Prepp

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SSC MTS Exam

Study Material for Genral Awareness

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LIGHT

Introduction

- Light is a radiation which makes our eyes able to see the object when light from an object enters our eyes that we see the object. The light may have been emitted by the object, or may have been reflected by it.
- Light wave is an electromagnetic wave. It has an electric and a magnetic component.
- Light is a transverse wave.
- Light seems to travel in straight lines.
- Opaque objects do not allow light to pass through them.
- Transparent objects allow light to pass through them and we can see through these objects clearly.
- Translucent objects allow light to pass through them partially.
- Shadows are formed when an opaque object comes in the path of light.
- Light travels in vacuum with an enormous speed of 3×10^8 m s^{-1}. The speed of light is different in different media.
- Sun light is white colour.
- Sunlight takes an average of 8 minutes and 20 seconds to travel from the Sun to the Earth.
- White light is composed of seven colours.
- Splitting of light into its constituent colours is known as dispersion.
- Light is reflected from all surfaces.
- Any polished or a shining surface acts as a mirror.
- An image which can be obtained on a screen is called a real image.
- An image which cannot be obtained on a screen is called a virtual image.
- The image formed by a plane mirror is erect. It is virtual and is of the same size as the object. The image is at the same distance behind the mirror as the object is in front of it.
- In an image formed by a mirror, the left side of the object is seen on the right side in the image, and right side of the object appears to be on the left side in the image.
- Visually impaired persons can read and write using the Braille system.
- Beautiful patterns are formed in a kaleidoscope because of multiple reflections.
- Periscope works on the Laws of Reflection.

Reflection

- A highly polished surface such as a mirror reflects most of the light falling on it.
- Mirror changes the direction of light that falls on it. This change of direction by a mirror is called reflection of light.
- Any polished or a shiny surface can act as a mirror.
- Example: a shining stainless steel plate or a shining steel spoon can change the direction of light. The surface of water can also act like a mirror and change the path of light.

- Image formed by a **plane mirror** is always **virtual and erect.**
- The size of the image is equal to that of the object.
- **Want to see full image** in a **plane mirror** a person required a mirror of at least half the object.

Laws of Reflection

- After striking the mirror the ray of light is reflected in another direction. The light ray which strikes any surface is called the incident ray.
- The ray that comes back from the surface after reflection is known as the reflected ray.
- **Two laws of reflection are:**
    1. The angle of incidence is equal to the angle of reflection.
    2. Incident ray, reflected ray and the normal drawn at the point of incidence to the reflecting surface, lie in the same plane.
- These laws of reflection are applicable to all types of reflecting surfaces including spherical surfaces

Spherical Mirror

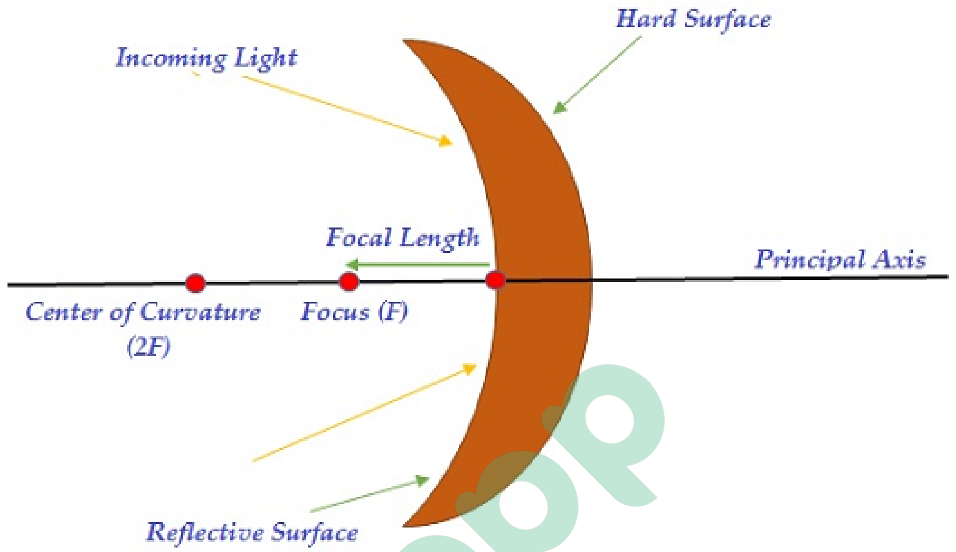
- The reflecting surface of a spherical mirror may be curved inwards or outwards.
- A spherical mirror whose reflecting surface is **curved inwards** that is faces towards the center of the sphere is called a **concave mirror.**
- A spherical mirror whose reflecting surface is curved **outwards** is called a **convex mirror.**

CONCAVE MIRROR

CONVEX MIRROR

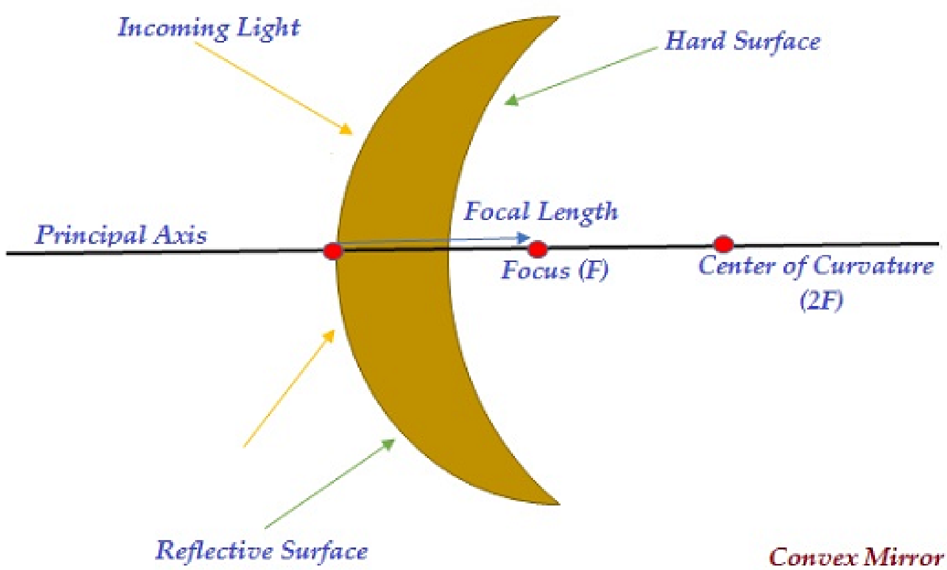
- Distance between the pole and the principal focus of a spherical mirror is called the focal length.
- Radius of curvature is found to be equal to twice the focal length.
- The centre of the reflecting surface of a spherical mirror is a point called the pole.
- The diameter of the reflecting surface of spherical mirror is known as its **aperture**.
- The reflecting surface of a spherical mirror forms a part of a sphere, which has a center, known as the **center of curvature** represented by English letter '**C**.'
- Remember, the center of curvature is not a part of the mirror, but rather it lies outside the reflecting surface.
- In case of concave mirror, the center of curvature lies in front of it.
- In case of convex mirror, the center of curvature lies behind the mirror.

- The radius of the sphere of which, the reflecting surface of a spherical mirror forms a part, is known as the **radius of curvature** of the mirror and represented by the English letter '**R**.'
- Remember, the distance pole P and center of curvature C is equal to the radius of curvature.
- The imaginary straight line, passing through the pole and the center of curvature of a spherical mirror, is known as the **principal axis**.
- All the reflecting rays meeting/intersecting at a point on the principal axis of the mirror; this point is known as principal focus of the concave mirror. It is represented by English letter **'F'**.



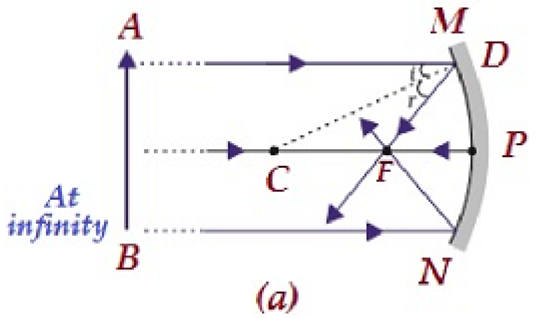
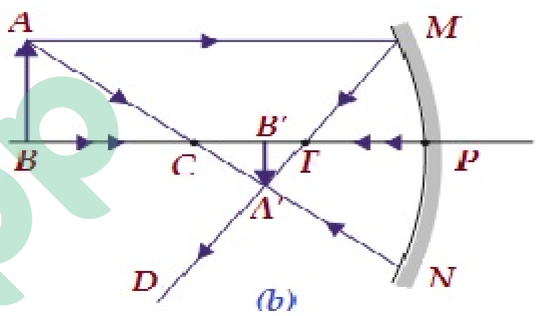
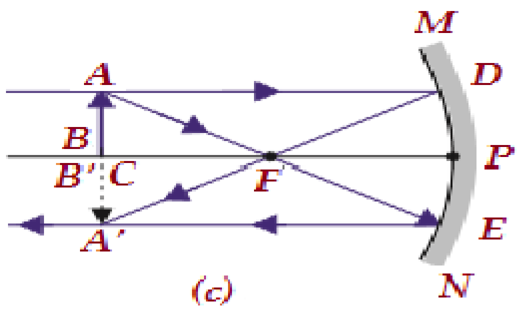
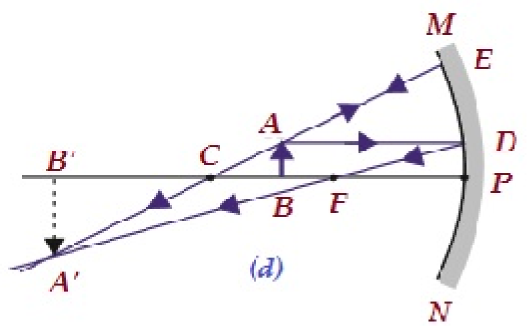
Concave Mirror Diagram

- On the other hand, in case of convex mirror, the reflected rays appear to come from a point on the principal axis, known as the **principal focus** *(F).*



Convex Mirror Diagram

Image Formation by a Concave Mirror for Different Positions of the Object

Position of Object	Position of Image	Size of Image	Nature of Image	Image
At infinity	At the focus F	Highly diminished, point sized	Real and inverted	
Beyond C	B/w F and C	Diminished	Real and inverted	
At C	At C	Same size	Real and inverted	
B/w C and F	Beyond C	Enlarged	Real and inverted	

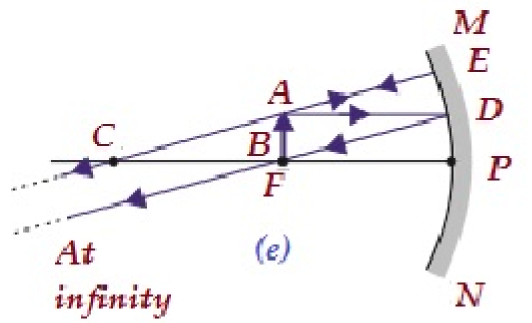
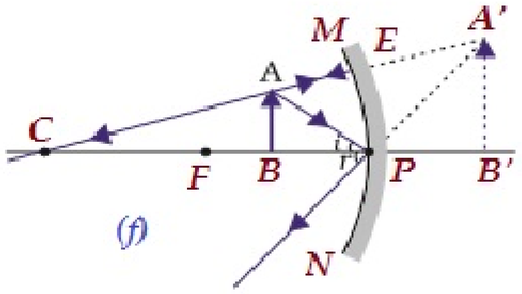
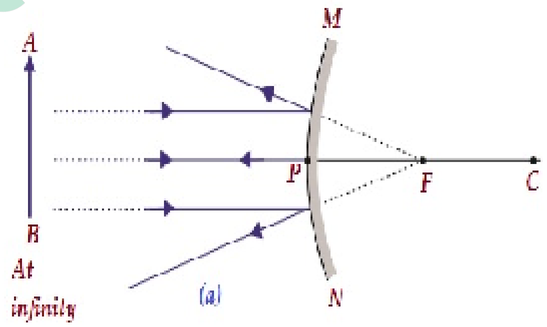
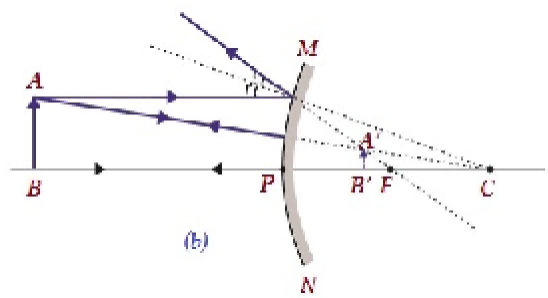
At F	At infinity	Highly enlarge	Real and inverted	
B/w P and F	Behind the mirror	Enlarged	Virtual and erect	

Image Formed by a Convex Mirror for Different Positions of the Object

Position of Object	Position of Image	Size of Image	Nature of Image	Image
At infinity	At the focus F, behind the mirror	Highly diminished, point sized	Virtual and erect	
B/w infinity and pole of the mirror	B/w P and F, behind the mirror	Diminished	Virtual and erect	

Uses of Concave Mirrors

- Concave mirrors are used in torches, search-lights and vehicles headlights to get powerful parallel beams of light.
- Used as a shaving mirrors to see a larger image of the face.

- Dentists use concave mirrors to see large images of the teeth of patients.
- Concave mirrors are used to concentrate sunlight to produce heat in solar furnaces.

Uses of Convex Mirrors

- Convex mirrors are commonly used as rear view mirrors in vehicles.
- Convex mirrors are installed on public roads as traffic safety device. They are used in acute bends of narrow roads such as hairpin bends in mountain passes where direct view of oncoming vehicles is restricted.

Mirror Formula

- The relationship between the object-distance (u), image-distance (v), and focal length (f) of a spherical mirror given by the mirror formula which is expressed as

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

Magnification

- Magnification is expressed as the ratio of the height of the image to the height of the Object

$$m = \frac{\text{Height of the image } (h')}{\text{Height of the object } (h)}$$

Refraction of Light

- Refraction of light is the change in direction of a light ray when it travels from one medium to another.
- This deviation (change in direction) in the path of light is due to the change in velocity of light in the different medium.
- Velocity of light is more in a rarer medium (low optical density) than in a denser medium (high optical density).
- Light does not travel in the same direction in all media. It appears that when travelling obliquely from one medium to another, the direction of propagation of light in the second medium changes. This phenomenon is known as refraction of light.
- The coin becomes visible on pouring water into the bowl. The coin appears slightly raised above its actual position due to refraction of light.
- Lemon kept in water in a glass tumbler appears to be bigger than its actual size, when viewed from the sides due to refraction of light.
- When a ray of light enters from one medium to another medium its phase and frequency do not change but wavelength and velocity change.

Laws of Refraction of Light

- The incident ray, the refracted ray and the normal to the interface of two transparent media at the point of incidence, all lie in the same plane.
- The ratio of sine of angle of incidence to the sine of angle of refraction is a constant, for the

light of a given colour and for the given pair of media. This law is also known as **Snell's law of refraction.**

(This is true for angle 0 <*i* < 90o)

If I is the angle of incidence and r is the angle of refraction

$$\frac{\sin i}{\sin r} = constant$$

Refractive Index

- Refraction of light in a medium depends on the speed of light in that medium. When the speed of light in a medium is more, the bending is less and when the speed of light is less, the bending is more.
- The refractive index of a transparent medium is the ratio of the speed of light in vacuum to that in the medium.
- **Refractive index = Speed of light in medium 1/Speed of light in medium 2**

Refractive indices of some common substances are

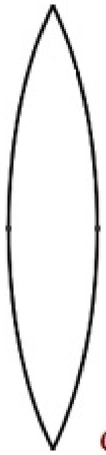
Substances	Refractive index
Air	1.0003
Ice	1.31
Water	1.33
Alcohol	1.36
Kerosene	1.44
Rock salt	1.54
Diamond	2.42

Spherical Lenses

- A transparent material normally glass bound by two surfaces, of which one or both surfaces are spherical, is known as 'spherical lens'.

Convex Lens

- A lens may have two spherical surfaces, bulging outwards, is known as convex lens or a double convex lens.



Convex Lens

- The middle part of this lens is bulged thicker and at the both ends, it is narrow.
- Convex lens converges the light rays; therefore, it is also known as **converging lens**.

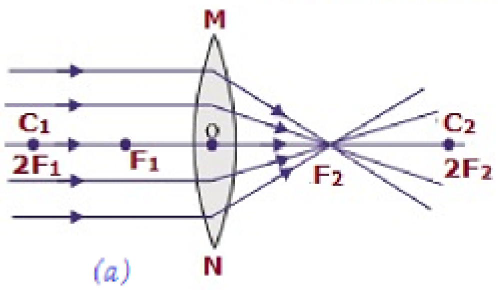
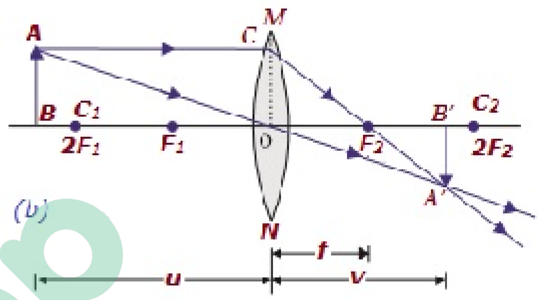
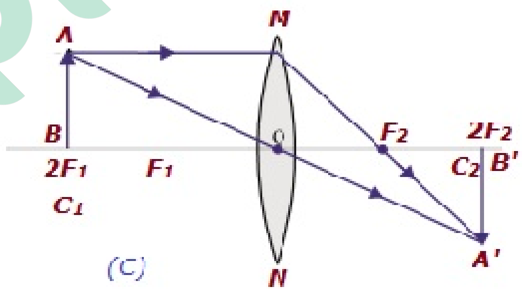
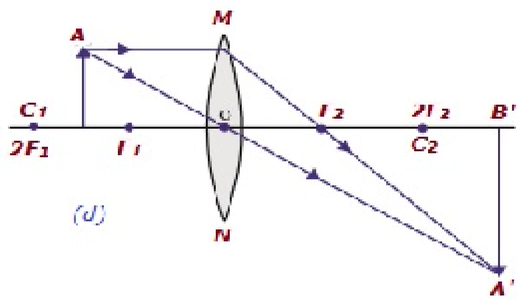
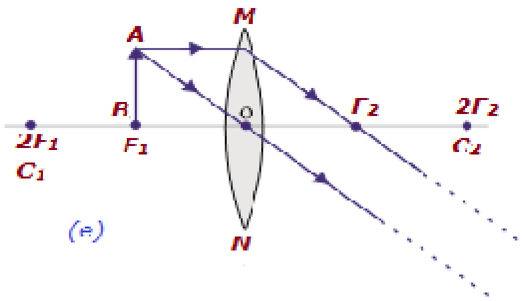
Concave Lens

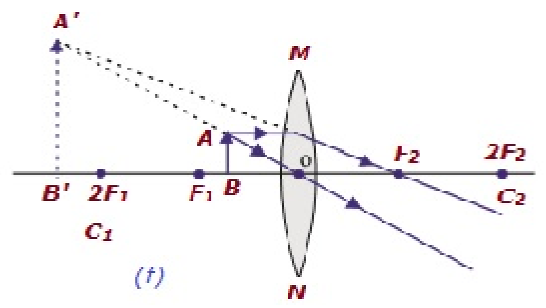
- A lens may have two spherical surfaces, curved inwards, is known as concave lens or a double concave lens.

Concave Lens

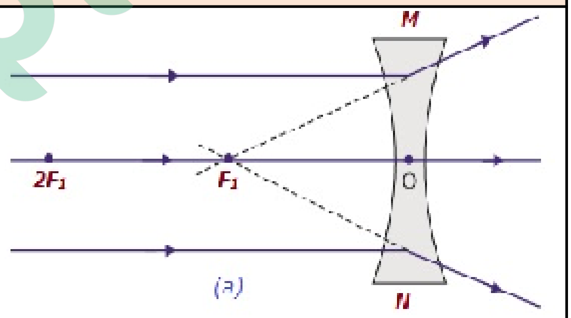
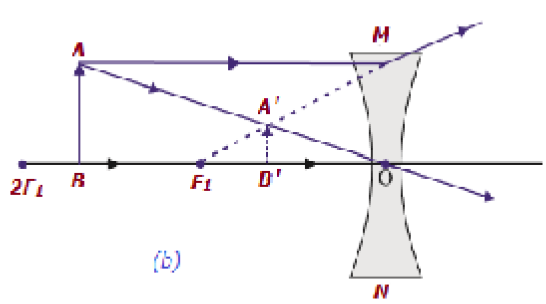
- The middle part of this lens is narrow curved inwards and the both the edges are thicker.
- Concave lens diverges the light rays; therefore, it is also known as **diverging lens**.
- A lens, either a concave or a convex, has two spherical surfaces and each of these surfaces forms a part of the sphere. The centers of these spheres are known as **centers of curvature**, represented by English letter '**C**.'
- As there are two centers of curvature, therefore, represented as 'C_1' and 'C_2.'
- An imaginary straight line, passing through both the centers of curvature of a lens, is known as **principal axis**.
- Optical center is the central point of a lens. It is represented by '**O**.'
- An aperture is the actual diameter of the circular outline of a spherical lens.
- Principal focus of lens is represented by '**F**.'
- A lens has usually two foci represented as F_1 and F_2.
- **Focal length** is the distance between the principal focus and the optical center of a lens. It is represented by '**f**.'

Nature and position of images formed by a convex lens

Position of Object	Position of Image	Size of Image	Nature of Image	Image
At infinity	At the focus F2	Highly diminished ,pointsized	Real and inverted	
Beyond 2F1	B/w F2 and 2F2	Diminished	Real and inverted	
At 2F1	At 2F2	Same size	Real and inverted	
B/w F1 & 2F1	Beyond 2F2	Enlarged	Real and inverted	
At focus F1	At infinity	Infinitely large or highly enlarged	Real & inverte d	

B/w focus F1 & optical center O	On the same side of the lens as the object	Enlarged	Virtual and erect	

Nature and position of images formed by a concave lens

Position of Object	Position of Image	Relative Size of Image	Nature of Image	Image
At infinity	At the focus F1	Highly diminished, pointsized	Virtual and erect	
B/w infinity & optical center O of the lens	B/w F1 & optical center O	Diminished	Virtual and erect	

Lens Formula

- Lens formula gives the relationship between object distance (*u*), image-distance (*v*) and the focal length *(f)*.
- The lens formula is:

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

Magnification

- The magnification is defined as the ratio of the height of the image and the height of the object.

$$m = \frac{\text{Height of the image } (h')}{\text{Height of the object } (h)}$$

Power Of Lens

- The degree of convergence or divergence of light rays achieved by a lens is expressed in terms of its power.
- Power of a lens is defined as the reciprocal of its focal length.
- SI unit of power of a lens is dioptre.

$$P = \frac{1}{f}$$

Total Internal Reflection

- When the angle of incidence exceeds the value of critical angle the refracted ray is impossible. Since r > 90°, refraction is impossible and the ray is totally reflected back to the same medium (denser medium). This is called as total internal reflection.
- Conditions to achieve total internal reflection:
  - Light must travel from denser medium to rarer medium. (Example: From water to air).
  - The angle of incidence inside the denser medium must be greater than that of the critical angle.

Examples of Total Internal Reflection

- **Optical fibres** work on the phenomenon of **total internal reflection.**
- Mirage.
- Total internal reflection is the main cause for the spectacular brilliance of **diamonds.**