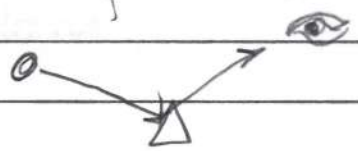
Light - R²

Light

→ form of energy that enables us to see
→ speed of light in vaccum / air = 3×10^8 m/s

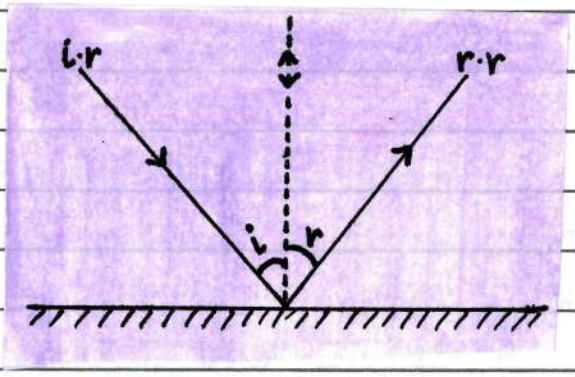
→ Rectilinear Propogation of Light: → sharp SHADOW formation
- light travels in a straight line
- all visible objects emit / reflect light

→ TO SEE AN OBJECT:
- a source
- rays must strike object
- light must reflect from object to eye.



Reflection

→ phenomenon of bouncing back of white light on striking a smooth surface.



→ Laws of Reflection

- $\angle i = \angle r$
- i.r, r.r & normal at the point of Incidence always lie on the same plane.

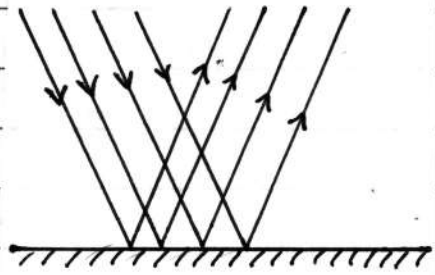
Types

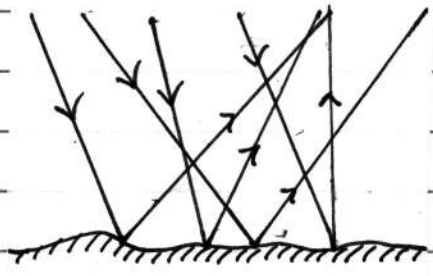
Regular

If parallel beam of light remain parallel even after reflection & go in only one direction

Diffused

If parallel beams of incident light is reflected in different directions.

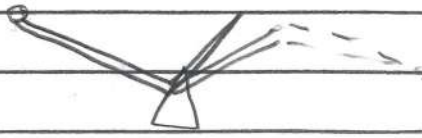




Image

→ Light rays coming from a point after reftection meet at another point (or) appear to meet at another point, then the second point is called the image of first point.

→ REAL: actually meet



→ VIRTUAL: appear to meet

plane — spherical — convex — concave

MIRROR

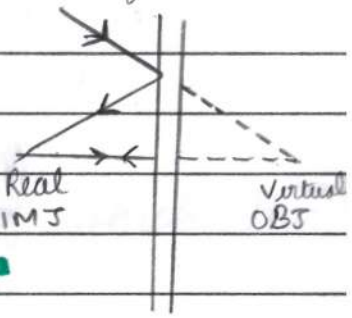
↳ polished surface which reflects almost all the light incident on it.

Plane

→ flat reflecting surface 

→ PROPERTIES OF IMAGE FORMED: Plane mirror may form R if O - virtual

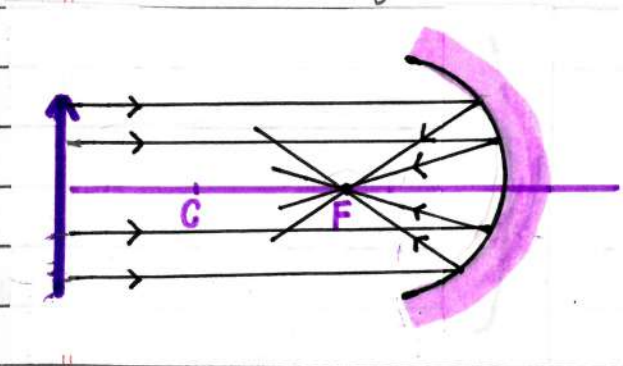
1. always virtual & erect
2. $h_i = h_o$
3. $u = v$
4. lateral inversion (left-right)
5. f is infinite ∞
6. R is ∞



Spherical

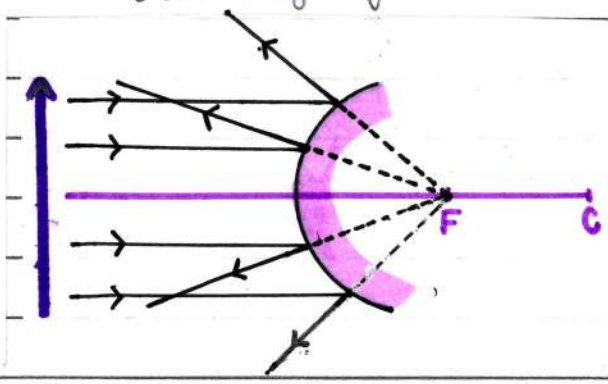
→ reflecting surface is curved inward / outward

CONCAVE
convergent



curved inward
convergent

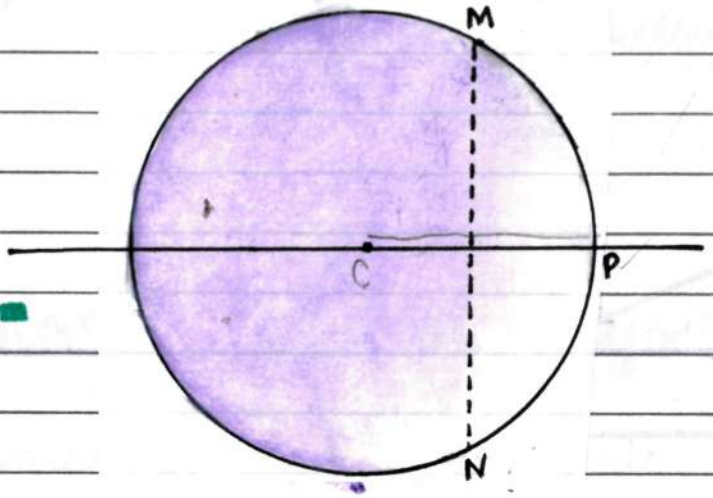
CONVEX
divergent



bulged curved outward
divergent

★ Image formed by Concave mirror is certainly real if object is virtual

Terms



1. Centre of Curvature (C)
Centre of imaginary sphere of which the mirror is a part of.

2. Radius of Curvature (R):
Radius of imaginary sphere of which the mirror is a part of.

3. Aperture (A): -> reflecting surface
Diameter of reflecting surface of spherical mirror. Part of reflecting surface of mirror which is exposed to incident light.

4. Pole (P): A / Z
Midpoint of Aperture or reflecing surface.

5. Principal Axis:
line joining P & C

6. Focal Length (f):
distance between pole and principal focus
↳ ALWAYS INDEPENDENT OF MEDIUM PLACED

7. Principal Focus (F):
A point on principal axis of mirror in which the light rays coming parallel to the principal axis meet after reflection.

$$R = 2f$$

Standard Incident Rays

1. A ray parallel to principal axis after reflection will pass through the focus.

2. A ray passing through focus after reflection will be parallel to principal axis.

3. A ray passing through centre of curvature "C" after reflection comes back along the same path.
$\angle i = \angle r = 0$

4. A ray incident obliquely to principal axis towards pole "P" is reflected obliquely, following the laws that is; $\angle i = \angle r$.

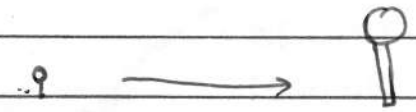
+ APPEAR for Convex

Concave : :

	U	V	Size	R/I
+	∞	F	↑ diminished point	R
2	beyond C	b/w F & C	diminished	R
	C	C	same size	R
4 ★	b/w C & F	beyond C	enlarged	R
5	F	∞	↑ enlarged	R
★	b/w F & P	behind mirror	enlarged	V

ob ∞ → beyond C → C → C & F → F → F & P

im F → F & C → C → beyond C → ∞ → B mirror



u comes close → image goes far & big

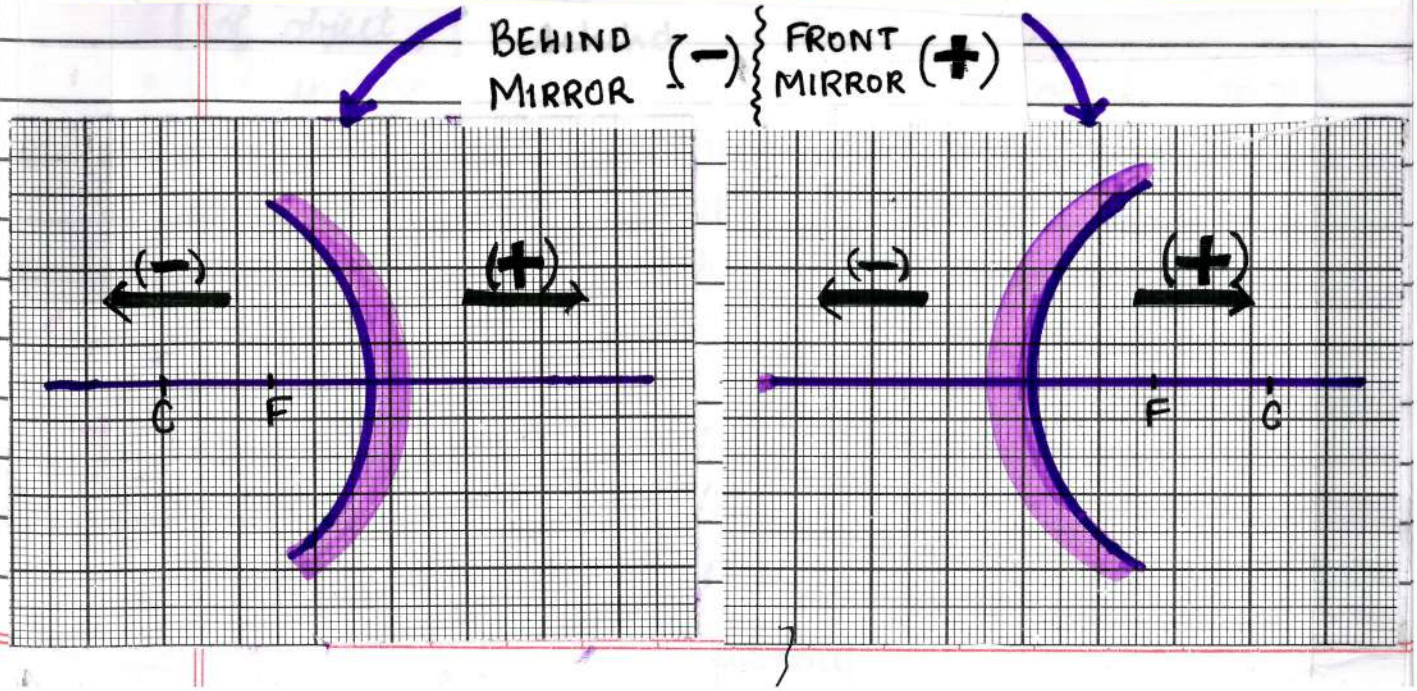
Convex $v \leq f$, $h_i < h_o$, $v < u$

	U	V	Size	R/V
1.	∞	at F behind mirror	point sized ↑ diminished	V, E
2.	b/w ∞ & P	b/w F & P behind mirror	diminished	V, E

$v < f$ always $\quad h_o > h_i$

Sign Convention

MIRROR	u	v		f	h_o	h_i	
		R	V			R	V
Concave	−	−	+	−	+	−	+
Convex	−	.	+	+	+	.	+

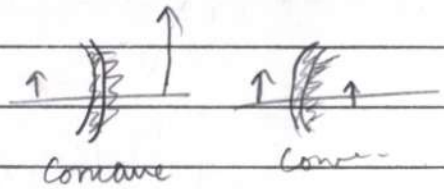


Mirror Formulae

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

Magnification

$$m = \frac{-v}{u} = \frac{h_i}{h_o}$$



	m	h
same size	$m = 1$	$h_i = h_o$
diminished	$m < 1$	$h_i < h_o$
enlarged	$m > 1$	$h_i > h_o$

Sign	Image
−	R, I (Concave)
+	V, E (Convex)

Identification

- If image formed is of same size as that of object, for different positions. = PLANE MIRROR
- If image formed is diminished for all positions of object, then mirror is CONVEX.
- If image formed behind the mirror is longer than object, then mirror is CONCAVE
- Focal length of Spherical mirror is independent of medium in which it is placed.

Obj/bulb - placed at F. Illel beam concentrated

Concave

- powerful beam of light - torch
- larger image - shaving, dentist
- converge sun rays on a point - produce ↑ concentrated Δ - solar furnace

Convex

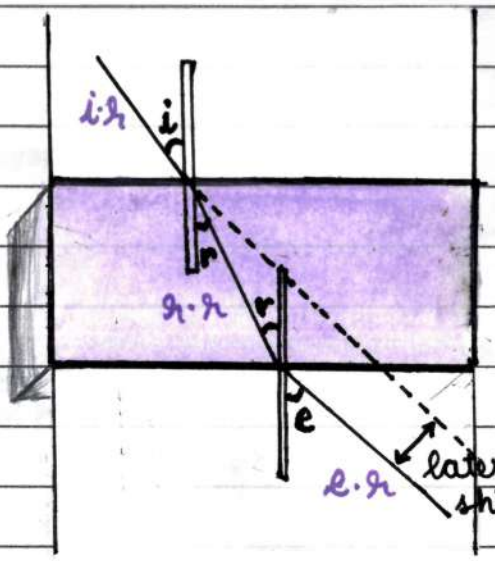
- erect, wider field view rear view mirrors - vehicles
- shops - security mirrors

REFRACTION

when travelling obliquely from 1 medium to another the direction of propogation of light changes.

Causes

difference in speed of light



rarer - ↑v
bends towards normal (v↓)
denser ↓v
∠r < ∠i
bends away from normal (v↑)
rarer ↑v

$\angle i = \angle e$

$\angle r > \angle i$

emergent ray ∥ incident ray

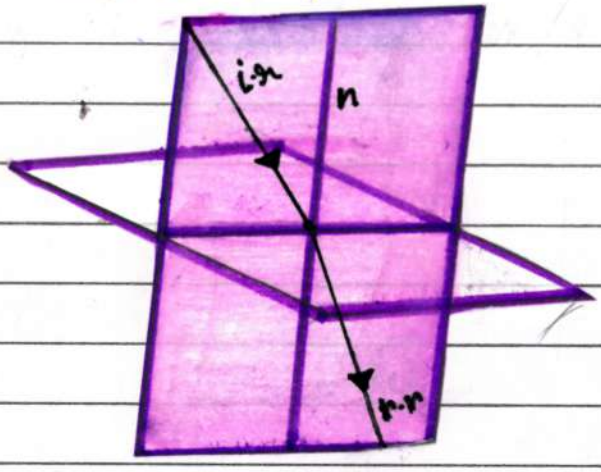
lateral shift

Examples

* bottom of pool / tank
* glass slab placed on paper with letters
* pencil partially immersed in H_2O
* lemon in water placed in glass tumblar

Laws of refraction snell

➢ incident ray, the normal and the refracted ray lie in the same plane.



➢ $\frac{\sin i}{\sin r}$ = constant, for light of a given colour & for a given pair of media.

$\angle i \propto \angle r$

Refractive Index

ABSOLUTE

refractive index with respect to vaccum

$C = 3 \times 10^8$ m/s

➢ vaccum / air

$n_m = \frac{C}{v_m}$

$n \propto \frac{1}{v}$
(density)

RELATIVE

when light travels from 1 medium to another medium

Refractive index of M_1 with respect to M_2

$n_{12} = \frac{n_1}{n_2} = \frac{v_2}{v_1}$

$= \frac{\frac{C}{v_1}}{\frac{C}{v_2}} = \frac{\cancel{c}}{v_1} \times \frac{v_2}{\cancel{c}}$

$n_{12} = \frac{1}{n_{21}}$

Optical Density

O.D $\propto$ n $\propto \frac{1}{v} \propto$ bending

optical density $\propto$ refractive index $\propto \frac{1}{\text{speed of light}}$

Spherical lens

transparent material bound by 2 surfaces of which 1 / both surfaces are spherical

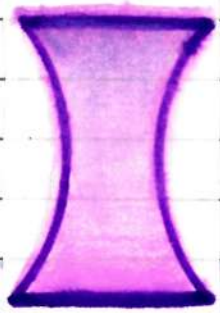
Concave

Convex

d = distance b/w eye ↔ obj

image $\propto \frac{1}{d}$

Magnifying lens



thicker

thin

thicker

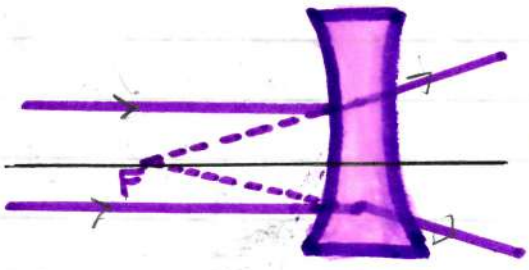
thin

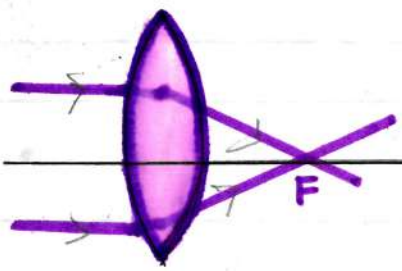
thicker

thin

curved inwards

bulging outwards





diverging

converging

Virual F

Real F

★ Optical Centre.
Centre point of a lens

★ Principal axis.
Imaginery line joining the 2 Centre of Curvatures
↑
Optical axis

★ 2 spherical mirrors
★ air R → glass D → air R
∴ 2 refractions
Double Refraction

Standard Incident Rays

★ Rays parallel to principal axis after refraction will pass through ~~a~~ the principal focus.

★ Ray passing through (directed to) the principal focus after refraction will emerge parallel to principal axis.

★ Ray directed to optical centre (c) of will emerge out undeviated [∴ i = ∠r = 0]

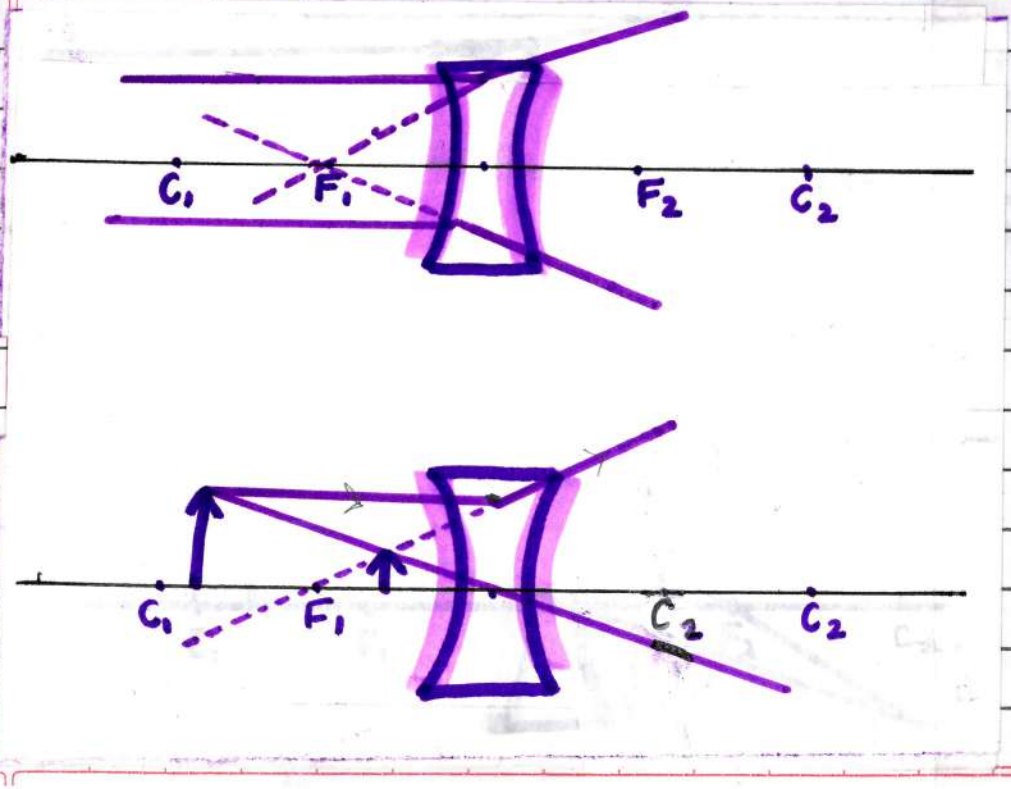
(+ appear = CONCAVE)

Convex Ray Diagrams

u	v	Size	Nature
∞	F	H D	R, I
beyond C	b/w C & F	D	R, I
C	C	Same	R, I
b/w C & F	beyond C	E	R, I
F	∞	H E	R, I
b/w F & P	behind same lens	E	V, E

Concave Ray Diagrams

u	v	Size	Nature
∞	F	H D	V E
b/w P & ∞	b/w F & C	D	V E



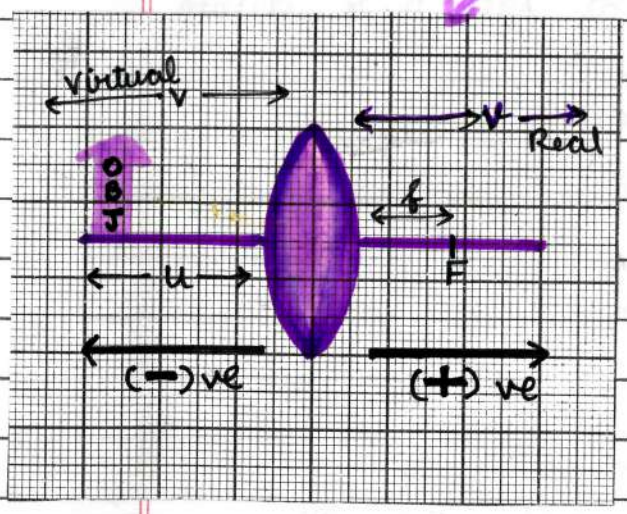
$u = -|f_{concave} = -$

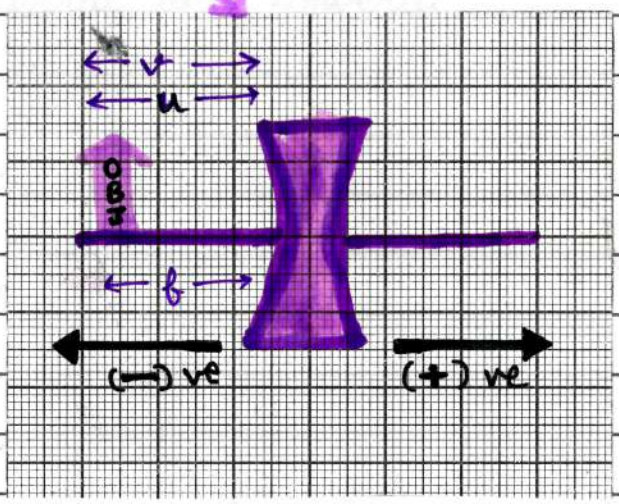
store 67 / 14

Sign Convention

- all distances measured from O
- distance opposite object = (+) ve
- distance in direction " = (−) ve

Lens	u	v		f		h_o	h_i	
		R	V	R	V		R	V
Convex	−	+	−	+	−	+	−	+
Concave	−		−		−	+		+





∴ If image is of same size of object and is real and inverted i.e $h_i = h_o$

$\therefore m = -1$

Lens formulae

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

Manification

$$m = \frac{v}{u} = \frac{h_i}{h_o}$$

convex = (+) ve
concave = (−) ve

h_i = (+) ve = erect
h_i = (−) ve = inverted

$m < 1$ = concave lens

$m = -/+ \times$ ⟶ $m = 1$ same size
(−)→R (+)→V $m < 1$ diminished
$m > 1$ enlarged

Power of Lens

ability of a lens to diverge and converge

$$P = \frac{1}{f\,(\text{meters})} \quad \text{or} \quad P = \frac{100}{f\,(\text{cm})}$$

$$P \propto \frac{1}{f} \propto \text{bending}$$

S.I. Unit = Diopters (D) in m (meters)
= 1m ⟶
= 1D = $\frac{1}{1m}$

1 Dioptres is defined as power of that lens whose focal length is 1m.