REVIEW QUESTIONS

12.1 What do you understand by reflection of light? Draw a diagram to illustrate reflection at a plane surface.

Ans. See Question No. 1

12.2 Describe the following terms used in reflection (i) Normal (ii) Angle of incidence Angle of reflection

Ans. **Normal:** The perpendicular to a reflecting or refracting surface at the point of incidence of the ray concerned is called normal

Angle of incidence:

The angle between the incident ray and the normal is called angle of incidence.

Angle of reflection

The angle between the normal and the reflected fray is called angle of reflection.

12.3 State laws of reflection. Describe how they can e verified graphically.

Ans. See Question No. 1

12.4 Define refection of light. Describe he passage of light through parallel-sided transparent material.

Ans. See Question No. 4

12.5 Define the following terms used in refraction : (i) Angle of incident (ii) Angle of refraction

Ans. **Angle of incidence:**

The angle made by the incident ray with the normal is called angle of incidence.

Angle of refraction:

The angle made by the refracted ray with the normal is called angle of refraction.

12.6 What is meant by refractive index of a material? How would you determine the refractive index of a rectangular glass slab?

Ans. **Refractive index:**

The refractive index of a medium is the ratio of the speed of light in a vacuum to the speed of light in the medium.

$$\text{Refractive index} = \frac{\text{Speed of light in vacuum}}{\text{Speed of light in medium}}$$

If refractive index is denoted by n, speed of light in a vacuum by c and speed of light in the medium by v, then.

$$n = \frac{c}{v} \quad \text{.....(12.2)}$$

12.7 State the laws of refraction of light and show how they may be verified using rectangular glass slab and pins.

Ans. **Laws of refraction of light:**

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

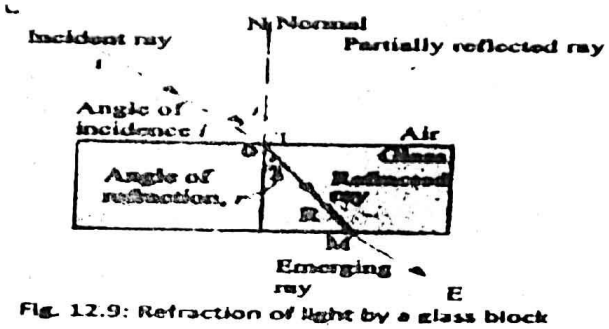


Fig. 12.9: Refraction of light by a glass block

(ii) The ratio of the sine of the angle of incidence I to the sin of the angle of refraction r is always equal to a constant.

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

Where the ratio sin i/sin r is known as the refractive index of the second medium with respect to the first medium. So , we have

$$\frac{\sin i}{\sin r} = n = \frac{n_2}{n_1}$$

It is called Snell's law:

12.8 What is meant by the term total interval reflection?

Ans. See Question No. 5

12.9 State the conditions for total internal reflection.

Ans. See Question No. 5

12.10 What is critical angle Derive a relationship between the critical angle and the refractive index of a substance?

Ans. See Question No. 5

12.11 What are optical fibres? Describe how total internal reflection is used in light propagating trough optical fibres.

Ans. See Question No. 11

12.12 Define the following terms applied to a lens:

Ans. See Question No. 7

12.13 What is meant by the principal focus of a (a) convex lens (b) a concave lens illustrate you answer with ray diagram.

Ans. See Question No. 7

12.14 Describe how light is refracted through convex lens.

Ans. See Question No. 7

12.15 With the help of a ray diagram, how you can show the use of thin converging lens as a magnifying glass.

Ans. See Question No. 8.

12.16 A coin is placed at a focal point of a converging lens. Is an image formed? What is its nature?

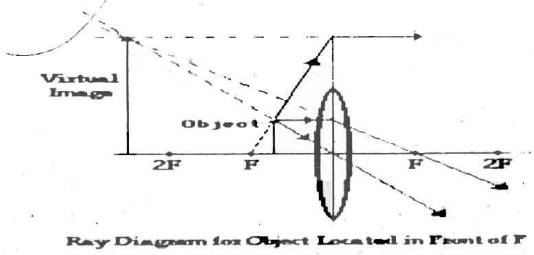
Ans. When a coin is placed at the focal point of the principal focus, no mage is formed because the refracted rays are parallel and never meet.

12.17 What are differences between real and virtual images?

Real Image	Virtual Image
1. It is formed by concave mirror only.	It can be formed by convex as well as concave mirror.
2. It is always inverted expiation.	It is always erect sun snpall.
3. It is formed at real principal focus (F) of a real object i.e light rays actually p ass the angle F.	It is formed at virtual principal focus (F) of a virtual object i.e lith rays appear the diverge from F.
4. It has positive sign convention.	It has negative sign convention.
5. It is formed infront of the mirror.	It is formed behind the mirror.
6. Focal length of real image is taken positive.	Focal length of virtual image is taken negative.

12.18 How does a converging lens form a virtual image of a real object? How does a diverging lens can form a real image of a real object?

Ans. When the object is placed between the convex lens and F, the image will be virtual. The ray diagram is shown in the figure given below.



Ray Diagram for Object Located in Front of F

A concave lens cannot form a real image of a real object in the air. If the concave lens is placed in a medium of refractive index greater than that of glass, then it will form real image of a real object.

12.19 Define power of a lens and its units.

Ans. See Question No. 7

12.20 Describe the passage of light through a glass prism and measure the angle of deviation.

Ans. See Question No. 4

12.21 Define the terms resolving power and magnifying power.

Ans. See Question No. 13

12.22 Draw the ray diagrams of (i) Simple microscope (ii) Compound microscope (iii) Refracting telescope

Ans. See Question No. 13 , 14 and 15

12.23 Draw ray diagrams to show the formation of images in the normal human eye.

Ans. See Question No. 16

12.24 What is meant by the terms nearsightedness and farsightedness? How can these defects can be corrected?

Ans. See Question No. 17

CONCEPTUAL QUESTIONS

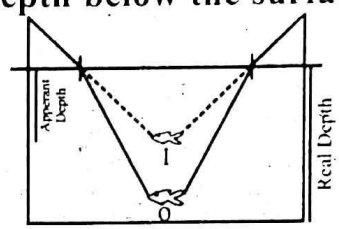
12.1 **A man raises his left hand in a plane mirror; the image facing him is raising his right hand. Explain why.**

Ans: A man raises his left hand in a plane mirror; the image facing him is raising his right hand. Because light rays are reflected in mirror causing us to see an inverted image.

12.2 **In your own words, explain why light waves are refracted at a boundary between two materials.**

Ans: Light waves are reflected at a boundary between two material due to change of speed of light while traveling form one medium to another. This change of speed of light at the boundary is caused by the change in the refractive indices of the two materials.

12.3 **Explain why a fish under water appears to be at a different depth below the surface than actually is. Does it appear deeper or shallower?**



Ans: A fish under water appear to the shallower that it really is, because of apparent depth, as a virtual image is formed at I above O, where image seem to be formed due to refraction of light.

12.4 **Why or why not concave mirrors are suitable for make up?**

Ans: Concave mirrors are suitable for makeup as they act as magnifier to form large size erect images of objects. When a person stand between principle focus and pole of mirror.

12.5 **Why is the driver's side mirror in many cars convex rather than plane or concave?**

Ans: Diver's side mirror is convex mirror as it gives an upright, erect although small image, it provider a wider field of view as it is curved outwards.

12.6 **When an optician's testing room is small, he uses a mirror to help him test the eye sight of his patients. Explain why?**

To increase the distance of alphabets form the patient, the optcianuses palen mirror if his testing room is small.

12.7 **How does the thickness of lens affect its focal length?**

If the thickness of a lens is increased, the power of the lens is also increased. Hence the focal length of the lens is decreased.

12.8 **Under what conditions will a converging lens form a virtual image?**

Ans: Converging lens forms a virtual image when object is placed between optical center and its focal point. The image formed will be eract and larger than the object.

12.9 **Under what conditions will a converging lens form a real image that is the same size as the object?**

Ans: When object is placed at 2F form the converging lens it forms a real and inverted image that has the same size as the object.

12.10 **Why do we use refracting telescope with large objective lens of large focal length?**

In refracting telescope we use objective lens of larger focal length so as to gather more light form weak distant sources. It not only makes them more visible but also increases the resolving power of the telescope.

SOLVED BOX INFORMATION

Point to ponder (Page 42)

Q.1 **In large shopping centres, convex mirrors are used for security purposes. Do you know why?**

Ans. In large shopping centres, convex mirrors are used to see hidden areas or places, it helps to avoid any stealing or theft and for better supervision.

Point to ponder (Page 42)

Q.2 **why the position of fish inside the water seems to be at less depth than that of its actual positon?**

Ans. Position of fish inside the water seems to be at less depth due to refraction of light at the surface or water.

Self assessment (Page 45)

Q.3 **Will the bending of the light be more or less for a medium with high refractive index?**

Ans. Bending of light is more for a medium with high refractive index.

Self Assessment (Page 55)

Q.4 **Where a pen is placed in front of a convex lens if the image is equal to the size of the pen? What will be the power of the lens in dioptres?**

Ans. To obtain an image of the pin where its size is equal to the size of the pen, the pen must be placed at 2F from the convex lens.

Quick Quiz (Page 62)

Q.5 **how the size of the pupil of our eye will change: (a) in dim light (b) in bright light.**

Ans. (a) In dim light, the size of the pupil of our eye increases.

(b) In bright light, the size of the pupil of our eye decrease.

EXERCISE

MULTIPLE CHOICE QUESTIONS

(1) **Which of the following quantities is not changed during refraction of light?**
(a) Its direction (b) Its speed (c) Its frequency (d) Is wavelength

(2) **A converging mirror with a radius of 20cm creates a real image 30 cm from the mirror. What is the object distance?**
(a) 5.0cm (b) 7.5cm (c) 15cm (d) 20cm

(3) **An object is placed at the centre of curvature of a concave mirror. The imge produced by the mirror is located**
(a) Out beyond the centre of the curvature
(b) At the centre of curvature
(c) Between the centre of curvature and the focal point
(d) At the focal point

(4) **An object 14cm in front of a convex mirror. The image is 5.8 cm behind the mirror. What is the focal length of the mirror?**
(a) 4.1cm (b) 8.2cm (c) 9.9cm (d) 20cm

(5) **The index of refraction depends on**
(a) The focal length (b) The speed of light (c) The image distance (d) The object distance

(6) **Which type of image is formed by a concave lens on a screen?**
(a) Inverted and real (b) Inverted and virtual (c) Upright and real (d) Upright and virtual

(7) **Which type of image is produced by the converging lens of human eye if it views a distant object?**
(a) Real, erect, same size (b) Real, inverted, diminished
(c) Virtual, erect, diminished (d) Virtual, inverted, magnified

(8) **Image formed on a camera is**
(a) Real, invited, and diminished (b) Real, inverted, diminished
(c) Virtual, erect, diminished (d) Virtual, inverted, magnified

(9) **If a ray of light in glass is incident on a n air surface at an angle greater than the critical angel, the ray will**
(a) Refract only (b) Reflect only
(c) Partially refract and partially reflect (d) Diffract only

(10) **The critical angle for a beam of light passing form water into air is 48.8 digress. This means that all light rays with an angle of incidence greater than this angle will be**
(a) Absorbed
(b) Totally reflected
(c) Partially reflected and partially transmitted
(d) Totally transmitted

ANSWER KEY

1	2	3	4	5	6	7	8	9	10
c	b	b	c	b	d	b	a	b	b

CHAPTER 12

GEOMETRICAL OPTICS

CONCEPT MAP

LIGHT

Light rays and reflection

Two laws of reflection:

The incident ray, reflected ray and the normal at the point of incidence all lie in the same plane

(ii) $i = r$

Characteristics of an image formed by a plane mirror:

- Same size as object
- Inverted front-to-back
- Upright
- Virtual
- As far behind the mirror as the object is in front of the mirror

Some applications of plane mirrors:

- Optical testing
- Periscope
- Blind corner
- Instrument scales

Ray diagrams

Refractive index n is defined as

$n = \frac{\sin i}{\sin r}$ where i is the angle of incidence in air

For the special case of the refracted ray in air:

$\sin c = \frac{1}{n}$

Where c is the critical angle

Total internal reflection occurs when:

- A ray of light travels from an optically denser to a less dense medium
- The angle of incidence in the optically denser medium is greater than the critical angle c

some applications of total internal reflection:

- Prisms in binoculars and periscopes
- optical fibres in telecommunications and the medical industry

Light rays and refraction

Two laws of refraction:

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

Snell's Law $\frac{\sin i}{\sin r}$=constant

Two laws of refraction:

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

Snell's Law $\frac{\sin i}{\sin r}$=constant

Real and inverted

- Real images are formed when object distance is $p < f$
- Virtual and upright images are formed when $p \leq f$

Some applications of thin converging lenses

- Magnifying glass
- projector
- Camera
- Visual correction for long-sightedness

TOPICAL MULTIPLE CHOICE QUESTIONS

12.1 Reflection:

(1) **Plank suggested that light consists of small packets of energy called:**
(a) Electrons (b) Neutrons (c) Photons (d) Positrons

(2) **The angle between incident ray and normal N is;**
(a) Angle of reflection (b) Angle of incidence (c) Angle of refraction (d) Normal angle

(3) **Angle of incidence is represented by**
(a) i (b) e (c) R (d) p

(4) **The angle between the normal and the reflected ray is called angle of**
(a) Reflection (b) Refraction (c) Incidence (d) Diffraction

(5) **The incident ray, the normal, and the reflected ray at the point of incidence all lie in the**
(a) Opposite direction (b) Same plane (c) x and y axis (d) y & z - axis

(6) **According to law of reflection**
(a) $i > r$ (b) $i < r$ (c) $r > i$ (d) $i = r$

(7) **Regular reflection is reflection by the**
(a) Rough surface (b) Smooth surface
(c) Irregular surface (d) Smooth and rough surfaces

(8) **The rough surfaces of object reflect the rays of light in many directions is called**
(a) Regular reflection (b) Irregular reflection (c) Refraction (d) Interference

12.2 Spherical Mirrors

(9) **In concave mirror the surface is reflecting;**
(a) Outer surface (b) Outer curved (c) Inner curved surface (d) Side of the mirror

(10) **Which statement is incorrect about concave mirror?**
(a) Size of image depends upon position of the object
(b) Both virtual and real images can form
(c) Inner surface of spherical mirror is reflecting
(d) Only virtual images are formed

(11) **A spherical mirror whose outer curved surface is reflecting is called**
(a) concave mirror (b) convex mirror (c) Concave lens (d) Convex lens

(12) **Which statement is correct about convex mirror?**
(a) Size of image is smaller than object (b) Only virtual erect image is formed
(c) Outer curved surface is reflecting (d) All of the given statements are true

(13) **Vertex is the midpoint of the curved surface of spherical mirror is also called**
(a) Radius of curvature (b) Principal axis
(c) Pole (d) Principal focus

(14) **A line joining centre of curvature and pole of the spherical mirror is**
(a) Principal axis (b) principal focus (c) Centre of curvature (d) Pole

(15) **The distance from the pole to the principal focus measured along the principal axis is**
(a) Principal focus (b) Radius of curvature (c) Focal length (d) Diameter

12.3 Image location by spherical mirror formula
12.4 Refraction of light

(16) The relationship between object distance p, image distance q from the mirror and focal length of the mirror is called;
(a) Mirror focal length (b) Distance from mirror
(c) Mirror formula (d) Lens formula

(17) Mirror formula is
(a) $\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$ (b) $\frac{1}{f} = \frac{1}{p} - \frac{1}{q}$ (c) $\frac{1}{f} = \frac{1}{p} - \frac{q}{p}$ (d) $\frac{1}{f} = \frac{1}{q} + \frac{p}{q}$

(18) Focal length of spherical mirror is
(a) $\frac{R}{4}$ (b) $\frac{R}{2}$ (c) $\frac{R}{3}$ (d) $\frac{R}{9}$

(19) Convex mirror produce images
(a) Larger than object (b) Smaller than object (c) Equal to object (d) Very large in size

(20) The bending of light as it passes from one transparent medium into another is
(a) Reflection (b) Refraction (c) Reverberation (d) Incidence

(21) According to law of refraction
(a) $\frac{\sin i}{\sin r} > i$ (b) $\frac{\sin r}{\sin i} > r$ (c) $\frac{\sin i}{\sin r} = cons\tan t$ (d) $\frac{\sin r}{\sin i} > n$

(22) $\frac{\sin i}{\sin r} = n = \frac{n_2}{n_1}$ is called
(a) Boyl's law (b) Charless's law (c) Snell's law (d) Newton's law

(23) Speed of light in air is approximately
(a) 3.0×10^8 ms^{-1} (b) 4×10^9 ms^{-1} (c) 4×10^{14} ms^{-1} (d) 3×10^7 ms^{-1}

(24) The speed of light is greater in
(a) Air (b) Water (c) Solid (d) Glass

(25) The speed of light in water is approximately
(a) 2.0×10^8 ms^{-1} (b) 2.3×10^8 ms^{-1} (c) 3×10^8 ms^{-1} (d) 3×10^7 ms^{-1}

(26) $? = \frac{\text{speed of light in vacuum}}{\text{speed of light in medium}}$
(a) Reflective index (b) Snell's law (c) Refractive index (d) Critical angle

12.5 Total internal reflection
12.6 Refraction through prism
12.7 Lenses

(27) When a ray of light enters from a denser medium to a rarer medium
(a) It bends toward the normal (b) It bends away from the normal
(c) It bends towards inside (d) None of these

(28) The angle of incidence that causes the refracted ray in the rarer medium to bend through 90° is called
(a) Critical angle (b) Angle of incidence (c) Angle of reflection (d) Angle of refraction

(29) No refraction occurs when the angle of incidence is
(a) Smaller than the critical angle (b) Larger than the critical angle
(c) Equal to the critical angle (d) Very small than the critical angle

(30) **The line passing through the two centres of curvatures of the lens is called**
(a) Principal focus (b) Optical centre (c) Principal axis (d) Focal length

(31) **Optical centre is represented by**
(a) A (b) f (c) F (d) C

(32) **For a concave lens, the parallel rays appear to come from a point behind the lens is called;**
(a) Principal focus (b) Principal axis (c) Focal length (d) Optical length

(33) **The distance between the optical centre and the principal focus is.**
(a) Principal focus (b) Principal axis (c) Focal length (d) Optical length

(34) **It is a transparent body (made of optical glass) with at least two polished plane faces inclined towards each other from which light is refracted;**
(a) prism (b) camera (c) lens (d) mirror

(35) **In lens number of curved surfaces at least;**
(a) two (b) three (c) one (d) four

(36) **Lenses are used in optical devices;**
(a) camera (b) eyeglasses (c) microscope (d) all given

(37) **The lens which causes incident parallel rays to converge at a point is;**
(a) convex lens (b) converging lens (c) both a & b (d) concave lens

(38) **Lens thick at the centre but thin at the edges is;**
(a) concave (b) convex (c) diverging (d) plane

(39) **SI unit of power of lens is:**
(a) meter (b) dioptre (c) centimeter (d) millimeter

(40) **1D = ?**
(a) $1m^{-1}$ (b) m^{-2} (c) m^{-3} (d) cm^{-1}

(41) **It has positive focal length;**
(a) simple lens (b) concave lens (c) convex lens (d) none of above

12.8 Refraction through lenses
12.9 Image Location by lens equation

(42) **In mirrors images are formed through reflection, but lenses form images through;**
(a) refraction (b) incidence (c) diffraction (d) reflection

(43) **In case of convex lens when object is placed beyond 2F,the image is formed;**
(a) between F and 2F (b) real, inverted (c) smaller than object (d) all of these

(44) **The image with convex lens is formed at 2F, real , inverted, the same size as the object when the object is placed at:**
(a) 2F (b) between F and 2F (c) F (d) C

(45) **When object is at F the image is;**
(a) inverted (b) real (c) small (d) not formed

(46) **Lens formula is**
(a) $\frac{1}{p}=\frac{1}{f}+\frac{1}{q}$ (b) $\frac{1}{f}=\frac{1}{p}+\frac{1}{q}$ (c) $\frac{1}{f}=\frac{q}{p}+\frac{1}{q}$ (d) $\frac{1}{f}=\frac{1}{p}-\frac{1}{q}$

(47) **For a converging lens f is;**
(a) negative (b) positive
(c) some time negative and some time positive (d) smaller

(48) **The study of behaviour of light is called;**
(a) optics (b) geometry (c) plasma (d) geometrical optics

(49) **If the object is on the right side of the lens then p is;**
(a) positive (b) negative (c) smaller (d) larger

(50) **Optical device is;**
(a) camera (b) slide projector (c) photograph enlarger (d) all of given

(51) **Which statement is correct about image formed by camera?**
(a) Real image is formed (b) Inverted image is formed
(c) Diminished image is formed (d) All options are true

(52) **In case of photograph enlarger the object is placed at distance;**
(a) more than F (b) less than 2F (c) both A and B (d) more than 3F

(53) **The working principle of photograph enlarger is the same as;**
(a) Slide projector (b) camera (c) Telescope (d) Endoscope

(54) **Which pipe is a bundle of thousand of optical fibres bounded together?**
(a) light pipe (b) Telescope (c) Microscope (d) Projector

(55) **It is used to explore the interior organs of the body?**
(a) Telescope (b) Endoscope (c) Microscope (d) Projector

(56) **Endoscope used to diagnose the stomach is;**
(a) Cystoscope (b) Gastroscope (c) Bronchoscope (d) Pancreoscope

(57) **Endoscope which is used to diagnose throat is;**
(a) Gastroscope (b) Cystoscope (c) Bronschoscope (d) None of these

12.11 Simple Microscope
12.12 Compound Microscope

(58) **A magnifying glass is a convex lens which is used to produce magnified images of small objects. It is also called;**
(a) Compound microscope (b) Simple microscope
(c) Electron microscope (d) Light microscope

(59) **For seeing tiny objects we use microscope of;**
(a) low resolving power (b) high resolving power
(c) Electron microscope (d) Light microscope

(60) **Which statement is correct about compound microscope?**
(a) Focal length of objective lens is smaller than eyepiece.
(b) Distance between objective lens and eyepiece is greater than $f_0 + f_e$.
(c) It is used to see very small object
(d) All given statements are true

(61) **The magnification of compound microscope is;**
(a) $M = \frac{L}{f_0}\left(1+\frac{d}{f_e}\right)$ (b) $M = \frac{L}{f_0}$ (c) $M = \left(1+\frac{d}{f_e}\right)$ (d) $M = \frac{L}{f_e}\left(1+\frac{d}{f_e}\right)$

12.13 Telescope
12.14 The Human Eye
12.15 Defects of Vision

(62) **It is an optical instrument which is used to observe distant objects using lens or mirror;**
(a) microscope (b) Kaledoscope (c) Telescope (d) Light microscope

(63) **Magnification of telescope can be determined by using formula;**
(a) $M = \frac{f_0}{f_e}$ (b) $M = \frac{f_0}{f_0}$ (c) $M = \frac{F}{L}$ (d) $M = \frac{L_0}{f_0}$

(64) **Human eye acts like;**
(a) Camera (b) Telescope (c) Kaledoscope (d) Microscope

(65) **Light enters the eye through transparent membrane called;**
(a) Retina (b) Cornea (c) Iris (d) Pupil

(66) **The coloured portion of eye controls the amount of light reaching the retina.**
(a) Iris (b) Pupil (c) Cornea (d) eye lens

(67) **The variation of focal length of eye lens is called;**
(a) Variation (b) Accommodation (c) Magnification (d) Resolution

(68) **When people cannot see distant objects clearly without the aid of spectacles the defect of vision is;**
(a) Short-sighted (b) near-sightedness (c) both A & B (d) Farsightedness

(69) **Short sighted may be due to eyeball being**
(a) too long (b) too short (c) too thick (d) too thin

(70) **Have ability to move eye lens forward or backward.**
(a) Fish (b) Human (c) Birds (d) Dog

(71) **The nearsighted eye can be corrected by using;**
(a) diverging lens (b) converging lens (c) both A & B (d) Concave mirror

(72) **The disability of the eye to form distinct images of nearby object on retina is called forsightedness or:**
(a) Short sightedness (b) isometropia (c) hypermetropia (d) Myopia

(73) **Farsightedness is corrected by using;**
(a) Converging lens (b) diverging lens (c) concave mirror (d) convex mirror

(74) **Power of concave lens is:**
(a) Greater (b) Less (c) Positive (d) Negative

(75) **Long sightedness is caused due to ---------- eye ball:**
(a) Thick (b) Thin (c) small (d) Both a & c

(76) **Near point of a normal human being is:**
(a) 25 cm (b) 50 cm (c) 100 cm (d) Infinity

(77) **Long sightedness is removed by:**
(a) Convex mirror (b) Concave mirror (c) Convex lens (d) Concave lens

ANSWER KEY

Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans	Q	Ans	Q	Ans	Q.	Ans
1	c	11	b	21	c	31	d	41	c	51	d	61	a	71	a
2	b	12	d	22	c	32	a	42	a	52	c	62	c	72	c
3	a	13	c	23	a	33	c	43	d	53	a	63	a	73	a
4	a	14	a	24	a	34	a	44	a	54	a	64	a	74	d
5	b	15	c	25	b	35	c	45	d	55	b	65	b	75	b
6	d	16	c	26	c	36	d	46	b	56	b	66	a	76	a
7	b	17	a	27	b	37	c	47	b	57	c	67	b	77	c
8	b	18	b	28	a	38	b	48	a	58	b	68	c		
9	c	19	b	29	b	39	b	49	b	59	b	69	a		
10	d	20	b	30	c	40	a	50	d	60	d	70	a		

SHORT QUESTIONS

12.1 Reflection of light

Q.1. What is reflection?

Ans: Reflection of light:

When light traveling in a certain medium falls on the surface of another medium, a part of it turns back in the same medium. This is called reflection of light.

OR

The bouncing back of light in first medium after striking with any reflecting surface.

Q.2. Define regular reflection and irregular reflection ?

Regular Reflection:

The reflection by smooth surface in which all the reflected rays are parallel to each other is called regular reflection.

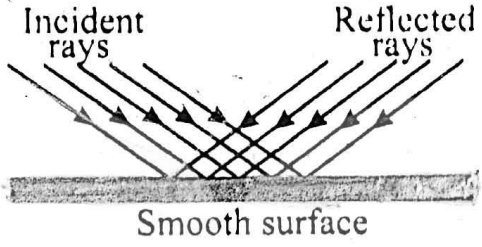


Fig. 12.3 Regular reflection

Irregular Reflection:

The reflection of light rays are not parallel to each other.

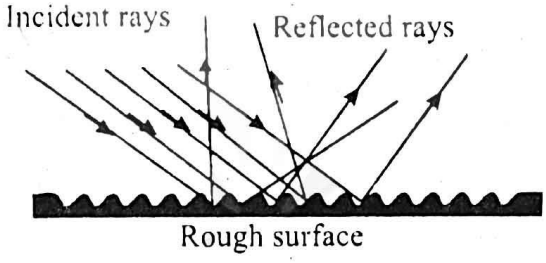


Fig. 12.4: Irregular reflection

Q.3. Write the conditions for regular and irregular reflection.

Ans: Conditions for Regular Reflection:

- The reflecting surface should be plane surface.
- The reflecting surface should be flat.
- The reflected rays of light should be parallel to each other and equal-space.

Conditions for Irregular Reflection:

- The reflecting surface should be rough.
- The reflecting rays of light are not parallel to each other.

Q.4. What are the laws of reflection of Light?

Ans: A ray of light obeys the following laws of reflection:

(i) The angle of incidence is equal to the angle of reflection.

(ii) The incident ray, the reflected ray and normal at the point of incidence, all lie in the same plane.

Q.5. **Define the following terms**
(i) Incident ray (ii) reflected ray (iii) normal (iv) angle of incidence (v) angle of reflection(vi) ray of light (vii) beam of light.

Ans:

(i) **Incident Ray:**
The ray of light coming form source of light is known as incident ray.

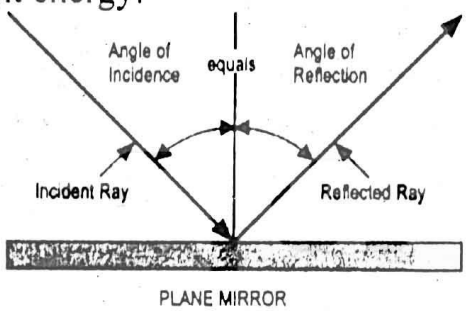
(ii) **Reflected Ray:**
The light ray which is thrown back, when incident ray hit the reflecting surface.

(iii) **Normal:**
A line (imaginary) at the right angle to the plane (surface) is called normal to surface.

(iv) **Angle of incidence:**
The angle between the incident ray and normal

(v) **Ray of light:**
The direction of path taken by light is known as ray of light.

(vi) **Beam of light:**
A beam is a stream of light energy.



12.2 Spherical Mirrors
12.3 Image location by spherical mirror formula

Q.6. **What are the spherical mirrors? How light is reflected from spherical mirrors? Give the uses of spherical mirrors?**

Ans: A spherical mirror, in fact, is a portion of the reflecting surface of a hollow sphere. Spherical mirrors are of two types:

(i) Concave Mirror

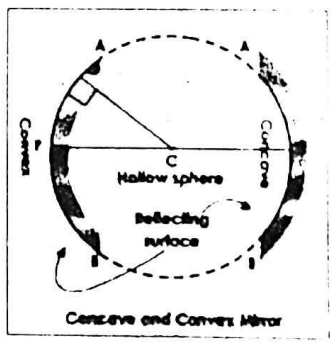
(ii) Convex Mirror

(i) **Concave Mirror**

The mirror whose inner curved surface is reflecting is called the concave mirror as shown in figure (a).

(ii) **Convex Mirror**

The mirror whose outer curved surface is reflecting is called the convex mirror as shown in figure (b).



Q.7. **Write down Uses of spherical mirrors**

Now-a-days spherical mirrors have a large number of scientific and practical uses. A few uses are given below:

1. Doctors use concave mirrors for examination of ear, nose, throat and eyes.
2. Concave mirrors with a parabolic shape are used in searchlight to throw an intense beam of light to a large distance.

3. Some people use a concave mirror for shaving because when a man stands between the principal focus and pole of a concave mirror, he sees an enlarged, erect and virtual image of his face. This is the reason why a concave mirror of large focal length is used for shaving.
4. Concave mirrors are used to throw light on the slides of microscope so that the slides can be viewed more clearly.
5. Now-a-days America and other developed countries use giant concave mirrors in their huge telescopes.
6. Convex mirrors are used in motorcycles and automobiles which enables the driver to see the automobiles coming behind him.
7. In huge shopping centers, convex mirrors are used for security purposes.

Q.8. Define the center of curvature, Radius of curvature, aperture, pole and principal axis.

Ans: Center of curvature

The centre of the sphere, of which a concave mirror or convex mirror is a part is known as the "Centre of Curvature" of the spherical mirror. In the figure, the point C is the center of curvature.

Radius of curvature

The radius of the sphere, of which a concave mirror or convex mirror is a part is known as the "Radius of Curvature" of the spherical mirror. In the figure, R is the radius of sphere or radius of curvature.

Aperture

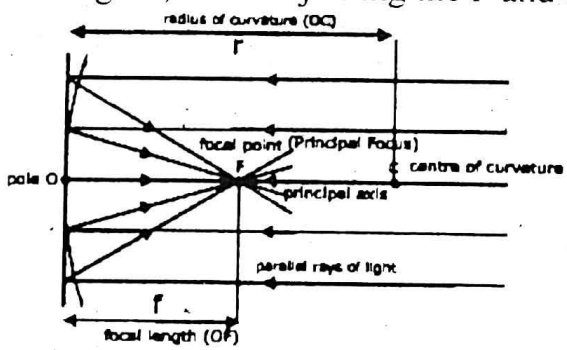
The front section of spherical mirror is circular one and its diameter is known as the "Aperture".

Pole

The centre of the concave or convex mirror is called the pole of the mirror. In the figure P is the pole of the mirror.

Principal Axis

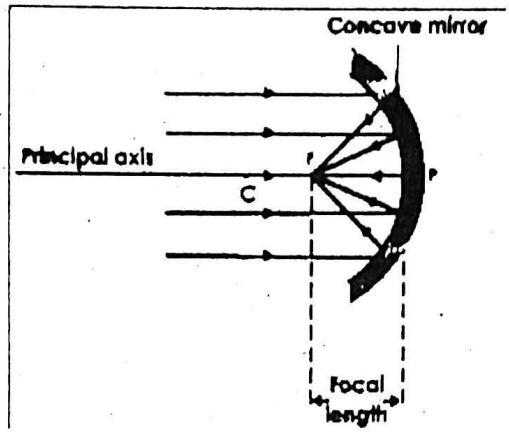
A line joining the pole of the mirror and the centre of curvature is called the "Principal Axis" of the mirror. In the figure, the line joining the P and the C is the principal axis.



Q.9. Define principal focus for concave and convex mirror and why they are called real and virtual focus?

Ans: Real Focus for Concave mirror

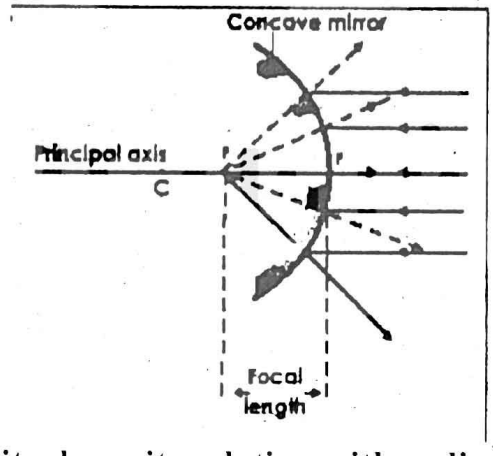
Rays of light parallel to the principal axis after reflection from a concave mirror converge to a point F. This point is called the "Principal Focus" of the mirror. Since rays, in fact, pass through this point, therefore, it is called real focus.



Virtual Focus for Convex mirror

In the case of a convex mirror, rays parallel to the principal axis after reflection appear to come from a point F situated behind the mirror. This point is called the principal focus of the convex mirror.

The principal focus of a convex mirror is virtual focus because the reflected rays do not actually pass through it but appear to do so. Therefore, its focus is called virtual focus.



Q.10. Define focal length and write down its relation with radius of curvature.

Ans: The distance between the pole and the principal focus of a spherical mirror (concave as well as convex) is called the "Focal Length". It is denoted by f.

Relation between Radius of curvature and focal length

The radius of curvature of a spherical mirror is twice of its focal length. i.e; R = 2f or f = R/2

Q.11. Define linear magnification.

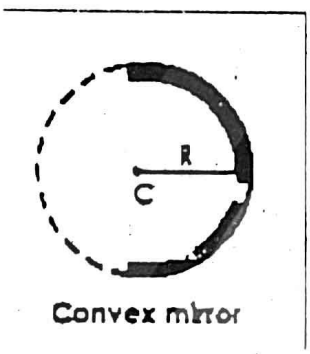
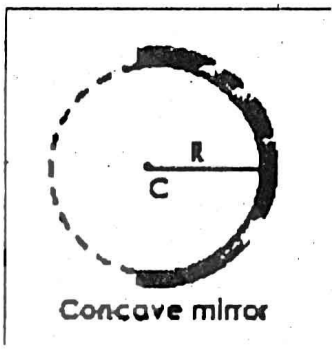
Ans: The ratio of the height of the image to that of the object is called as linear magnification or simply magnification and is denoted by the letter m. Thus

$$m = \frac{\text{Size of Image}}{\text{Size of Object}} = \frac{\text{Image distance}}{\text{Object distance}}$$

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

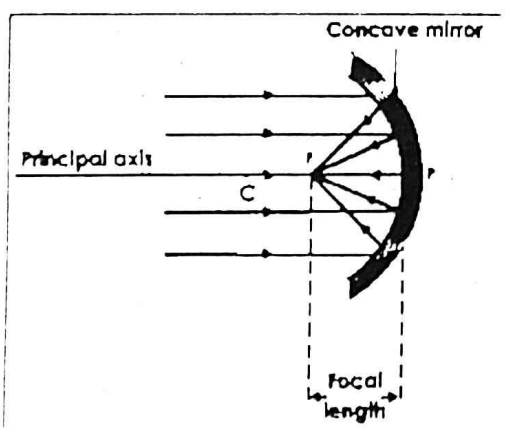
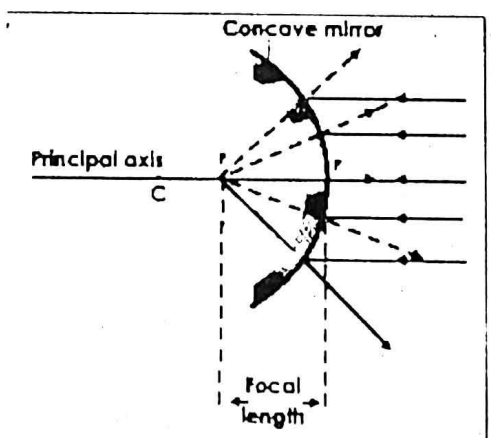
Q.12. **Write the characteristics of focus of concave and convex mirror.**

Ans: Characteristics of focus of concave and convex mirror:

Convex Mirror	Concave Mirror
• The mirror whose outer curve surface is reflecting is called convex mirror • Focus lie behind the mirror	• The mirror whose inner curve surface is refleacting is called concave mirror • Focus is in-front of the mirror.
• The focus is virtual as the reflected rays appear to come from focus.	• The focus is real as the rays of light after reflection converge at the focus.
• The focus of convex mirror is a diverging point of reflected rays. 	• The focus of concave mirror is a converging point of reflected rays. 

Q.13. **Differentiate between real and virtual principal focus.**

Ans:

DIFFERENCE BETWEEN REAL AND VIRTUAL FOCUS	
Real Focus	**Virtual Focus**
In concave mirror, the reflected rays actually pass through its principal focus. So it is real focus. 	In convex mirror, the reflected rays do not pass through the focus but appears to do so. So it is virtual focus. 

Q.14. Difference between Real Image and Virtual Image

Real Image	Virtual Image
1. Real image is formed when rays after reflection actually meet at a point.	1. Virtual image is formed when rays do not actually meet but appear to diverge from a point.
2. Real image is inverted and can be seen on a screen.	2. Virtual image is erect and cannot be seen on a screen.
3. It has a physical existence.	3. It does not have a physical existence.

Q.15. Why convex mirror are fixed on blind turns on the roads in hill areas?

Ans: Convex mirrors are fixed on blind turns on the road in hill areas because driver from one side of turn can see the automobiles coming from other side of mountain. So chances of accidents can be minimized.

Q.16. Why concave mirrors are used for examination of nose, ear, throat and eye?

Ans: Concave mirrors are used for examination of nose, ear, throat and eye to view a big and clear image of these organs.

Q.17. Why concave mirror is used for make up or shave?

Ans: Concave mirror is used for make up or shave because when a man/woman stands between the principal focus and pole of the concave mirror, he sees an enlarged image of his/her face. This is the reason why a concave mirror of large focal length is used for shaving and make up.

Q.18. Explain with help of activity whether the image is smaller or large, erect or inverted, real or virtual in a convex mirror.

Ans: Take a convex mirror or a well polished spoon (using out side of the spoon) and hold it in one hand and a pencil in other hand with its tip in upright position. Now look at the image in mirror. The image in convex mirror.

- Appears smaller
- Upright
- Behind the mirror
- Virtual

Now an object moves closer to convex mirror the image in convex mirror.

- Moves closer to the mirror
- Becomes larger
- Upright
- Stays virtual

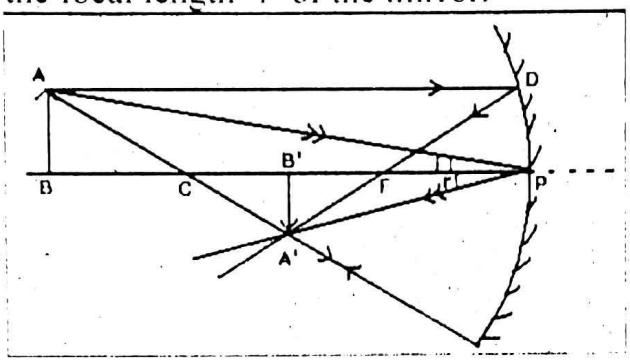
Q.19. How we can locate image by spherical mirrors? How we can tell the nature of image an size of image.

Ans: The location of the image, nature of image and the size of image calculated by he mirror formula which can be written as $\frac{1}{f} = \frac{1}{p} + \frac{1}{q} \rightarrow (1)$

f = focal length of mirror
p = distance between the pole and object
q =distance between mirror and image
The equation can be used for both concave and convex mirrors.

Q.20. Define mirror formula/mirror equation? Also write signs of convention.

Ans: Curved mirror formula is the relationship between object distance 'p' image distance 'q' from the mirror and the focal length 'f' of the mirror.



Mathematically it can be written as:

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q} \rightarrow (2)$$

This equation is true for both type concave and convex mirror. But we already seen that the image is formed sometimes in the front of curved mirror and sometimes behind it. This make it necessary to have a signs convection so that we may distinguish between the two cases and obtain the correct answer when substituting in the formula.

Explain showing the use of the two signs conventions in common use are given below.

1. All distances are measured from the pole of mirror.
2. Distances measured against the incident light are negative.
3. Distances measured in the same direction as incident of light are positive.

If the object is placed to the left of the mirror, the ordinary graphical convention of signs comes into operation, i.e., distance measured to the let are negative,; those to the right, positive.

Signs of convection:

The focal length of concave mirror is positive and the negative of convex mirror. Sign of convections are given as following.

Quantity	When positive (+)	when negative (-)
1. Object distance 'p'	1. Real object	**1. Virtual object**
2. Image distance 'q'	2. Real image	**2. Virtual image**
3. Focal length 'f'	**3. Concave mirror**	**3. Convex mirror**

Q.21. Explain with the help of activity whether the image is smaller or larger, erect or inverted in a concave mirror.

Ans: Take a concave mirror or a well polished speed with a concave surface hold it in one hand and pencil in other hand with the tip in upright. The image formed by concave mirror is

- Real image
- Inverted

For all object positions outside the principal focus. But when the object is placed between focus and pole then the image is

- Virtual
- Upright

Q.22. What do you know about mirage?

Ans: In hot summer days, reflection of motor cars is seen on the roads and the image of an aeroplane is seen on runway, infact there is no water on the runway. It is due to total internal reflection and this phenomenon is known as mirage.

12.4 Refraction of light

Q.23. Write down the law of refraction.

Ans: The refraction of light takes place according to the following two laws:

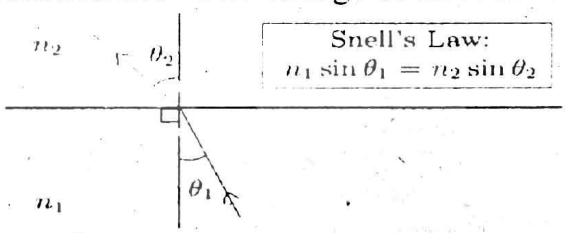
(i) The incident ray, the refracted ray and normal all lie in the same plane.

(ii) When a ray of light passes from one particular medium to another, the ratio of the sine of the angle of incidence (i) to the sine of angle of refraction (r) is constant.

This constant ratio is called the "Refractive Index" of the second medium with respect to the first and it is denoted by the letter 'n'. It can be mathematically written as:

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

It is called Snell's law. A ray of light entering the second medium perpendicularly through the surface of separation shows no change of direction.



Q.24. What is Snell's law?

Ans: When a ray of light passes from one particular medium to another, the ratio of the sine of the angle of incidence (i) to the sine of angle of refraction (r) is constant. This constant ratio is called the "Refractive Index" of the second medium with respect to the first and it is denoted by the letter 'n'. It is called Snell's law.

It can mathematically be written as:

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{n_2}{n_1} = n$$

It is called Snell's law. A ray of light entering the second medium perpendicularly through the surface of separation shows no change of direction.

Q.25. What is refractive index? Write down the methods to calculate the refractive index.

Ans: When a ray of light passes from one particular medium to another, the ratio of the sine of the angle of incidence (i) to the sine of angle of refraction (r) is constant. This constant ratio is called the "Refractive Index" of the second medium with respect to the first and it is denoted by the letter 'n'. It can mathematically be written as:

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

Second method

The refractive index of a medium can also be calculated by dividing the speed of light in vacuum by the speed of light in that medium. As the speed of light in vacuum is almost equal to the speed of light in air, therefore, we use the speed of light in air instead of vacuum, while calculating the refractive index of a medium.

Refractive index of medium with respect to air = $\frac{\textit{Speed of light in air}}{\textit{Speed of light in a medium}}$

$$n = \frac{C}{V}$$

Q.26. The speed of light in glass is 2 x 10^8 ms^{-1} and that in air is approximately 3 x 10^8 ms^{-1}, calculate refractive index of glass.

Ans: Refractive index of glass with respect to air = $\frac{\textit{Speed of light in air}}{\textit{Speed of light in glass}}$

$$n = \frac{C}{V}$$

By putting the values, we have

$$n = \frac{3 \times 10^8}{2 \times 10^8}$$

$$= 1.5$$

So refractive index of glass with respect to air is 1.5.

Q.27. Explain when does the light change its path, when pass through two different medium.

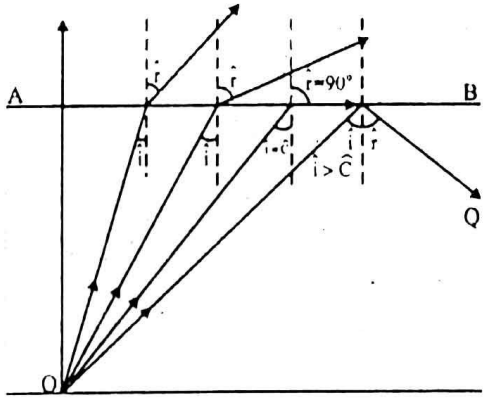
Ans:

1. During refraction light bends towards normal as the light enters from rate to denser medium.
2. During refraction light bends away as light enters from the denser to rare medium.
3. The angel of incidence is greater than angel of refraction. When light enters from rate to denser medium.
4. The angle of incidence is smaller than angle of refraction when light enters from denser to rare medium
5. If the light ray (incident ray) is along the normal (i.e. 90°) to the interface between the two medium, the ray pass through without deviation.
6. No refraction take place in the same medium.

12.5 Total internal reflection

Q.28. Define total internal reflection. What is meant by critical angle? Explain total internal reflection and conditions necessary for it.

Ans: "When a ray of light from a denser medium enters a rarer medium in such a way that angle of incidence is greater than critical angle, then the ray is reflected totally inside and does not emerge out from the denser medium. This phenomenon is called total internal reflection".



Q.29. **What is meant by critical angle**

"The angle of incidence in the denser medium for which corresponding angle of refraction is 90° in the rarer medium is called the critical angle. This angle of incidence is denoted by C."

Q.30. **Write Conditions for total internal reflection**

(i) The ray of light should travel from a denser medium to a rare medium.

(ii) The angle of incidence should be greater than the critical angle

Q.31. **What should be angle of incidence for total internal reflection?**

Ans: The angle of incidence for total internal reflection should be greater than the critical angle

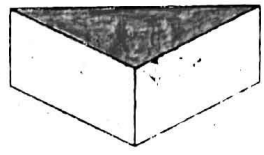
12.6 Refraction though prism

12.7 Lenses

Q.32. **What is prism ?**

Ans: **Prism**

Prism is a transparent body having three rectangular and two triangular surfaces ~~as shown in Figure (a).~~



Angle of Prism

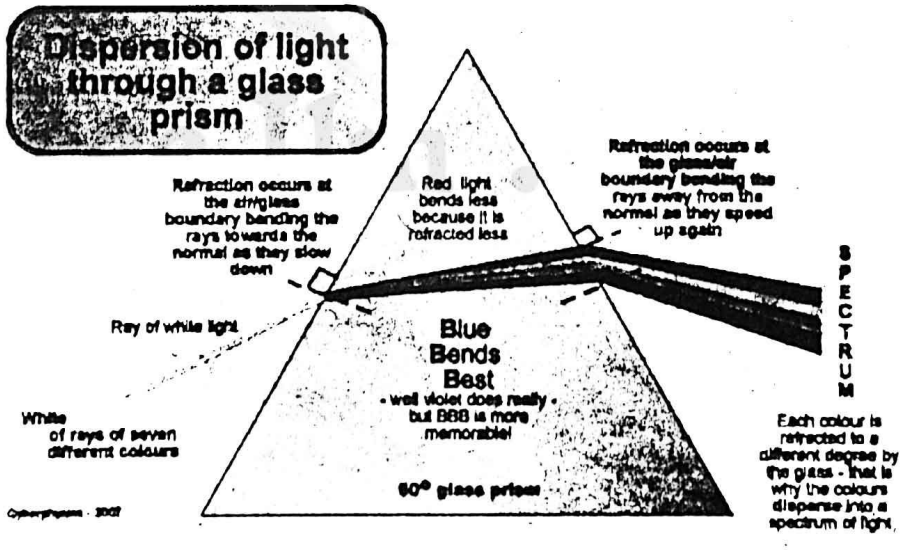
The angle of the triangular surface opposite to its base is known as "Angle of Prism".

Q.33. **What is meant by Dispersion of Light**

Ans: The refraction of waves depends on their wavelength. Since the sunlight consists of different colors, the waves of different wavelengths, thus when it passes through a prism then the waves of different wavelengths deviate on different paths, due to this white light disperses in different colors, which is called dispersion,

Solar spectrum

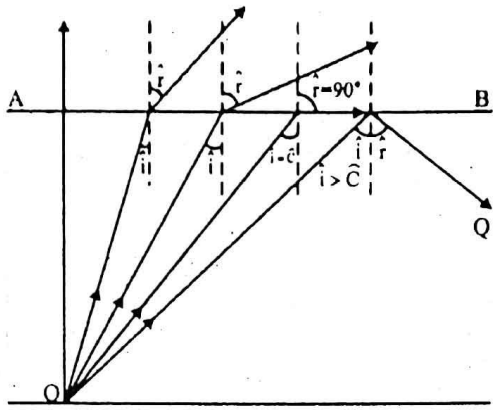
The band of colors which is seen after dispersion of white light on the screen is called solar spectrum.



Q.34. **Define critical angle?**

Ans: **Critical angle**

Critical angle is the angle of incidences in the denser medium to which the corresponding angle of refraction in the rarer medium is 90°



Q.35. What is totally reflecting prism?

Ans: A totally reflecting prism is that which has one of its angle equal to 90^{o} and each of the remaining two angles equal to 45^{o}.

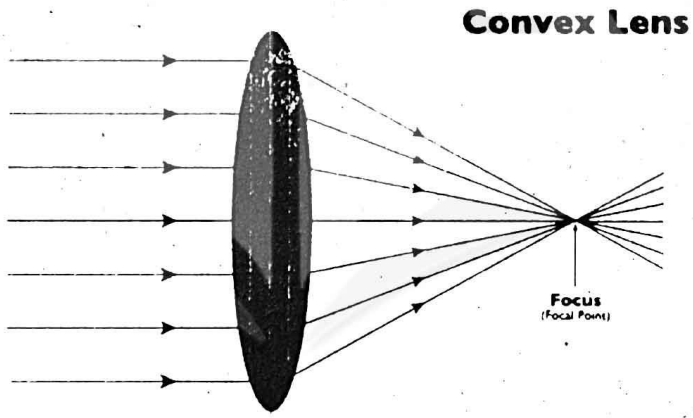
Q.36. What is meant by Angle of Deviation?

Ans: "The angle between the original path of incident ray and path of refracted ray through a prism is known as angle of deviation. "It is represented by 'D'.

Q.37. Define lenses.

Ans: "A transparent body having two surfaces of which at least one is curved. **OR**

Lens is piece of transparent medium bounded by two surfaces at least one of which is curved".



Q.38. How many types of lenses? Describe briefly.

Ans: Lenses are classified into two categories.

1. Convex or Converging Lens:

The lens which converge the all parallel incident rays after refraction is called convex or converging lens. **OR**

The lens which is thicker at middle and thinner at the edges.

Concave or Diverging Lens:

"The lens which diverge the light at point from all incident parallel rays. **OR**

The lenses which are thinner in middle than at the edges."

Type of Curved Lenses

No	Convex Lens	Shape	Concave Lens	Shape
1	Double convex OR bi convex		Double Concave OR Bi-concave	
2	Plano – Convex		Plano Concave	
3	Concavo – convex OR Convex meniscus		Convexo – concave OR Concave meniscus	

Q.39. What are the sign conventions adopted in case of Lenses?

Ans: The following sign conventions are adopted in case of lenses.

(i) All the distances are measured from the optical centre of the lens.

(ii) The distance of the real objects and real images are taken as positive and those of virtual objects and virtual images are taken as negative.

(iii)The focal length is taken as positive for convex lens and negative for concave lens.

Q.40. Define power and its unit.

"If the focal length of a lens is f then its reciprocal $\left(\frac{1}{f}\right)$ is called the power of the lens.

Dioptre

The unit of power "Dioptre" is defined as the power of a lens of focal length of one meter. Its symbol is 'D'.

Positive Power

Because the focal length of a convex lens is positive (+f) therefore the power of a lens is also positive.

Negative Power

Whereas the focal length of a concave lens is negative therefore the power of a concave lens is negative.

Opticians and eye specialist refer to the power of a lens instead of its focal length for their patients.

Q.41. Which lens has greater power, the lens of less focal length or of greater focal length?

Ans: The power of a lens is given by the formula: $p = 1/f$

Where 'f' is the focal length in meters. Hence for a lens of large power, the focal length will be small.

12.8 Refraction though Lenses
12.9 Image location by lens Equation

Q.42. To get a greater and clear image at what distance lens should be placed from the object?

Ans: To get a greater and clear image, the object should be placed within the principal focus from the lens so that a clear, enlarged and erected image is obtained.

Q.43. How image formation from convex lens can be explained?

Ans. Image formation in convex lens can be explained with three rays.

(i) The ray parallel to the principal axis passes through the focal point after refraction by the lens

(ii) The ray passing through the optical centre passes straight through the lens and passes undeviated.

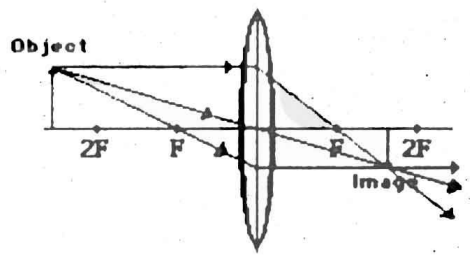
(iii) The ray passing through the focal point becomes parallel to the principal axis after refraction by the lens.

Q.44. When object is beyond 2F form converging lens, which type of image is formed?

Ans. When object is beyond 2F form converging lens, the image is between F and 2F, real, inverted, smaller than the object.

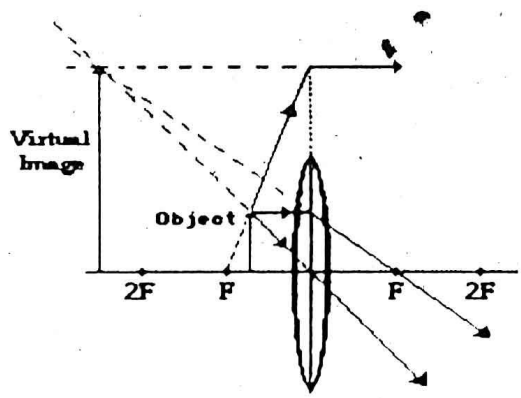
Q.45. When object is present at 2F which type of image is formed in case of convex lens?

Ans. The image is at 2F real inverted and of the same size as the object in case of convex lens.



Q.46. When object is present between lens and f then what is nature of image formed by convex lens?

Ans. When object is between lens and F the image is formed behind the object, virtual, erect and larger than the object in case of convex lens.



Ray Diagram for Object Located in Front of F

Q.47. What is meant by lens formula?

Ans. The relation between the object and image distance form the lens in term of the focal length of the lens is called lens formula and is given by: $\frac{1}{f}=\frac{1}{p}+\frac{1}{q}$

12.10 Applications of Lenses

Q.48. What do you know about periscope?

Ans: Periscope is a long tube at the two ends of which are adjusted two totally reflecting prisms. The rays of light from an object are totally reflected through an angle of 90^0 by each prism. Thus light from a viewed object enters the observer's eye. Periscope is normally used in tanks and submarines. With the help of periscope, the commander of the submarine sitting in his cabin can see the objects on the surface of the sea. Similarly a soldier sitting inside a tank can see the objects outside the tank.

Q.49. How the power is lost in optical fibre through dispersion? Explain.

Ans: When a light signal travels along fibres by multiple refraction, some of light is absorbed by the impurities in the glass. Some of it is scattered by the group of atoms formed at the places such as joints when fibres are joined together.

Note: Careful manufacturing can reduce the power loss by scatting and absorption.

Q.50. What do you understand form linear and angular magnification.

Ans: **Linear Magnification**

"The ratio of the size of image to the size of object is called linear magnification."

Angular Magnification

"The ratio of the angle subtended by the image as seen through device to that subtended by the object at unaided eye is know as angular magnification"

Q.51. What do you know about totally reflecting prism? Also write its uses.

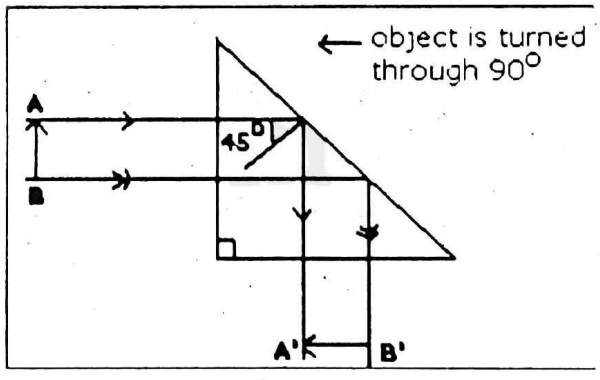
Ans: A transparent body, whose three sides are rectangular and two sides are right-angled triangular is called totally reflecting prism.

Totally reflecting prism:

The prism which has one angle 90^0 is called totally reflecting prism.

Principal of totally reflecting prism

The total reflecting prism works on the principal of total internal reflection. The totally reflecting prism reflect a beam of light through 90^0 or 180^0. One angle of the right angle and other two 45^0 each. When light falls perpendicular to the one side it enter in the prism without deviation. These light rays strike with hypotenous of prism. The hypotenuse at the angle of 45^0.



This angle is greater then the critical angle of glass which is 42^0. So the angle of incidence is greater than critical angel the lights totally reflect through prism at an angle of 90^0.

Uses of totally reflecting Prism

- The totally reflecting prism is used in periscope.
- It is used in binocular.
- It is used in textile engineering for designing.
- It is used in projectors.

Q.52. **How the light signal is transmitted through optical fibre?**

Ans: The light signal is transmitted through the optical fibre in the form of 1 and 0. The digit 1 represents the presence of light while the digit 0 represents the absence of light.

Note: Usually the light signal is produced by "LASER" or "LED" which travel through the optical fibre.

Q.53. **Explain the difference between the angular magnification and resolving power of an optical instrument?**

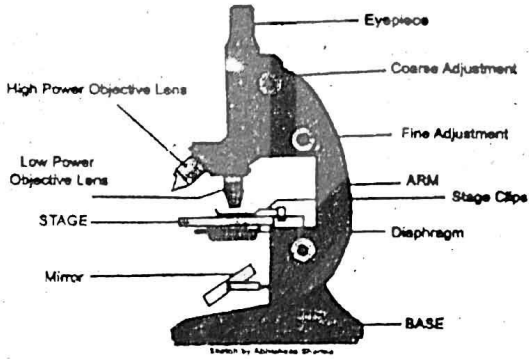
Ans:

Angular Magnification	Resolving Power
• Angular magnification simply increases the apparent size of image of an object when seen through an optical devices.	• The resolving power of an optical instrument is its at to reveal the minor details of an object under exam.
• It can be made as, large as, we wish, by using the lenses of suitable focal length.	• It is minimum angle between the point sources then allow the image to resolved as the distinct points of light rather than.

12.11 Simple Microscope
12.12 Compound Microscope

Q.54. **What is simple microscope?**

Ans. A magnifying glass is a convex lens which is used to produced magnified images of small objects. Hence it is called simple microscope.



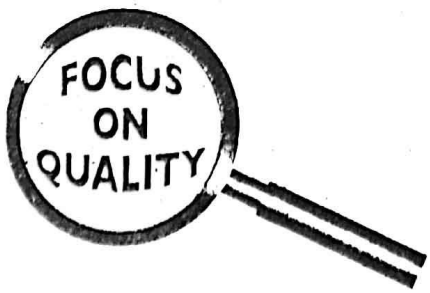
Labeled Microscope Diagram

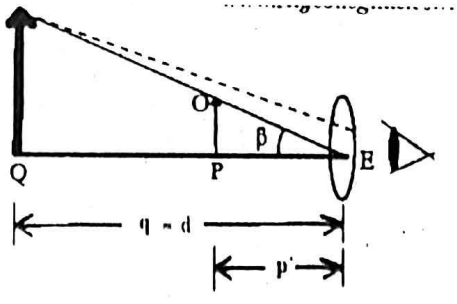
Q.55. **What is meant by resolving power of instrument?**

Ans. The resolving power of an instrument is fits ability to distinguish between two closely placed objects or point sources

Q.56. **What is magnifying glass?**

Ans. Magnifying glass is a lens that forms a virtual image that is larger than object and appears behind the lens.





Q.57. What is compound microscope? Also write its three features.

Ans. Compound microscope has two converging sets of lenses, the objective and the eyepiece and is used to investigate structure of small objects.

Features:

(i) It gives greater magnification than a single lens.

(ii) The objective lens has a short focal length, $f_o < 1$cm.

(iii) The eyepiece has a focal length, f_e of a few cm.

Q.58. Which formula is used to determine magnification of compound microscope?

Ans. The magnification of compound microscope is given by.

$$M = \frac{L}{f_0}\left(1 + \frac{d}{f_e}\right)$$

Q.59. Write uses of compound microscope.

Ans: A compound microscope is used to study bacteria and other micro-objects. It is also used for research in several fields of sciences like Microbiology, Botany, Geology and Genetics.

Q.60. Why would it be advantageous to us when blue light is used with a compound microscope?

Ans: The blue light of short wavelength produces less diffraction are increases its resolving power. Hence, it allows more details to be seen

Q.61. What is least distance of distinct vision. How it is affected with increase of age?

Ans: The minimum distance of an object from the eye at which it produces a sharp image on eye is called least distance of distinct or near point.

Its volume is normally 25 cm with the increase in age its value usually increases

Q.62. The object of telescope is of 20 and eye piece of 50cm focal length. What is the magnifying power and length of telescope?

Ans:

Given Data:

Focal length of objective = $f_o = 20$cm

Focal length of eye piece = fc = 5.0 cm

Required:

Magnifying power = M =?

Length of telescope = L = ?

Solution:

As, we know that

$$M = \frac{f_o}{f_e}$$

By substituting the values

$$M = \frac{20}{50}$$

M = 4

Now, length of the telescope is given the

$$L = f_o + f_e$$

$$L = 20 + 5$$

L = 70 cm

Q.63. Why objective of short focal length is preferred in microscope?

Ans: The magnification of microscope can be expressed as

$$M = \frac{L}{f_o}\left(1 + \frac{d}{f_e}\right)$$

It is chair from the above equation that

$$M \propto \frac{1}{f_o}$$

i.e smaller to focal length of objective greater will be its magnifying power and vice versa. Therefore, to increase the magnification power the value of focal lneght of objective must be smaller.

12.13 Telescope
12.14 The Human eye
12.15 Defects of Vision

Q.64. Define telescope. What do you know about refracting telescope?

Ans. Telescope is an optical instrument which is used to observe distant objects using lenses or mirrors. A telescope that uses two converging lenses is called refracting telescope.

Q.65. How terrestrial telescope is different form a telescope?

Ans. Terrestrial telescope has an extra lens between objective and eye piece.

Q.66. What is magnification of refracting telescope?

Ans. Magnification of refracting telescope can be determined by using formula;

$$M = \frac{f_o}{f_e}$$

Q.67. What should be the length of telescope of f_o = 20cm and f_e = 4cm?

Ans: **Given Data:**

f_o = 20cm

fe = 4cm

Required:

Length of Telescope = L = ?

Solution:

As we know that

$L = f_o + F_e$

L = 20 + 4

L = 24cm

Q.68. Which human organ works like camera?

Ans: Human eye works like camera.

Q.69. What is pupil?

Ans: Iris has an opening at its centre is called pupil.

Q.70. What is meant by defect of vision? What are its types?

Ans: The inability of the eye to see the image of objects clearly is called defect of vision.

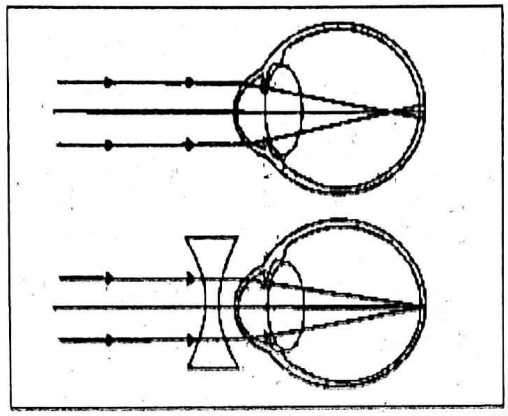
The defect of vision are.

(i) Nearsightedness (Myopia)

(ii) Farsightedness(Hypermetropia)

Q.71. What is reason of short sightedness? How it is corrected?

Ans: Shortsightedness is due to eyeball being too long. Light rays form a distant object ar focused in front of the retina and a blurred image is produced. It is corrected by using, diverging lens.

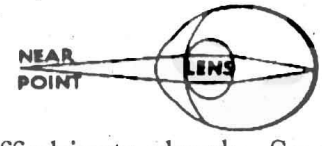


Q.72. What is meant by hypermetropia? How is it corrected?

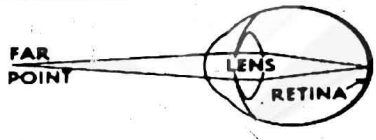
Ans: The disability of the eye to form distinct images of nearby objects on its retina is known as farsightedness or hypermetropia. This defect can be corrected with the aid of a suitable converging lens.

Q.73. What are the near and far points of the normal eye?

Ans: **Near Point:** A normal eye can see near objects clearly at distance of about 25cm from the eye. This is near point of normal eye.

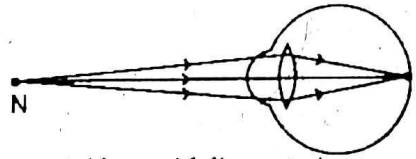


Far Point: A normal eye can see far off objects clearly. So we can say that far point of a normal eye will be at infinite distance.

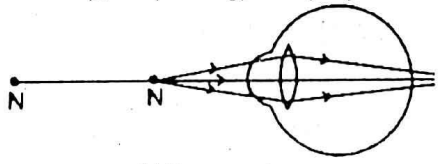


Q.74. Which lens is used for the long sightedness?

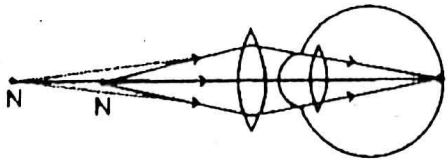
Ans: Long sightedness is corrected by wearing spectacles having convex lens of such focal length which forms a virtual image of the object placed at normal 25 cm, at the near point O of the eye. Hence a clear image of the object is formed on the retina.



(a) near point of hypermetropic eye



(b) Hypermetropia eye



(c) correction of hypermetropia eye

Q.75. What is different between compound microscope and astronomical telescope?

Compound microscope	Astronomical telescope
• Objective lens has smaller focal length, than the eyepiece	• Objective lens has larger focal length than the eyepiece
• Distance between the objective lens and the eyepiece is greater than f_0+f_e	• Distance between the objective lens and the eyepiece is equal to f_0+f_e
• It is used to see very small objects	• It is used to see distant astronomical objects

LONG QUESTIONS

12.1 Reflection of light

Q.1 **What is reflection? Also explain the laws and types of reflection.**

Ans: **Reflection of light:**

When light traveling in a certain medium falls on he surface of another medium, a part of it turns back in the same medium. This is called reflection of light. **OR**

The bouncing back of light in first medium after striking with any reflecting surface.

OR

The property of light wave being thrown back from reflecting surface such as mirror.

Explanation:

Consider a light ray along the path 'AO' falls on a plane mirror M. This light ray known as incident ray. When this incident ray 'AO' strike to mirror M at point 'O'. This incident ray will be reflected back in first medium along with the path 'OB". The ray 'OB' is known as reflected ray. Now take a 'N' normal at a point 'O'. The angle between 'AO' incident ray and normal 'N' $'N' \angle AON = i$ is known as angle of incidence is represented by $\angle AON$. The angle between reflected ray 'OB' and normal 'N' is known as angle of reflection . In diagram it is represented by $\angle NOB = r$.

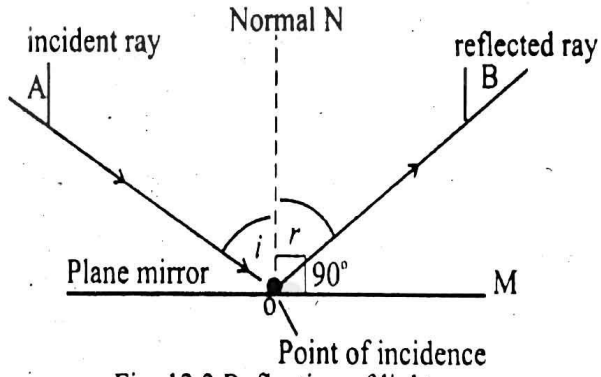


Fig. 12.2 Reflection of light

Law of Reflection

When a ray of light strikes a flate reflecting surface at a point the angle of incidence is equal to the angel of reflection and the incident ray, reflected ray and normal lie at single point. So the laws of reflection can be written as:

(i) Incident ray, normal and reflected ray at the point of incidence lie in the same plane.

(ii) Always the angle of incidence is equal to the angle of reflection i.e. $\angle i = \angle r$.

Types of Reflection:

The direction of reflected ray depends upon the smoothness of the surface on which incident ray strike. So, there are two type of reflection.

(i) Regular Reflection

(ii) Irregular Reflection

(i) **Regular Reflection:**

The reflection by smooth surface in which all the reflected rays the parallel to each other is called regular reflection.

For example a smooth surface reflects the rays of light in one direction only For regular reflection of light, the angle of incidence is equal to the angle of reflection i.e. $\angle i = \angle r$.

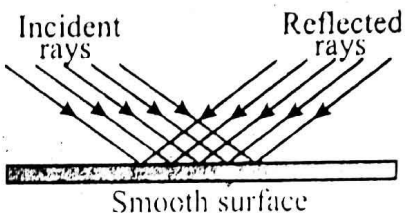


Fig. 12.3 Regular reflection

Conditions for Regular Reflection:

- The reflecting surface should be plane surface.
- The reflecting surface should be flate.
- The reflected rays of light should be parallel to each other and have equal-space between them.

(ii) **Irregular Reflection:**

The reflection by the rough surface in which all the reflected rays not parallel to each other is called irregular reflection.

For example, a rough surface reflects the light rays in many directions as shown fig.

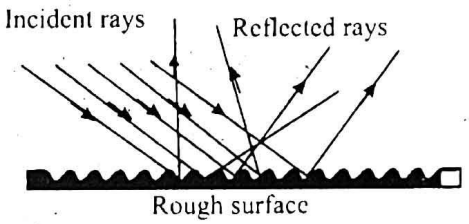


Fig. 12.4: Irregular reflection

Conditions for Irregular Reflection:

- The reflecting surface should be rough.
- The reflecting rays of light are not parallel to each other.

Q.2: What are spherical mirrors? Describe types for spherical mirrors.

An: Spherical Mirrors:

"The kind we use generally made by a silvering a piece of glass which is part of shell of hollow sphere. "OR.

"A mirror which is a part of a hollow sphere of glass or plastic is called spherical mirrors." In spherical mirrors one surface from of its two surfaces is coated with thin silver layer which is covered by a read lead oxide paint. Therefore, one side of spherical mirror is opaque and other side highly polished, that is know as reflecting surface. Spherical mirrors are classified in two categories on the basis of reflecting surface.

1. Concave or Converging mirror.
2. Convex or Diverging mirror.

Concave or Converging Mirror:

The mirror whose reflecting surface is on the inside of the curved shape.

Characteristics of Concave Mirror:

In concave mirror

- Size of image depend upon the position of object.
- Virtual or real image can be formed.

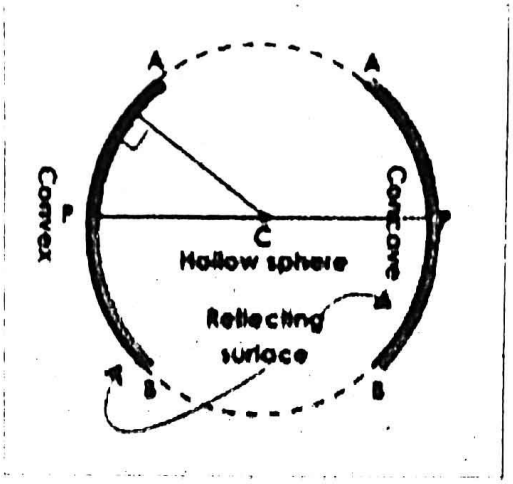
Convex or Diverging Mirror

The mirror whose reflecting surface is one the outside of the curved shape.

Characteristics of Convex Mirror

In convex mirror.

- Size of image is always smaller then the size of object.
- Virtual and erect image can be formed.



Q.3 Define the following terms associated with spherical mirrors? Pole, centre of curvature, radius of curvature, principal axis, principal focus, focal length, real focus, virtual focus.

Ans: Pole OR Vertex:

The midpoint of the curved surface of a spherical mirror is knows as pole or vertex.

Center of Curvature (C):

The center of sphere from which concave or convex mirror is formed, that is known as center of curvature.

OR

Spherical mirror is a part of sphere. The center of that sphere is known as center of curvature.

Radius of Curvature (R):

The radius of sphere of which spherical mirror is a part.

$$R = 2f$$

Principal axis:

The line joining center of curvature and pole of spherical mirror.

OR

The principal axis of curved mirror is line at right angles to the curved surface which meets the mirror at its center or pole.

Principal Focus (F):

The light rays which are parallel to the principal axis, after reflection the light rays pass through a single point on principal axis, that point is known as "principal focus " of spherical mirrors.

OR

The incident rays are parallel to the principal axis, after reflection the rays pass through a point on principal axis which lies just midway between the pole and the center of curvature is called principal focus.

Real Focus:

In concave or converging mirror, the reflected rays actually pass t through the focus point therefore it is called real focus.

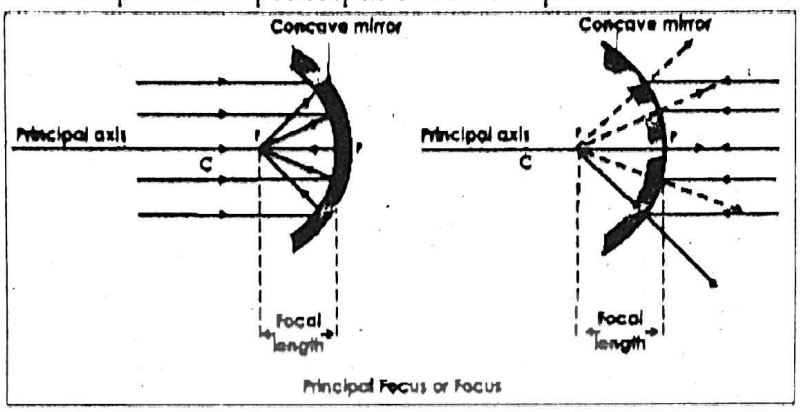
Virtual focus:

In convex or diverging mirror, the rays parallel to principal axis, after reflection appear to come from point 'F' situated behind the mirror.

"The principal focus of convex mirror is known as virtual focus because reflected rays do not actually pass through it but appear to do so."

Focal Length:

The distance between pole and principal focus of spherical mirrors is called focal length.



Q.4 Define refraction of light. Describe the passage of light through parallel – sided transparent material.

OR

How the refraction of light can be verified using glass slab and pins.

Ans: Refraction:

"When light enter from one transparent medium to another medium then it changes its path. This is known as refraction of light..

OR

"The deviation in path of light when it enter from one medium to another medium is known as refraction."

Glass-slab experiment

Take a rectangular glass block (slab), a ray which is defined by the line connecting pins. The ray IO hit the glass-slab at point 'O'. This ray is known as incident ray. The normal 'N' is also at point 'O'. The angle $\angle ION$ between the incident ray and normal is known as angle of incident. The ray OR inside the glass-slab. This ray is known as refracted ray. The angle between the refracted ray and normal is known as angle of refraction. When ray 'OR' leaves the glass-slab, it moves away from the normal along with path ME. This 'ME' ray is known as emergent ray. So, the refraction of light is process in which light rays change its direction as it enter in other transparent medium which has different optical density.

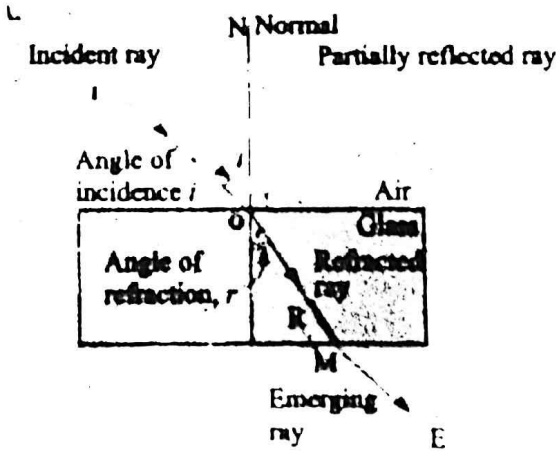


Fig. 12.9: Refraction of light by a glass block

Dependence of Refraction

This refraction depends on

1. The nature of two materials and speed of light in each material
2. The angle at which the ray strikes the surface.

Q.5 what is meant by total internal reflection? Also describe critical angle Derive relation of critical angle and refractive index.

Ans: The wave changes direction when passing from one medium to other due to change in the speed. This phenomenon is called as refraction. The change in direction of the wave can be quantified using the refractive indexes of the two materials. When a ray passes from denser medium (medium with higher refractive index) to rarer medium it bends or refracts away from the imaginary line, called normal, perpendicular to the surface. As the angle of incidence in denser medium becomes greater with respect to normal, the refracted ray bends further away from it.

At one particular angle, called critical angle, the refracted light does not enter rarer medium but instead travels along the surface between the two media.

Critical Angle

"The angle of incident that causes the refracted ray in rare medium to bend through 90° called critical angle."

OR

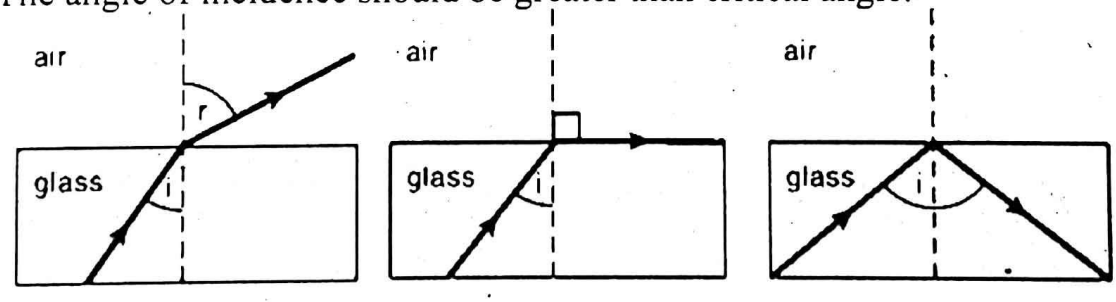
"The angle of incidence, whose corresponding angle of refraction is 90° is known as critical angle. The critical angle is denoted by c. "When the angle of incidence is greater then critical angle 'c. then light does not refract in second medium but reflects back in first (denser) medium.

Total Internal Reflection

When angle of incidence is greater than critical angle then no refraction occurs in second medium but light reflected back in first (denser) medium. This reflection is known as total internal reflection.

Conditions for total internal reflection

- The light should enter from denser medium to rare medium.
- The angle of incidence should be greater than critical angle.



if the angle of incidence is less than the critical angle, the light refracts away from the normal

if the angle of incidence is equal to the critical angle, the light refracts at 90 to the normal

if the angle of incidence is greater than the critical angle, total internal reflection occurs

Relation for critical angle and refractive index

Consider light enter from glass to air. The Snell's law $\frac{1}{n} = \frac{\sin i}{\sin r}$

Which can also written as

$$n = \frac{\sin r}{\sin i} = \frac{\sin 90}{\sin \hat{c}} \qquad \hat{i} = c \qquad \hat{r} = 90 \qquad (\therefore \sin 90^o = 1)$$

$$n = \frac{1}{Sin\hat{C}}$$

Q.6 What is Prism? How refraction occurs through prism?

Ans: **Prism:** "Prism is transparent body with at least two polished plane faces inclined toward each other from which light is refracted." **OR**

"Optical transparent body having three rectangular sides and two triangular sides is known as prism.

Types of Prism:

There are two types of prism in general

(i) Simple Prism (ii). Totally Reflecting Prism.

(i) Simple Prism

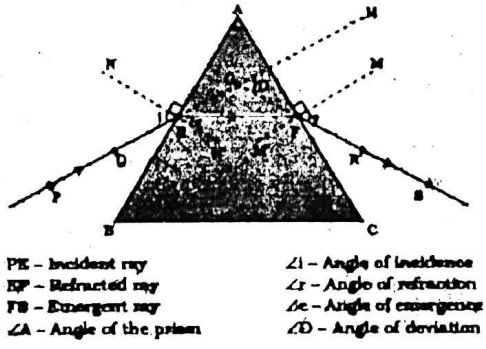
The prism whose triangular sides are equal in length and angles at vertices of triangular faces are also equal.

(ii) Totally Reflecting Prism

A totally reflecting prism is that which has one angle of 90° an each of the remaining two angles equal to 45° at its triangular faces.

Refraction through Prism

In triangular prism light ray 'PQ' hit the side. AB of prism at point 'E. The angle $\angle QEN$ is angle of incidence 'I'. The light ray should move along with path E,G to H. But when light enter in prism it bends toward normal and moves along path 'EF'.



According to law of refraction $n = \frac{Sin\hat{i}}{Sin\hat{r}}$. The emergent ray is 'FS'. We can observe that incident ray 'PE' is not parallel to emergent ray 'FS'. This means that, when light pass through a prism, it is deviated from its original path. The original path is 'PEH' and deviated path GFS. The angel 'D' is the angle of deviation.

Angle of Deviation:

"The angle between the original path of incident ray and path of refracted ray through a prism is known as angle of deviation. "It is represented by 'D'.

Q.7 **Define lenses. How many types of lenses? Describe briefly explain the following terms:**

(1) Principal Axis **(2) Optical Center** **(3) Principal Focus**

(4) Focal Length **(5) Power of Lens.**

Ans: Lens:

"A transparent body having two surfaces of which at least one is curved.

OR

Lens is piece of transparent medium bounded by two surfaces at least one of which is curved".

Types of lenses:

Lenses are classified into two categories.

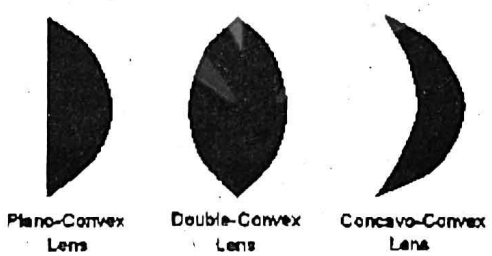
1. **Convex or Converging Lens:**

The lens which converge all parallel incident rays after refraction is called convex or converging lens.

OR

The lens which is thicker at middle and thinner at the edges.

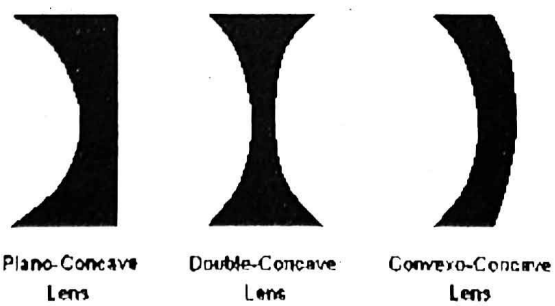
Type of Convex Lenses



Concave or Diverging Lens:

"The lens which diverge the light at point from all incident parallel rays. "OR" The lenses which are thinner in middle than at the edges."

Type of Concave Lenses



(1) **Principal Axis:**

"The each surface of the spherical lens are section of sphere, the line passing through the center of curvatures of two spheres is called the principal axis of lens."

"OR"

The line joining the two center of curvatures of the spheres is called principal axis, but this line also passes through the optical center and foci of lens."

(2) **Optical Center**

"A point on principal axis at the center of lens is called optical center." OR. "Optical center is a point inside the body of lens through which light rays pass, undeviated."

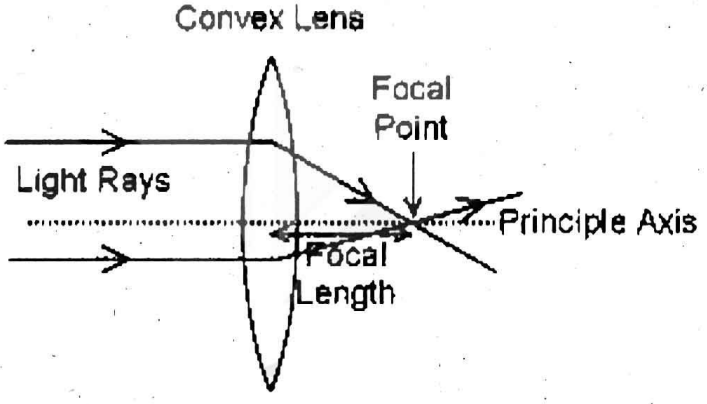
(3) **Principal Focus**

The light rays traveling parallel to the principal axis, passes through the lens. After refraction light converge at a point or appears to be diverge from the appoint. That co converging or diverging point is known as principle focus."

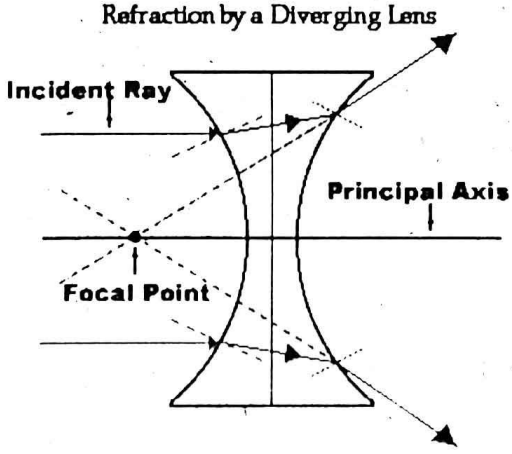
OR

The principal focus of curved lens is the point 'F'. Where incoming rays which are parallel to principal axis come to a focus.

(a) For convex lens, principal focus is a point of convergence of refracted rays. It is a real point.



(b) For concave lens, principal focus is a point of divergence of refracted rays. It is imaginary point.



Incident rays traveling parallel to the principal axis will refract through the lens and diverge, never intersecting.

(4) **Focal Length:**

The distance between principal focus and optical center is called forcal length its is denoted by 'f'.

(5) **Power of Lens:**

The power or strength of lens is the reciprocal of the focal length.

OR

Power of lens is its ability to deviate light ray from its original path.

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

Where 'f' is the focal length in meter. SI unit of power of lens is "dioptre" and it is denoted by D. the dioptre 'D' is reciprocal of meter (m^{-1})

- Power of convex lens is positive, because its focal length is positive.
- Power of concave lens is negative because its focal length is negative.

Q.8 How is image formed by lens? Explain with ray diagram? Also explain ray diagram.

Ans: The image is formed through lenses by means of refraction.

Ray Diagram:

A graphical method of locating the image formed by spherical lens is called ray diagram.

We will investigate the method for drawing ray diagrams for objects placed at various locations in front of a double convex lens. To draw these ray diagrams, we will have to recall the three ***rules*** of refraction for a double convex lens:

(i) Any incident ray traveling parallel to the principal axis of a converging lens will refract through the lens and travel through the focal point on the opposite side of the lens.

(ii) Any incident ray traveling through the focal point on the way to the lens will refract through the lens and travel parallel to the principal axis.

(iii) An incident ray that passes through the center of the lens will in effect continue in the same direction that it had when it entered the lens.

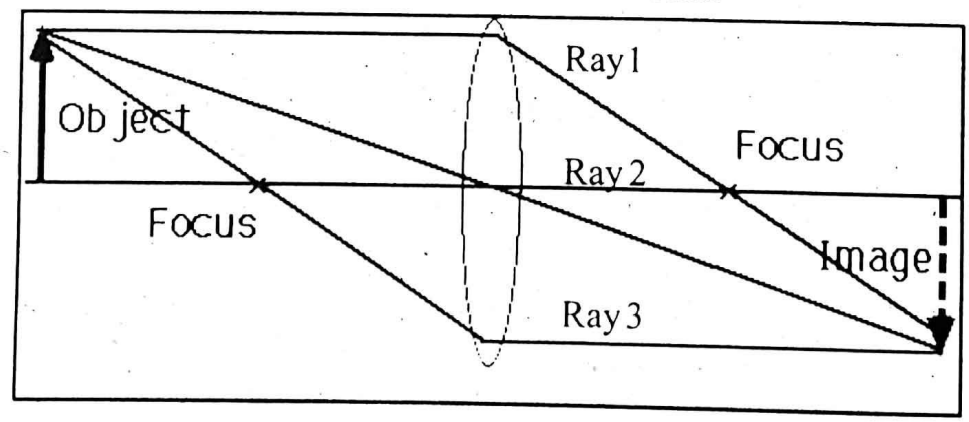
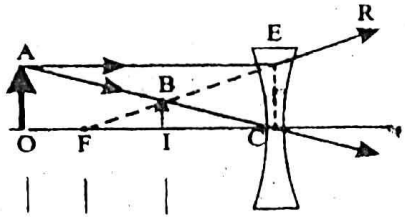


Image Formation through Concave Lens:

The ray diagram for concave lens is shown in fig



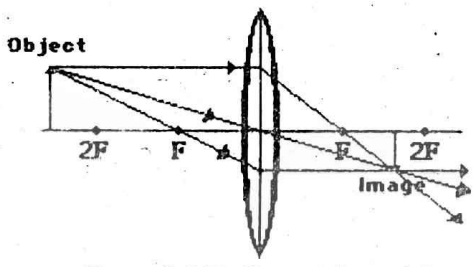
The Image is , Virtual, Erect, small in size and formed at Same side of lens .

Image Formation through Convex Lens

The following diagram illustrating the path of light from an object through a lens to an eye placed at various locations is as shown.

1. **Object Beyond 2F:**

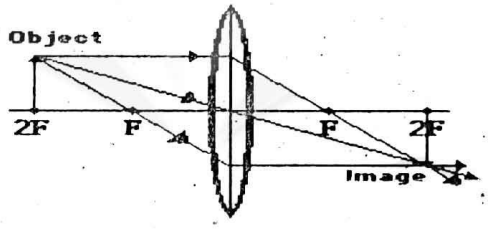
When object is placed at some distance from 2F then image is formed between the focus and center of curvature (2F).



The Image is formed Between F and 2F Opposite side of Lens, Real, Inverted and Small in size

2. **Object at 2F:**

When object placed at center of curvature, image is formed at center of curvature at the opposite side.

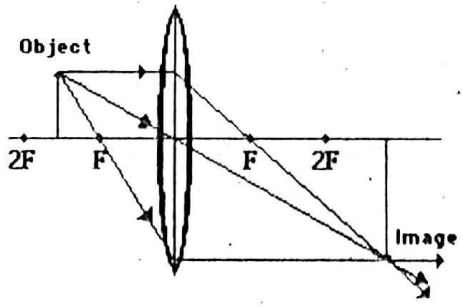


Ray Diagram for Object Located at 2F

The Image, Real, Inverted, at 2F , Same in size and At the opposite side of the Lens

3. **Object between F and 2F:**

When object is placed between the focus and center of curvature then the image is formed on opposite side beyond the center of curvature.

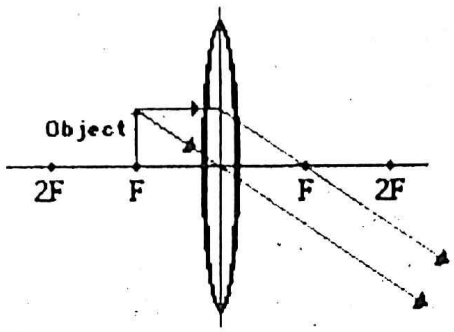


Ray Diagram for Object Located Between F and 2F

The Image, Real, Inverted, Large in size, Opposite side of lens and Beyond 2F

4. **Object at F:**

When object is placed at focus the refracted rays are parallel to each other and meet at infinity.

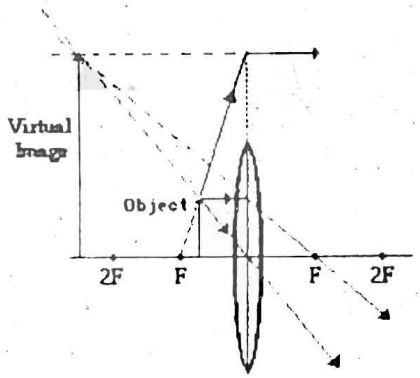


Ray Diagram for Object Located at F (an image is not formed)

No image form because refracted rays are parallel and they never meet.

5. **Object between F and O**

When object is placed between the lens and principal focus, then the refracted rays does not meet at opposite side but image is formed at the same side where the object is placed.



Ray Diagram for Object Located in Front of F

The Image is Virtual, Erect, Large, Same side of lens and Beyond the object. We can also draw the ray diagram for object placed different position from a convex lens. Position and nature of image for convex lens given in following table.

Position of Object	Position of Image	Nature of Image
Beyond the 2F	Between F and 2F	Rea, inverted, small
At 2F	At 2F	Real, inverted, equal
Between F and 2F	Beyond 2F	Real, inverted, enlarged
At F	At infinity	No image is formed
Inside F	Behind the object	Virtual, erect, enlarged
At infinity	At F	Real, inverted, small

Q.9 How image location can be found using lens equation?

Ans: Consider, an object OP is placed in the front of convex lens. A 'PR' ray is parallel to the principal axis. According to ray diagram rules, it will pass through the focus point after refraction. An other ray 'PC' will pass through the optical center of lens. The ray PC pass through directly without deviation and intersect the ray RP' at point P' a real image O' P' is formed at distance 'q' where the distance of object from lens denoted by 'p'. To find the nature and the distance of image from lens, we use lens equation. Def: 'The relationship between the object and image distance from the lens in the term of focal length of the lens is called lens equation. "Lens equation can be written as:

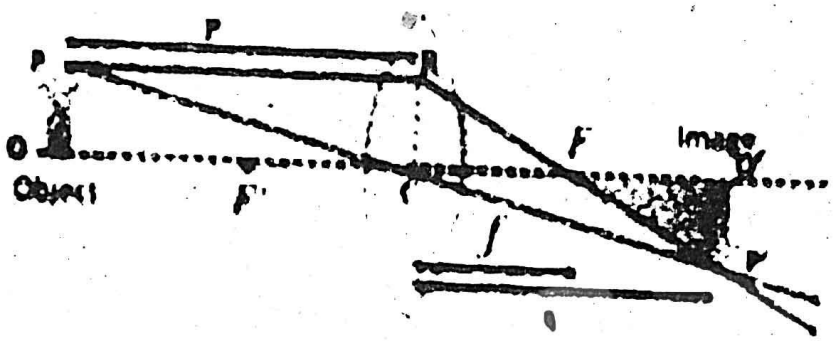


Fig.12.20

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

This curved lens equation is applicable for convex and concave lens but following sign of convections be followed

Sigh of Convections for Lenses

Focal Length (f):

- 'f' is positive for converging lens (convex lens).
- 'f' is negative for diverging lens (concave lens).

Object distance (p)

- 'p' distance is taken as positive, if the object is at left of lens. It is called real object.
- 'p' is taken as negative distance if the object is on the right sides of lens. It is called virtual object.

Image Distance (q)

- The image distance 'q' is taken as positive for a real image made on the right side of lens by the real object.
- The image distance 'q' is taken as negative for a virtual image made on the left side of the lens by real object.

Q.10 Write a note on the following application of lenses.

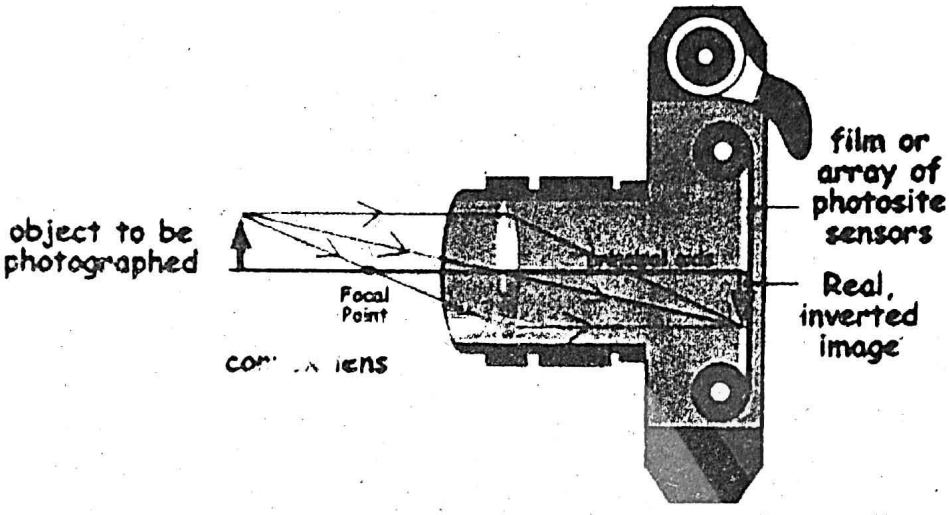
(1) Camera (2) Projector (3) Photographed enlarger.

Ans: (1) Camera

Definition: A camera is an optical device for obtaining still photographs, or for exposing cinematic films.

Construction and working:

It is light-proof box. The whole interior surface is normally matt black. A converging lens is adjusted in the front of camara. A shutter of variable speed and diaphragm of variable aperture, regulate the amount of light admitted though the lens. A sensitive film or plate fixed behind the lens at the focus point of lens. The image formed by simple camera is real, inverted (vertically and laterally diminished or magnified.)



(2) **Slide Projector:**

A slide projector is an upto-mechanical device to view photographic slides. A projector has four main elements:

CONSTRUCTION:

Slide projector consists on concave mirror, light source condenser (two palno convex) lenses, slide and projection lens. A light source (quartz iodine lamp) is placed at the center of curvature). Concave mirror reflect the light in the form of parallel rays. A condenser consisting of two plano-convex lens collect the parallel light rays.

WORKING:

The parallel light rays which passes from condenser falls on the slide and illuminated it. A projectior lens is adjusted next to slide in such a way that the slide should in between the F and 2f of projection of lens. The projection lens refract the rays and real inverted (vertically and lateral) image is formed on screen. The slide placed upside down and flipped 180o. So that the image will be projected right way.

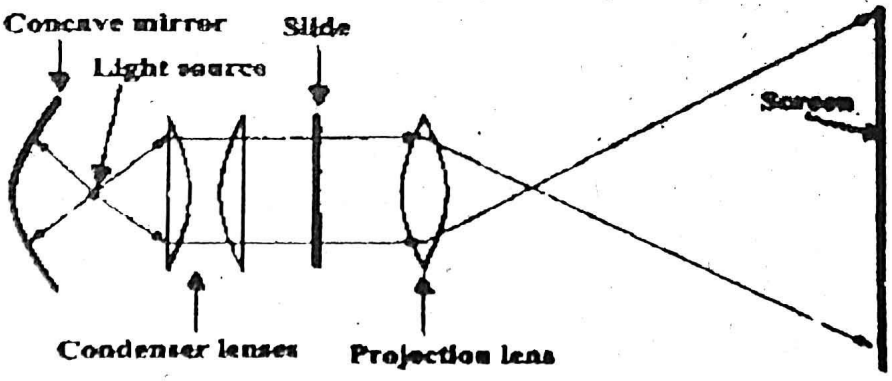


Fig.12.22: Diagram of slide projector

Photograph Enlarger:

An enlarger is a specialized transparency projector used to produce photographic prints from film or glass negatives using the gelatin silver process, or from transparencies.

Construction and Working:

A photograph enlarger is basically same as that slide projector. A light bulbs produce light and fall on condenser. Condenser consisting of two plano-convex lenses which collect the light rays. The light rays becomes parallel when pass through condenser and fall on film .A projection lens is placed next to film in such a way that the film should in between the F and 2F. The projection convex lens produces are magnified and inverted image of from on the photographic paper.

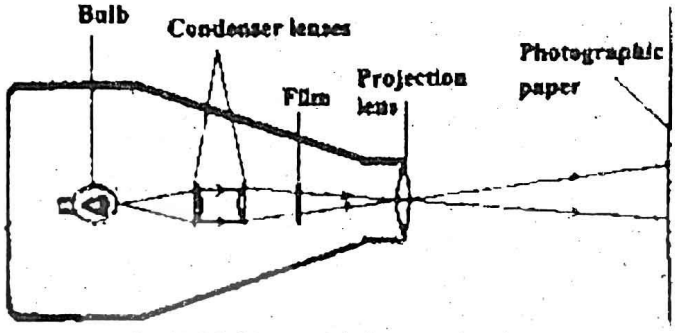


Fig.12.23: Diagram of photograph enlarger

Q.11 What is optical fiber? Describe how total internal reflection is used in light propagating through optical fiber.

What are the optical fibers? On which principal they work? Describe their few uses. (14.6)

Ans? Optical Fiber:

An optical fiber is made of a highly transparent fine strand of glass or plastic coated or cladded with another type of glass whose refractive index is less than the inner tube is called optical fiber

Principal

In recent years an important and interesting application of principal of total internal reflection is used in optical fibers.

Construction

A thin hair like rod of glass having central portion of light refractive index called core, which is surrounded by a glass layer having low refractive index called cladding." The central part of fiber is made of plastic or glass with high refractive index. The core is surrounded by an other layer of glass or plastic or low refraction index From figure, an optical fiber is made of a highly transparent fine strand of glass or plastic coated or cladded with another type of glass whose refractive index is less than the inner tube. Generally the refractive index of inner tube is 1.52 and that of outer coating is 1.48.

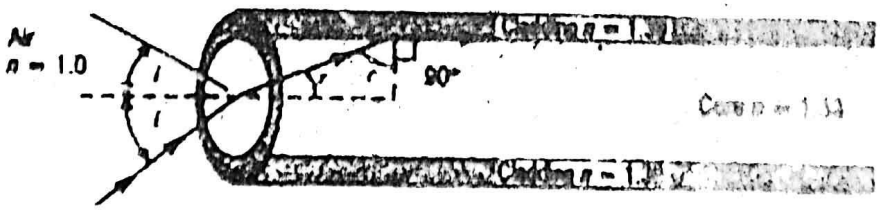


Fig.12.28: Passage of light through optical fibre

Transmission of Light/Data

If light rays enter at one end of an optical fiber at an angle of incidence greater than the critical angle then these rays undergo total internal reflection repeatedly at the walls and come out at the other end without any loss of intensity core and covers the distance of 30km. That s why the repeaters used at 30Km distance in optical fiber network. The simplest optical fiber, operates 14000 telephones calls and 14 TV channels at a time Thus, light travels along the fiber no matter how it may be curved and comes out with the same intensity

Q.12 What is light pipe? How it is used in daily life? What is Endoscope and Endoscopy? Describe the type of endoscope?

Ans: Light Pipe:

The light pipe is bundle of thousands optical fibers bounded together through a flexible pipe jacket. The light pipes are used by doctors are engineers to illuminate those inaccessible places which otherwise are not possible to examine. Light pipes also used to transmit data (image, calls, movies) from one plane to another.

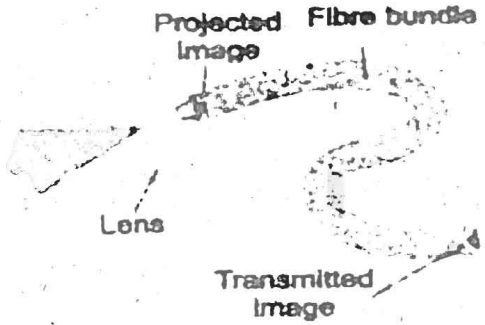


Fig.12.29: A lens and light pipe can be used together to produce a magnified transmitted image of an object

Endoscope

Endoscope is a medical instrument used for viewing and photographing internal structure of human body. Due to small size the endoscope is inserted through the mouth and illuminates the internal parts viewed by another bundle of optical fiber. A video camera is fitted outside of this bundle and it makes the interior parts visible to doctors which helps them to diagnose easily.

Endoscopy

A medical procedure in which any type of endoscope is used called endoscopy.

Types of Endoscope

The endoscope is divided into different type on the bases of use in medical filed.

1) Gastroscope 2) Cytoscope 3) Bronchosope

1) **Gastroscope:**
Gastroscope is an instrument used to diagnose the stomach.

2) **Cytoscope:**
Cytoscope is an instrument used to diagnose the bladder.

3) **Bronchoscope:**
Bronchoscope is an instrument used to diagnose sore throat.

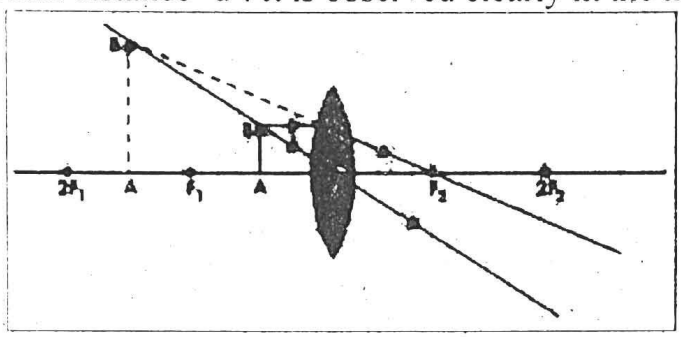
Q.13 **What is simple microscope? Draw the diagram of simple microscope. Write the formula of its magnifying power.**

Ans: **Simple Microscope (Magnifier)**

It is a simple convex (bi – convex) lens which is used to produce magnified (large) image of small object.

Principal

When object is placed within focal length of convex lens, then the magnified virtual and erect image is formed at least distance 'd'. It is observed clearly in the maximum possible size.

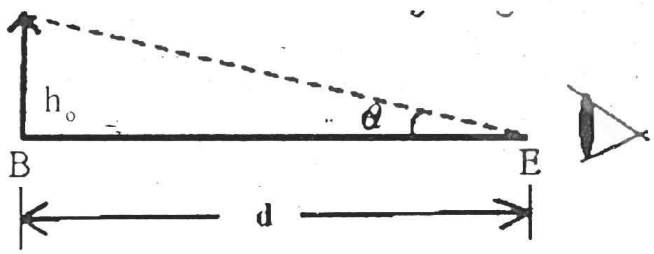


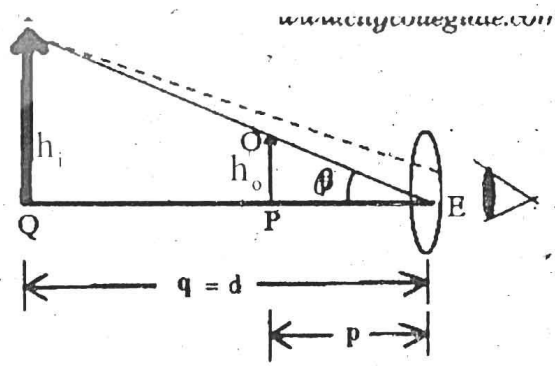
Magnifying Power

The angular magnification (or magnifying power) M is the angular size θ of the final image produced by the magnified glass divided by angular size θ of the object seen without magnifying glass.

Expatiation:

Let θ is the angle subtended at the eye by the object, when its placed before the eye at least distance. The 'θ' is angle subtended by the final image at eye when object is placed close to eye at distance less than 'f'.





$$M = \frac{\text{Angular size of final imge produced by magnfying glass}}{\text{Angular size of object seen without magnifying glass}}$$

$M = \frac{\theta'}{\theta}$ "The ratio of angles subtended by image as seen through the optical device (by using lens) to that subtended by object at unaided eye (without using lens) is called magnifying power."

So, enlarge virtual image is formed which is upright with respect to object. Magnifying power can be calculated by formula.

$$M \approx \left(\frac{d}{f}\right) + 1$$

Where 'd' is the near distance of object form eye which 25cm.

Resolving power of optical device

"The ability of an optical device to reveal (show) the minor detail of an object under the examination is called resolving power.

OR

"The ability of an optical device to reveal (show) the mirror detail of an object under the examinations is called resolving power.

OR

"The resolving power of an instrument is its ability to distinguish between two closely placed objects or point sources."

Q.14 **Write a note compound microscope. Draw the ray diagram. Also explain its magnifying power.**

Ans: **Compound Microscope:**

An optical device which consists on two converging lens, (objective and eyepiece) is used to get the minor detail of the structure of small objects.

Construction

It consists of two convex lenses placed parallel and co-axial with each other. One lens is called is called objective "because it is set towards the object to be viewed. The focal length of objective is very small. Second lens is called eyepiece because it is set towards the observer eye. The focal length of eyepiece is large. This microscope give greater magnification that a single lens.

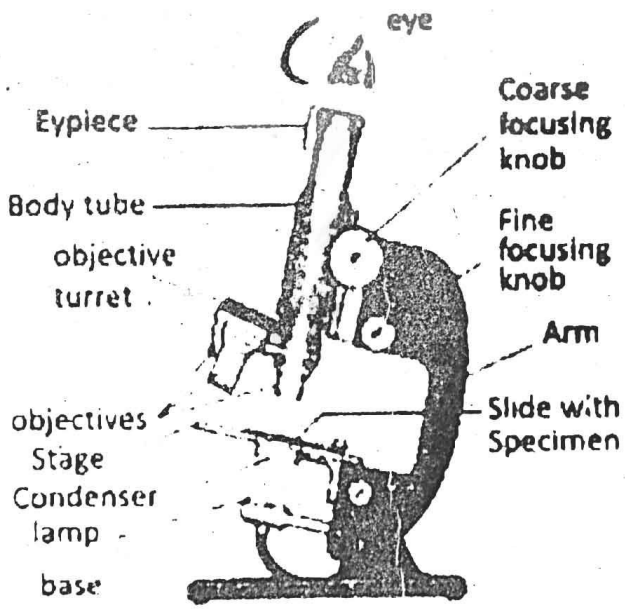
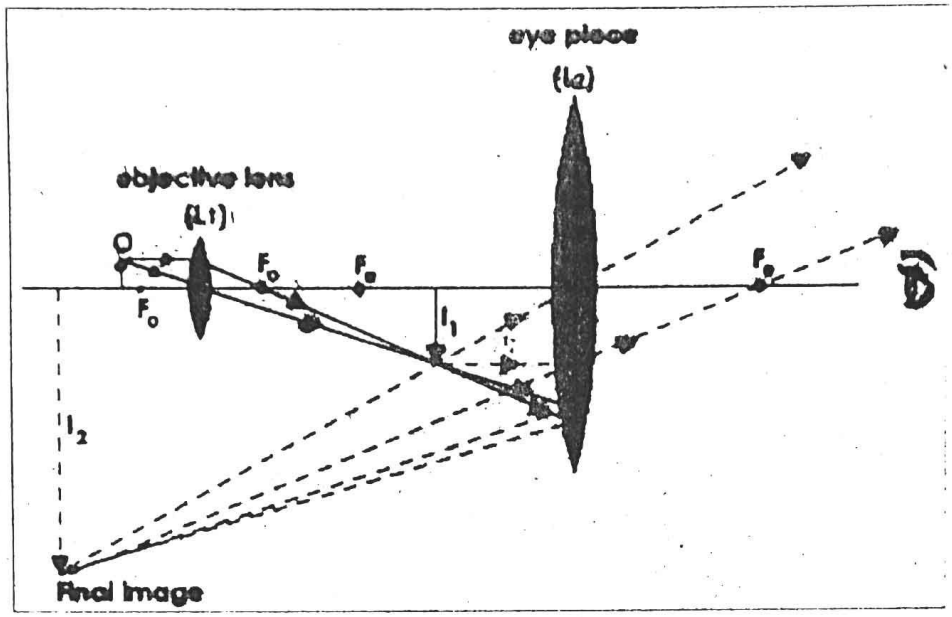


Fig.12.32. Compound microscope

Magnifying power of compound microscope

The object 'op' is just placed beyond the principal focus'f' of the objective. This produce a real inverted and magnified image I, beyond the double focus of objective lens. The position of eyepiece is adjusted that image I, lies with in the focus 'f' of the eye-piece. The eye piece acts as magnifying glass and forms virtual erect and magnified image I, formed outside the focal point of objective.



The magnifying of compound microscope is given by:

$$M=\frac{L}{f_o}(1+\frac{d}{f})$$

When 'L' is the length of compound microscope, which is equal to the distance between objective and eyepiece, d is near distance of object from eye, f_o and f_e are the focal length of objective and eye-piece respectively.

Used of compound microscope

A compound microscope is used to study bacteria and other micro objectives. It is also used in different fields of science like microbiology, botany, geology and genetics.

Q.15 **What is refracting telescope? Draw its ray diagram and mention its magnifying power.**

Ans: **Telescope:**

"Telescope is an optical device which is used to see the distant object clearly and distinctly. '

OR

"Telescope is an optical device, which enables the observer to see the fine details of a far off object."

Construction: A refracting telescope consists of two convex lenses.

(i) Objective

(ii) Eyepiece

Objective: It is convex lens which is near the observer's eye and has short focal length (f_o)and larger aperture.

Eyepiece: It is a convex lens which is near the observer's eye and has short focal length(f_e) and small aperture.

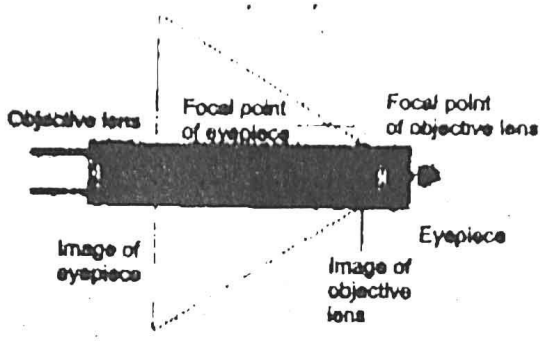


Fig. 12.34: An astronomical refracting telescope creates a virtual image that is inverted compared to the object.

Working of refracting telescope

The rays of light coming from object are considered to parallel are converged by objective lens to form a real diminished and inverted image 'I' is formed at the focus f_o of objective. This image acts as object for the eyepiece. The eyepiece magnifies I' thus the final image 'I'_2 see through the eyepiece, is virtual enlarge and inverted. This image makes an angle '0' at the eyepiece.

Magnification of telescope

Magnifying power of the telescope is defined as the ratio of the angle made by the image at eye as seen through the telescope to the angle made by the objective at the naked eye when the object and the image are at infinity.

But magnifying power of refracting telescope an be determined through ray diagram and given by:

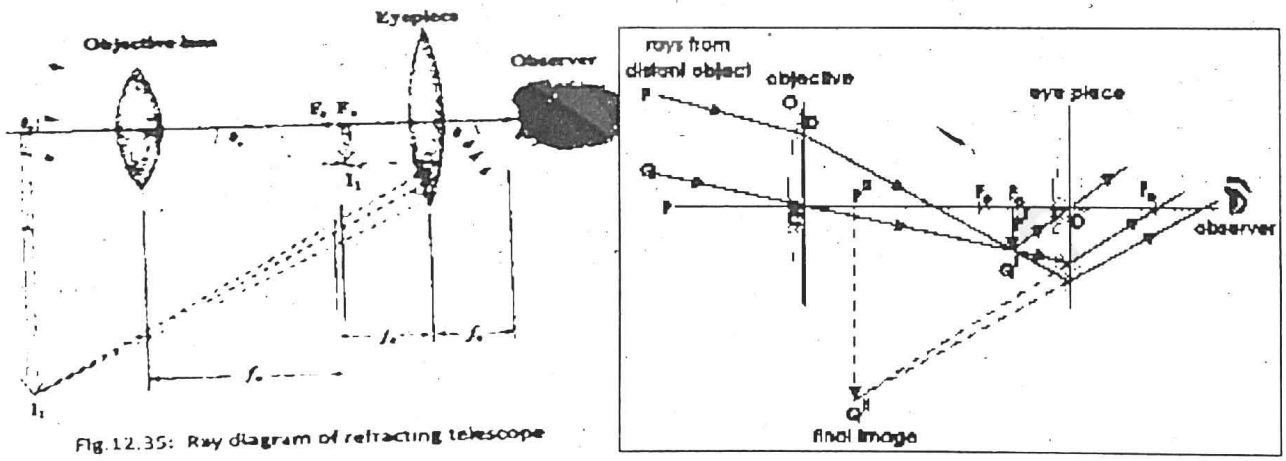


Fig. 12.35: Ray diagram of refracting telescope

Q.16: Draw ray diagrams to show the formation of images in the normal human eye. Also explain the accommodation of eye.

Ans: **human eye:** in many respects the human eye is similar to camera. It has white wall called sclerotic in the front of eye there is a lens.

Parts of human eye

Retina: the light passing through the lens cross the vitreous humour to form an image an specific wall which is called retinal. Retina records the picture and work as film in camera.

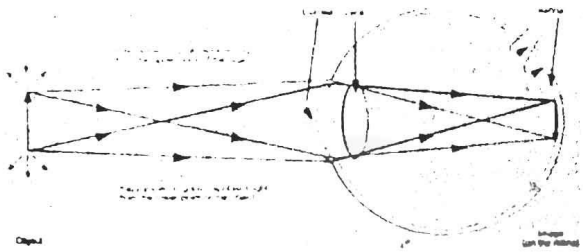
Lens: There is converging lens in the front of eye; naturally, this lens has ability to change the focal length.

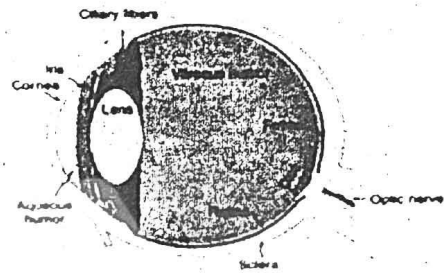
Iris: The iris is the coloured part of eye which automatically adjust the size of pupil and controls the amount of light reaching the retinal.

Pupil: pupil is circular in the center according to intensity of light falling on it. When white light passes, the iris contracts the size of pupil while in dim light pupil is enlarged.

Cornea: the light enters the eye through transparent membrane called corea.

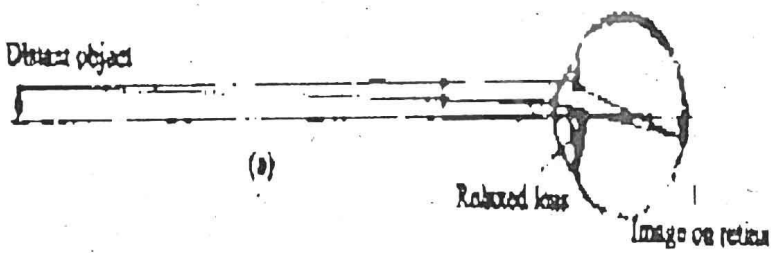
Formation of image: the camera focuses the image of an object at given distance form it by moving the lens towards or away from the film. The eye has another mechanism to focus the image on retina of object. The 'ciliary muscles control the size of lens. In this way the focal length of lens can be increased or decreased.

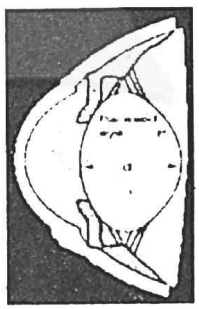




Far object: if the object is far away from eye, to deviation of light through lens must be lens. In this situation, The ciliary muscles relax. The curvature of lens is decreased. The focal length decreased.

The divergent rays from mean object are thus bent more and come to focus on retinal.





Nearer object: if an object is close to eye, The ciliary muscles contracts. The curvature of lens increased. The focal length decreased.

The divergent rays from near object are thus bent more and come to focus on retina.

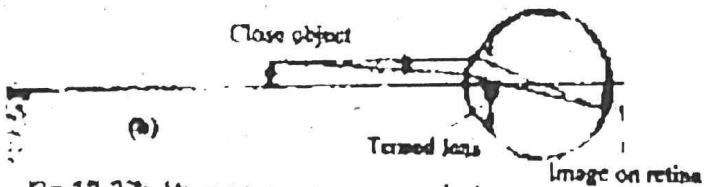
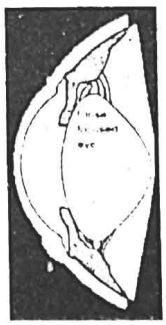


Fig.12.37: Human eye accommodation

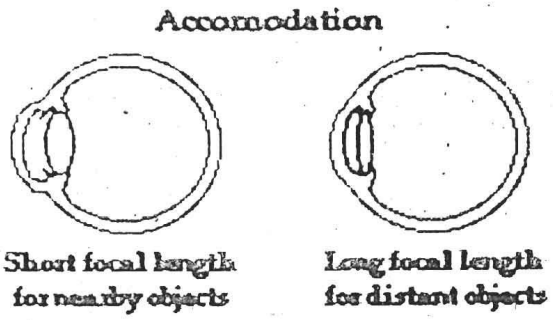


Accommodation:

The variation of the focal length of eye lens is called accommodation. "OR

"The sharpness of image formed in retina for objects at different distances from the eye is controlled by an alternation in the focal length of eye lens. This is called accommodation."

Accommodation is larger of healthy eye in young people while it goes on decreasing with increasing the age.



Q. 17: What is meant by the near sightedness and far sightedness? How these defects can be corrected? Define the defect of vision.

Ans. **Defect of Vision:** The inability of the eye to see the image of objects clearly is called defect of vision.

The defects of vision arise when the eye lens is unable to accommodate effectively. Therefore, the image formed at retina is blurred. There are two main defects of human eye.

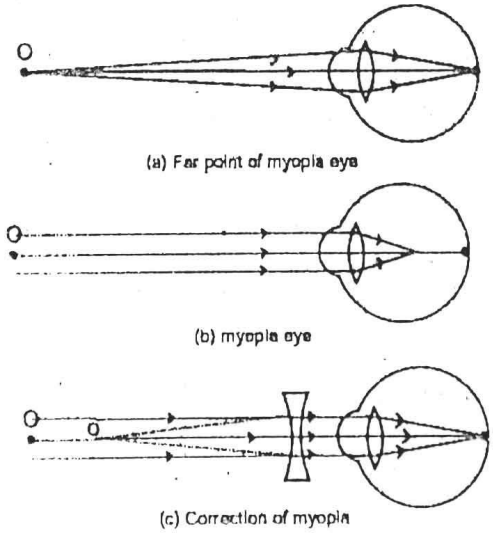
1. Nearsightedness (myopia)
2. Far sightedness (hypermetropia)

1. **Nearsightedness:**

A person suffering from nearsightedness or shortsightedness cannot see distant object clearly. This defect is due to that either the lens of eye ball is thick with short focal length or the eye-ball is too long so that effectively parallel rays from a point for such an eye on a very distant object are focused in front of the retina instead to focus on retina. That is why blurred image is formed.

Correction of nearsightedness

The nearsightedness can be corrected with suitable concave lens. The light rays coming from distant object are diverged by diverging lens so that they appear to be coming from eyes own far point. Therefore the rays focused on retina and sharp image is formed.



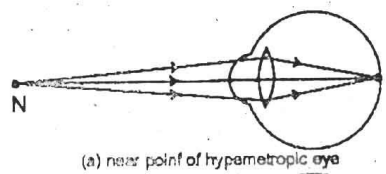
2. **Farsightedness (hypermetropia)**

The disability of the eye to form distinct image of nearby objects on its retina known as farsightedness.

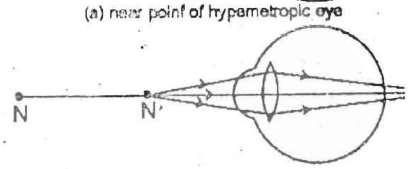
This defect can be caused by the eye-ball which is shorter than the normal size of eye-ball or due thinner eye-lens which has less converging ability. This means that the image is not focused on retina but behind the retina. A man suffering from farsightedness or long-sightedness is unable to read the book which is placed at normal near point 25cm from such eye. Because the near point of such eye is greater than 25 cm.

Correction of far-sightedness

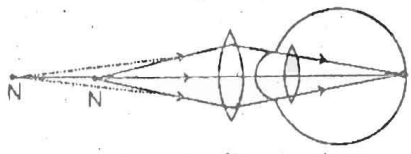
The farsightedness can be corrected with suitable convex lens focused the image on retina. In this way the refracted rays appears to come from near point. Than a sharp virtual image is formed on retina.



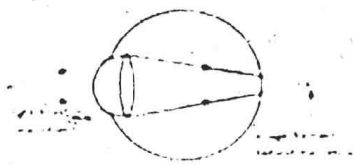
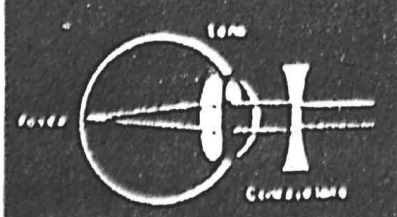
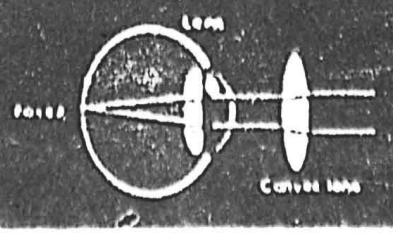
(a) near point of hypemetropic eye



(b) Hypemetropia eye



(c) correction of hypemetropia eye

Myopia	Aspects	Hypermetropia
•See near object clearly •Can't focus far object	Condition	•Sees distant object clearly •Can't focus near object
•Eye lens too thick •Eyeball too long	Causes	•Eye lens too thin •Eyeball too short
Image form in front retina 	Focus	Image form behind retina 
Myopic Vision Corrected 	Correction	Hyperopic Vision Corrected 

NUMERICAL PROBLEMS

12.1 An object 10.0 cm in front of a convex mirror forms an image 5.0 cm behind the mirror. What is the focal length of the mirror?

Solution:

Given that:

Distance of object $p = 10$ cm

Distance of image $q = -5$ cm (For convex mirror)

To Find:

Focal length $f = ?$

Calculations: Using the formula

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

By putting the values

$$\frac{1}{f} = \frac{1}{10\text{cm}} - \frac{1}{5\text{cm}}$$

$$= \frac{1-2}{10\text{cm}}$$

$$\frac{1}{f} = \frac{-1}{10\text{cm}}$$

$f = -10$ cm **Ans.**

12.2 An object 30.0 cm tall is located 10.5 cm from a concave mirror with focal length 16.0cm. (a) Where is the image located) (b) How high is it?

Solution: Given that,

Object height $h_o = 30$ cm

Distance of object $p = 10.5$ cm

Focal length $f = 16$ cm

To Find

(a) Distance of image $q = ?$

(b) Image height $h_i = ?$

Calculations: (a) Using the formula

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

By putting the values

$$\frac{1}{q} = \frac{1}{16\,cm} - \frac{1}{10.5\,cm}$$

Or $$\frac{1}{q} = \frac{1}{16\,cm} - \frac{10}{105\,cm}$$

$$= \frac{105 - 160}{(16)(105)\,cm}$$

$$= \frac{-55}{(16)(105)\,cm}$$

q= 30.54 cm **Ans.**

(b) we know that

$$\frac{image\,hegith}{object\,height} = \frac{q}{p}$$

or $$\frac{h_i}{h_o} = \frac{q}{p}$$

by putting the values

$$\frac{h_i}{30\,cm} = \frac{30.54\,cm}{10.5\,cm}$$

$$h_i = \frac{30.54\,cm}{10.5\,cm} \times 30\,cm$$

h_i = 87.26 cm Ans.

12.3 An object and its image in a concave mirror are of the same height, yet inverted, when the object is 20.0 cm form the mirror. What is the focal length of the mirror?

Solution: given that,

Distance of object p = 20 cm

Distance of image q =20 cm

To find: focal length f =?

Calculations: using the formula

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

By putting the values

$$\frac{1}{f} = \frac{1}{20cm} + \frac{1}{20cm}$$

$$= \frac{1+1}{20\,cm}$$

$$= \frac{2}{20\,cm}$$

$$f = \frac{20\,cm}{2}$$

$$f = 10\ cm$$ **Ans.**

12.4 Find the focal length of a mirror that form an image 5.66 cm behind a mirror of an object placed at 34.4 cm in front of the mirror

Solution **Given Data:**

Distance of the image form the mirror = q = 5.66

Distance of object form the mirror = q = 34.4 cm

Required Data:

Find out the focal length of the mirror = ?

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

Calculations: By using the above formula

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

As the image is formed behind the mirror, so it would be convex mirror, so q and f are all negative.

q = - 5. 66 cm

p = + 34 .4 cm

By substituting values in above equation, we get;

$$\frac{1}{f} = -\frac{1}{5.66} + \frac{1}{34.4}$$

$$\frac{1}{f} = -0.177 + 0.029$$

$$\frac{1}{f} = -0.148$$

$$f = -6.77cm$$

12.5 An image of a statue appears to be 11.5 cm behind a convex mirror with focal length 13.5 cm. find the distance form the statue to the mirror.

Solution: Given that,

Distance of image q = -11.5 cm (For convex mirror)

Focal length f = 13.5 c

To Find: Distance of object p = ?

Calculations: Using the formula

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

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

By putting the values

$$\frac{1}{p} = \frac{1}{13.5\,cm} + \frac{1}{11.5\,cm}$$

$$= \frac{11.5 + 13.5}{(13.5)(11.5)\,cm}$$

$$= \frac{25}{155.25\,cm}$$

$$p = \frac{155.25\,cm}{25}$$

$$p = 6.21\ cm$$ **Ans.**

12.6 An image is produced by a concave mirror of focal length 8.70cm. The object is 13.2 cm tall and at a distance 19.3 cm from the mirror. (a) Find the location and height of the image. (b) Find the height of the image produced by the mirror if the object is twice as far from the mirror.

Solution: Given that,

Focal length f = 8.70 cm

Object height h_o = 13.2 cm

Distance of object p = 19.3 cm

To Find:

(a) (i) Location of image q = ?

(ii) Height of image h_o = ?

Calculation: (i) Using the formula

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

Or $$\frac{1}{q} = \frac{1}{f} - \frac{1}{p}$$

By putting the values

$$= \frac{1}{8.7\,cm} + \frac{1}{19.3\,cm}$$

13.1.7 A capacitor holds 0.06 coulombs of charge when fully charged by a 9 volt battery. Calculate capacitance of the capacitor.

Solution: Given that,

Charge $Q = 0.06\ C$

Voltage $V = 9V$

To Find: Capacitance $C = ?$

Calculations: Using the formula

$$Q = CV$$

Or $$C = \frac{Q}{V}$$

By putting the values

$$C = \frac{0.06C}{9v}$$

$$C = 6.67 \times 10^{-3}\ F$$ **Ans.**

13.1.8 A capacitor holds 0.03 coulombs of charge when fully charged by a 6 volt battery. How much voltage would be required for it to hold 2 coulombs of charge?

Solutions: Given that

Charge $= Q = 0.03\ C$

Voltage $V = 6V$

To Find: Voltage to hold 2C of charge $V = ?$

Calculations: Since

$$0.03\ C = 6V$$

Or $$1C = \frac{6V}{0.03}$$

Therefore,

$$2C = \frac{6V}{0.03} \times 2$$

$$= \frac{1200V}{3}$$

$$V = 400\ V$$ **Ans.**

12.7 **Nabeela uses a concave mirror when applying makeup. The mirror has a radius of curvature of 38.0 cm. (a) what is the focal length of the mirror? (b) Nabeela is located 50cm from the mirror. Where will her image appear? (c) Will the image be upright or invited?**

Solution: Given that,

Radius of curvature R = 38 cm

Distance of object p = 50 cm

To Find

(a) Focal length f = ?

(b) Distance of image q = ?

(c) Nature of image = ?

Calculation (a) Using the formula

$$f = \frac{R}{2}$$

or $$f = \frac{38\,cm}{2}$$

$$f = 19\ cm \quad \textbf{Ans}$$

(b) Using the formula

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

Or $$\frac{1}{q} = \frac{1}{f} - \frac{1}{p}$$

By putting the values

$$\frac{1}{q} = \frac{1}{19\,cm} - \frac{1}{50\,cm}$$

$$= \frac{50 - 19}{(19)\,(50)\,cm}$$

$$= \frac{31}{950\,cm}$$

$$q = \frac{950\,cm}{31}$$

$$q = 30.64\ cm \quad \textbf{Ans}$$

(c) Because magnification $m = \frac{q}{p}$ is positive, so image will be upright.

12.8 An object 4cm high is placed at a distance of 12cm form a convex lens of focal length 8cm. Calculate the position and size of the image. Also state the nature of the image.

Solution: Given that,

Height of object $h_o = 4cm$

Distance of object $p = 12\ cm$

Focal length $f = 8\ cm$

To Find

(i) Position of image $q = ?$

(ii) Size of image $h_i = ?$

(iii) Nature f the image $= ?$

Calculations: (i) Using the formula

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

or $$\frac{1}{q} = \frac{1}{f} - \frac{1}{p}$$

By putting the values

$$\frac{1}{q} = \frac{1}{8\,cm} - \frac{1}{12\,cm}$$

$$= \frac{12 - 8}{(8)\,(12)\,cm}$$

$$= \frac{4}{96\,cm}$$

$$q = \frac{96\,cm}{4}$$

$$q = 24\ cm \quad \textbf{Ans.}$$

(ii) We know that

$$\frac{h_i}{h_o} = \frac{q}{p}$$

Or $$h_i = \frac{q}{p} \times h_o$$

By putting the values

$$h_i = \frac{24\,cm}{12\,cm} \times 4cm$$

$$h_i = 8\ cm \quad \textbf{Ans}$$

(iii) Since the lens in convex and size of image is larger than the size of the object, therefore, image formed is real, inverted and magnified

12.9 An object 10cm high is placed at a distance of 20cm from a concave lens of focal length 15cm high is placed at a instance of 20 cm from a concave lens of focal length 15cm. Calculate the position and size of the image. Also state the nature of the image.

Solution: Given that.

Size of object $h_o = 10$ cm

Distance of object $p = 20$ cm

Focal length $f = -15$ cm (for concave lens)

To Find

(i) Politico of image $q = ?$

(ii) Size of image $h_i = ?$

(iii) Nature of image $= ?$

Calculations: (i) Using the formula

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

or $$\frac{1}{q} = \frac{1}{f} - \frac{1}{p}$$

By putting the values

$$\frac{1}{q} = \frac{1}{15\,cm} - \frac{1}{20\,cm}$$

$$= \frac{-4-3}{60\,cm}$$

$$= \frac{-7}{60\,cm}$$

$$q = -\frac{60}{7}\,cm$$

$$= -.57\ cm \quad \textbf{Ans.}$$

(ii) We know that

$$\frac{h_i}{h_o} = \frac{q}{p}$$

Or $$h_i = \frac{q}{p} \times h_o$$

By putting the values

$$h_i = \frac{-8.57\,cm}{20\,cm} \times 10cm$$

$$h_i = 4.28\ cm \quad \text{Ans}$$

(iii) Since the lens is concave and object is larger in size than the size of the image, therefore, the image in virtual, eract and diminished.

12.10 A convex lens of focal length 6cm is to be used to form a virtual image three times the size of the object. Where must the lens be placed?

Solution: Given that,

Focal length $f = 6$ cm (For virtual image)

Distance of image $q = 3p$

To Find: Distance of object p = ?

Calculations: Using the formula

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

By putting the valuses

$$\frac{1}{6\,cm} = \frac{1}{p} + \frac{1}{3p}$$

$$\frac{1}{6\,cm} = \frac{3-1}{3p}$$

$$\frac{1}{6\,cm} = \frac{2}{3p}$$

Or $3p = 12\,cm$

$$p = \frac{12\,cm}{3}$$

$p = 4cm$ **Ans.**

12.11 A ray of light from air is incident on a liquid surface at an angle of incidence 35°. Calculate the angle refraction if the refractive index of the liquid is 12.5. Also calculate the critical angle between the liquid air inter-face.

Solution: Given that,

Angle of incidence $i = 35^0$

Refractive index $n = 1.25$

To Find

(i) Angle of refraction r = ?

(ii) Critical angle C = ?

Calculation: (i) Using Snell's law

$$\frac{\sin i}{f} = n$$

$$\text{Or } \sin r = \frac{\sin i}{n}$$

By putting the values

$$\sin r = \frac{\sin(35^0)}{1.25}$$

$$\sin r = \frac{0.57}{1.25}$$

$$= 0.456$$

$$r = \sin^{-1}(0.456)$$

$$r = 27.13^0$$

(ii) For critical angle. We know that

$$\sin C = \left(\frac{1}{n}\right)$$

or $C = \sin^{-1}\left(\frac{1}{n}\right)$

By putting the values

$$C = \sin^{-1}\left(\frac{1}{1.25}\right)$$

$$= \sin^{-1}(0.8)$$

$C = 52.13^{\circ}$ **Ans**

12.12 The power of a convex lens is 5D. At whit distance the object should be placed from the lens so that its real and 2 times larger image is formed.

Solution: Given that

Power of the lens p = 5D

Size of image q = 2p

To Find: Distance of object p = ?

Calculations: Using the formula

$$\text{Power of lens } p = \frac{1}{f}$$

or $$5 = \frac{1}{f}$$

or $$f = \frac{1}{5}$$

or $$f = 0.2\text{m}$$

$$= \frac{2}{10} \times 100 \text{ cm} = 20 \text{ cm}$$

Now using the formula

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

By putting the values

$$\frac{1}{20\,\text{cm}} = \frac{1}{p} + \frac{1}{2p}$$

$$\frac{1}{20\,\text{cm}} = \frac{2+1}{2p}$$

$$\frac{1}{20\,\text{cm}} = \frac{3}{2p}$$

$$2p = 60 \text{ cm}$$

$$p = \frac{60\,\text{cm}}{2}$$

$p = 30$ cm **Ans.**