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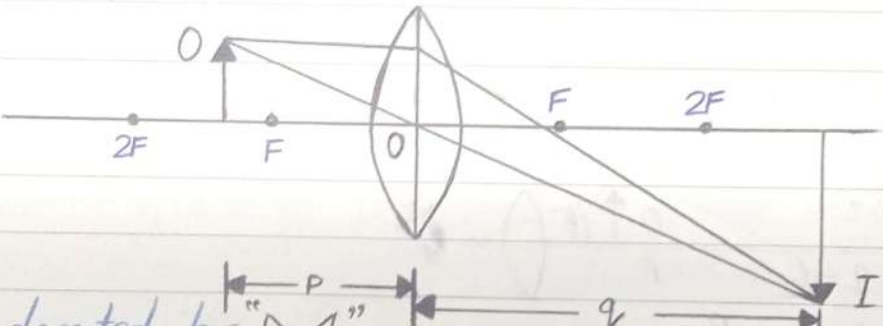
Least Distance Of Distinct Vision

The maximum distance from an eye at which an object appears to be distinct is called least distance of distinct vision or near point

Linear Magnification

The ratio between the size of the object is called linear magnification.



It is denoted by "M"

$$M = \frac{I}{O} = \frac{\text{Size of the image}}{\text{Size of the object}}$$

$$M = \frac{h_i}{h_o} = \frac{\text{height of Image}}{\text{height of object}}$$

It is also defined as

"The ratio between the distance of the image from the lenz to the distance of the object from the lenz"

$$M = \frac{q}{p}$$

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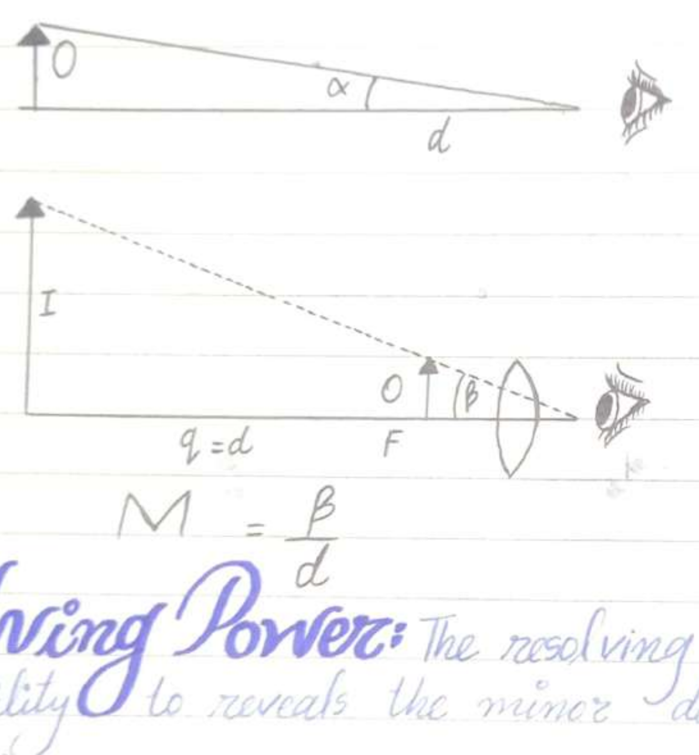
Angular Magnification:

The ratio between the angle subtended by an image as seen through optical device to the subtended by the object at the unaided eye is called angular magnification.

It is also called magnifying power.



$$M = \frac{\beta}{d}$$

Resolving Power:

The resolving power of an instrument is its ability to reveals the minor detals of an object under examination.

- It is expressed as the reciprocal of the minimum angle which two point sources sublends at the instrument So that their images are seen as two distinct sports of light rather than one.

- Raleigh showed that for light of wavelength "λ"

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through a lens of diameter "D" the resolving power will be

$$R = \frac{1}{\alpha_{min}}$$

where $\alpha_{min} = 1.22 \frac{\lambda}{D}$

Put this in above equation.

$$R = \frac{1}{1.22\,\lambda/D}$$

$$R = \frac{D}{1.22\lambda}$$

Equ **(1)** shows that smaller the minimum angle, greater the resolving power, because two distinct object which are close together can be seen through the instrument.

In case of gratting the resolving power will be.

$$R = \frac{\lambda}{\lambda_2 - \lambda_1} = \frac{\lambda}{\Delta\lambda}$$

It shows gratting with high resolving power can distinguish Small difference in wavelength.

- If 'N' is the number of lines on gratting so Resolving power of m^{th} order will be

$$R = N \times m$$

(LONG) **Simple Microscope**

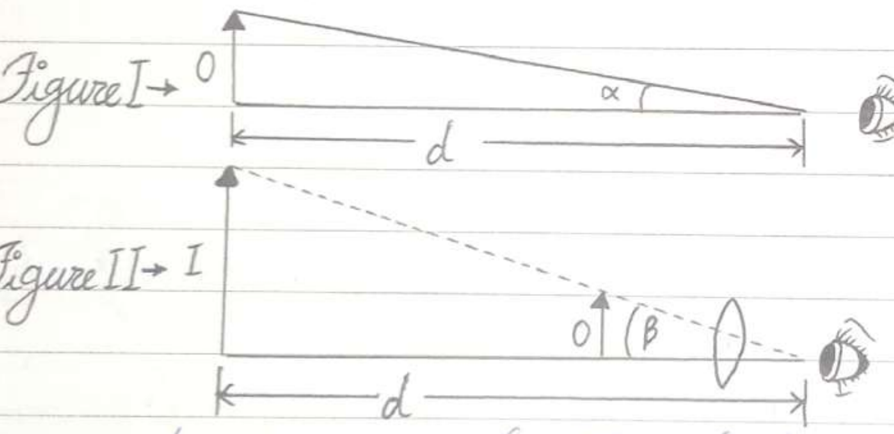
An instrument which is used to see small objects called simple microscope

- It consist of biconvex lens also called magnifying glass

Principle: When the object is placed inside the focal length An erect, virtual, magnifyed image is formed at near point (d)

Magnification: The image formed placed at point 'd' as shown

When biconvex lens is placed with in the object and eye, a magnifying image is formed as shown



according to angular Magnification

$$M = \frac{\beta}{d} \qquad (1)$$

From figure I

base = d

Perp = O

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$$\tan\alpha = \frac{O}{d} \qquad (2)$$

From figure II

base = d

Perp = I

$$\tan\alpha = \frac{I}{d} \qquad (3)$$

If 'α' and 'β' are very small angles So

$$\tan\alpha \approx \alpha$$

$$\tan\beta \approx \beta$$

So equ **(2)** and **(3)** becomes.

$$\tan\alpha \approx \alpha = \frac{O}{d}$$

$$\tan\beta \approx \beta = \frac{I}{d}$$

Put this in equ **(1)**

$$M = \frac{\frac{I}{d}}{O/d}$$

$$M = \frac{I}{d} \times \frac{d}{O}$$

$$M = \frac{I}{O} \qquad (4)$$

We know that

$$M = \frac{q}{p} \qquad (5)$$

Compare equ **(4)** and **(5)**

$$\frac{I}{O} = \frac{q}{p}$$

$$M = \frac{q}{p} \quad \textbf{(6)}$$

q = distance of the image from the lens $= d$

So equ **(6)** becomes

$$M = \frac{d}{p} \quad \textbf{(7)}$$

Now

We know

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

for virtual image $\frac{1}{f} = \frac{1}{p} - \frac{1}{q}$

Multiply with 'd'

$$\frac{d}{f} = \frac{d}{p} - \frac{d}{q} \qquad \therefore q = d$$

$$\frac{d}{f} = \frac{d}{p} - \frac{d}{d}$$

$$\frac{d}{f} = M - 1$$

$$1 + \frac{d}{f} = M$$

This is the expression of Simple Microscope.

→ It shows for higher magnification frequency would be lower.

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(LONG) Imp

Compound Microscope

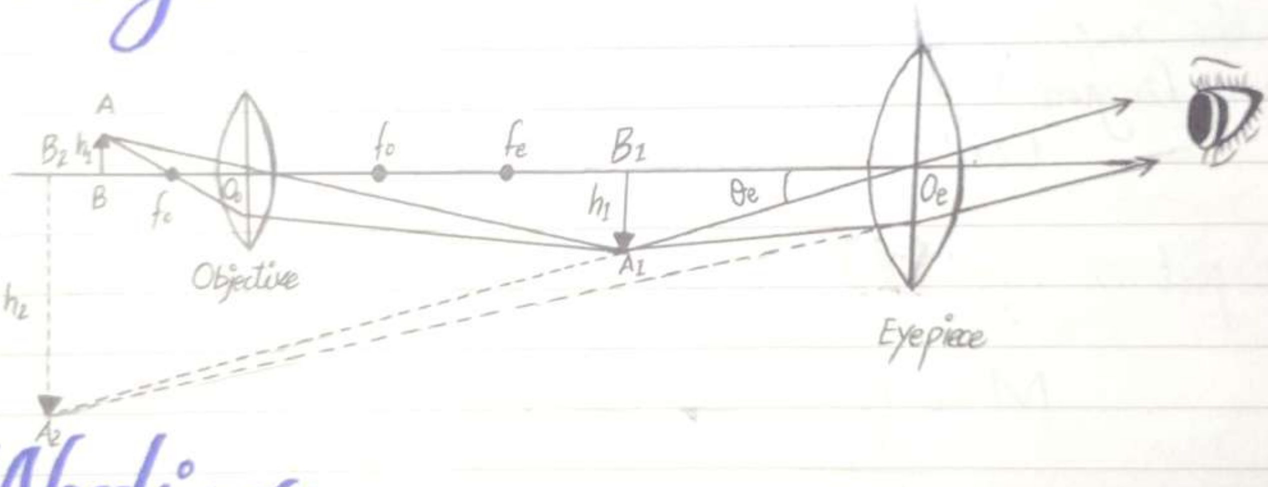
Whenever a high magnification is desired we use compound microscope.

Construction:

It consist of a two biconvex lenses.

- One having small focal length or small Aperture called objective
- 2nd having long focal length or long Aperture called eye piece

Diagram:



Working:

An object of height 'h' is place just beyond the focal length of objective

- An real image of height 'h_1' is made with in the focal length of an eye piece as shown.
- This image behave as an object for eye piece.

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- The final image seen by the eye through microscope is virtual and enlarged.
- In normal adjustment, the eye piece is positioned so that the final image is formed at the near point of the eye at 'd'

Magnification:

As we see from figure

$$M = \frac{\tan\theta_e}{\tan\theta} \quad \mathbf{(1)}$$

where 'θ_e' is the angle made from an eyepiece and 'θ' be the angle made from object

From fingure

$$\tan\theta_e = \frac{h_2}{d} \; ; \; \tan\theta = \frac{h}{d}$$

So put in equ **(1)**

$$M = \frac{\frac{h_2}{d}}{h/d} \rightarrow \frac{h_2}{d} \times \frac{d}{h}$$

$$M = \frac{h_2}{h}$$

$$M = \frac{h_2}{h_1} \times \frac{h_1}{h} \rightarrow \mathbf{(2)}$$ Multiply and divide by 'h_1'

$\frac{h_2}{h_1}$ = Magnification of eyepiece which made a virtual image.

So

$$M_2 = \frac{h_1}{h_2} = \left(1 + \frac{d}{fe}\right) \text{[from Simple Microscope]}$$

$$M_1 = \frac{h_1}{h} = \text{Real image formed by objective}$$

So

$$M_1 = \frac{q_o}{P_o} = \text{(From figure)}$$

So equ **(2)** becomes.

$$M = M_1 \times M_2$$

putting the values 'M_1' and 'M_2'

$$M = \frac{q_o}{P_o}\left(1 + \frac{d}{fe}\right)$$

- It is the expression of magnification of Compound Microscope
- It is customary to refer the values of 'M' as multiples of 5, 10, 40 etc and are marked as X5, X10, X40 on the instrument

The limit to which a microscope can be used to resolve details, depends on the width of of the objective

A wider objective and use of blue light of short wavelength produces less diffraction and allows more detail to be seen.