Light – Reflection and Refraction

1. What are essential to see around us?

A) Light and eyes are essential to see around us.

Light: A form of energy which gives us sense of vision.

Eye: The eye is a sense organ that helps us to see the world around us.

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2. Name the phenomenon helps us to see the world around us.

A) Reflection of Light

Reflection of Light: The bouncing back of light after incident on any surface is called Reflection light. Reflection of Light is two types. They are:

i. Regular Reflection:

> Reflection of light on a smooth and shiny surface is called Regular Reflection
> In this reflection all reflected light rays travels in same direction.
> Hence, clear image is formed.
> Ex: Reflection on plane mirror

ii. **Diffused Reflection (Irregular Reflection):**

> Reflection of light on a rough surface is called Diffused reflection.
> In this reflection all reflected light rays travels in different directions.
> Hence, no clear image is formed.
> Ex: Paper, wall, etc…..

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3. State laws of reflection.

A) **1st Law**: Angle of reflection is always equal to angle of incidence, i.e. $\angle i = \angle r$

2nd Law: Incident ray, point of incidence and reflected ray all are in same plane.

Note:

The laws of reflection apply everywhere that light is reflected, whether the surface is smooth or rough.

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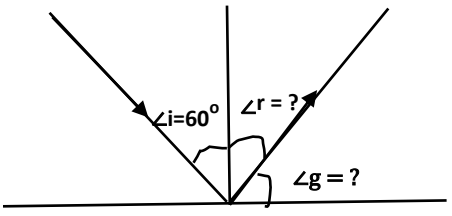
4. Angle of incidence of a light ray is 60^o. What is the angle of reflection of light and glancing angle?

A) **Glancing angle**: The glancing angle is the angle between the reflected ray and the reflecting surface like mirror surface. Generally represented as $\angle g$

Given: $\angle i = 60^o$, $\angle r = ?$, $\angle g = ?$

We know that by laws of reflection $\angle i = \angle r$

therefore, $\angle r = 60^0$



From the diagram, $\angle r + \angle g = 90^0$

$$60^0 + \angle g = 90^0$$

$$\therefore \angle g = \quad 90^0 - 60^0 \quad = 30^0$$

5. The angle between incident ray and reflected ray is 130^0. What is the angle of incidence?

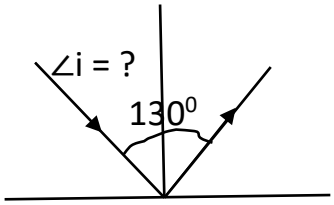
A) Given: $\angle i + \angle r = 130^0$, $\angle i = ?$

We know that by laws of reflection $\angle i = \angle r$

$\angle i + \angle i = 130^0$

$2\angle i = 130^0$

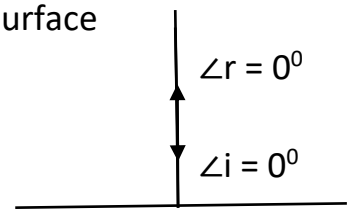
$\angle i = 130^0 / 2 = 65^0$



6. Is it possible that $\angle i + \angle r = 0$.

A) Yes, if a light is incident normal (perpendicular) to the reflecting surface

$\angle i + \angle r = 0^0$ because, $\angle i = 0^0$ and $\angle r = 0^0$



7. Write a short note on image.

A) **Image**: The apparent reproduction of an object by an optical phenomenon is called an 'Image'. Basically, images are two types. They are:

i. Real Image

ii. Virtual Image

Real Image	Virtual Image
i. Image can able to hold on a screen is called 'Real image'.	i. Image can not able to hold on a screen is called 'Virtual image'.
ii. It can be formed where the emergent light rays are really intersecting after an optical phenomenon.	ii. It can be formed where the emergent light rays are appeared to be intersecting after an optical phenomenon.
iii. Example: Photographs taken by camera	iii. Example: Image in a plane mirror.

8. What is a shadow?

A) A dark region formed behind an opaque object due to rectilinear propagation of light is called 'Shadow'.

9. Write a short note on mirrors.

A) **Mirror**: A mirror is a glass plate with one side made shiny so that it can reflect light and show the image of things in front of it.

Mirrors are two types. They are: i. Plane Mirror ii. Spherical mirror

Plane Mirror: A plane mirror is a flat, smooth surface that reflects light to form an image.

Spherical Mirror: A spherical mirror is a curved glass plate with smooth surface that reflects light to form an image.

Again, Spherical mirrors are of two types. They are:

i. **Concave Mirror**: A concave mirror is a spherical mirror whose reflecting surface is curved inward, that is, towards the center of the sphere

ii. **Convex Mirror**: A convex mirror is a spherical mirror whose reflecting surface is curved outward, that is, away from the center of the sphere.

(a) Concave mirror *(b) Convex mirror*

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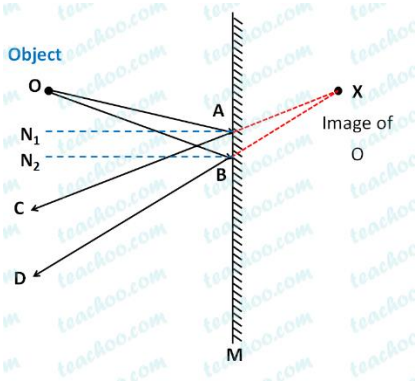
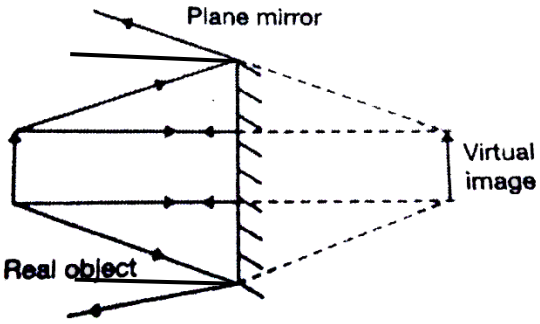
10. Draw a neat diagram of image formed by plane mirror.

A)



(a) Image of point size object



(b) Image of an object

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11. What are the characteristics of image formed by a plane mirror?

A) i. Image is virtual and erected image.

ii. Size of image is same as size of the object.

iii. Image distance from the mirror is equals to object distance from the mirror.

iv. Image is laterally inverted.

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12. What is lateral inversion of an image?

A) The right of an object is appeared as left in the image and vice versa is called later inversion.

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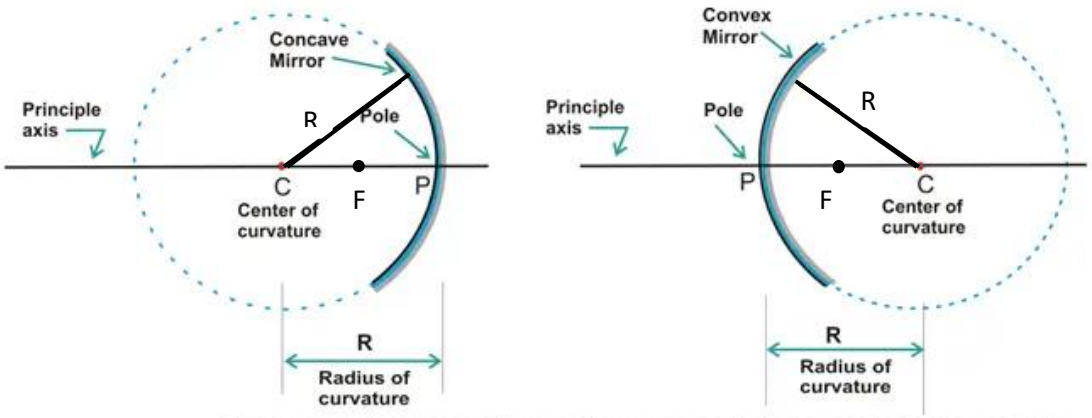
13. Define the parts of a Spherical mirror.

A) **Pole**: The geometrical center of a spherical mirror is called 'Pole'. It can be represented with letter 'P'.

Centre of Curvature: The center of curvature of a spherical mirror is the center of the sphere from which the mirror is made. It can be represented with 'C'.

Principal Axis: An imaginary straight line which passes through centre of curvature and pole of a spherical mirror is called 'Principal Axis'.



Concave and convex mirrors shown as part of complete hollow sphere

Radius of Curvature: The distance between any point on the surface of the spherical mirror to its centre of curvature is called 'Radius of curvature'. **(OR)**

The distance between pole to the centre of curvature of a spherical mirror is called 'Radius of curvature'. It can be represented with 'R'

Normal of a Spherical Mirror: Radius of curvature of a spherical mirror at which a point the light ray is incident is called 'Normal'.

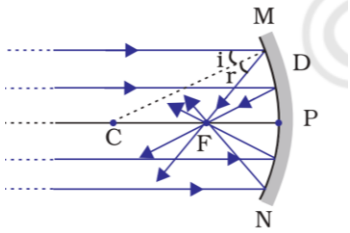
NOTE:

> A spherical mirror contains infinite number of radii of curvature and normal.

Focal Point / Principal Focus: The point of real intersection or apparent intersection of reflected light rays of a parallel beam of light incident on a spherical mirror is called the 'Focal point / principal focus'.It can be represented with 'F'.

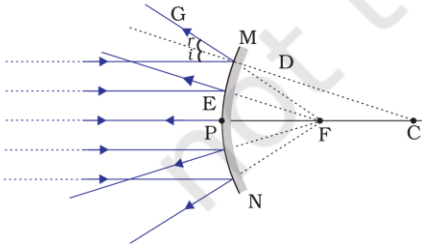
Principal Focus of Concave mirror:

The point of **real** intersection of reflected light rays of a parallel beam of light incident on a Concave mirror is called Principal Focus of Concave mirror.



Principal Focus of Convex mirror:

The point of **appearent** intersection of reflected light rays of parrallel beam of light incident on a Convex mirror is called Principal focus of convex mirror.



Focal Length: The distance between pole to the Principal focus of a spherical mirror is called 'Focal length'. It can be represented with 'f'.

NOTE:

> The relation between radius of curvature and focal length is R = 2 f (or) f = R/2

> The Principal focus of a spherical mirror is the mid point of pole and centre of Curvature.

Aperture of a Spherical mirror: The diamter of the reflecting surface of a spherical mirror is called 'Aperture of a spherical mirror'.

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14. How can you find the focal length of a given concave mirror?

A) i. Hold a concave mirror in your hand and direct its reflecting surface towards the Sun.

ii. Direct the light reflected by the mirror on to a sheet of paper held close to the mirror.

iii. Move the sheet of paper back and forth gradually until you find on the paper sheet a bright, sharp spot of light.

iv. That bright, sharp spot of light is the image of sun.

v. Now, measure the distance between pole of the mirror to image of the sun on the paper.

vi. This distance is approximate focal length of a given concave mirror.

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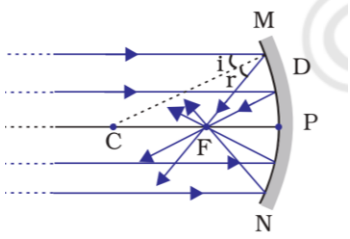
15. Which mirror is called converging mirror? Why?

A) i. Concave mirror is called 'Converging mirror'

ii. Because, the reflected light rays of parallel beam of light incident on a cancave mirror moves towards Principal axis and meet at a point.

iii. That's why concave mirror is called converging mirror.



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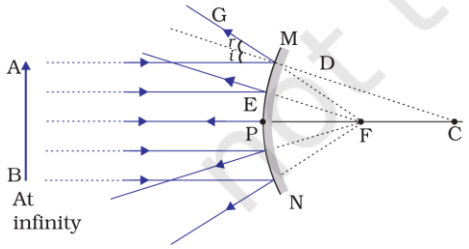
16. Which mirror is called diverging mirror? Why?

A) i. Convex mirror is called 'Diverging mirror'.

ii. Because, the reflected light rays of parallel beam of light incident on a convex mirror moves away from Principal axis in different directions and they appear to comes from a point.

iii. That's why convex mirror is called diverging mirror.



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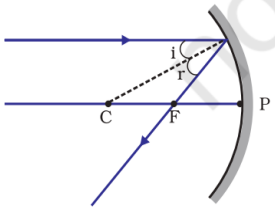
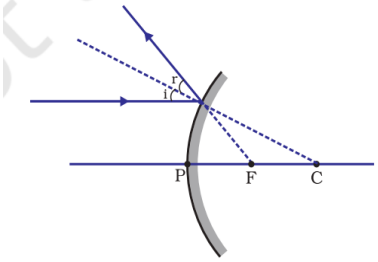
17. Write rules of reflection of light in spherical mirrors.

A) i. A ray incident on a spherical mirror parallel to the principal axis reflects through the focus.

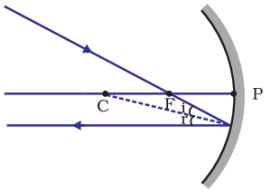


Concave mirror

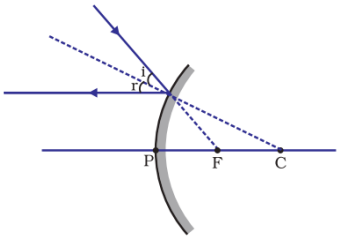


Convex mirror

ii. A ray incident on a spherical mirror through the focus reflects parallel to the principal axis.

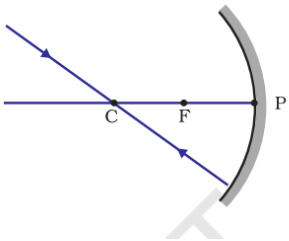


Concave mirror

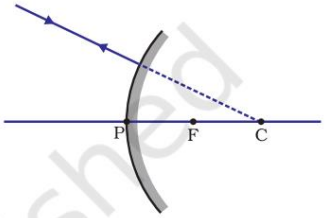


Convex mirror

iii. A ray incident on a spherical mirror passing through the center of curvature reflects back along the same path.

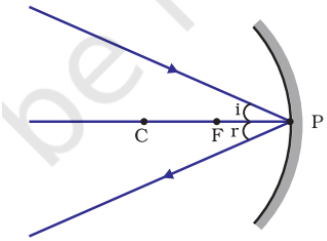


Concave mirror

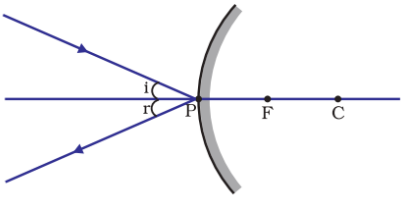


Convex mirror

iv. A ray incident at the pole of a spherical mirror reflects such that the angle of incidence equals the angle of reflection.



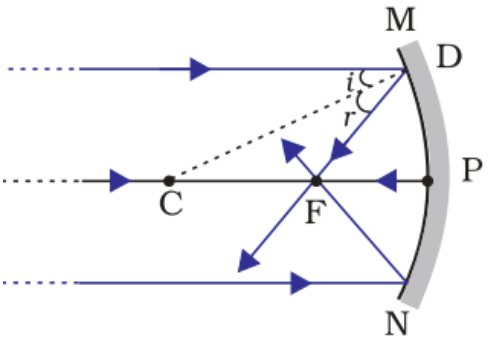
Concave mirror



Convex mirror

18. Draw neat labeled ray diagrams of formation of image by concave mirror.

A) **Situation -1**: Object at infinite distance.



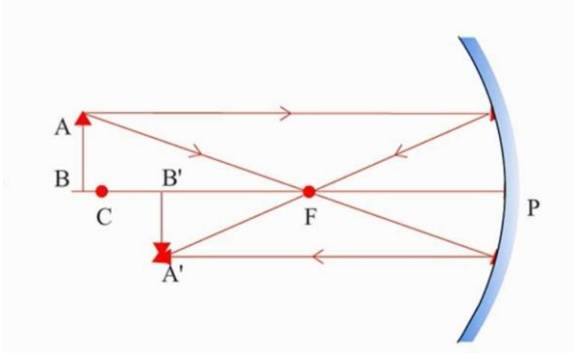
Characters of image:

> Image is real and inverted.

> Size of the image is highly diminished, i.e. point size

> Image formed at principle focus (F).

Situation -2: Object beyond centre of curvature (C).



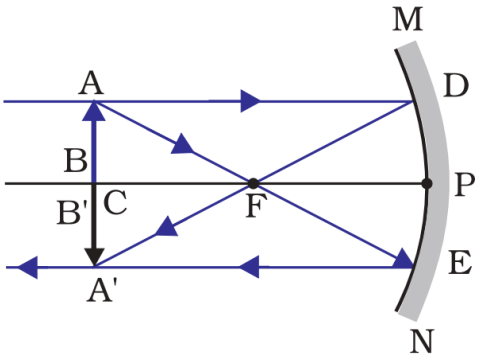
Characters of image:

> Image is real and inverted.

> Size of the image is diminished

> Image formed between 'F and C'.

Situation -3: Object at centre of curvature (C).



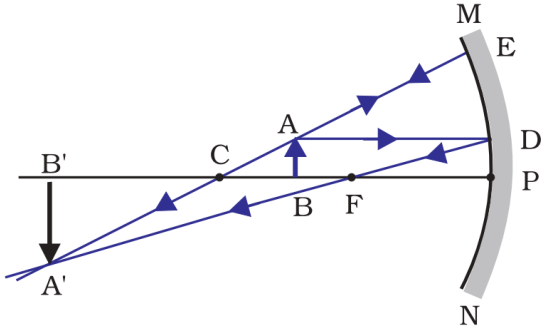
Characters of image:

> Image is real and inverted.

> Size of the image is same as size of object

> Image formed at 'C'.

Situation -4: Object between centre of curvature and Principal focus i.e. between 'F and C'.



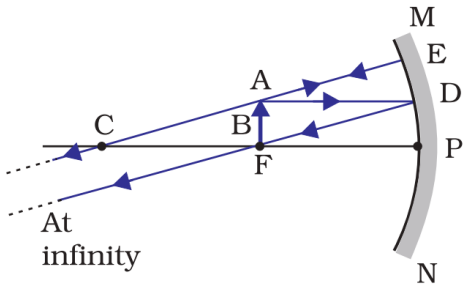
Characters of image:

> Image is real and inverted.

> Size of the image is enlarged

> Image formed beyond 'C'.

Situation -5: Object at Principal focus (F).



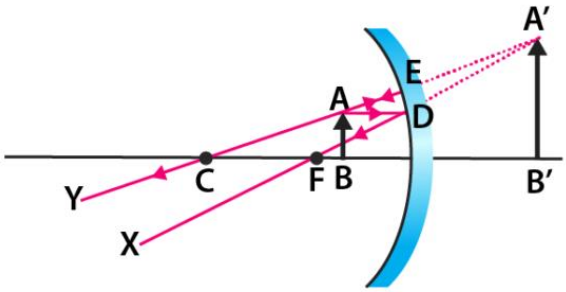
Characters of image:

> Image is real and inverted.

> Size of the image is highly enlarged

> Image formed at infinity.

Situation -6: Object between Principal focus and pole, i.e. between 'F and P'.



Characters of image:

> Image is virtual and erected.

> Size of the image is enlarged

> Image formed behind the mirror.

19. Write the tabular form of characteristics of image formed by concave mirror with respect to object distance.

A)

Position of the object	Position of the image	Size of the image	Nature of the image
At infinity	At the focus F	Highly diminished, point-sized	Real and inverted
Beyond C	Between F and C	Diminished	Real and inverted
At C	At C	Same size	Real and inverted
Between C and F	Beyond C	Enlarged	Real and inverted
At F	At infinity	Highly enlarged	Real and inverted
Between P and F	Behind the mirror	Enlarged	Virtual and erect

20. Write two situations of formation of magnified/ enlarged image by concave mirror. Write the differences of images you are observed in such cases.

A) i. We are observing magnified images in two cases are

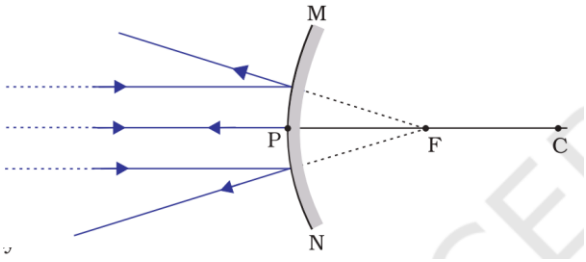
a. object between C and F b. object between P and F.

ii. The differences between images formed in these cases are

Object between C and F	Object between P and F
i. Image is real and inverted	i. Image is virtual and erected
ii. Image formed beyond C	ii. Image formed behind the mirror

21. Draw ray diagrams of formation of image by convex mirror.

A) **Situation -1**: Object at infinte distance



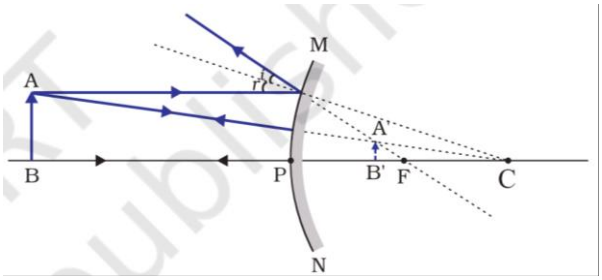
Characters of image:

> Image is virtual and erected.

> Size of the image is highly diminished, i.e. point sized

> Image formed behind the mirror at F.

Situation -2: Object near the mirror



Characters of image:

> Image is virtual and erected.

> Size of the image is diminished

> Image formed behind the mirror between F and P.

22. Write the mirror formula. Explain each and every term.

A) Mirror forumla: $1/f = 1/v + 1/u$ (OR) $f = uv/(u+v)$.

Here, f ---> focal length

u ---> object distance

v ---> image distance

23. Write the sign convention for reflection of light by spherical mirrors.

A) i. The object is always placed to the left of the mirror. This implies that the light from the object falls on the mirror from the left-hand side.

ii. All distances parallel to the principal axis are measured from the pole of the mirror.

iii. All the distances measured to the right of the origin are taken as positive while those measured to the left of the origin are taken as negative.

iv. Distances measured perpendicular to and above the principal axis are taken as positive and below the principal axis are taken as negative.

NOTE:

i. By sign convention for concave mirrors, focal length (f) and radius of curvature (R) are positive and for convex mirrors, focal length (f) and radius of curvature(R) are negative.

ii. By sign convention, object distance (u) is always negative.

iii. By sign convention, image distance (v) for real images is negative and virtual images is positive.

iv. In a concave mirror, if the difference between focal length (f) and image distance (v) is Zero, i.e. f – v = 0, then the object is at infinte distance.

v. In a concave mirror, if the difference between object distance(u) and image distance(v) is zero, i.e. u – v = 0 , then the object is at centre of curvature (C).

24. Write a short note on maginificaiton of image formed by mirrors.

A) i. The relative size of image with respect to the object size is called magnification.

ii. Mathematically, magnification is the ratio between image size and object size.It is represented as 'm'.

iii. $m = h_i / h_o$ where, h_i is image size and h_o is object size

iv. Magnification is also defined with respect to image distance and object distance.

i.e. $m = -v/u$

therefore, $m = h_i / h_o = -v/u$

v. Magnification is having no units.

NOTE:

i. If 'm' value is positive, then image is virtual.

ii. If 'm' value is negative, then image is real.

iii. If m > 1, the image is enlarged.

m = 1, the image size is same as object size.

m < 1, the image is deminished.

iv. if u > v, the image is deminshed

u = v, the image size is same as object size.

u < v, the image is enlarged.

25. Table for identification of image characters with respect to magnification value of mirrors.

A)

Sl. No	m – value =	Nature of image	Image position	Object position	Nature of the mirror
1.	m > -1 i.e. m is "-ve" m > 1	Real image. Enlarged image	Beyond 'C'	Between 'C' and 'F'	Concave mirror
2.	m = -1 i.e. m is "-ve" m=1	Real image. Same size of the object	At 'C'	At 'C'	Concave mirror
3.	m < -1 i.e. m is "-ve" m < 1	Real image. Diminished image	Between 'C' and 'F'	Beyond 'C'	Concave mirror
4.	m > +1 i.e. m is "+ve" m > 1	Virtual image. Magnified image	Behind the mirror	Between 'F' and 'P'	Concave mirror

5.	m = +1 i.e. m is "+ve" m = 1	Virtual image. Same size of the object	Behind the mirror	Irrespective of object poisiton	Plane mirror
6.	m < +1 i.e. m is "+ve" m < 1	Virtual image. Diminished image	Behind the mirror from 'F' to 'P'	Irrespective of object position	Convex mirror

NOTE:

i. A mirror can form real images is 'Concave mirror'.

ii. A mirror can form both real and virtual images is 'Concave mirror'

iii. Mirrors can form virtual images are 'Concave mirror, Convex mirror and Plane mirror'

iv. Mirror can form virtual magnified image is 'Concave mirror'.

v. Mirrors can form only virtual images irrespective of object distance are 'Convex mirror and Plane mirror'.

vi. Mirror can form only diminished virtual images irrespective of object distance is 'Convex mirror'.

vii. Mirror can form only virtual image of same size of object irrespective of object distance is 'Plane mirror'.

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26. Magnification of an image is +1. What does it mean?

A) The image is virtual, erected image of same size of the object. This kind of maginification is existed in plane mirror only.

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27. Magnification of an image is +3. What does it mean?

A) The image is virtual, erected and 3 times enlarged image. It is observed in concave mirror.

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28. Magnification of an image is -4. What does it mean?

A) The image is real, inverted and 4 times enlarged image. It is observed in concave mirror.

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29. Magnification of an image is -1/4 or (0.25). What does it mean?

A) The image is real, inverted image. The image size is $1/4^{th}$ of object size, i.e. diminished image. It is observed in concave mirror.

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30. Why a plane mirror always forms virtual images?

A) i. Plane mirror is a kind of concave mirror having infinite radius of curvature. So, its focal point is also at infinite distance.

ii. That's why where ever the object is placed before a plane mirror is like object between 'F' and 'P' of a concave mirror. Therefore, plane mirror always forms virtual images.

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31. Write the uses of mirrors.

A) i. **Uses of Concave mirror:**

> Used as reflectors in touch lights, head lights of automobiles.

REASON: Mirror produces a bright parallel beam of light, when bulb is placed at focal Point of the mirror.

> Used by ENT specialists and dentists, to examine inner parts like ear, nose, mouth etc… of a patient.

> Used as shaving mirror and make up mirror by beauticians.

REASON: Mirror produce a clear magnified, virtual, erected image when an object is placed between 'F' and 'P'.Hence, can see clearly.

> Used in solar furnace as heating device .

REASON: Rays from Sun are almost parallel, here incident on a concave mirror. Then they meet at Principal focus and produce heat. If you keep any object at focus, it may gets heated.

ii. **Uses of Convex mirror**:

- Used as a rear view mirrors of automobiles.
- Placed at blind curves of roads to avoid roas accidents.
- Used as secuirty mirror at shops

REASON: Convex mirror always forms virtual, diminished and erected image. It has a larger rear field view. Hence, can see the objects in the mirror Somewhat clearly.

iii. **Uses of Plane mirror**:

- Used at home as dressing mirrors to see our reflection.
- Used in periscopes for seeing over walls or around corners like in submarines.
- Used in shops and salons for decoration

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32. Write the differences between Concave mirror and Convex mirror.

A)

Concave Mirror	Convex Mirror
i. A spherical mirror whose lowered in surface is reflecting surface is 'Concave mirror'	i. A spherical mirror whose bulged our surface is reflecting surface is 'Convex mirror'
ii. It forms both real and virtual images	ii. It forms only virtual images.
iii. It is also called as 'converging mirror'	iii. It is also called as 'diverging mirror'
iv. By sign convention, whose focal length is negative	iv. By sign convention, whose focal length is positive.
v.Size of image and position of image changes with respect to object distance by following reference points like centre of curvature (C) , focal point (F) , pole (P)	v. It always produce diminished image from focal point (F) to pole (P) irrespective of object distance.
vi. Shape of concave mirror as follows 	vi. Shape of convex mirror as follows 

33. Define the following.

A) i. **Medium of light**: Substance which allows the light through it is called medium of light.

ii. **Speed of light**: Distance covered by light in a medium per a second is called speed of light.

iii. **Optical rarer medium:** Comparitively in which medium speed of light is maximum is called optical rarer medium or simply rarer medium.

iv. **Optical denser medium:** Comparitively in which medium speed of light is minimum is called optical denser medium or simply denser medium.

v. **Interface:** A plane which separates two transparent media is called interface.

---

34. Two transparent media A and B are having speed of light is 2.4 x 10^8 m/sec and 2 x 10^8 m/sec respectively. Which one of them is rarer and denser media?

A)

Sl. No	Medium	Speed of light	Nature
1.	A	2.4 x 10^8 m/sec	Rarer Medium
2.	B	2.0 x 10^8 m/sec	Denser Medium

NOTE:

Speed of light in vacuum and air (C) is 3 x 10^8 m/sec.

---

35. What is refraction of light? Why light is refracted?

A) i. If a light travels obliquely between two transparent media, at their interface light deviates from its orginal path is called refraction of light.

ii. It is occurred due to change in speed of light at the interface of two media.

iii. Example: a. A pencil in a glass of water appears bent at the water surface.

b. Lemon appeared larger than its size in a glass of water

c. A pool looks shallower than it real depth.

d. Twinklling of stars etc…..

---

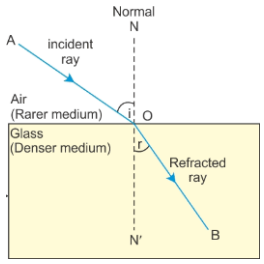
36. Explain the following situations with diagram.

A)i. **Light travles from rarer medium to denser medium**:

i. If a light ray travels from rarer medium to denser medium, at their interface speed of light is decreases.

ii. As a result, refracted ray bends towards the normal.

iii. Therefore ∠i > ∠r.

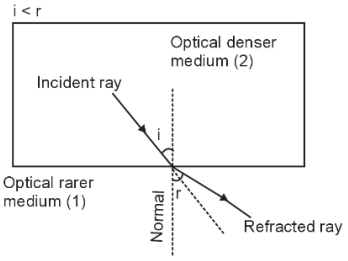


ii. **Light travels from denser medium to rarer medium**.

i. If a light ray travels from denser medium to rarer medium, at their interface speed of light is increases.

ii. As a result, refracted ray bends away from the normal.

iii. Therefore ∠i < ∠r.



NOTE:

i. Angle of refraction increases with respect to increase in angle of incidence.

ii. Light is not deviated when it is incident normal (Perpendicular) to the interface.

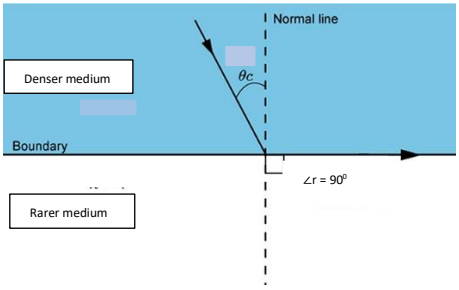
i.e. $\angle i = \angle r = 0^0$

---

37. What is critical angle?

A)

If a light ray travels from denser medium to rarer medium, at a particular angle of incidence, refracted ray retraces along the interface. i.e. $\angle r = 90^0$, Such angle of incidence is called Critical angle. It can be represented with θ_c.



NOTE:

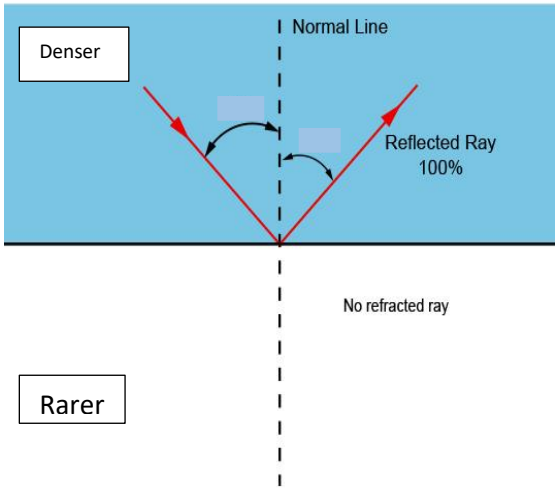
At the critical angle, angle of refraction is 90^0

---

38. What is total internal relfection (TIR) ?

A)

If a light ray travels from denser medium to rarer medium, with angle of incidence is greater than critical angle (i.e. $\angle i > \theta_c$) instead of refraction, light reflects in the same denser medium. Such phenomenon is called total internal reflection. (T.I.R)



Applications:

i. Formation of mirage

ii. brilliance of diamond

iii. working of optical fibers

---

39. Write the laws of refraction.

A) i. The incident ray, the refracted ray, and the normal all lie in the same plane at the point of incidence.

ii. The ratio of the sine of the angle of incidence to the sine of the angle of refraction is constant for the given two media.

i.e. $\sin i / \sin r = \text{constant} = n$

constant (n) value is called refractive index of the second medium.

---

40. What is Snell's law.

A) The ratio of the sine of the angle of incidence to the sine of the angle of refraction is constant for the given two media.

i.e. $\sin i / \sin r = \text{constant} = n$

constant (n) value is called refractive index of the second medium

---

41. Write a short note on refractive index.

A) i. The ability of bending of light ray in a medium when light travels from air or vacuum to given transparent medium is absolute refractive index or simply refractive index.

ii. Mathematically it can be defined as ration between speed of light in air or vacuum to the speed of light in a given medium.It is represented with 'n'.

$$n = C/V$$

where, n → refractive index

C → speed of light in vacuum or air

V → speed of light in the given medium.

NOTE:

i. Refractive index is having no units.

ii. n = C/V always greater than 1 (n > 1) for a medium because in no medium speed of light is greater than speed of light in vacuum or air.

iii. Refractive index (n) of a medium is always inversly proportional to the speed of light

i.e. $n \propto 1/v$

iv. If refractive index(n) value is maximum, the medium is denser and the light travels slower.

v. If refractive index(n) value is minimum, the medium is rarer and the light travels faster.

---

42. Observe the table and answer the following questions.

Material medium	Diamond	Turpentine oil	Air	Ruby	Glycerine	Water
Refractive index	2.42	1.47	1.003	1.71	1.47	1.33

i. What is the relation between refractive index and speed of light of a medium?

A) Refractive index (n) of a medium is always inversly proportional to the speed of light

i.e. $n \propto 1/v$

ii. What is the S.I unit of refractive index?

A) Refractive index is having no units.

iii. In which medium light travels faster or which is rarer medium?

A) Air.

iv. In which medium light travels slower or which is denser medium?

A) Diamond.

v. What happends if light travels from turpentine oil to ruby?

A) Refracted ray bend towards normal (because turpentine oil is rarer medium and ruby is denser medium).

vi. What happends if light travels from glycerine to water ?

A) Refracted ray bends away from the normal (because glycerine is denser medium and water is rarer medium).

vii. How light deviates when it travels from glycerine to turpentine oil?

A) No deviation of light takes place (because both media are having same refractive index. Hence no change in speed of light at their interface).

viii. Calculate speed of light in diamond.

A) for diamond, n = 2.42

We know that, n = C/V

=> V = C /n

=> V = 3 x 10^{8} / 2.42

= 1.24 x 10^{8} m/sec.

---

43. The speed of light in a medium is 2,50,000 km/sec. Calculate its refractive index.

A) Given: V = 2,50,000 km/sec.

We know that, n = C/V

= 3,00,000 / 2,50,000 (3 x 10^{8} m/sec = 3,00,000 km/sec)

= 1.2

---

44. The speed of light in a medium is 1.2 x 10^{8} m/sec. What is its refractive index?

A) Given: V = 1.2 x 10^{8} m/sec.

We know that, n = C/V

= 3 x 10^{8} / 1.2 x 10^{8}

= 2.5

---

45. The refractive index of a diamond is 2.4. What does it mean?

A) It means the speed of light in diamond is (1/ 2.4) times of speed of light in vacuum. (OR) The ratio between speed of light in vacuum to the diamond is 2.4

---

46. Is any realtion between optical density and normal density of medium?

A)

Medium	Optical Density	Normal Density
Water	1.33	1 g/cm³
Kerosene	1.44	0.82 g/cm³

i. Optical density refers to how much light slows down in a medium (measured by refractive index).

ii. Normal density is the mass per unit volume of a substance.

iii. Here, water has more normal density than kerosene i.e. water is heavier than kerosene

iv. kerosene is optically denser than water i.e. light travels faster in water than kerosene

v. From above observation we conclude that there is no direct relation between normal denisty and optical denisty.

---

47. What is relative refractive index?

A) i. The refractive index of second medium with respect to first medium is called relative refractive index of second medium. It is repersented as 'n_{21}'

ii. $n_{21} = n_2 / n_1 = v_1 / v_2$

Here, n_1 is refractive index of 1st medium (incident medium) and n_2 is refractive index of 2nd medium (refracted medium).

Also, v_1 is speed of light in 1st medium and v_2 is speed of light in 2nd medium.

NOTE:

i. The refractive index of 1st medium with respect to 2nd medium is n_{12}

$n_{12} = 1/ n_{21} = n_1 / n_2 = v_2 / v_1$

---

48. The refractive index of water is 1.33 and the glass is 1.51. What is the refractive index of water with respect to glass and what is the refractive index of glass with respect to water?

A) Given: R.I of water (n_1) = 1.33 R.I of glass (n_2) = 1.51

i. R.I of water with respect to glass (n_{12}) = $n_1 / n_2 = 1.33 / 1.51$

$= 0.88$

ii. R.I of glass with respect to water (n_{21}) = $1 / n_{12} = 1 / 0.88$

$= 1.14$

---

49. The speed of light in 1st medium is 1.2×10^8 m/sec and 2nd medium is 2×10^8 m/sec. Calculate refractive index of 1st medium with respect to 2nd medium and refractive index of 2nd medium with respect to 1st medium.

A) Given: $v_1 = 1.2 \times 10^8$ m/sec $V_2 = 2 \times 10^8$ m/sex

i. R.I of 1st medium with respect to 2nd medium (n_{12}) = v_2 / v_1

$= 2 \times 10^8 / 1.2 \times 10^8 = 1.67$

ii. R.I of 2nd medium with respect to 1st medium (n_{21}) = $v_1 / v_2 = 1 / n_{12}$

$= 1/ 1.67 = 0.6$

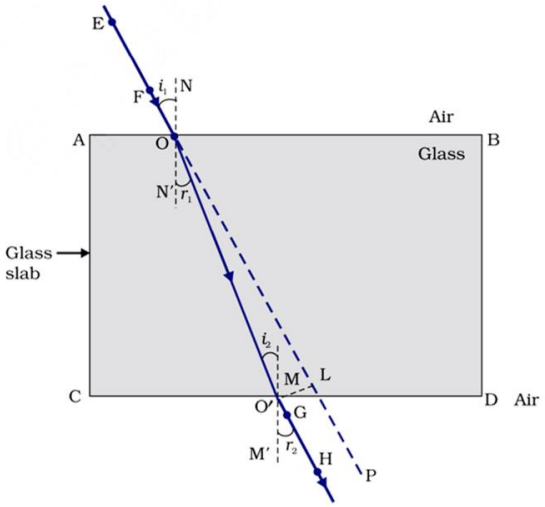
---

50. Explain the refraction of light through a rectangular glass slab.

A) **Aim:** To study about refraction of light through rectangular glass slab.

Apparatus: Drawing board, white paper, scale, pencil, some identical drawing pins, protractor and rectangular glass slab.

Diagram:



Procedure:

i. Fix a sheet of white paper on a drawing board using drawing pins
ii. Place a rectangular glass slab over the centre of the sheet.
iii. Draw the outlines of the slab with a pencil. Let us name the outline as ABCD.
iv. Take four identical pins.
v. fix two pins, say E and F vertically such that the line joining the pins is inclined to the edge AB.
vi. Look for the images of pins E and F through the opposite edge. Fix two more pins say G and H such that these pins and the images of E and F lie on a straight line.
vii. Remove the pins and the slab.
viii. Join the positions of tip of the pins E and F and produce the line up to AB.
ix. Let EF meet AB at O
x. Similarly, join the positions of tip of the pins G and H and produce it up to the edge CD. let HG meet CD at O'
xi. Join O and O' and also produce EF up to P as shown by a dotted line in the fig.

Explanation:

i. Here EO an incident ray is refracted at O of the side AB of glass slab travels from air into glass.
ii. OO' is the refracted ray travels in the glass slab reached to side CD and incident at O'.
iii. At O' light deviates form its original path and emerges as a ray O'H is called emergent ray.
iv. You are easily observed that $\angle i_1 = \angle r_2$ and the emergent ray is shifted slightly lateral.
v. The emergent ray and the extended incident ray are parallel.
vi. The perpendicular distance between emerged ray and extended incident ray is called lateral shift.
vii. The angle of deviation in rectangular glass slab is zero.

---

51. Can you shoot a fish in the water pond?

A) i. No, we can not able to shoot the fish in the water pond.
ii. Because the apparent position of fish is differing from its original position.
iii. It is caused by the light coming from the fish is refracted away from the normal at water-air interface.

---

52. If you are there in the pool, how do you appear to your friend who is standing at the bank of the pool?

A) i. Appear shorter than your original height
ii. Because light rays travels from your side to your friend, which is from water to air.
iii. Due to this, light rays refract away from normal at water and air interface.

---

53. If you are in the pool and your friend at the bank of pool. How did he appear to you?

A) i. He appears taller than his original height.

ii. Because light rays travels from your friend to you, which is from air to water.

iii. Due to this, light rays refract towards normal at air and water interface.

---

54. List the situations where light doesn't deviate when it travels between two different transparent media.

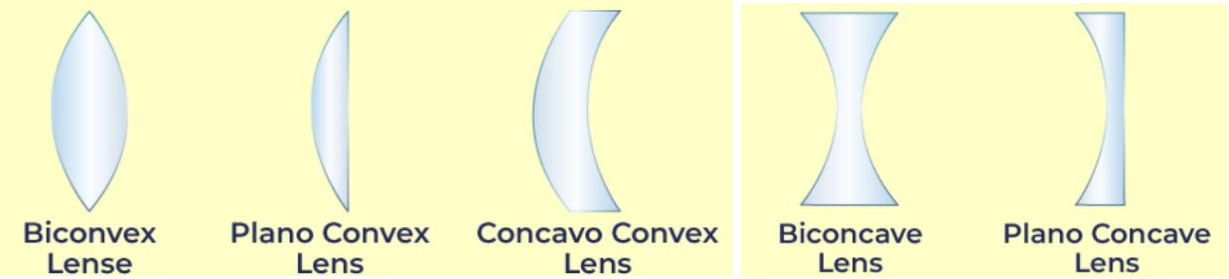
A) i. When the light travels normal (perpendicular) to the interface of two media.

ii. When the light travels between two transparent media of same refractive index because no change in speed of light.

---

55. What is lens? Draw the shapes of different lenses.

A) i. A lens is a transparent medium having two surfaces either both surfaces are curved surfaces or at least one surface is a curved surface.



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56. Define the following.

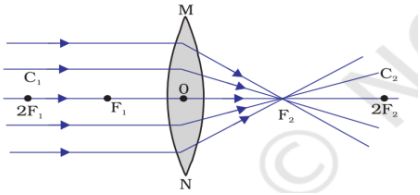
A) i. **Optic Centre of a Lens:** The optic centre of a lens is the central point inside the lens through which a ray of light passes without any deviation.

ii. **Principal Axis of a Lens:** The principal axis of a lens is an imaginary straight line passing through the optic centre and the centers of curvature of the lens surfaces.

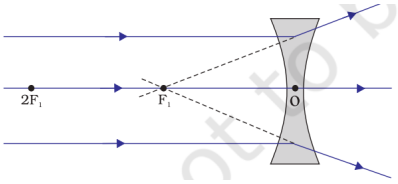
iii. **Principal Focus of a Lens**: The real or apparent point of intersection of refracted rays of a parallel beam incident on a surface of a lens is called Principal focus. A lens has two Principal foci F_1 and F_2.

iv. **Aperture of a Lens**: The diameter of the circular outline of a spherical lens is its aperture.

v. **Principal focus of Convex Lens:** The principal focus of a convex lens is the point where parallel light rays meet after refracted through the lens



vi. **Principal focus of Concave Lens:** The principal focus of a concave lens is the point from which rays of light appear to diverge after refracted through the lens



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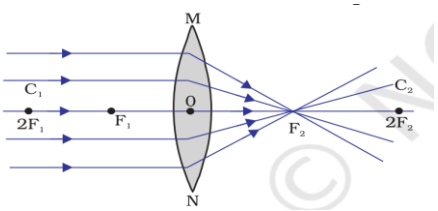
57. Which lens is called converging lens and why?

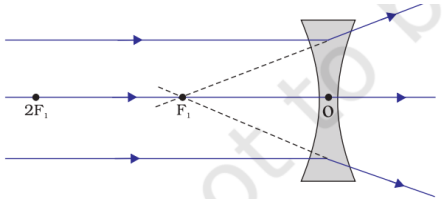
A) i. A convex lens is called a converging lens

ii. Because it makes parallel rays of light to meet at a point on the principal axis after refraction through the lens.



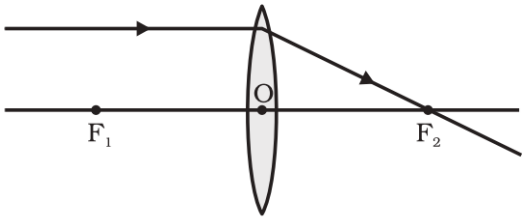
58. Which lens is called diverging lens and why?

A) i. A concave lens is called a diverging lens
ii. Because it makes parallel rays of light appear to move different directions from a point on principal axis after refraction through the lens

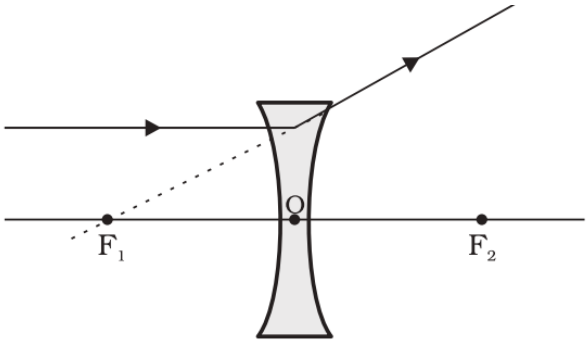


59. Write the rules of refraction of lenses.

A) i. An incident ray parallel to the principal axis after refraction passing through the principal focus.

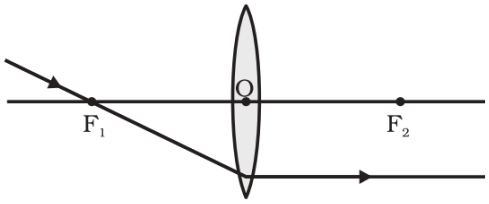


Convex Lens

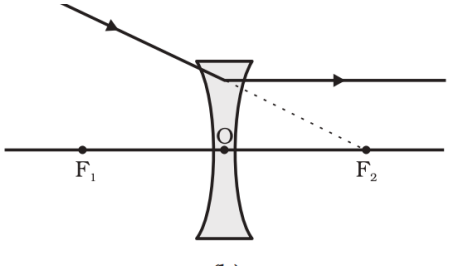


Concave Lens

ii. A ray passing through the principal focus emerges parallel to the principal axis after refraction.

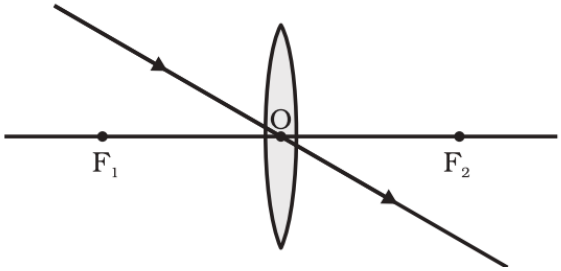


Convex Lens

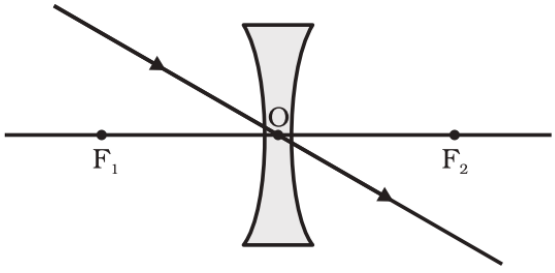


Concave Lens

iii. A ray passing through the optic centre of the lens goes straight without bending.



Convex Lens



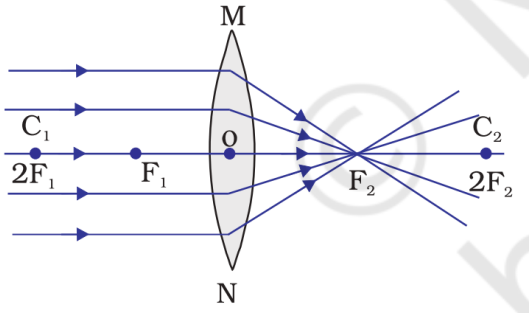
Concave Lens

NOTE:

If a light ray passes along the principal axis of the lens, goes straight without bending.

60. Draw ray diagrams of formation of images by Convex lens.

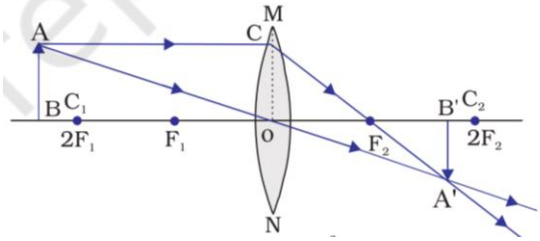
A) **Situation -1**: Object at infinite distance.



Characters of Image:

i. Image is real and inverted.
ii. Image size is highly diminished (point size)
iii. Image formed at principal focus

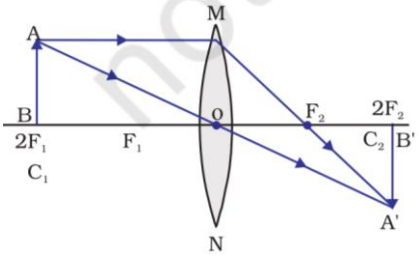
Situation -2: Object beyond $2F_1$



Characters of Image:

i. Image is real and inverted.
ii. Image size is diminished
iii. Image formed between F_2 and $2F_2$

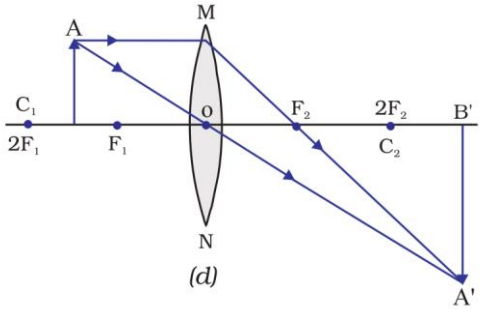
Situation -3: Object at $2F_1$.



Characters of Image:

i. Image is real and inverted.
ii. Image size is same as object size
iii. Image formed at $2F_2$

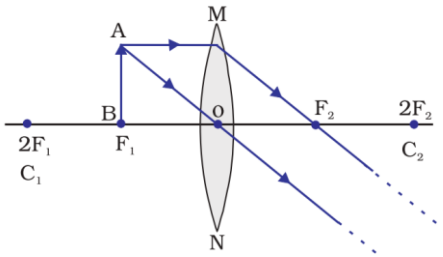
Situation -4: Object between $2F_1$ and F_1



Characters of Image:

i. Image is real and inverted.
ii. Image size is enlarged
iii. Image formed beyond $2F_2$

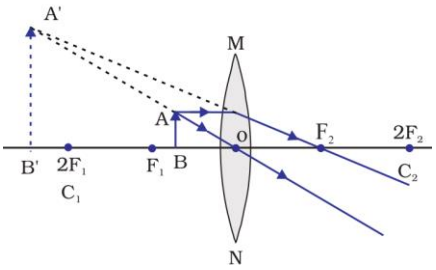
Situation -5: Object at F_1



Characters of Image:

i. Image is real and inverted.
ii. Image size is highly enlarged
iii. Image formed at infinite distance

Situation -6: Object between F_1 and O



Characters of Image:

i. Image is virtual and erected.

ii. Image size is enlarged

iii. Image formed at the same side of the object

---

61. Write the tabular form of characteristics of image formed by convex lens with respect to object distance

A

Position of the object	Position of the image	Relative size of the image	Nature of the image
At infinity	At focus F_2	Highly diminished, point-sized	Real and inverted
Beyond $2F_1$	Between F_2 and $2F_2$	Diminished	Real and inverted
At $2F_1$	At $2F_2$	Same size	Real and inverted
Between F_1 and $2F_1$	Beyond $2F_2$	Enlarged	Real and inverted
At focus F_1	At infinity	Infinitely large or highly enlarged	Real and inverted
Between focus F_1 and optical centre O	On the same side of the lens as the object	Enlarged	Virtual and erect

---

62. List the situations of enlarged images formed by convex lens and write the differences of images in that situations.

A) i. There are two situations where the image formed is enlarged.

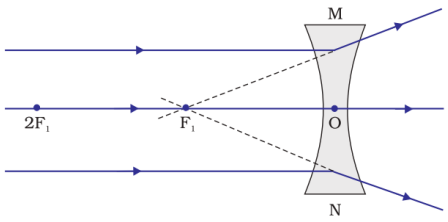
a. Object between F_1 and $2F_1$ b. Object between F_1 and O

Object between F_1 and $2F_1$	Object between F_1 and O
i. Image is real and inverted	i. Image is virtual and erected.
ii. Image formed beyond $2F_2$	ii. Image formed at the same side of the object

---

63. Draw ray diagrams of formation of images by Convex lens.

A) i. **Situation -1**: Object at infinite distance



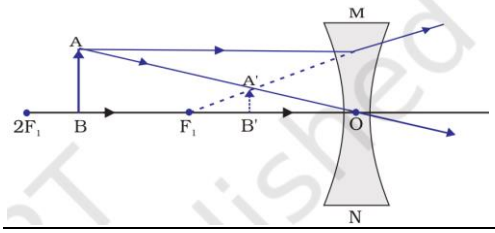
Characters of Image:

i. Image is virtual and erected.

ii. Image size is diminished

iii. Image formed at the same side of the object at F_1

ii. **Situation -2:** Object between Infinity and Optic centre of the lens



Characters of Image:

i. Image is virtual and erected.
ii. Image size is diminished
iii. Image formed at the same side of the object between F_1 and O

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64. Write the lens formula and explain each term.

A) Lens formula: $1/f = 1/v - 1/u$ (OR) $f = uv / u-v$

Where f ---> focal length

u ---> object distance

v ---> image distance

NOTE:

i. By sign convention, focal length of convex lens is positive and concave lens is negative.
ii. By sign convention, object distance is always negative.
iii. By sign convention, image distance of real image is positive and virtual image is negative.

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65. Write formula for magnification of lenses.

A) Magnification (m) = $h_i / h_o = v / u$

Here, h_i → size of image

h_o → size of object

NOTE:

i. By sign convention, magnification for real image is negative and virtual image is positive.

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66. Table for identification of image characters with respect to magnification value of lenses.

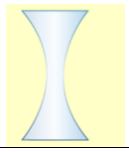
A)

Sl. No	m – value =	Nature of image	Image position	Object position	Nature of the Lens
1.	m > -1 i.e. m is "-ve" m > 1	Real image. Enlarged image	Beyond '$2F_2$'	Between '$2F_1$' and 'F_1'	Convex lens
2.	m = -1 i.e. m is "-ve" m=1	Real image. Same size of the object	At '$2F_2$'	At '$2F_1$'	Convex lens
3.	m < -1 i.e. m is "-ve" m < 1	Real image. Diminished image	Between '$2F_2$' and 'F_2'	Beyond '$2F_1$'	Convex lens
4.	m > +1 i.e. m is "+ve" m > 1	Virtual image. Magnified image	Same side of the object	Between 'F_1' and 'O'	Convex lens

5.	m < +1 i.e. m is "+ve" m < 1	Virtual image. Diminished image	Same side of the object from 'F_1' to 'O'	Irrespective of object position	Concave lens

67. Write the differences between Convex and Concave lens.

A)

Convex Lens	Concave Lens
i. Both surfaces of this lens is bulged out	i. Both surfaces of this lens is lowered inn
ii. Middle portion of the lens is thicker than the edges	ii. Middle portion of the lens is thinner than the edges
iii. It is called converging lens	iii. It is called diverging lens
iv. This lens converges refracted rays of parallel beam of incident light	iv. This lens diverges refracted rays of parallel beam of incident light
v. It forms both real and virtual images	v. It forms only virtual images
vi. By sign convention, its focal length is positive	vi. By sign convention, its focal length is negative.
vii. The shape of convex lens is 	vii. The shape of concave lens is 

68. Write the uses of lenses.

A) i. **Uses of Convex Lens**:

> Used as magnifying glass.
> Used by watch mechanic to repair watches.
> Used to correct eye defect – Hypermetropia
> Used in cameras, projectors, microscopes etc…

ii. **Uses of Concave Lens**:

> Used as spy-hole of doors.
> Used to correct eye defect – Myopia
> Used in telescopes.
> Used in DVD players to diverge laser lights to read CDs

69. Write short note on Power of a lens.

A) i. The degree of bending of light by a lens is called power of lens.

ii. Mathematically, power of a lens is reciprocal of focal length of given lens.

i.e. Power (P) = 1/ focal length

p = 1/f , where, f is in meters.

P =100 /f, where, f is in centi-meters.

iii. The S.I unit of power of a lens is diopter (D).

NOTE:

By sign convention, power of convex lens is positive and concave lens is negative.

70. Define diopter. (or) The power of lens is 1D. what does it mean?

A) If the focal length of a given lens is 1 metre i.e. 100cms, then its power is said to be 1 diopter(D).

71. What is the focal length and power of combination of two lenses of focal length f_1 and f_2?

A) i. When two lenses are in contact

The resultant focal length $1/f = 1/f_1 + 1/f_2$ (or) $f = f_1 f_2 / f_1 + f_2$

The resultant power $P = P_1 + P_2$.

ii. When two lenses are at a distance (d),

The resultant focal length $1/f = 1/f_1 + 1/f_2 - d/ f_1f_2$

The resultant power $P = P_1 + P_2 - d (P_1 P_2)$

72. The radius of curvature of a spherical mirror is 20 cm. What is its focal length?

A) Given: R = 20 cm, f =?

We know that, f = R/2

= 20/2 = 10 cm

73. A ray of light travelling in air enters obliquely into water. Does the light ray bend towards the normal or away from the normal? Why?

A) i. Light bend towards the normal.

ii. Because here light travels from air to water i.e. from rarer medium to denser medium.

iii. In denser medium speed of light decreases and bend towards the normal.

74. You are given kerosene, turpentine and water. In which of these does the light travel fastest?

Material medium	Kerosene	Turpentine Oil	Water
Refractive Index	1.44	1.47	1.33

We know that, $n \propto 1/v$

If 'n' is maximum, speed of light is minimum. Like that, if 'n' is minimum, speed of light is maximum.

Here, water is having least 'n' value. That's why in water the light travels fastest.

75. Find the power of a concave lens of focal length 2 m.

A) Given: f = -2m, P =?

P = 1/f = 1/-2 = -0.5D

76. One-half of a convex lens is covered with a black paper. Will this lens produce a complete image of the object? Verify your answer experimentally. Explain your observations

A) Yes, the lens produces complete blurred image of the object.