$

$$\Delta\mu = \left|\frac{\partial \mu}{\partial i}\right| \Delta i + \left|\frac{\partial \mu}{\partial r}\right| \Delta r$$

$$= \frac{\cos(i)}{\sin(r)} \Delta i + \left|- \frac{\sin(i)\cos(r)}{\sin^2(r)}\right| \Delta r$$

$\Delta i, \Delta r$: in rad

$$\boxed{\theta^\circ \left(\frac{\pi}{180}\right) = \theta \text{ rad}}$$

* Method of Least square:

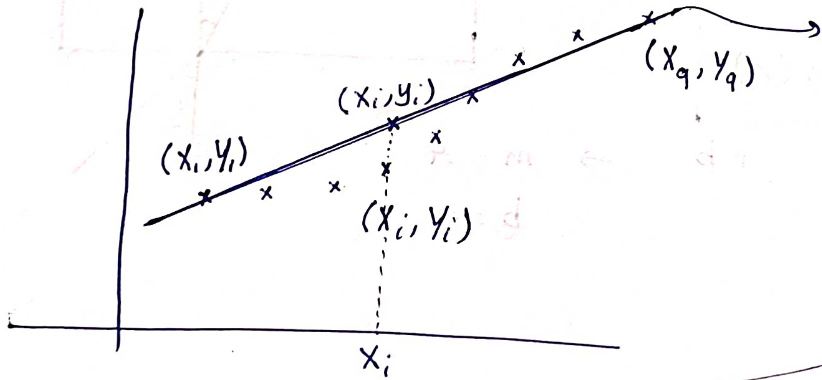
Suppose we plot y vs. x on a linear graph paper.

The equation of the straight line is:

$$y = mx + b$$

In the method of least square fit, we want to find the best slope "m_b" & the best y_{int} "b_b".

* Consider the graph of y vs. x of a set of N data points $\{(X_1, Y_1), (X_2, Y_2) \dots (X_N, Y_N)\}$



let this line is the best line $y = m_b x + b_b$

$(x_i, y_i) \rightarrow (x_i, m_b x_i + b_b)$

The best line is the one which makes the quantity $|Y_i - y_i|$ as small as possible for all points.

$$\delta^2 = \sum_{i=1}^{N} (Y_i - y_i)^2$$

$$= \sum_{i=1}^{N} (Y_i - m_b X_i - b_b)^2$$

$$\frac{\partial(\delta^2)}{\partial m} = 0 \quad , \quad \frac{\partial(\delta^2)}{\partial b} = 0$$

$m, \ b, \ \Delta m, \ \Delta b$

