Chapter: 12

Geometrical Optics

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Objective

1. Thomas young's proved the wave nature of light in:

Ⓐ 1804 Ⓑ 1802 Ⓒ 1801 Ⓓ 1800

2. In ……Planck suggested that light consists of small packets of energy called photon:

Ⓐ 1904 Ⓑ 1901 Ⓒ 1900 Ⓓ 1902

3. Laws of reflection of light are:

Ⓐ 2 Ⓑ 3 Ⓒ 4 Ⓓ 5

4. Who suggested the wave theory of light?

Ⓐ Ibn Al Haytham Ⓑ Einstein Ⓒ Maxwell Ⓓ Newton

5. In a convex mirror focus is:

Ⓐ Behind the mirror Ⓑ Under the mirror
Ⓒ On the mirror Ⓓ In-front of the mirror

6. The formula for focal length is: OR The relation between focal length and radius of curvature is:

Ⓐ Wm^{-2} Ⓑ f = R/3 Ⓒ f = R/4 Ⓓ f = R/2

7. The principal focus of a concave mirror is:

Ⓐ Real Ⓑ Both a and b Ⓒ Virtual Ⓓ None of these

8. A converging mirror with a radius of 20 cm creates a real image 30 cm from the mirror. What is the object distance?

Ⓐ -20 cm Ⓑ -7.5 cm Ⓒ -15 cm Ⓓ -5.0 cm

9. An object is 14 cm in front of a convex mirror; the image is 5.8 cm behind the mirror. What is the focal length of the mirror?

Ⓐ -20 cm Ⓑ -8.2 cm Ⓒ -4.1 cm Ⓓ -9.9 cm

10. An object is placed at the center of curvature of a concave mirror. The image produced by the mirror is located:

Ⓐ At the center of curvature Ⓑ Out beyond the center of curvature
Ⓒ Between the center of curvature and focal point Ⓓ At the focal point

11. Magnification does not always mean?

Ⓐ Virtual Ⓑ Real Ⓒ Enlargement Ⓓ Smallness

12. In magnification image could also be …….. Than the object.

Ⓐ Real Ⓑ Virtual Ⓒ Smaller Ⓓ Same

13. Convex mirrors produce images that are smaller than objects. This increase:

Ⓐ View for the observer Ⓑ A and C
Ⓒ View for the image Ⓓ None of these

14. Which of the following quantities not change during refraction of light?

Ⓐ Its frequency Ⓑ Its wavelength Ⓒ Its speed Ⓓ Its Direction

15. The index of refraction depends on:

Ⓐ Speed of light Ⓑ Image distance Ⓒ Object distance Ⓓ The focal length

16. The refractive index is equal to:

(A) n = v/c (B) n= c/v (C) n = 1/cv (D) n = cv

17. The refractive index of diamond is:

(A) 2.42 (B) 2.21 (C) 1.66 (D) 1.52

18. The value of refractive index of air is:

(A) 2 (B) 1 (C) 3 (D) 4

19. The refractive index of ice is

(A) 1.33 (B) 2.42 (C) 1.52 (D) 1.31

20. The refractive index of crown glass is:

(A) 1.52 (B) 1.66 (C) 2.21 (D) 2.42

21. The speed of light in water is approximately:

(A) 2.6×10^8 m/s (B) 2.5×10^8 m/s (C) 3.3×10^8 m/s (D) 2.3×10^8 m/s

22. The speed of light in glass is:

(A) 3×10^{-8} m/s (B) 2×10^8 m/s (C) 3×10^8 m/s (D) 2×10^{-8} m/s

23. Snell's law is:

(A) $n = \frac{\sin < r}{\sin < i}$ (B) $n = \frac{\sin < i}{\sin < r}$ (C) $n = sin < i$ (D) $n = sin < r$

24. If a ray of light in glass is incident on an air surface at an angle greater than the critical angle, the ray will:

(A) Diffract only (B) Partially reflect (C) Refract Only (D) Reflect only

25. The critical angle for a beam of light passing from water into air is 48.8 degrees. This means that all light rays with an angle of incidence greater than this angle will be:

(A) Totally transmitted (B) Totally Reflected
(C) Absorbed (D) Partially reflected and partially transmitted

26. Critical angle of water is:

(A) 48.8^0 (B) 49.50^0 (C) 50^0 (D) 45^0

27. Conditions for total internal reflection are:

(A) 5 (B) 4 (C) 3 (D) 2

28. Optical fiber works on the principle of:

(A) Total internal reflection (B) Reflection
(C) Refraction (D) Diffraction

29. An instrument used to view the stomach of human body is called:

(A) Cystoscopy (B) Gastroscopy (C) Bronchoscope (D) Endoscope

30. Endoscope is a:

(A) Principle (B) Formula (C) Technique (D) Instrument

31. An instrument used to view the throat of human body is called:

(A) Cystoscopy (B) Bronchoscope (C) Gastroscopy (D) Endoscope

32. The power of lens is reciprocal of:

(A) Principal axis (B) Principal focus (C) Diopter (D) Focal length

33. The power of lenses is equal to:

(A) 4/f (B) 1/f (C) 2/f (D) 3/f

34. The focal length of lens is 1 meter, then its power will be:

(A) 0.5D (B) 1D (C) 1.5D (D) 2D

35. Concave lens spreads light away from the:

(A) Centre of curvature (B) Optical center (C) Principal axis (D) Principal focus

36. Convex lens bends light towards the:

(A) Centre of curvature (B) Optical center (C) Principal axis (D) Principal focus

37. If the image is virtual then its distance from lens is taken as:

(A) Half (B) Negative (C) Double (D) Positive

38. Which type of image is formed by convex lens on a screen?

(A) Inverted and virtual (B) Inverted and real
(C) Upright and virtual (D) Upright and real

39. Which type of image is formed by concave lens on a screen?

(A) Inverted and virtual (B) Upright and virtual
(C) Upright and real (D) Inverted and real

40. For diverging lens f is:

(A) Zero (B) Negative (C) Positive (D) None of these

41. For converging lens f is:

(A) Zero (B) Positive (C) Negative (D) None of these

42. If p = 30cm, q = -10cm then magnification will be:

(A) 3 (B) 1/3 (C) 20 (D) 30

43. The branch of optics that focuses on the creation of images is called:

(A) Image study (B) Optics (C) None of these (D) Geometrical Optics

44. Image formed by camera is:

(A) Virtual, upright and magnified (B) Real, inverted and diminished
(C) Virtual, upright and diminished (D) Real, inverted and magnified

45. The working principle of photograph enlarger is basically the same as that of:

(A) Slide projector (B) Concave lens (C) Convex lens (D) Camera

46. In slide projector Projection lens is a:

(A) Convex mirror (B) Concave mirror (C) Concave lens (D) Convex lens

47. In compound microscope objective lens has focal length:

(A) Less than 1 cm (B) Greater than 1 m (C) Zero (D) Equal to 1 cm

48. The mathematical equation for magnification of compound microscope is:

(A) $L\left(1+\frac{L}{f_e}\right)$ (B) $F_0\left(1+\frac{1}{f_e}\right)$ (C) $\frac{L}{f_0}\left(1+\frac{f_e}{L}\right)$ (D) $\frac{L}{f_0}\left(1+\frac{L}{f_e}\right)$

49. In astronomical telescope objective lens has ..... focal length than eyepiece.

(A) Equal (B) Larger (C) Lesser (D) None of these

50. In astronomical telescope the distance between objective lens and eyepiece is equal to:

(A) f_0 (B) $f_0 + f_e$ (C) $f_0 - f_e$ (D) f_0/f_e

51. Which type of image is produced by the converging lens of human eye if it views a distant object?

Ⓐ Real, Erect, same size Ⓑ Real, Inverted, Diminished
Ⓒ Virtual, inverted, magnified Ⓓ Virtual, Erect, Diminished

52. The human eye has:

Ⓐ Concave lens Ⓑ Concave mirror Ⓒ Convex mirror Ⓓ Convex lens

53. At the age of 40 the value of least distance of distinct vision is:

Ⓐ 500 cm Ⓑ 50 cm Ⓒ 60 cm Ⓓ 25 cm

54. For people in twenties with normal vision, the near point is located at……. From the eye.

Ⓐ 50 cm Ⓑ 25 cm Ⓒ 500 cm Ⓓ 20 cm

55. There are……. main defects in human eye.

Ⓐ 4 Ⓑ 3 Ⓒ 2 Ⓓ 1

56. In near-sightedness light rays from a distant object are focused ……retina.

Ⓐ In Front of Ⓑ After Ⓒ Beyond Ⓓ None of these

57. Hypermetropia can be corrected using ……..lenses.

Ⓐ Simple Ⓑ Concave Ⓒ Convex Ⓓ None of these

58. In Far-sightedness light rays from an object forms a sharp image ……retina.

Ⓐ Behind Ⓑ On Ⓒ After Ⓓ Before

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Subjective

Q1: ***What do you understand by reflection of light? Draw a diagram to illustrate reflection at a plane surface.***

Ans: ***Reflection:***

When light travelling 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.

Following diagram show reflection of light from a plane surface:

Fig. Reflection of light

Q2: ***Describe the following terms used in reflection. i. Normal ii. Angle of incidence iii. Angle of reflection***

Ans: ***i. Normal:***

A line drawn perpendicular to the surface of mirror at the point of incidence of light rays is called normal.

ii. Angle of incidence:

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

iii. Angle of reflection:

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

Q3: ***State laws of reflection.***

Ans: ***Laws of Reflection:***

- *The incident ray, the normal and the reflected ray at the point of incidence all lie in the same plane.*
- *The angle of incidence is equal to the angle of reflection.*

Q4: ***Define refraction of light.***

Ans: The bending of light as it passes from one transparent medium to another transparent medium is called refraction of light.

Q5: ***Define angle of refraction.***

Ans: ***Angle of Refraction****:*

The angle between the refracted ray and normal is called angle of refraction.

Q6: ***What is meant by refractive index? How would you determine the refractive index of rectangular glass slab?***

Ans: ***Refractive Index:***

Refractive index of the medium is the ratio of the speed of light in air to the speed of light in the medium.

$$\text{Refractive Index} = \frac{\text{Ispeed of light in air}}{\text{speed of light in medium}}$$

Or $$n = \frac{c}{v}$$

Refractive index of glass slab:

Speed of light in air $= c = 3 \times 10^8\ ms^{-1}$

Speed of light in glass $= v = 2 \times 10^8\ ms^{-1}$

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

$$n = 1.5$$

For your information

Substance	Index of Refraction (*n*)
Diamond	2.42
Cubic Zirconia	2.21
Glass (flint)	1.66
Glass(crown)	1.52
Ethyl Alcohol	1.36
Ice	1.31
Water	1.33
Air	1.00

Q7: ***What is meant by term total internal reflection?***

Ans: ***Total Internal Reflection:***

When the value of angle of incidence becomes greater than the critical angle, then the ray does not enter in to the second medium, but reflects back in the same medium such reflection of light is called total internal reflection.

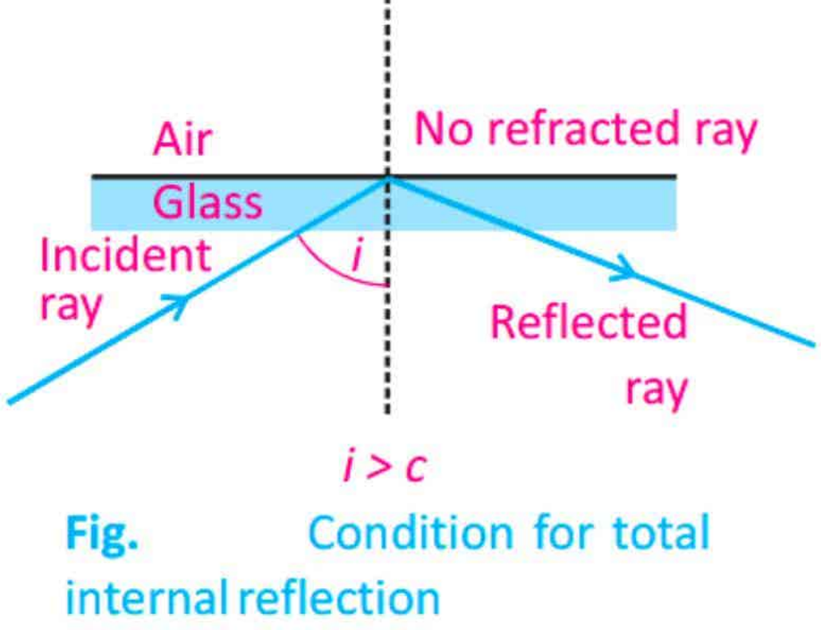

Fig. Condition for total internal reflection

Q8: ***State the conditions for total internal reflection?***

Ans: Conditions for Total Internal Reflection:

- *The angle of incidence should be greater than critical angle.*
- *The ray of light should travel from denser medium to rarer medium.*

Q9: ***What is critical angle? Describe the relation between critical angle and refractive index of a substance.***

Ans: ***Critical Angle:***

The angle of incidence that causes the refracted ray in the rare medium to bend through 90^0 is called critical angle.

Relation between Critical angle and Refractive index:

If refractive index of air with respect to glass is n, then refractive index of ray from glass to air in $\frac{1}{n}$*. According to Snell's law:*

$$\frac{1}{n} = \frac{\sin<i}{\sin<r} \qquad \text{Since} < i =< C$$

$$\frac{1}{n} = \frac{\sin<i}{n\sin<90^0} \qquad \text{Since } <r = 90^o$$

$$\frac{1}{n} = \frac{\sin<i}{1} \quad \textbf{or} \quad n = \frac{1}{\sin<c}$$

Q10: ***Define the following terms applied to a lens. i. Principal axis ii. Optical Center iii. Focal Length.***

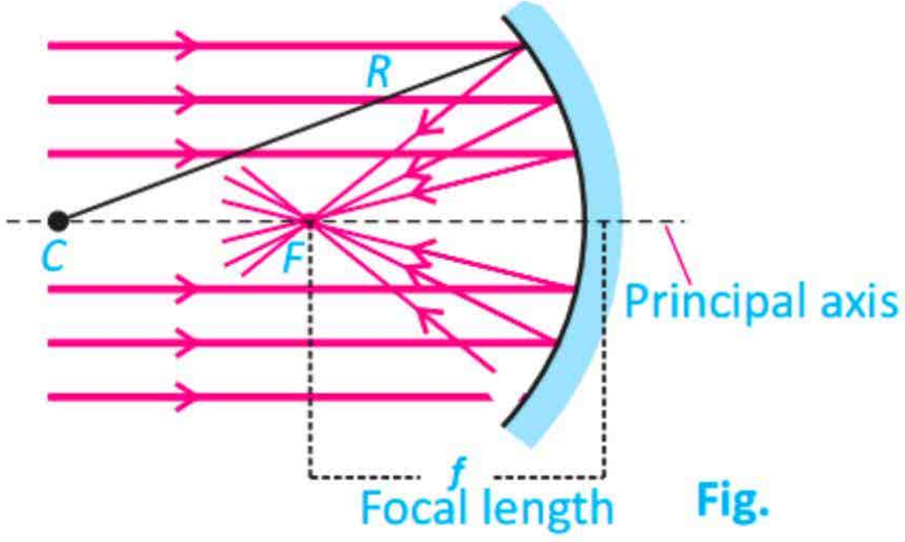

Fig.

Ans: ***i. Principal axis:***

Each of the two surfaces of a spherical lens is a section of a sphere. The line passing through the two centers of curvature of the lens is called principal axis.

ii. Optical Center (C):

A point on the principal axis at the center of the lens is called optical center.

iii. Focal Length:

This is the distance between the optical center and principal focus.

Q11: ***How can you use thin converging lens as magnifying glass.***

Ans: A magnifying glass is a convex lens which is used to produce magnified images of small objects. Hence it is also called simple microscope. When object is placed between principal focus and the optical center than an upright, virtual and magnified image is seen from normal eye.

Q12: ***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 a principal focus of a convex lens no image is formed because the refracted rays become parallel and never meet.

Q13: ***What is meant by principal focus of (a) Convex lens (b) Concave lens? Illustrate your answer with ray diagram.***

Ans: ***(a) Convex lens:***

The light rays travelling parallel to the principal axis of convex lens after refraction meet a point on the principal axis called principal focus F. Hence convex lens is also called converging lens.

(b) Concave lens:

For concave lens the parallel rays appear to come from a point behind the lens called principal focus F. Hence concave lens is also called diverging lens.

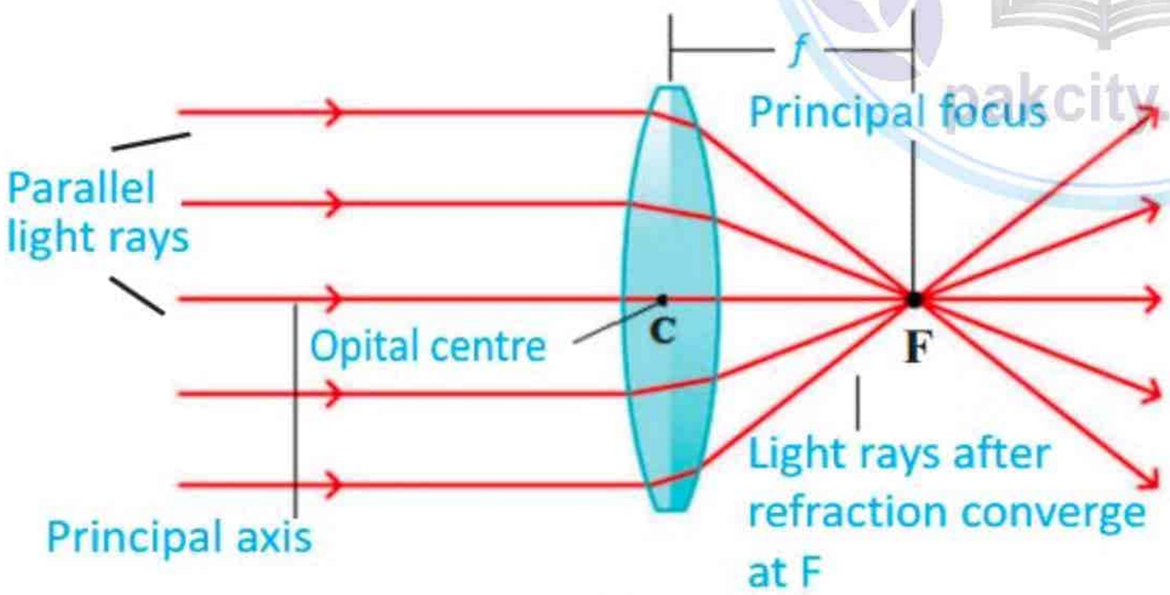

Fig. Convex lens

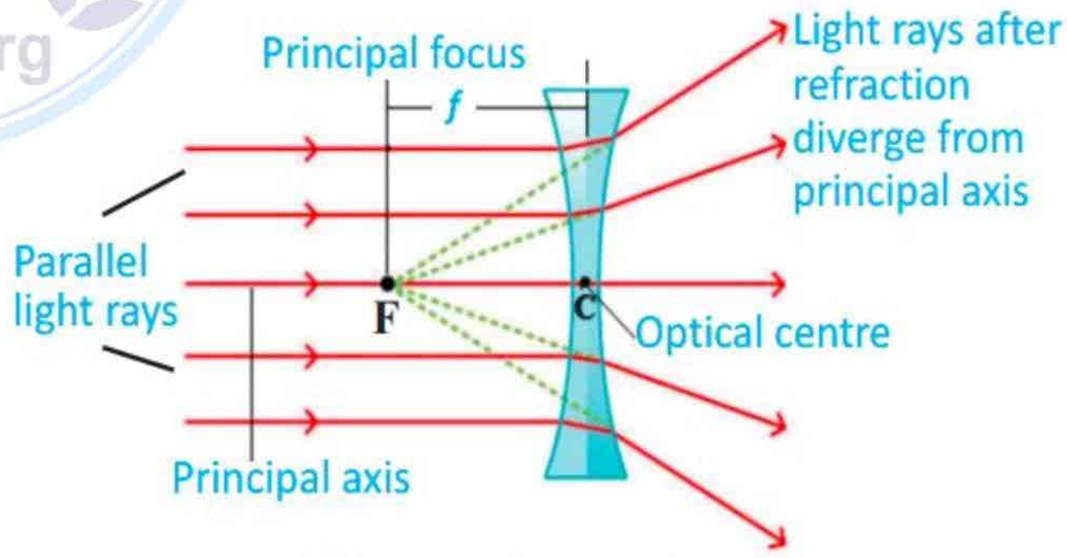

Fig. Concave lens

Q14: ***What are the differences between real and virtual images?***

Ans: The differences between real and virtual images are:

Real Image	Virtual Image
❖ Image is inverted. ❖ In real image, rays of light actually converge to form image. ❖ The image that can be obtained on screen is called real image.	❖ Virtual image is erect ❖ In virtual image rays of light appear to diverge. ❖ The image that cannot obtain on screen is called virtual image.

Q15: ***Define the term resolving power and magnifying power.***

Ans: ***Magnifying Power:***

It is the ratio of angular size of final image produced by magnifying glass to the angular size of object seen without magnifying glass.

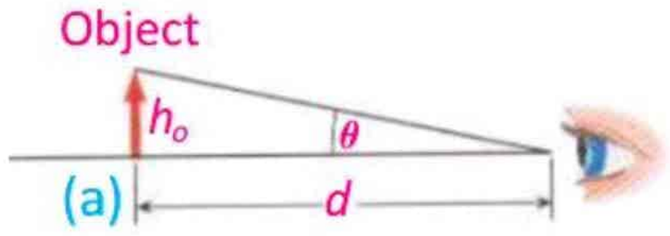

Fig.

Formula:

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

$$M = \frac{\theta'}{\theta}$$

Resolving power:

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

Q16: ***Mention the magnifying powers of the following optical instruments.***

i. Simple Microscope ii. Compound Microscope

iii. Refracting Telescope.

Ans: ***i. Simple microscope:***

Magnifying power of Simple microscope.

$$M = 1 + \frac{d}{f}$$

Fig. Image formation in magnifying glass

ii. Compound Microscope:

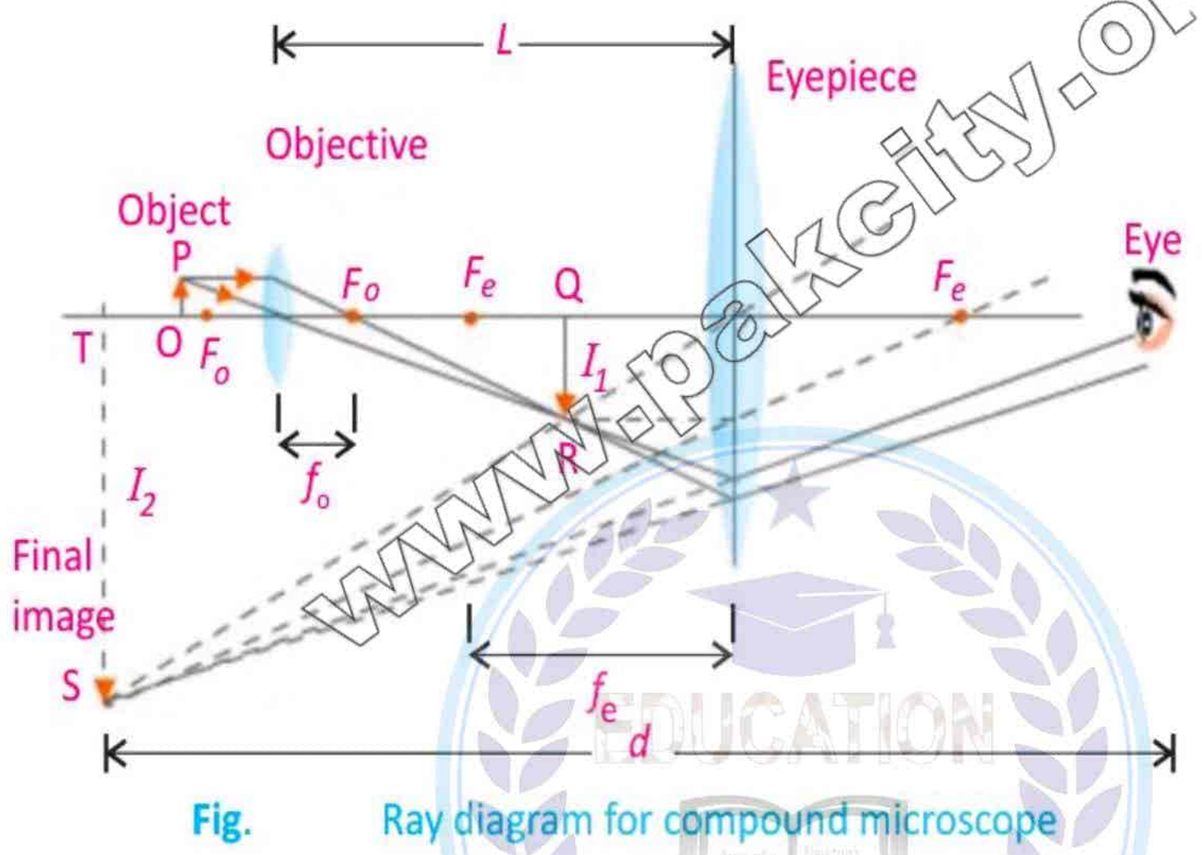

Fig. Ray diagram for compound microscope

Magnifying power of Compound microscope.

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

iii. Refracting Telescope:

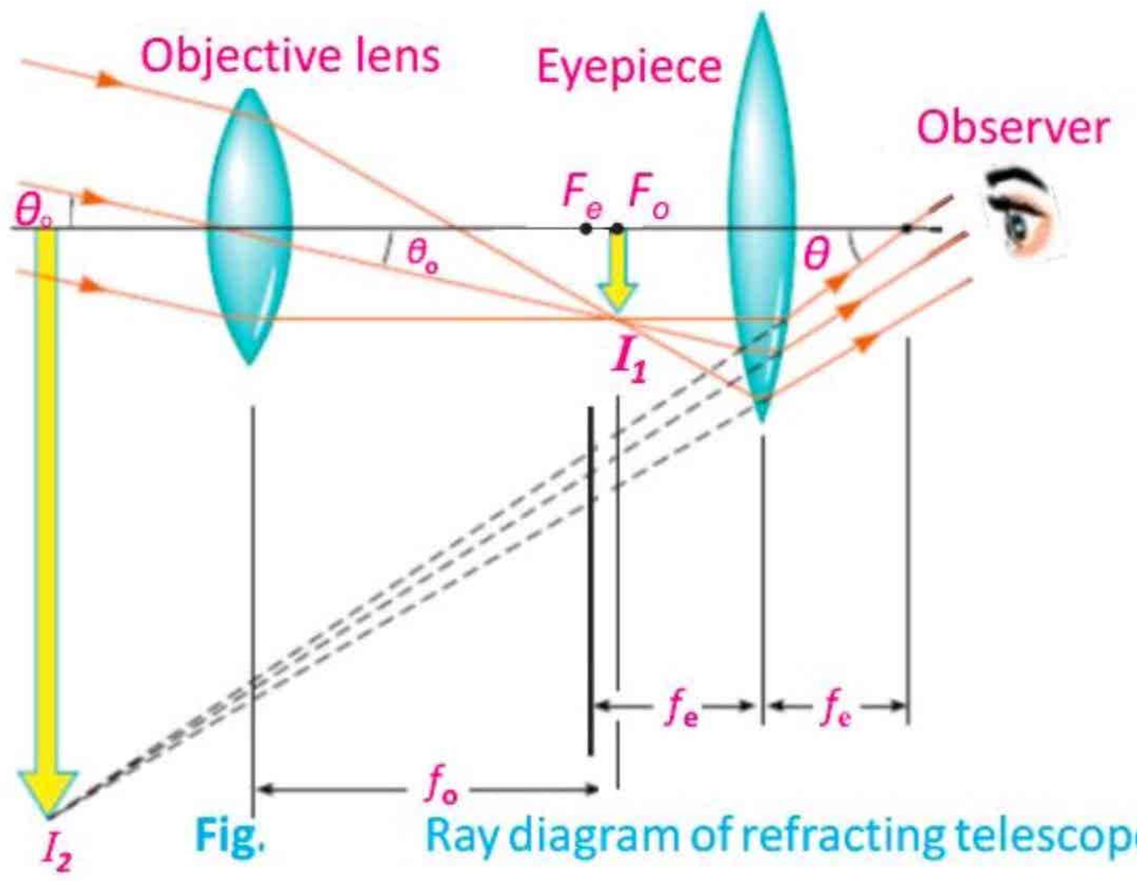

Fig. Ray diagram of refracting telescope

Magnifying power of Refracting Telescope.

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

Q17: ***Define power of lens and its units.***

Ans: ***Power of lens:***

Power of lens is defined as the reciprocal of its focal length in meters. Thus Power of lens $= \frac{1}{f}$ *(focal length in meter)*

Unit of power of lens:

The S.I unit of power of lens is Diopter denoted by a symbol 'D'.

Diopter:

One Diopter is the power of lens whose focal length is one meter.

Conceptual Question

Q1: ***A man raises his left hand in a plane mirror, the image facing him is raising his right hand. Explain why?***

Ans: *It is because the images produced by the plane mirror are virtual, upright, left-right reversed, and the same distance from the mirror and of same size as object.*

Q2: ***In your own words, explain why light waves are refracted at a boundary between two materials?***

Ans: *When light rays enter from one transparent medium to another medium the speed of light changes due to change in wavelength, so light rays are refracted at the boundary between two materials.*

Q3: ***Explain why a fish under water appears to be at a different depth below the surface than it actually is. Does it appear deeper or shallower?***

Ans: *A fish under water appears to be at different depth below the surface, it appears to be shallower because apparent depth is always less than the real depth and image is formed at apparent depth.*

Q4: ***Why or why not concave mirrors are suitable for make up?***

Ans: *Concave mirrors are suitable for make up because when a man stands between principal focus and pole of mirror, he sees enlarge erect and virtual image of his face. And it is not suitable when person is not standing between focus and pole of mirror.*

Q5: ***Why is the driver's side mirror in many cars convex mirror rather than plane or concave?***

Ans: *The image formed by the convex mirror is always virtual, erect and diminished so convex mirrors are used in automobiles which enables the driver to see the vehicle coming behind him.*

Q6: ***When an optician's testing room is small, he uses a mirror to help him test the eye sight of his patients. Explain why?***

Ans: *If the optician's room is small then for testing eye sight words are placed at the back side or patient and mirror is placed in front of the patient. So that image of words is formed at the distance doubled than the size of room.*

Q7: ***How does the thickness of lens affect its focal length?***

Ans: *As we know that focal length is half of radius of curvature. So a thick lens has short focal length and a thin lens has large focal length.*

Q8: ***Under what condition will a converging lens form a virtual image?***

Ans: *If the object is placed in between principal focus and optical center of the lens, the image formed will be virtual, erect and large in size than the object.*

Q9: ***Under what condition the converging lens form a real image that is the same size as the object?***

Ans: *If object is placed at 2F distance from the lens the image formed will be real and inverted.*

Q10: ***Why do we use refracting telescope with large objective lens of large focal length?***

Ans: *In telescope objective lens of large focal length is used in order to collect information of distant object from infinity. So, that we get better magnification.*

Since,

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

Additional Question

Q1: ***For which purpose the gastroscopy, cystoscopy and bronchoscope are used medical field?***

Ans: *Gastroscopy is used to view stomach, Cystoscopy is used to view liver or bladder and Bronchoscope is used to view sore throat.*

Q2: ***What is difference between concave mirror and convex mirror?***

Ans:

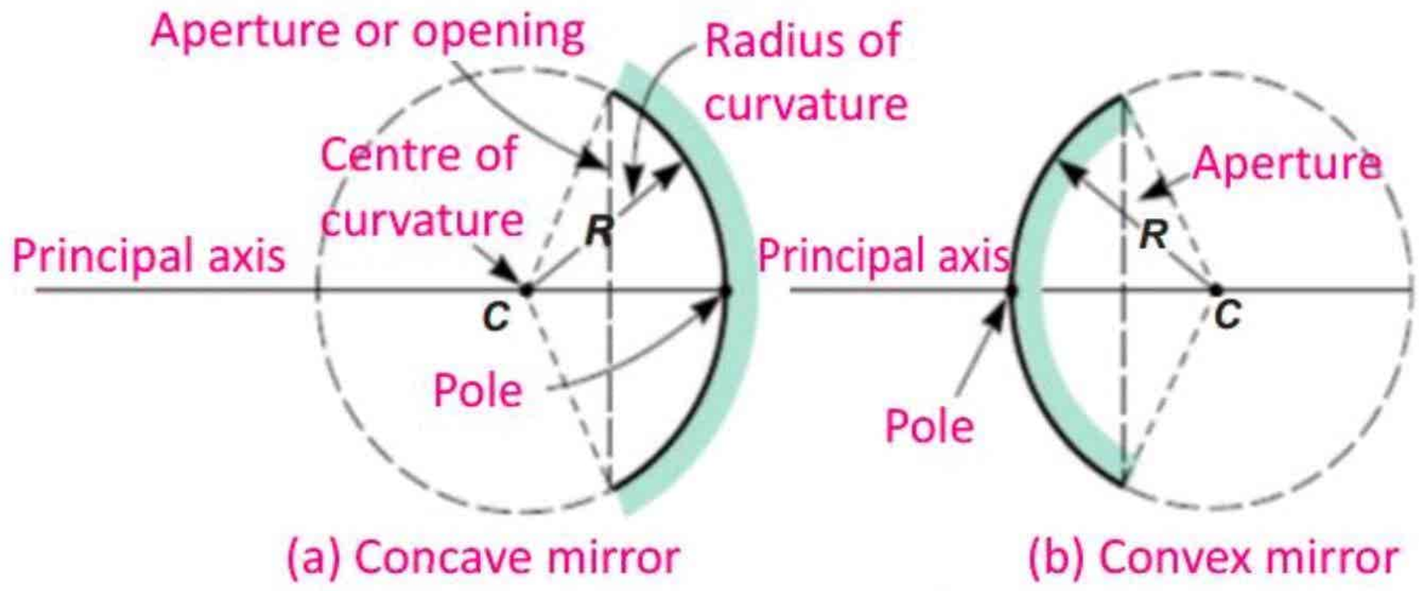

Fig. Types of spherical mirrors

Concave mirror:

- *Focal length of concave mirror is taken as positive.*
- *The mirror whose inner curved surface is reflecting is called concave mirror.*

Convex mirror:

- *Focal length of convex mirror is taken as negative.*
- *The mirror whose outer curved surface is reflecting is called convex mirror.*

Q3: ***Define focal length.***

Ans: ***Focal Length:***

The distance between principal focus and pole of the mirror is called focal length.

Q4: ***What is endoscope?***

Ans: *It is an instrument, which is used to observe and get the image of the internal organ of the body.*

Q5: ***Define refractive index. What is its unit?***

Ans: ***Refractive index:***

The refractive index 'n' of a medium is the ratio of the speed 'c' of light in a vacuum to the speed 'v' of light in the medium.

$$n = \frac{c}{v}$$

Unit: *It has no unit.*

Q6: ***Describe the simple microscope.***

Ans: *If the object is placed in between principal focus and optical center of the lens, the image formed will be virtual, erect and large in size than the object. So it is called simple microscope.*

Q7: ***What is difference between regular and irregular reflection?***

Ans: *Difference between regular and irregular reflection:*

Regular Reflection	Irregular Reflection
❖ *The smooth surface of silver reflects rays of light in one direction only. The reflection by these smooth surfaces is called regular reflection.*	❖ *Most of the object in everyday world is not smooth on the microscopic level. The rough surfaces of these objects reflect the rays of light in many*

	directions. Such type of reflection is called irregular reflections.

Q8: ***Define Snell's law. Write down its formula.***

Ans: *According to Snell's law the ratio of sin of angle of incidence to the sin of angle of reflection is known as refractive index of the second medium with respect to first medium.*

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

Q9: ***What are applications of lenses?***

Ans: *Lenses are used in many optical devices to get images of objects. Following are some devices in which lenses are used.*

1. *Camera*
2. *Slide projector*
3. *Photograph enlarger*
4. *Optical microscope*
5. *Refracting telescope*

Q10: ***Define pole of the mirror.***

Ans: *It is the mid- point of curved surface of spherical mirror. It is also called vertex and it is denoted by P.*

Q11: ***Describe the difference between simple microscope and compound microscope.***

Ans: *Difference between simple microscope and compound microscope:*

Simple Microscope	Compound Microscope
❖ *Its total magnification is limited to the magnification of single lens used.* ❖ *It has only one lens for magnifying objects.*	❖ *Its total magnifications are the multiplication of the eyepiece and objective magnification.* ❖ *It has two lenses for magnifying objects, eyepiece and objective.*

Q12: ***What is prism?***

Ans: *A solid geometric figure whose two ends are similar, equal, and parallel rectilinear figures, and whose sides are parallelograms.*

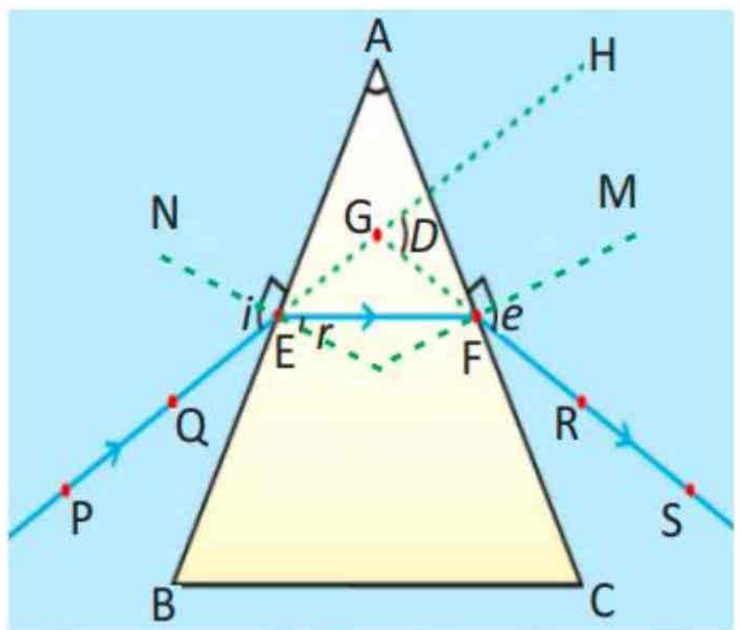

Fig. Refraction through a triangular glass prism

Imp.Long Questions

Q.1: ***Describe the structure and image formation in human eye.***

Q.2: ***What do you mean by defect of vision? Describe the main defects of vision and how are they minimized?***

Q.3: ***Describe the applications of lenses in the following optical devices.***
i. Camera ii. Slide Projector iii. Photograph Enlarger

Q.4: ***Find the value of critical angle for water (refracted angle = 90^0). The refractive index of water is 1.33 and that of air is 1.***

Q.5: ***An object is placed 6 cm in front of a concave mirror that has focal length . Determine the location of 10 cm the image.***

Q.6: ***An object 30 cm tall is located 10.5 cm from a concave mirror with focal length 16 cm. (a) Where is the image located? (b) How high is it?***

Q.7: ***A convex lens of focal length 6 cm is to be used to form a virtual image three times the size of the object. Where must the lens be placed?***

Q.8: ***Find the focal length of a mirror that forms an image 5.66 cm behind the mirror of an Object placed at 34.4 cm in front of the mirror. Is the mirror concave or convex?***

Q.9: ***An object 4 cm high is placed at a distance of 12 cm from a convex lens of focal length 8 cm. Calculate the position and size of the image. Also state the nature of the image.***