Assignments in Science Class X

Topic: - **Light — Reflection and Refraction**

IMPORTANT NOTES

1. **Reflection of light** is the phenomenon due to which a parallel beam of light travelling through a certain medium on striking some surface, bounces off from it in some other direction.
2. **Laws of reflection:**
    A. The incident ray, the reflected ray and the normal lie in the same plane at the point of incidence.
    B. The angle of incidence is always equal to the angle of reflection.
3. **Real image:** When the rays of light, diverging from a point, after reflection or refraction, *actually converge* at some other point, then the image so formed at that point is called the *real image* of the object.
4. **Virtual image:** When the rays of light, diverging from a point, after reflection or refraction, *appear to diverge from another point,* then the image so formed at that point is called its *virtual image.*
5. **Plane mirror is used**
    A. as looking glass
    B. for providing false dimensions in show-cases
    C. in the construction of reflecting periscope
    D. in solar cookers
    E. and for signaling purposes.
6. **Concave mirror:** A mirror which is polished from the outer side of a hollow sphere, such that the reflecting side is towards its hollow side, is called a **concave mirror.**
7. **Convex mirror:** A mirror which is polished on the hollow side of the sphere, such that the reflecting surface is towards its bulging side, is called a convex mirror.
8. **Pole:** The mid-point of a spherical mirror is called **pole.**
9. **Centre of curvature** is the centre of the sphere of which the spherical mirror is a part.
10. **Principal axis** is an imaginary line passing through the pole and centre of curvature of a spherical mirror.
11. **Linear aperture** is the length of effective surface, from which reflection takes place.
12. **Principal focus** of a spherical mirror is the point on the principal axis where the rays travelling parallel to the principal axis either *actually meet* or *appear to meet.* In case of concave mirror the rays actually meet, whereas in case of convex mirror, they appear to meet.
13. **Focal length** is the linear distance between the pole and principal focus of a spherical mirror.

14. **Radius of curvature** is the linear distance between the pole and the centre of curvature of a spherical mirror.
15. **Sign conventions for spherical mirrors:**
    A. All distances are measured from the pole of the spherical mirror.
    B. The distances measured in the same direction as incident light are taken as positive.
    C. The distances measured in opposite the direction of incident light, are taken as negative.
    D. Distances measured upward and perpendicular to the principal axis, are taken as positive.
    E. Distances measured downward and perpendicular to the principal axis, are taken as negative.
16. $\dfrac{1}{v} + \dfrac{1}{u} = \dfrac{1}{f}$ is the mirror formula where 'u' is the distance of object from the pole, 'v' is the distance of image from the pole and 'f' is the focal length of the spherical mirror.
17. Linear magnification: $m = \dfrac{h_i}{h_o} = -\dfrac{v}{u}$ where h_i is the height of image and ho is the height of object.

18. **Uses of convex mirror:** It is used as:
    (i) rear-view mirror   (ii) reflector of street lights.
19. **Uses of concave mirror:** It is used as:
    (i)   reflector in automobile lights   (ii) as a shaving mirror
    (iii) by dentists for seeing the back of tooth   (iv) reflector of solar furnaces.
20. **Refraction** is the phenomenon due to which a ray of light deviates from its original path, while travelling from one optical medium to another optical medium.
21. **Laws of refraction:**
    A. The ratio between sine of angle of incidence and sine of angle of refraction for two given media, is a constant quantity. This law is also known as **Snell's law** of refraction.
    B. The incident ray, the refracted ray and the normal at the point of incidence, lie in the same plane.
22. **Refractive index:** The ratio between the sine of angle of incidence (in air) and the sine of angle of refraction (in denser medium) is called refractive index (μ).
$$(\mu) = \frac{\sin i}{\sin r}$$
$$\frac{\text{Velocity of light in air or vacuum}}{\text{Velocity of light in a given medium}}$$
23. **Lateral displacement** is perpendicular shift in the path of the incident ray, while emerging out from an optical slab. It is (a) directly proportional to :
    (i) thickness of the optical slab,
    (ii) refractive index of the optical material (medium),
    (iii) angle of incidence, and
    (b) inversely proportional to wavelength of light.
24. When a ray of light emerges out from a rectangular optical slab, then:
    (i) incident ray is parallel to emergent ray
    (ii) Angle of incidence is equal to angle of emergence.

25. **Lens** is defined as a portion of a transparent, optical material, having one or two spherical surfaces.

26. **Convex lens or converging lens** is a piece of transparent, optical material, having one or two spherical surfaces, such that it is thicker in the middle and tapering at the edges.

27. **Concave lens or diverging lens** is a piece of transparent, optical material, having one or two spherical surfaces, such that it is tapering in the middle and thicker at the edges.

28. **Principal axis of a lens** is an imaginary line joining the centres of curvature of two spherical surfaces.

29. **Optical centre of a lens** is the point within the lens, where a line drawn through the aperture, meets the principal axis.

30. **Principal focus of a lens** is a point on the principal axis of the lens such that a beam of light parallel to the principal axis after refraction either actually meets or appears to meet.

31. **Focal length of a lens** is the linear distance between the optical centre and principal focus.

32. **Focal plane:** A vertical plane passing through the principal focus of the lens is called a focal plane.

33. **Power of lens** is the reciprocal of focal length in meters.

34. **Unit of power of lens** is diopter (D). It is +ve for convex lens and −ve for concave lens.

35. **Sign conventions for lenses :**
    A. All distances are measured from the optical centre of the lens.
    B. Distances measured from the optical centre in the direction of the incident light are taken as positive.
    C. Distances measured from the optical centre in opposite the direction of the incident light are taken as negative.
    D. The distances measured upward and perpendicular to the principal axis are taken as positive.
    E. The distance measured downward and perpendicular to the principal axis is taken as negative.

36. $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$ is the lens formula where 'v' is the distance of image from the optical centre, 'u' is the distance of
    Object from the optical centre and 'f' is the focal length of the lens.

37. **Linear magnification** $m = \frac{h_i}{h_o} = \frac{v}{u}$, where h_o is the height of the object and h_i is the height of the image.

VERY SHORT ANSWER QUESTIONS
IMPORTANT QUESTIONS

1. What do you understand by the term principal focus in case of a convex mirror?

2. What do you understand by the term 'refractive index'?

3. What do you understand by the term 'lateral displacement'?

4. What do you understand by the term lens?

5. State and define the unit of the power of a lens.

6. What do you understand by the term power of a lens?

7. When is the power of the lens,
    (i) positive
   (ii) negative?

8. Why is a convex lens is called a converging lens?

9. Why is a concave mirror called a converging mirror?

10. Define optical centre of a lens.

11. Define principal focus of a convex lens.

12. A virtual, erect and enlarged image is formed by a lens. Is the lens convex or concave?

13. Where will you place an electric lamp from a convex lens, so that a parallel beam of light comes out of it?

14. A small object is placed in front of a convex lens, when a real, inverted and enlarged image is formed on the other side of the lens. Where is the object placed?

15. Printed letters appear diminished when viewed through a lens. What is the nature of the lens?

16. A thin spherical lens has a focal length – 20 cm. What is the nature of the lens?

17. A thin spherical lens has a radius of curvature 50 cm. What is its focal length?

18. P1 and P2 are the powers of two thin lenses. What is the power P when both lenses are placed in contact with one another?

19. At what angle a ray of light should strike the surface of glass, so that it does not suffer any refraction?

20. Will the lateral displacement increase/decrease, if a glass block is made thicker?

21. Where is the image formed in a concave mirror, when the object is between infinity and centre of curvature?

22. Where is the image formed in a convex mirror, when the object is anywhere in front of it?

23. No matter how far you stand from a spherical mirror, your image always appears erect. What is the kind of spherical mirror?

24. If the power of a lens is +5 diopter, what is its focal length?

# QUESTIONS FROM CBSE EXAMINATION PAPERS

1. Draw a ray diagram to show reflection of an incident ray parallel to principal axis by a convex mirror.

2. What is the minimum distance between an object and its real image in case of a concave mirror?

3. Why is the refractive index of atmosphere different at different altitudes?

4. When a light ray passes obliquely through the atmosphere in an upward direction, how does its path generally change?

5. What are the two factors on which the lateral displacement of an emergent ray from a glass slab depends?

6. Between which two points related to a concave mirror should an object be placed to obtain on a screen an image twice the size of the object?

7. Why does a ray of light bend when it travels from one medium into another?

8. Draw the diagram given in question 9 in your answer-book and complete it for the path of a ray of light beyond the lens.

9. Take down this diagram into your answer-book and complete the path of the ray.
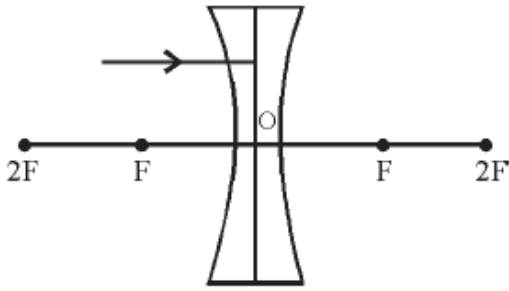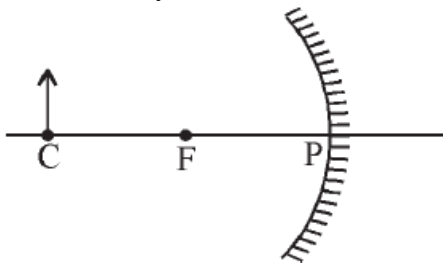
10. Copy this figure in your answer book and show the directions of light ray after reflection.
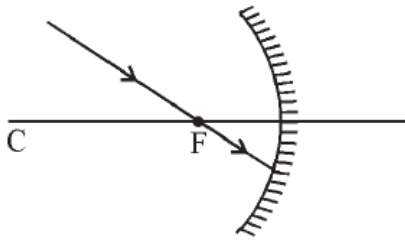
11. Draw the following diagram in your answer book and show the formation of image of the object AB with the help of suitable rays.
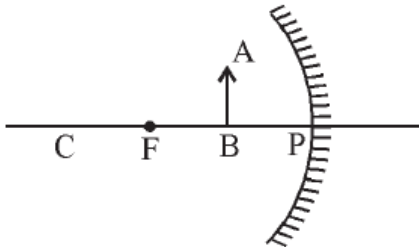
12. Draw the following diagram in your answer book and show the formation of image with the help of suitable rays.

13. The refractive index of diamond is 2.42. What is the meaning of this statement in relation to speed of light?

14. How does the frequency of a beam of ultraviolet light change when it goes from air into glass?

15. What is the focal length of a plane mirror?

16. When light undergoes refraction at the surface of separation of two media, what happens to its wavelength?

17. When light undergoes refraction, what happens to its frequency?

18. How does the focal length of convex lens change if monochromatic red light is used instead of monochromatic blue light?

SHORT ANSWER QUESTIONS
IMPORTANT QUESTIONS

1. Give one use of each:

        (i) Regular reflection   (ii) irregular reflection.

2. State four characteristics of image formed in a plane mirror.

3. Give any two uses of plane mirrors other than looking glass.

4. Convex mirror and a plane mirror form virtual images. How will you distinguish between the two by looking at the images of an object?

5. State two uses of concave mirrors.

6. An object 1 cm high produces a real image 1.5 cm high, when placed at a distance of 15 cm from concave mirror. Calculate the position of image.

7. State two uses of convex mirrors.

8. The image of an object is formed on itself when placed at a distance of 30 cm from concave mirror. What is the focal length of concave mirror?

9. State the characteristics of image formed, when an object is between infinity and the centre of curvature of a concave mirror.

10. Light coming from the bottom of a water tank does not come out of the water. What should be the minimum angle of incidence for the same?

11. An object is placed at a distance of 25 cm from the pole of a spherical mirror which forms a real, inverted image on the same side of object at 37.5 cm from the pole. Calculate the focal length of mirror and find nature of the mirror.

12. Why does a tank filled with water appear shallow? Explain.

13. Why does a fisherman aim at the tail of a fish, during spear fishing?

14. An object is placed anywhere between the pole and infinity in case of a convex mirror. State the characteristics of the image.

15. What name is given to linear distance between the pole and principal focus of a spherical mirror? If this distance is 25 cm, how far is the centre of curvature from the pole of the spherical mirror?

16. The velocity of light in air is 3×10^8 ms^{-1} and in diamond is 1.2×10^8 ms^{-1}. Find the refractive index of diamond.

17. State two factors which determine lateral displacement of ray of light passing through a rectangular glass slab.

18. Show the path of a ray of light through a rectangular glass block, showing clearly the lateral displacement of the ray of light.

19. The refractive index of flint glass is 1.60 and that of water is 1.33 with respect to air. What is the refractive index of flint glass with respect to water?

20. Give two uses of convex lens. **21.** Give two uses of concave lens.

22. State whether the following are positive or negative when a convex lens forms real image:
    (i) distance of object from lens (ii) distance of image from lens.

23. State whether the following are positive or negative when a concave lens forms a virtual image:
    (i) distance of image from lens (ii) focal length of lens.

24. Light enters from air to water having refractive index 4/3. What is the speed of light in water? Speed of light in vacuum is 3×108 ms−1.

25. The focal length of the glasses of a short-sighted person is 37.5 cm. Calculate the power of glasses and their nature.

QUESTIONS FROM CBSE EXAMINATION PAPERS

**1.** How can you identify the three types of mirrors without touching?

2. The refractive indices of alcohol and turpentine oil with respect to air are 1.36 and 1.47 respectively. Find the refractive index of turpentine oil with respect to alcohol. Which one of these will permit the light to travel faster?

3. Light enters from air to kerosene having refractive index 1.47. What is the speed of light in kerosene? The speed of light in air is 3×10^8 m/s.

4. (a) What happens to a ray of light when it travels from one medium to another having equal refractive index?

(b) State the cause of refraction of light.

5. Where should an object be placed in front of a concave mirror of focal length 20 cm so as to obtain real image two times magnified?

6. An object 3 cm high is placed at a distance of 9 cm from a concave mirror of focal length 18 cm. Calculate the position of the image formed.

7. Identify the nature of the mirror and mention two characteristics of the image formed when magnification (m) = + 6.

8. (a) We prefer a convex mirror as a rear view mirror in vehicles. Why?

(b) State a condition for no refraction of light when light enters from one medium to another.

9. What is meant by Refractive Index? If the speed of light in a medium is 2/3rd of the speed of light in vacuum, find the refractive index of that medium.

10. Name the type of mirror used in a solar furnace. How is high temperature achieved by this device?

11. A convex lens of focal length 10 cm is placed at a distance of 12 cm from a wall. Calculate the distance from the lens where an object be placed so as to form its distinct real image on the wall.

12. One portion of a convex lens is covered as shown. Will the lens produce a complete image of the object? Describe in brief the characteristics of the image formed.

13. State laws of refraction of light.

14. The given diagram shows an object O and its image I. Copy the diagram on your answer book and draw suitable rays to locate the lens and its focus. Name the type of lens in this case.
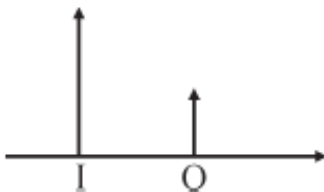
15. For driving a car what type of mirror would you prefer to see traffic at your back and why?

16. Complete the diagram in your answer book and write the nature of the image formed.
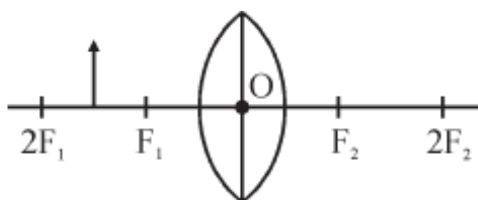
17. Two lenses of power –2.5D and + 1.5D are placed in contact. Find the total power of the combination of lenses. Calculate the focal length of this combination.

18. Draw ray diagram to show the position and nature of the image formed by a convex lens when the object is placed:
    (i) Beyond 2F   (ii) between F and 2F

19. (a) What should be the position of the object, when a concave mirror is to be used :
    (i) as a shaving mirror, and (ii) in torches producing parallel beam of light?

(b) A man standing in front of a mirror, finds his image having a very small head and legs of normal size. What type of mirrors are used in designing such a mirror?

20. The power of a lens is –1.5D. Find the focal length of the lens and state its nature.

21. To get a real and inverted image of same size as that of the object by a thin convex lens of focal length 29 cm, where should the object be placed? Draw ray diagram to show image formation in this case.

22. In an experiment with a rectangular glass slab, a student observed that a ray of light incident at an angle of 60° with the normal on one face of the slab, after refraction, strikes the opposite face of the slab before emerging out into air making an angle of 42° with the normal. Draw a labelled diagram to show the path of this ray.
What value would you assign to the angle of refraction and angle of emergence?

23. In an experiment with a rectangular glass slab, a student observed that a ray of light incident at an angle of 50° with the normal on one face of the slab, after refraction, strikes the opposite face of the slab before emerging out into air making an angle of 38° with the normal. Draw a labelled diagram to show the path of this ray. What value would you assign to the angle of refraction and angle of emergence?

24. In an experiment with a rectangular glass slab, a student observed that a ray of light incident at an angle of 55° with the normal on one face of the slab, after refraction strikes the opposite face of the slab before emerging out into air making an angle of 40° with the normal. Draw a labeled diagram to show the path of this ray. What value would you assign to the angle of refraction and angle of emergence?

25. What is the minimum number of rays required for locating the image formed by a concave mirror for an object? Draw a ray diagram to show the formation of a virtual image by a concave mirror.

26. Explain with the help of a diagram, why a pencil partly immersed in water appears to be bent at the water surface.

27. Draw ray diagrams to repesent the nature, position and relative size of the image formed by a convex lens for the object placed:
 (a) at 2F1. (b) between F1 and the optical centre O of the lens.

28. Draw a ray diagram to show the
    (i) position and
    (ii) nature of the image formed when an object is placed between focus F and pole P of a concave mirror.

29. An object is placed at a distance of 12 cm in front of a concave mirror. It forms a real image four times larger than the object. Calculate the distance of the image from the mirror.

30. With respect to air, the refractive index of ice is 1.31 and that of rock salt is 1.54. Calculate the refractive index of rock salt with respect to ice.

31. Light enters from air into glass plate which has a refractive index of 1.50. Calculate the speed of light in glass. The speed of light in air is 3×10^8 ms^{-1}.

32. In what S.I. unit is power of lenses rated? A convex lens has a focal length of 50 cm. Calculate its power.

33. A convex lens has a focal length of 40 cm. Calculate its power.

34. Draw ray diagram to show the passage of rays of light through a rectangular glass slab, when angle of incidence is (a) zero   (b) a little less than 90°.

35. Prove that for a concave mirror the radius of curvature is twice its focal length.

36. A ray of light incident on an equilateral glass prism shows minimum deviation of 30°. Calculate the speed of light through the glass prism.

SHORT ANSWER QUESTIONS
IMPORTANT QUESTIONS

1. Identify the device used as a spherical mirror or lens in following cases, when the image formed is virtual and erect in each case.

(a) Object is placed between device and its focus, image formed is enlarged and behind it.

(b) Object is placed between the focus and device, image formed is enlarged and on the same side as that of the object.

(c) Object is placed between infinity and device, image formed is diminished and between focus and optical centre on the same side as that of the object.

(d) Object is placed between infinity and device, image formed is diminished and between pole and focus, behind it.

2. Why does a light ray incident on a rectangular glass slab immersed in any medium emerge parallel to itself? Explain using a diagram.

3. A pencil, when dipped in water in a glass tumbler appears to be bent at the interface of air and water. Will the pencil appear to be bent to the same extent, if instead of water we use liquids like kerosene or turpentine? Support your answer with reason. **[HOTS]**

4. How is the refractive index of a medium related to the speed of light? Obtain an expression for refractive index of a medium with respect to another in terms of speed of light in these two media. **[HOTS]**

5. Refractive index of diamond with respect to glass is 1.6 and absolute refractive index of glass is 1.5. Find out the absolute refractive index of diamond.

6. A convex lens of focal length 20 cm can produce a magnified virtual as well as real image. Is this a correct statement? If yes, where shall the object be placed in each case for obtaining these images? **[HOTS]**

7. Sudha finds out that the sharp image of the window pane of her science laboratory is formed at a distance of 15 cm from the lens. She now tries to focus the building visible to her outside the window instead of the window pane without disturbing the lens. In which direction will she move the screen to obtain a sharp image of the building? What is the approximate focal length of this lens? **[HOTS]**

8. How are power and focal length of a lens related? You are provided with two lenses of focal length 20 cm and 40 cm respectively. Which lens will you use to obtain more convergent light? **[HOTS]**

9. Under what condition in an arrangement of two plane mirrors, incident ray and reflected ray will always be parallel to each other, whatever may be angle of incidence. Show the same with the help of diagram. **[HOTS]**

10. Draw a ray diagram showing the path of rays of light when it enters with oblique incidence
　(i) from air into water　　　(ii) from water into air.

11. State the sign convention of *u*, *v* and *f* for a concave mirror when image is real.

12. State the sign convention of *u*, *v* and *f* for a concave mirror, when it forms a virtual image.

13. State the sign conventions for *u*, *v* and *f* for a convex mirror.

14. An object is placed in front of a convex mirror, such that its virtual image is formed behind the mirror. Draw a ray diagram for the formation of image and state its characteristics.

15. A convex lens is used as burning glass. Show it by drawing a neat diagram, stating clearly where the image is formed. Is there any relation between the distance from lens at which image is formed and focal length of lens?

16. By drawing a neat diagram show how the image of a small slide can be projected on large screen. State two characteristics of the image.

17. You are required to obtain an erect image of an object placed in front of a concave mirror. Draw a ray diagram to show the formation of image and state its characteristics.

18. A convex lens produces a real and inverted image 2.5 times magnified at a distance of 25 cm from the lens. Calculate focal length of the lens.

19. Two thin lenses of power + 2.5 D and −1.5 D are placed in contact with each other. Calculate:
　(i) power of the combination,　　(ii) focal length of the combination.

20. A convex lens of focal length 40 cm and a concave lens of focal length 50 cm are placed in contact with each other. Calculate:
　(i) the power of the combination,　　(ii) focal length of the combination.

21. You are required to obtain an inverted image of an object placed in front of a concave mirror. If the image is larger than the size of object, draw a ray diagram to show the formation of image and state its characteristics.

22. A student places an object at a certain distance C from a concave mirror, when he notices that image is formed directly above the object. Draw a ray diagram to show the formation of image and state its characteristics.

23. An object is placed in front of a convex mirror, such that its virtual image is formed behind the mirror. Draw a ray diagram for the formation of image and state its characteristics.

QUESTIONS FROM CBSE EXAMINATION PAPERS

1. A real image, $1/5^{th}$ the size of object is formed at a distance of 18 cm from a mirror. What is the nature of mirror? Calculate its focal length.

2. A ray of light is incident obliquely on a glass slab. Draw a ray - diagram showing the path of the light ray. Clearly mark angle of incidence, angle of refraction, angle of emergence and lateral displacement of the ray. Give a formula to find refractive index of glass slab in terms of angle of incidence and angle of refraction.

3. A point object is placed at a distance of 12 cm from a convex lens on its principal axis. Its image is formed on the other side of the lens at a distance of 18 cm from the lens. Find the focal length of the lens. Is the image magnified? Justify your answer.

4. (a) Why does a ray of light passing through the centre of curvature of a concave mirror after reflection, is reflected back along the same path?

(b) Why are convex mirrors commonly used as rear-view mirrors in vehicles?

(c) A pencil partly immersed in water in a glass tumbler appears to be displaced at the interface of air and water. Name the phenomenon of light responsible for it.

5. (a) Which mirror do we use as a rear view mirror in vehicles?

(b) Draw a ray diagram to illustrate the formation of an image when an object is placed anywhere in front of the mirror on its Principal Axis. State the nature and position of the image formed.

6. A convex lens of focal length 20 cm is placed at a distance of 24 cm from the screen. How far from the lens should an object be placed so as to form a real image on the screen? Also find the nature and magnification produced by the lens.

7. A needle placed 45 cm from a lens forms an image on a screen placed 90 cm on the other side of the lens. Identify the type of lens. Determine its focal length and the power. What is the size of image if, needle is 5 cm in height?

8. (a) Define absolute refractive index of a medium.

(b) Light travels through glycerine at a speed of 2.05×108 m/s. Find the refractive index of glycerine. Given, speed of light in vaccum = 3×108 m/s.

9. (a) For the same angle of incidence 45º, the angle of refraction in two transparent media; I and II is 20º and 30º respectively. Out of I and II, which medium is optically denser and why?

(b) Light enters from air to diamond which has refractive index of 2.42. Calculate the speed of light in diamond, if speed of light in air is 3.00×108 ms–1.

10. (a) Define one dioptre.

(b) A doctor has prescribed a corrective lens of power +1.5D. Find the focal length of the lens. Is the prescribed lens diverging or converging?

11. (a) What is meant by magnification in the context of image formation by mirror and lenses? (b) Power of a lens is + 5D. What is the focal length and nature of the lens?

12. A convex lens forms a real image 4 times magnified at a distance of 60 cm from the lens. Calculate the focal length and the power of the lens.

13. (a) Mention two properties of image formed by a convex mirror.

(b) Draw a ray diagram for the formation of an image, when the object is placed beyond C in front of a concave mirror.

14. (a) We wish to obtain an erect image of an object, using a concave mirror of focal length 15 cm. What should be the range of distance of the object from the mirror? Draw a ray diagram to show the image formation in this case.

(b) Why does a ray of light bend when it travels from one medium into another?

15. An object is 2m away from a lens, which forms an erect image one-fourth the size of the object. Determine the focal length of the lens. What type of lens is this?

16. A concave mirror produces three times enlarged real image of an object placed at 12 cm in front of it. Calculate the radius of curvature of the mirror.

17. An object is placed at a distance 100 cm from a lens of power –4D. Find the position and nature of image so formed.

18. (a) The magnification produced by a mirror is –1.5. What does it signify about the image formed?

(b) You are given two mirrors of equal size. One is plane mirror and other is convex mirror. How will you identify them without touching their surface?

19. (a) What is meant by 'Power' of a lens? (b) State its unit and define it. (c) Which of the two lenses has a greater power:

(i) a convex lens of focal length 5 cm? (ii) a convex lens of focal length 50 cm? Justify your answer.

20. (a) State the laws of refraction of light.

(b) A transparent medium 'P' floats on another transparent medium 'Q'. When a ray of light travels obliquely from 'P' to 'Q', the refracted ray bends away from the normal. Which of the two media 'P' or 'Q' is optically denser and why?

21. A student focused the image of a candle flame on a white screen by placing the flame at various distances from a convex lens. He noted his observation in the following table–