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Lens~~s~~

Lens :- It is a trasparent medium bounded by two refracting surfaces. (At least 1 sperical~~s~~ surface)

i) Convex lens (converging lens) :-

-> It is thick at middle and thin at edge. When parallel beam of light incidence on a convex lens, after refraction each ray of light converge ~~at~~ to a point. So it is called converging lens. It is also called bi-convex lens.

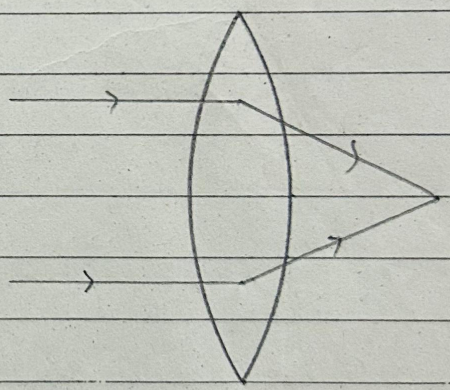

fig :- Convex lens.

ii) Concave lens (diverging lens) :-

-) It is thick at edge and thin at middle. When ~~ligt~~ parallel beam of light passes through the concave lens, after refraction each ray of light diverge from a point. So it is called diverging lens. It is also called bi-convex lens.

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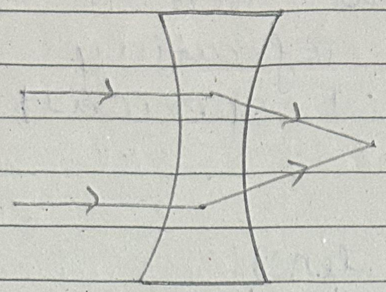
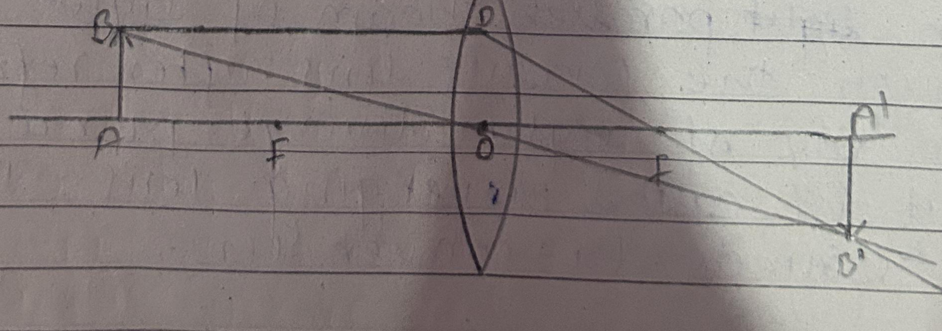


fig:- Concave lens

(1) All the distance are measured from optical centre
(2) Real distance are taken as positive and virtual distance as negative
(3) focal length and radius is positive for convex lens and negative for concave lens.
(4) lens should be thin.

lens formula

(I)
(1) Convex lens (Real image)



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Consider an object 'AB' placed infront of convex lens at a distance greater than focal length. Two rays from an object "AB" after refraction through lens meet at a point B' to form a real image A'B'.

from figure

ΔABO and $A'B'O$ are similar.

$$\therefore \frac{AB}{A'B'} = \frac{AO}{A'O} \text{ —— (1)}$$

Again

ΔDOf & $A'B'F$ are similar

$$\frac{DO}{A'B'} = \frac{Of}{A'f}$$

$$\frac{AB}{A'B'} = \frac{Of}{A'f} \text{ —— (2)} \quad [\because DO = AB]$$

from (1) and (2)

$$\frac{AO}{A'O} = \frac{Of}{A'f}$$

or $$\frac{AO}{A'O} = \frac{Of}{A'O - Of}$$

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or, $\frac{u}{v} = \frac{f}{v-f}$

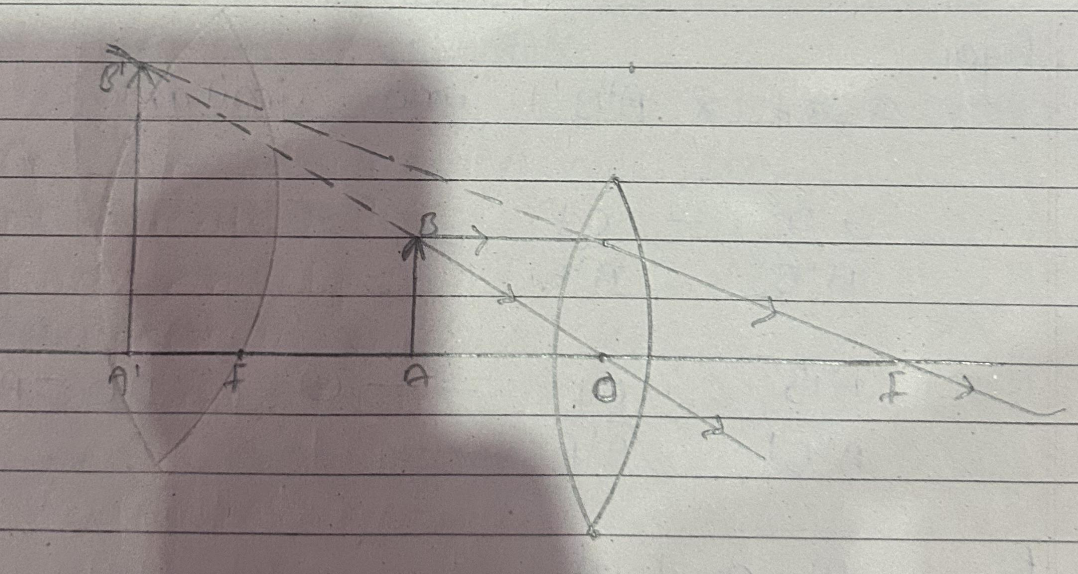
Dividing both side by uvf

$\frac{uv}{uvf} - \frac{uf}{uvf} = \frac{vf}{uvf}$

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

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

Convex lens (virtual image)



Consider an object "AB" placed infornt of lens less than focal length (f). Two rays from an object refracted through lens which appears to meet at point B' to from a virtual image A'B'.

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In the figure

ΔABO and $\Delta A'B'O$ are similar

$$\therefore \frac{AB}{A'B} = \frac{AO}{A'O} \quad ---- \quad (I)$$

Again ΔDOF and $\Delta A'B'F$ are similar

$$\frac{DO}{A'B'} = \frac{OF}{A'F} \quad ------ \quad (II)$$

from (I) and (II)

$$\frac{AO}{A'O} = \frac{OF}{A'F}$$

On $\frac{AO}{A'O} = \frac{OF}{A'O+OF}$

or $\frac{u}{-v} = \frac{f}{-v+f}$

or $-uv + uf = -vf$

Dividing both side by uvf

$$\frac{-\cancel{uv}}{\cancel{uv}f} + \frac{\cancel{u}\cancel{f}}{\cancel{u}v\cancel{f}} = \frac{-\cancel{v}\cancel{f}}{u\cancel{v}\cancel{f}}$$

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

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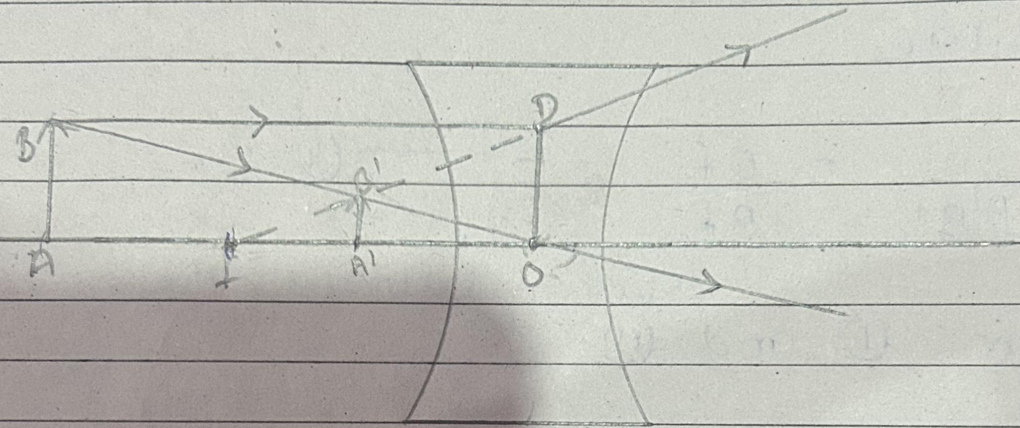
or, $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$

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

Concave lens



Consider, an object "AB" placed infront of lens greater than focal length(f). Two rays from an object refracted through lens which appears to meet at point B' to form a virtual image A'B'

In the figure

ΔABO and $\Delta A'B'O$ are similar

$\therefore \frac{AB}{A'B'} = \frac{AO}{A'O}$ ------ (1)

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Again $\triangle DOf$ and $A'B'f$ are similar

$$\frac{DO}{A'B'} = \frac{Of}{A'f} \quad \cancel{\text{----- (ii) } [\because DO = AB]}$$

$$\frac{AB}{A'B'} = \frac{Of}{A'f} \quad \text{------ (ii) } [\because DO = AB]$$

from eqn (i) and (ii), we get

$$\frac{AO}{A'O} = \frac{Of}{A'f}$$

$$\frac{u}{-v} = \frac{-f}{AO - A'O}$$

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

$$-uf + uv = fv$$

Dividing both sides by uvf, we get

$$\frac{-\cancel{u}\cancel{f}}{\cancel{u}v\cancel{f}} + \frac{\cancel{u}\cancel{v}}{\cancel{u}\cancel{v}f} = \frac{\cancel{f}\cancel{v}}{u\cancel{v}\cancel{f}}$$

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

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