Light Reflection and Refraction

9.1 Reflection of Light

MCQ

1. The laws of reflection hold true for
   (a) plane mirrors only
   (b) concave mirrors only
   (c) convex mirrors only
   (d) all reflecting surface   (2020) R

VSA (1 mark)

2. What is the magnification of the images formed by plane mirrors and why?   (Delhi 2015)

9.2 Spherical Mirrors

MCQ

3. An optical device forms an erect image of an object placed in front of it. If the size of the image is one half that of the object, the optical device is a
   (a) concave mirror   (b) convex mirror
   (c) plane mirror   (d) convex lens.
                              (Term I, 2021-22) U

4. The image of an object placed in front of a concave mirror of focal length 15 cm is of the same size as the object. The distance between the object and its image is
   (a) 15 cm   (b) 30 cm
   (c) 60 cm   (d) zero.
   (Term I, 2021-22) Ap

5. The relation $R = 2f$ is valid
   (a) for concave mirrors but not for convex mirrors
   (b) for convex mirrors but not for concave mirrors
   (c) neither for concave mirrors nor for convex mirrors
   (d) for both concave and convex mirrors.
                              (Term I, 2021-22)

6. In which of the following is a concave mirror used?
   (a) A solar cooker
   (b) A rear view mirror in vehicles
   (c) A safety mirror in shopping malls
   (d) In viewing full size image of distant tall buildings.
                              (Term I, 2021-22)

7.
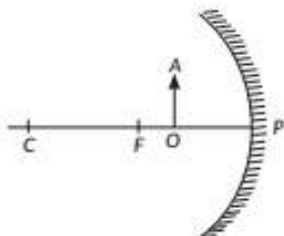
For the diagram shown, according to the new Cartesian sign convention the magnification of the image formed will have the following specifications :
   (a) Sign – Positive, Value – Less than 1
   (b) Sign – Positive, Value – More than 1
   (c) Sign – Negative, Value – Less than 1
   (d) Sign – Negative, Value – More than 1
                              (Term I, 2021-22)

8. The radius of curvature of a converging mirror is 30 cm. At what distance from the mirror should an object be placed so as to obtain a virtual image?
   (a) Infinity
   (b) 30 cm
   (c) Between 15 cm and 30 cm
   (d) Between 0 cm and 15 cm   (Term I, 2021-22) U
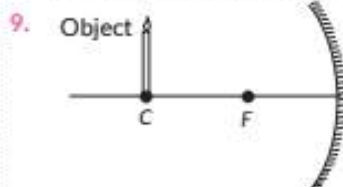
9. Object

Which of the following statements is not true in reference to the diagram shown above?
   (a) Image formed is real.
   (b) Image formed is enlarged.
   (c) Image is formed at a distance equal to double the focal length.
   (d) Image formed is inverted.   (Term I, 2021-22)

10. An object of height 4 cm is kept at a distance of 30 cm from the pole of a diverging mirror. If the focal length of the mirror is 10 cm, the height of the image formed is
   (a) +3.0 cm   (b) +2.5 cm
   (c) +1.0 cm   (d) +0.75 cm
                              (Term I, 2021-22) Ap

11. When an object is kept within the focus of a concave mirror, an enlarged image is formed behind the mirror. This image is
   (a) real   (b) inverted
   (c) virtual and inverted   (d) virtual and erect
                              (2020) U

VSA (1 mark)

12. Define pole of a spherical mirror.   (2020 C)

SA I (2 marks)

13. Draw a labelled ray diagram to show the path of the reflected ray corresponding to an incident ray of light parallel to the principal axis of a convex mirror.

Mark the angle of incidence and angle of reflection on it. *(AI 2019)* [Ap]

14. If the image formed by a spherical mirror for all positions of the object placed in front of it is always erect and diminished , what type of mirror is it? Draw a labelled ray diagram to support your answer. *(2018)*

15. An object is placed at a distance of 30 cm in front of a convex mirror of focal length 15 cm. Write four characteristics of the image formed by the mirror. *(Delhi 2017)*

OR

List four specific characteristics of the images of the objects formed by convex mirrors. *(Delhi 2015)* [R]

16. An object is placed at a distance of 12 cm in front of a concave mirror of radius of curvature 30 cm. List four characteristics of the image formed by the mirror. *(Delhi 2017)* [An]

17. A ray of light is incident on a convex mirror as shown. Redraw the diagram and complete the path of this ray after reflection from the mirror. Mark angle of incidence and angle of reflection on it.
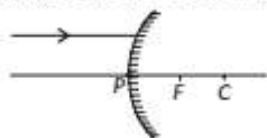
(Delhi 2016)

18. Name the type of mirrors used in the design of solar furnaces. Explain how high temperature is achieved by this device. *(AI 2016)* [R]

19. "The magnification produced by a spherical mirror is −3". List four informations you obtain from this statement about the mirror/image. *(AI 2016)* [U]

20. AB and CD, two spherical mirrors, from parts of a hollow spherical ball with its centre at O as shown in the diagram. If arc $AB = \frac{1}{2}$ arc CD, what is the ratio of their focal lengths? State which of the two mirrors will always form virtual image of an object placed in front of it and why?

(Foreign 2016)
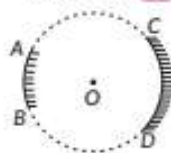
21. List two properties of the images formed by convex mirrors. Draw ray diagram in support of your answer. *(Foreign 2016)* [U]

22. The linear magnification produced by a spherical mirror is +3. Analyse this value and state the (i) type of mirror and (ii) position of the object with respect to the pole of the mirror. Draw a ray diagram to show the formation of image in this case. *(Foreign 2016)*

23. Draw a ray diagram to show the path of the reflected ray corresponding to an incident ray which is directed towards the principal focus of a convex mirror. Mark on it the angle of incidence and the angle of reflection. *(Delhi 2014)*

24. Draw a ray diagram to show the path of the reflected ray corresponding to an incident ray of light parallel to the principal axis of a concave mirror. Mark the angle of incidence and angle of reflection on it. *(Delhi 2014)* [U]

25. List two possible ways in which a concave mirror can produce a magnified image of an object placed in front of it. State the difference if any between these two images. *(AI 2014)*

26. The image formed by a concave mirror is observed to be virtual, erect and larger than the object. Where should the position of the object be relative to the mirror? Draw ray diagram to justify your answer. *(AI 2014)* [An]

27. The linear magnification produced by a spherical mirror is +1/3. Analysing this value state the (i) type of mirror and (ii) position of the object with respect to the pole of the mirror. Draw any diagram to justify your answer. *(AI 2014, Foreign 2014)* [Ap]

28. The linear magnification produced by a spherical mirror is −1. Analysing this value state the (i) type of mirror and (ii) position of the object with respect to the pole of the mirror. Draw any diagram to justify your answer. *(Foreign 2014)*

29. The linear magnification produced by a spherical mirror is −1/5. Analysing this value state the (i) type of spherical mirror and (ii) the position of the object with respect to the pole of the mirror. Draw ray diagram to justify your answer. *(Foreign 2014)* [Ap]

SA II (3 marks)

30. The magnification produced when an object is placed at a distance of 20 cm from a spherical mirror is +1/2. Where should the object be placed to reduce the magnification to +1/3? *(2023)*

31. Define the following terms in the context of a diverging mirror :
(i) Principal focus
(ii) Focal length *(2023)* [U]
Draw a labelled ray diagram to illustrate your answer.

32. A student has focused the image of an object of height 3 cm on a white screen using a concave mirror of focal length 12 cm. If the distance of the object from the mirror is 18 cm, find the values of the following:
(i) distance of the image from the mirror.
(ii) height of the image. *(2023)* [Ev]

33. Draw ray diagrams for the following cases when a ray of light :
    (i) passing through centre of curvature of a concave mirror is incident on it.
    (ii) parallel to principal axis is incident on convex mirror.
    (iii) is passing through focus of a concave mirror incident on it. (2020) [Cr]

34. A concave mirror is used for image formation for different positions of an object. What inferences can be drawn about the following when an object is placed at a distance of 10 cm from the pole of a concave mirror of focal length 15 cm?
    (a) Position of the image   (b) Size of the image
    (c) Nature of the image
    Draw a labelled ray diagram to justify your inferences. (2020)

35. (a) To get an enlarged, real and inverted image of an object by a concave mirror, where should the object be placed ? Draw a labelled ray diagram to justify your answer.
    (b) If an object is placed at the centre of curvature of this mirror, what will be the magnification produced ? (2020 C) [An]

36. Where should an object be placed in front of a concave mirror of focal length 20 cm so as to obtain a two times magnified virtual image of the object ? (2019 C) [An]

37. A concave mirror has a focal length of 20 cm. At what distance from the mirror should a 4 cm tall object be placed so that it forms an image at a distance of 30 cm from the mirror? Also calculate the size of the image formed. (AI 2019) [An]

38. The image of a candle flame placed at a distance of 30 cm from a mirror is formed on a screen placed in front of the mirror at a distance of 60 cm from its pole. What is the nature of the mirror? Find its focal length. If the height of the flame is 2.4 cm, find the height of its image. State whether the image formed is erect or inverted. (Delhi 2017) [Cr]

39. An object 4 cm in height is placed at 15 cm in front of a concave mirror of focal length 10 cm. At what distance from the mirror should a screen be placed to obtain a sharp image of the object. Calculate the height of the image. (Delhi 2017)

40. Draw the following diagram in which a ray of light is incident on a concave/convex mirror, on your answer sheet. Show the path of this ray, after reflection, in each case.
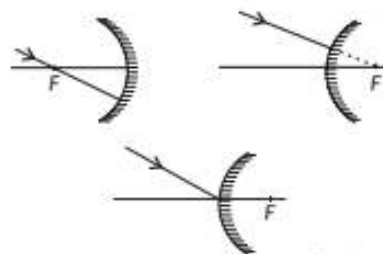
(Delhi 2016) [An]

41. The image of an object formed by a mirror is real, inverted and is of magnification −1. If the image is at a distance of 40 cm from the mirror, where is the object placed? Where would the image be if the object is moved 20 cm towards the mirror? State reason and also draw ray diagram for the new position of the object to justify your answer. (AI 2016)

42. The image formed by a spherical mirror is real, inverted and its magnification is −2. If the image is at a distance of 30 cm from the mirror, where is the object placed? Find the focal length of the mirror. List two characteristics of the image formed if the object is moved 10 cm towards the mirror. (AI 2016) [An]

43. If the image formed by mirror for all positions of the object placed in front of it is always virtual and diminished, state the type of the mirror. Draw a ray diagram in support of your answer. Where are such mirrors commonly used and why? (Foreign 2016, AI 2015)

44. To construct a ray diagram we use two rays of light which are so chosen that it is easy to determine their directions after reflection from the mirror. Choose these two rays and state the path of these rays after reflection from a concave mirror. Use these two rays to find the nature and position of the image of an object placed at a distance of 15 cm from a concave mirror of focal length 10 cm. (Delhi 2015) [Ap]

45. Draw a ray diagram to show the path of the reflected ray in each of the following cases. A ray of light incident on a convex mirror :
    (a) strikes at its pole making an angle θ from the principal axis.
    (b) is directed towards its principle focus.
    (c) is parallel to its principal axis. (Foreign 2015) [Ap]

46. A spherical mirror produces an image of magnification −1 on a screen placed at a distance of 50 cm from the mirror.
    (a) Write the type of mirror.
    (b) Find the distance of the image from the object.
    (c) What is the focal length of the mirror?
   (d) Draw the ray diagram to show the image formation in this case. (Delhi 2014, AI 2014)

47. A spherical mirror produces an image of magnification −1 on a screen placed at a distance of 40 cm from the mirror.
   (i) Write type of mirror.
   (ii) What is the nature of the image formed?
   (iii) How far is the object located from the mirror?
   (iv) Draw the ray diagram to show the image formation in this case. (Delhi 2014) [An]

48. A spherical mirror produces an image of magnification −1.0 on a screen placed at a distance of 30 cm from the pole of the mirror.
   (i) Write the type of mirror in this case.
   (ii) What is the focal length of the mirror?
   (iii) What is the nature of the images formed?
   (iv) Draw the ray diagram to show the image formation in this case. (Delhi 2014)

49. A student wants to project the image of a candle flame on a screen 48 cm in front of a mirror by keeping the flame at a distance of 12 cm from its pole.
   (a) Suggest the type of mirror he should use.
   (b) Find the linear magnification of the image produced.
   (c) How far is the image from its object?
   (d) Draw ray diagram to show the image formation in this case. (AI 2014) [Cr]

50. A student wants to obtain an erect image of an object using a concave mirror of 12 cm focal length. What should be the range of distance of the candle flame from the mirror? State the nature and size of the image he is likely to observe. Draw a ray diagram to show the image formation in this case. (Foreign 2014)

51. A student wants to obtain an erect image of a candle flame using a concave mirror of focal length 15 cm. What should be the range of distance of the candle flame from the mirror? State the nature and size of the image he is likely to observe. Draw a ray diagram to show the image formation in this case. (Foreign 2014)

52. A student has a concave mirror of 20 cm focal length and he wants to see an erect image of his face in the mirror. What should be the range of distance of the mirror from his face? State the nature and size of the image he is likely to observe. Draw a ray diagram to justify your answer. (Foreign 2014) [Ap]

LA (5 marks)

53. An object 4.0 cm in size, is placed 25.0 cm in front of a concave mirror of focal length 15.0 cm.
   (i) At what distance from the mirror should a screen be placed in order to obtain a sharp image?
   (ii) Find the size of the image.
   (iii) Draw a ray diagram to show the formation of image in this case. (2020) [Ev]

54. (a) A concave mirror of focal length 10 cm can produce a magnified real as well as virtual image of an object placed in front of it. Draw ray diagrams to justify this statement.
   (b) An object is placed perpendicular to the principal axis of a convex mirror of focal length 10 cm. The distance of the object from the pole of the mirror is 10 cm. Find the position of the image formed. (2020)

55. (a) A security mirror used in a big showroom has radius of curvature 5 m. If a customer is standing at a distance of 20 m from the cash counter, find the position, nature and size of the image formed in the security mirror.
   (b) Neha visited a dentist in his clinic. She observed that the dentist was holding an instrument fitted with a mirror. State the nature of this mirror and reason for its use in the instrument used by dentist. (2020) [An]

56. (a) To construct a ray diagram we use two rays which are so chosen that it is easy to know their directions after reflection from the mirror. Use these two rays and draw ray diagram to locate the image of an object placed between pole and focus of a concave mirror.
   (b) A concave mirror produces three times magnified image on a screen. If the objects placed 20 cm in front of the mirror, how far is the screen from the object? (Delhi 2017)

57. (a) If the image formed by a mirror for all positions of the object placed in front of it is always diminished, erect and virtual, state the type of the mirror and also draw a ray diagram to justify your answer. Write one use such mirrors are put to and why?
   (b) Define the radius of curvature of spherical mirrors. Find the nature and focal length of a spherical mirror whose radius of curvature is +24 cm. (AI 2017) [An]

58. (a) Define the following terms in the context of spherical mirrors:
   (i) Pole   (ii) Centre of curvature
   (iii) Principal axis   (iv) Principal focus
   (b) Draw ray diagrams to show the principal focus of a
   (i) Concave mirror   (ii) Convex mirror
   (c) Consider the following diagram in which M is a mirror and P is an object and Q is its magnified image formed by the mirror.
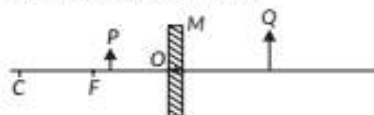
State the type of the mirror M and one characteristic property of the image Q. (Delhi 2016) [Ev]

59. It is desired to obtain an erect image of an object, using concave mirror of focal length of 12 cm.
    (i) What should be the range of distance of a object placed in front of the mirror?
    (ii) Will the image be smaller or larger than the object? Draw ray diagram to show the formation of image in this case.
    (iii) Where will the image of this object be, if it is placed 24 cm in front of the mirror? Draw ray diagram for this situation also to justify your answer.
    Show the positions of pole, principal focus and the centre of curvature in the above ray diagrams.
    (AI 2016)

60. Suppose you have three concave mirrors A, B and C of focal lengths 10 cm, 15 cm and 20 cm. For each concave mirror you perform the experiment of image formation for three values of object distances of 10 cm, 20 cm and 30 cm. By giving reason, answer the following:
    (a) For the three object distances, identify the mirror/mirrors which will form an image of magnification −1.
    (b) Out of the three mirrors, identify the mirror which would be preferred to be used for shaving purposes/make up.
    (c) For the mirror B draw ray diagram for image formation for object distances 10 cm and 20 cm.
    (Foreign 2016) [Ev]

61. A student has focused the image of a candle flame on a white screen using a concave mirror. The situation is a given below :
    Length of the flame = 1.5 cm
    Focal length of the mirror = 12 cm
    Distance of flame from the mirror = 18 cm
    If the flame is perpendicular to the principal axis of the mirror, then calculate the following:
    (a) Distance of the image from the mirror
    (b) Length of the image
    If the distance between the mirror and the flame is reduced to 10 cm, then what would be observed on the screen? Draw ray diagram to justify your answer from this situation.
   (Foreign 2015)

62. A student wants to project the image of a candle flame on the walls of school laboratory by using a mirror.
    (a) Which type of mirror should he use and why?
    (b) At what distance in terms of focal length 'f ' of the mirror should he place the candle flame so as to get the magnified image on the wall?
    (c) Draw a ray diagram to show the formation of image in this case.
    (d) Can he use this mirror to project a diminished image of the candle flame on the same wall? State 'how' if your answer is 'yes' and 'why not' if your answer is 'no'
    (Delhi 2014) [Cr]

9.3 Refraction of Light

MCQ

63. If a lens and a spherical mirror both have a focal length of −15 cm, then it may be concluded that
    (a) both are concave
    (b) the lens is concave and the mirror is convex
    (c) the lens is convex and the mirror is concave
    (d) both are convex.
    (Term I, 2021-22) [U]

64. A student determines the focal length of a device' A' by focussing the image of a far off object on a screen placed on the opposite side of the object. The device 'A' is
    (a) concave lens   (b) concave mirror
    (c) convex lens   (d) convex mirror.
    (Term I, 2021-22) [U]

65. When light is incident on a glass slab, the incident ray, refracted ray and the emergent ray are in three media, A, B and C. If n_1, n_2 and n_3 are the refractive indices of A, B and C respectively and the emergent ray is parallel to the incident ray, which of the following is true?
    (a) $n_1 < n_2 < n_3$ (b) $n_1 > n_2 > n_3$
    (c) $n_1 < n_2 = n_3$ (d) $n_1 = n_3 < n_2$
    (Term I, 2021-22) [U]

66. The image of a candle flame formed by a lens is obtained on a screen placed on the other side of the lens. According to new cartesian sign convention, if the image is three times the size of the flame, then the lens is
    (a) concave and magnification is +3
    (b) concave and magnification is −3
    (c) convex and magnification is −3
    (d) convex and magnification is +3.
    (Term I, 2021-22) [Ap]

67. The power of a combination of two lenses in contact is +1.0 D. If the focal length of one of the lenses of the combination is +20.0 cm, the focal length of the other lens would be
    (a) −120.0 cm   (b) +80.0 cm
    (c) −25.0 cm   (d) −20.0 cm
    (Term I, 2021-22)

68. Study the diagram given below and identify the type of the lens XX' and the position of the point on the principal axis OO' where the image of the object AB appears to be formed
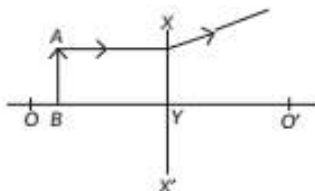
(a) Concave; between O' and Y
(b) Concave : between O and Y
(c) Convex; between O' and Y
(d) Convex; between O and Y *(Term I, 2021-22)* Ap

69. An object of height 3.0 cm is placed vertically on the principal axis of a convex lens. When the object distance is –37.5 cm, an image of height –2.0 cm is formed at a distance of 25.0 cm from the lens. Next, the same object is placed vertically at 25.0 cm from the lens. In this situation the image distance v and height h of the image is (according to the new Cartesian sign convention)

(a) $v = +37.5$ cm; $h = +4.5$ cm
(b) $v = -37.5$ cm; $h = +4.5$ cm
(c) $v = +37.5$ cm; $h = -4.5$ cm
(d) $v = -37.5$ cm; $h = -4.5$ cm *(Term I, 2021-22)* Ap

70. A lens has a power of +4.0 D. It is
(a) a convex lens of focal length 4 m
(b) a concave lens of focal length 4 m
(c) a convex lens of focal length 0.25 m
(d) a concave lens of focal length 0.25 m. *(Term I, 2021-22)*

71. An object is placed in front of a concave lens. For all positions of the object the image formed is always
(a) real, diminished and inverted
(b) virtual, diminished and erect
(c) real, enlarged and erect
(d) virtual, erect and enlarged. *(Term I, 2021-22)* U

72. A ray of light starting from air passes through medium A of refractive index 1.50, enters medium B of refractive index 1.33 and finally enters medium C of refractive index 2.42. If this ray emerges out in air from C, then for which of the following pairs of media the bending of light is least?
(a) air-A (b) A-B (c) B-C (d) C-air
(Term I, 2021-22)

73. A ray of light is incident as shown. If A, B and C are three different transparent media, then which among the following options is true for the given diagram?
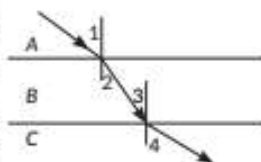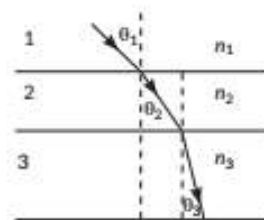

(a) $\angle 1 > \angle 4$
(b) $\angle 1 < \angle 2$
(c) $\angle 3 = \angle 2$
(d) $\angle 3 > \angle 4$
(Term I, 2021-22) U

74. In the diagram shown above n_1, n_2 and n_3 are refractive indices of the media 1, 2 and 3 respectively. Which one of the following is true in this case?

(a) $n_1 = n_2$
(b) $n_1 > n_2$
(c) $n_2 > n_3$
(d) $n_3 > n_1$
(Term I, 2021-22)

75. The refractive index of medium A is 1.5 and that of medium B is 1.33. If the speed of light in air is 3×10^8 m/s, what is the speed of light in medium A and B respectively?
(a) 2×10^8 m/s and 1.33×10^8 m/s
(b) 1.33×10^8 m/s and 2×10^8 m/s
(c) 2.25×10^8 m/s and 2×10^8 m/s
(d) 2×10^8 m/s and 2.25×10^8 m/s
(Term I, 2021-22) Ap

76. A student wants to obtain magnified image of an object AB as on a screen. Which one of the following arrangements shows the correct position of AB for him/ her to be successful?

(a)

(b)

(c)

(d)
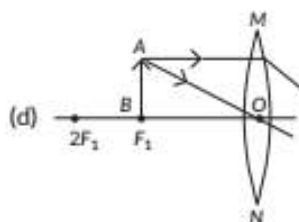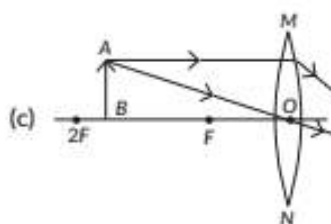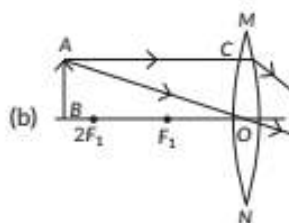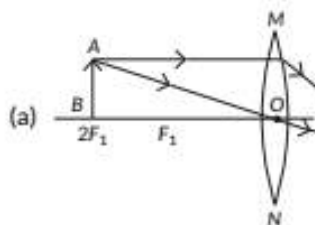
(Term I, 2021-22)

77. The following diagram shows the use of an optical device to perform an experiment of light. As per the arrangement shown, the optical device is likely to be a
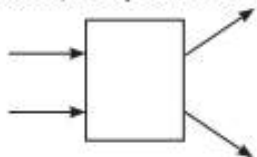
(a) concave mirror
(b) concave lens
(c) convex mirror
(d) convex lens

(Term I, 2021-22) [U]

78. If a lens can converge the sun rays at a point 20 cm away from its optical centre, the power of this lens is
(a) +2D
(b) −2D
(c) +5D
(d) −5D (Term I, 2021-22)

79. A converging lens forms a three times magnified image of an object, which can be taken on a screen. If the focal length of the lens is 30 cm, then the distance of the object from the lens is
(a) −55 cm
(b) −50 cm
(c) −45 cm
(d) −40 cm

(Term I, 2021-22) [U]

80. **Assertion (A)** : A concave lens of very short focal length causes higher divergence than one with longer focal length.
Reason (R) : The power of a lens is directly proportional to its focal length.
(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false, but Reason (R) is true.

(2021 C) [U]

81. **Assertion (A)** :The SI unit of power of lens is 'dioptre'.
Reason (R) : The power of a concave lens is positive and that of a convex lens is negative.
(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false, but Reason (R) is true.

(2021 C)

82. The refractive index of glass is 1.50. What is the meaning of this statement? (2021 C)

83. What is meant by power of a lens? (Delhi 2015) [R]

84. State Snell's law of refraction of light. Write an expression for the absolute refractive index of a medium in terms of speed of light. (2019 C)

85. Light enters from air to glass having refractive index 1.50. Calculate the speed of light in the glass.
Given : The speed of light in vacuum is 3×10^8 m/s. (2019 C) [Ap]

86. An object is placed at a distance of 15 cm from a convex lens of focal length 20 cm. List four characteristics (nature, position, etc.) of the image formed by the lens. (AI 2017)

87. What is meant by power of a lens? What does its sign (+ve or −ve) indicate? State its S.I. unit related to focal length of a lens. (Delhi 2016) [U]

88. The refractive indices of glass and water with respect to air are 3/2 and 4/3 respectively. If speed of light in glass is 2×10^8 m/s, find the speed of light in water. (AI 2016)

89. The absolute refractive indices of glass and water are 4/3 and 3/2 respectively. If the speed of light in glass is 2×10^8 m/s, calculate the speed of light in (i) vacuum, (ii) water. (AI 2015) [An]

90. The power of a lens is +4 D. Find the focal length of this lens. An object is placed at a distance of 50 cm from the optical centre of this lens. State the nature and magnification of the image formed by the lens and also draw a ray diagram to justify your answer. (2023) [Ev]

91. An object of height 10 cm is placed 25 cm away from the optical centre of a converging lens of focal length 15 cm. Calculate the image-distance and height of the image formed. (2023)

92. Define power of a lens. The focal length of a lens is −10 cm. Write the nature of the lens and find its power. If an object is placed at a distance of 20 cm from the optical centre of this lens, according to the New Cartesian Sign Convention, what will be the sign of magnification in this case? (2023) [Ap]

93. (a) Water has refractive index 1.33 and alcohol has refractive index 1.36. Which of the two medium is optically denser? Give reason for your answer.
(b) Draw a ray diagram to show the path of a ray of light passing obliquely from water to alcohol.

(c) State the relationship between angle of incidence and angle of refraction in the above case. *(2020)*

94. The refractive index of a medium 'x' with respect to a medium 'y' is 2/3 and the refractive index of medium 'y' with respect to medium 'z' is 4/3. Find the refractive index of medium 'z' with respect to medium 'x'. If the speed of light in medium 'x' is 3×10^8 m s^{-1}, calculate the speed of light in medium 'y'. *(2020)* (Ap)

95. Study the ray diagram given below and answer the questions that follow :
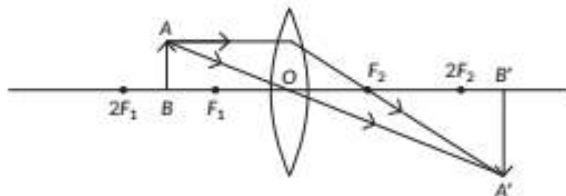
(a) Is the type of lens used converging or diverging ?
(b) List three characteristics of the image formed.
(c) In which position of the object will the magnification be – 1 ? *(2020 C)* (An)

96. How far should an object be placed from a convex lens of focal length 20 cm to obtain its real image at a distance of 30 cm from the lens ? Determine the height of the image if the object is 4 cm tall. *(2019 C)* (Ap)

97. A real image 2/3rd of the size of an object is formed by a convex lens when the object is at a distance of 12 cm from it. Find the focal length of the lens. *(AI 2019)*

98. State the laws of refraction of light. Explain the term 'absolute refractive index of a medium' and write an expression to relate it with the speed of light in vaccum. *(2018)* (R)

99. What is meant by power of a lens? Write its SI unit. A student uses a lens of focal length 40 cm and another of –20 cm. Write the nature and power of each lens. *(2018)*

100. Draw ray diagrams to show the formation of three times magnified (a) real, and (b) virtual image of an object by a converging lens. Mark the positions of O, F and 2F in each diagram. *(AI 2017)* (An)

101. (a) Draw a diagram to show the refraction of light through a glass slab and mark angle of refraction and the lateral shift suffered by a ray of light while passing through the slab.
(b) If the refractive index of glass for light going from air to glass is 3/2, find the refractive index of air for light going from glass to air. *(Delhi 2016)* (Ev)

102. The image of an object formed by a lens is of magnification –1. If the distance between the object and its image is 60 cm, what is the focal length of the lens? If the object is moved 20 cm towards the lens, where would the image be formed? State reason and also draw a ray diagram in support of your answer. *(AI 2016)* (Ev)

103. (a) Define focal length of a spherical lens.
(b) A divergent lens has a focal length of 30 cm. At what distance should an object of height 5 cm from the optical centre of the lens be placed so that its image is formed 15 cm away from the lens? Find the size of the image also.
(c) Draw a ray diagram to show the formation of image in the above situation. *(AI 2016)*

104. If the image formed by a lens for all positions of the object placed in front of it is always virtual, erect and diminished, state the type of the lens. Draw a ray diagram in support of your answer. If the numerical value of focal length of such a lens is 20 cm, find its power in new cartesian sign conventions. *(Foreign 2016)* (Ev)

105. State the laws of refraction of light. If the speed of light in vacuum is 3×10^8 m/s, find the absolute refractive index of a medium in which light travels with a speed of 1.4×10^8 m/s. *(Foreign 2015)*

106. State the laws of refraction of light. If the speed of light in vacuum is 3×10^8 m s^{-1}, find the speed of light in a medium of absolute refractive index 1.5. *(Delhi 2014, AI 2014)* (An)

107. The image of a candle flame placed at a distance of 40 cm from a spherical lens is formed on a screen placed on the other side of the lens at a distance of 40 cm from the lens. Identify the type of lens and write its focal length. What will be the nature of the image formed if the candle flame is shifted 25 cm towards the lens? Draw a ray diagram to justify your answer. *(Foreign 2014)* (Ap)

LA (4 / 5 marks)

108. The ability of a medium to refract light is expressed in terms of its optical density. Optical density has a definite connotation. It is not the same as mass density. On comparing two media, the one with the large refractive index is optically denser medium than the other. The other medium with a lower refractive index is optically rarer. Also the speed of light through a given medium is inversely proportional to its optical density.

(i) Determine the speed of light in diamond if the refractive index of diamond with respect

to vacuum is 2.42. Speed of light in vacuum is 3×10^8 m/s.

(ii) Refractive indices of glass, water and carbon disulphide are 1.5, 1.33 and 1.62 respectively. If a ray of light is incident in these media at the same angle (say θ), then write the increasing order of the angle of refraction in these media.

(iii) The speed of light in glass is 2×10^8 m/s and in water is 2.25×10^8 m/s.

(a) Which one of the two is optically denser and why?

(b) A ray of light is incident normally at the water-glass interface when it enters a thick glass container filled with water. What will happen to the path of the ray after entering the glass? Give reason.

OR

(iii) The absolute refractive indices of water and glass are 4/3 and 3/2 respectively. If the speed of light in glass is 2×10^8 m/s, find the speed of light in (i) vacuum and (ii) water. *(2023)* Ev

109. Many optical instruments consists of a number of lenses. They are combined to increase the magnification and sharpness of the image. The net power (P) of the lenses places in contact is given by the algebraic sum of the powers of the individual lenses P_1, P_2, P_3 .... as

$P = P_1 + P_2 + P_3 ....$

This is also termed as the simple additive property of the power of lens, widely used to design lens systems of cameras, microscopes and telescopes. These lens systems can have a combination of convex lenses and also concave lenses.

(a) What is the nature (convergent/divergent) of the combination of a convex lens of power +4 D and a concave lens of power −2 D?

(b) Calculate the focal length of a lens of power −2.5 D.

(c) Draw a ray diagram to show the nature and position of an image formed by a convex lens of power +0.1 D, when an object is placed at a distance of 20 cm from its optical centre.

OR

(c) How is a virtual image formed by a convex lens different from that formed by a concave lens? Under what conditions do a convex and a concave lens form virtual image? *(2023)*

110. (a) State Snell's law refraction of light.

(b) When a ray of light travelling in air enters obliquely into a glass slab, it is observed that the light ray emerges parallel to the incident ray but it is shifted sideways slightly. Draw a labelled ray diagram to illustrate it. *(2020)*

111. Draw a ray diagram in each of the following cases to show the formation of image, when the object is placed:

(i) between optical centre and principal focus of a convex lens.

(ii) anywhere in front of a concave lens.

(iii) at 2F of a convex lens.

State the signs and values of magnifications in the above mentioned cases (i) and (ii). *(2020)* Ev

112. (a) Define the following terms :

(i) Power of lens

(ii) Principal focus of a concave mirror

(b) Write the relationship among the object distance (u), image distance (v) and the focal length (f) of a

(i) Spherical lens

(ii) Spherical mirror

(c) An object is placed at a distance of 10 cm from optical centre of a convex lens of focal length 15 cm. Draw a labelled ray diagram to show the formation of image in this case. *(2020)* Cr

113. Rishi went to a palmist to show his palm. The palmist used a special lens for this purpose.

(i) State the nature of the lens and reason for its use.

(ii) Where should the palmist place/hold the lens so as to have a real and magnified image of an object?

(iii) If the focal length of this lens is 10 cm, the lens is held at a distance of 5 cm from the palm, use lens formula to find the position and size of the image. *(2020)*

114. An object is placed at a distance of 60 cm from a concave lens of focal length 30 cm.

(i) Use lens formula to find the distance of the image from the lens _____ .

(ii) List four characteristics of the image (nature, position, size, erect/inverted) formed by the lens in this case

(iii) Draw ray diagram to justify your answer of pair (ii) _____ . *(Delhi 2019)* An

115. (a) A 5 cm tall object is placed perpendicular to the principal axis of a convex lens of focal length 20 cm. The distance of the object from the lens is 30 cm. Find the position, nature and size of the image formed.

(b) Draw a labelled ray diagram showing object distance, image distance and focal length in the above case. *(AI 2019)*

116. Analyse the following observation table showing variation of image distance (v) with object distance

(*u*) in case of a convex lens and answer the questions that follows, without doing any calculations :

S. No.	Object distance u (cm)	Image distance v (cm)
1	– 90	+ 18
2	– 60	+ 20
3	– 30	+ 30
4	– 20	+ 60
5	– 18	+ 90
6	– 10	+ 100

(a) What is the focal length of the convex lens? Give reason in support of your answer.

(b) Write the serial number of that observation which is not correct. How did you arrive at this conclusion?

(c) Take an appropriate scale to draw ray diagram for the observation at S. No. 4 and the approximate value of magnification. *(Delhi 2017)* `Cr`

117. Analyse the following observation table showing variation of image-distance (*v*) with object-distance (*u*) in case of a convex lens and answer the questions that follow without doing any calculations.

S. No.	Object Distance u(cm)	Image Distance v(cm)
1	–100	+25
2	–60	+30
3	–40	+40
4	–30	+60
5	–25	+100
6	–15	+120

(a) What is the focal length of the convex lens? Give reason to justify your answer.

(b) Write the serial number of the observation which is not correct. On what basis have you arrived at this conclusion?

(c) Select an appropriate scale and draw a ray diagram for the observation at S. No. 2. Also find the approximate value of magnification.

(AI 2017)

118. (a) Draw a ray diagram to show the formation of image by a convex lens when an object is placed in front of the lens between its optical centre and principal focus.

(b) In the above ray diagram mark the object distance (*u*) and the image distance (*v*) with their proper sign (+ve or –ve as per the new Cartesian sign convention) and state how these distances are related to the focal length (*f*) of the convex lens in this case.

(c) Find the power of a convex lens which forms a real and inverted image of magnification –1 of an object placed at a distance of 20 cm from its optical centre. *(Delhi 2016)* `Ev`

119. (a) Draw a ray diagram to show the formation of image by a concave lens when an object is placed in front of it.

(b) In the above diagram mark the object distance (*u*) and the image distance (*v*) with their proper sign (+ve or –ve as per the new Cartesian sign convention) and state how these distances are related to the focal length (*f*) of the concave lens in this case.

(c) Find the nature and power of a lens which forms a real and inverted image of magnification –1 at a distance of 40 cm from its optical centre.

(Delhi 2016)

120. (a) Define optical centre of a spherical lens.

(b) A divergent lens has a focal length of 20cm. At what distance should an object of height 4 cm from the optical centre of the lens be placed so that its image is formed 10 cm away from the lens. Find the size of the image also.

(c) Draw a ray diagram to show the formation of image in above situation. *(AI 2016)* `An`

121. (a) Define focal length of a divergent lens.

(b) A divergent lens has a focal length of 30 cm forms the image of an object of size 6 cm on the same side as the object at a distance of 15 cm from its optical centre. Use lens formula to determine the distance of the object from the lens and the size of the image formed.

(c) Draw a ray diagram to show the formation of image in the above situation. *(AI 2016)*

122. At what distance from a concave lens of focal length 20 cm a 6 cm tall object be placed so as to obtain its image at 15 cm from the lens? Also calculate the size of the image formed.

Draw a ray diagram to justify your answer for the above situation and label it. *(Foreign 2016)* `Ap`

123. At what distance from a concave lens of focal length 25 cm a 10 cm tall object be placed so as to obtain its image at 20 cm from the lens. Also calculate the size of the image formed.

Draw a ray diagram to justify your answer for the above situation and label it. *(Foreign 2016)*

124. "A convex lens can form a magnified erect as well as magnified inverted image of an object placed in front of it". Draw ray diagram to justify this statement stating the position of the object with respect to the lens in each case.

An object of height 4 cm is placed at a distance of 20 cm from a concave lens of focal length 10 cm. Use lens formula to determine the position of the image formed. *(Delhi 2015)* `Cr`

125. The image of a candle flame placed at a distance of 30 cm from a spherical lens is formed on a screen placed on the other side of the lens at a distance of 60 cm from the optical centre of the lens. Identify the type of lens and calculate its focal length. If the height of the flame is 3 cm, find the height of its image. *(Delhi 2015)* `Ev`

126. (a) State the laws of refraction of light. Explain the term absolute refractive index of a medium and write an expression to relate it with the speed of light in vacuum.
   (b) The absolute refractive indices of two media A and B are 2.0 and 1.5 respectively. If the speed of light in medium B is 2×10^8 m/s. Calculate the speed of light in
      (i) vacuum
      (ii) medium A *(Delhi 2015)*

127. What is meant by power of a lens? Define its S.I. unit. You have two lenses A and B of focal lengths +10 and −10 cm respectively. State the nature and power of each lens. Which of the two lenses will form a virtual and magnified image of an object placed 8 cm from the lens? Draw a ray diagram to justify your answer. *(AI 2015)* `Ev`

128. One half of a convex lens of focal length 10 cm is covered with a black paper. Can such a lens produce an image of a complete object placed at a distance of 30 cm from the lens? Draw a ray diagram to justify your answer.
   A 4 cm tall object is placed perpendicular to the principal axis of a concave lens of focal length 20 cm. The distance of the object from the lens is 15 cm.

Find the nature, position and size of the image. *(AI 2015)* `Cr`

129. What is meant by the power of a lens? What is its S.I. unit? Name the type of lens whose power is positive. The image of an object formed by a lens is real, inverted and of the same size as the object. If the image is at a distance of 40 cm from the lens, what is the nature and power of the lens? Draw ray diagram to justify your answer. *(Foreign 2015)*

130. (a) Explain the following terms related to spherical lenses:
      (i) optical centre   (ii) centre of curvature
      (iii) principal axis   (iv) aperture
      (v) principal focus   (vi) focal length
   (b) A converging lens has focal length of 12 cm. Calculate at what distance should the object be placed from the lens so that it forms an image at 48 cm on the other side of the lens. *(AI 2014)* `An`

131. (i) Explain the following terms related to spherical lenses
      (a) Centre of curvature
      (b) Principal axis
      (c) Optical centre
      (d) Principal focus
   (ii) At what distance from a concave lens of focal length 20 cm, should a 6 cm tall object be placed so that it forms an image at 15 cm from the lens? Also determine the size of the image formed. *(AI 2014)*

132. What is meant by power of a lens? Name and define its S.I. unit.
   One student uses a lens of focal length +50 cm and another of −50 cm. State the nature and find the power of each lens. Which of the two lenses will always give a virtual and diminished image irrespective of the position of the object? *(Foreign 2014)*

CBSE Sample Questions

9.2 Spherical Mirrors

`MCQ`

1. Which of the following mirror is used by a dentist to examine a small cavity in a patient's teeth?
   (a) Convex mirror
   (b) Plane mirror
   (c) Concave mirror
   (d) Any spherical mirror   *(Term I, 2021-22)* `U`

2.
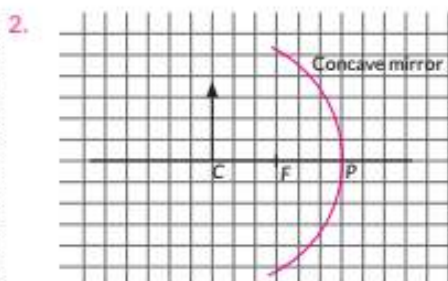
   Examine the above figure and state which of the following option is correct?

[One small box in the figure is equal to 1 cm.]
  (a) The mirror has a focal length of −6 cm and will produce an image of magnification +1.
  (b) The mirror has a focal length of −3 cm and will produce an image of magnification −1.
  (c) The mirror has a focal length of −3 cm and will produce an image of magnification +1.
  (d) The mirror has a focal length of −6 cm and will produce an image of magnification −1.

(Term I, 2021-22) [Ap]

3. Rays from Sun converge at a point 15 cm in front of a concave mirror. Where should an object be placed so that size of its image is equal to the size of the object?
  (a) 30 cm in front of the mirror
  (b) 15 cm in front of the mirror
  (c) Between 15 cm and 30 cm in front of the mirror
  (d) More than 30 cm in front of the mirror

(Term I, 2021-22)

4. Principal Axis
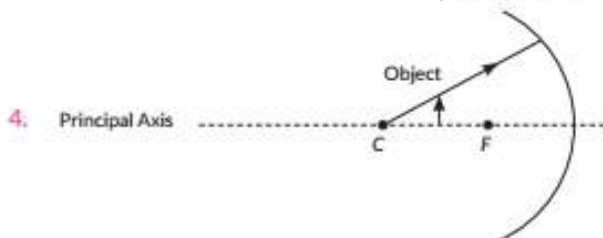
While looking at the above diagram, Nalini concluded the following-
  (i) The image of the object will be a virtual one.
  (ii) The reflected ray will travel along the same path as the incident ray but in opposite direction.
  (iii) The image of the object will be inverted
  (iv) This is a concave mirror and hence the focal length will be negative.
Which one of the above statements are correct?
  (a) (i) and (ii)   (b) (i) and (iii)
  (c) (ii), (iii) and (iv)   (d) (i), (ii), (iii) and (iv)

(Term I, 2021-22) [Ap]

VSA (1 mark)

5. The image formed by a concave mirror is observed to be real, inverted and larger than the object. Where is the object placed?   *(2020-21)*

SA II (3 marks)

6. Rohit wants to have an erect image of an object using a converging mirror of focal length 40 cm.
  (a) Specify the range of distance where the object can be placed in front of the mirror. Justify.
  (b) Draw a ray diagram to show image formation in this case.
  (c) State one use of the mirror based on the above kind of image formation.   *(2022-23)*

9.3 Refraction of Light

MCQ

7. Which diagram shows image formation of an object on a screen by a converging lens?
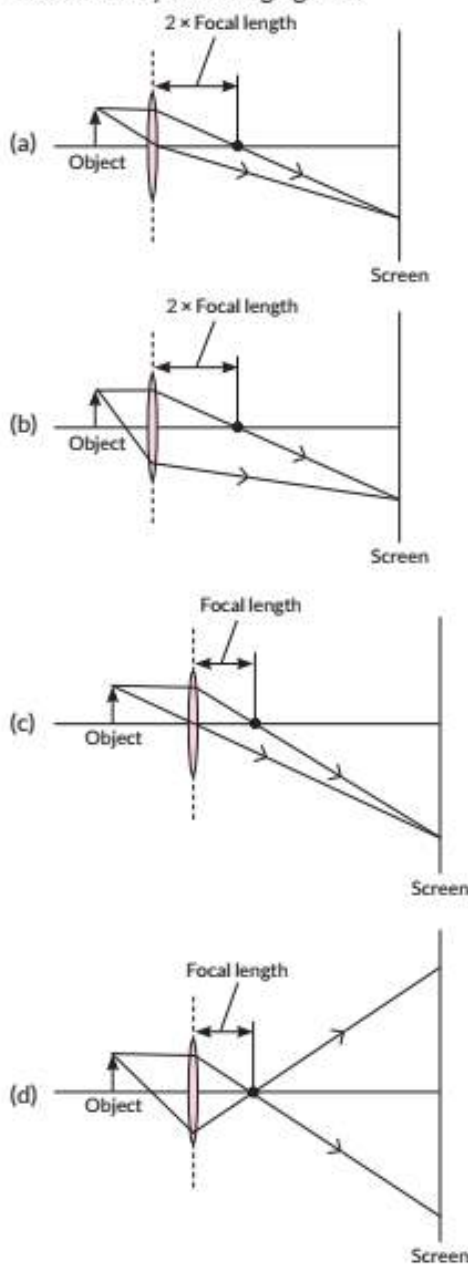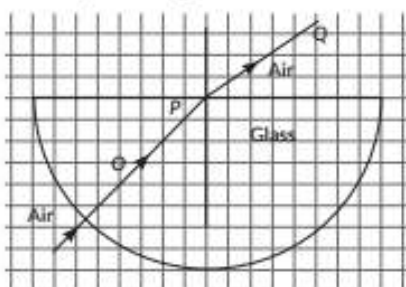

(Term I, 2021-22) [Ap]

8. Which of the following can make a parallel beam of light when light from a point source is incident on it?
  (a) Concave mirror as well as convex lens.
  (b) Convex mirror as well as concave lens.
  (c) Two plane mirrors placed at 90° to each others.
  (d) Concave mirror as well as concave lens.

(Term I, 2021-22) [Ap]

9. Consider these indices of refraction: glass: 1.52; air: 1.0003; water: 1.333. Based on the refractive indices of three materials, arrange the speed of light through them in decreasing order.
   (a) The speed of light in water > the speed of light in air > the speed of light in glass.
   (b) The speed of light in glass > the speed of light in water > the speed of light in air.
   (c) The speed of light in air > the speed of light in water > the speed of light in glass.
   (d) The speed of light in glass > the speed of light in air > the speed of light in water.

   (Term I, 2021-22) **An**

10. The angle of incidence from air to glass at the point O on the hemispherical glass slab is.

   (a) 45°
   (b) 0°
   (c) 90°
   (d) 180° *(Term I, 2021-22)*

11. If the power of a lens is −4.0 D, then it means that the lens is a
    (a) concave lens of focal length −50 m
    (b) convex lens of focal length +50 cm
    (c) concave lens of focal length −25 cm
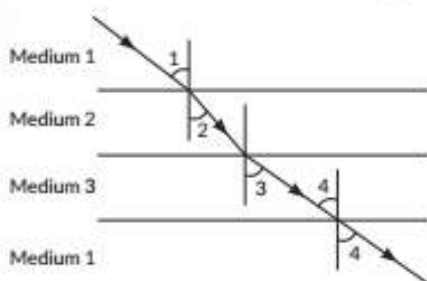   (d) convex lens of focal length −25 m

    (Term I, 2021-22) **Ap**

12. If the real image of a candle flame formed by a lens is three times the size of the flame and the distance between lens and image is 80 cm, at what distance should the candle be placed from the lens?
    (a) −80 cm
    (b) −40 cm
    (c) −40/3 cm
    (d) −80/3 cm

    (Term I, 2021-22)

13.

In the above diagram light is travelling through different media. It is noted by a scientist that

∠1 = ∠3 = ∠4 but ∠2 < ∠1. Which of the following statement would be correct?
(a) Medium 1 is the denser than medium 3 but it's density is equal to medium 2.
(b) Medium 2 is the rarest medium.
(c) Medium 3 is denser than medium 1.
(d) Medium 1 and 3 are essentially the same medium, but medium 2 is denser than 1 and 3.
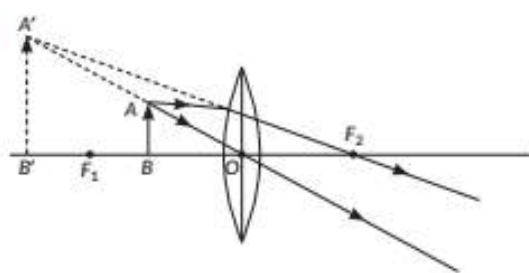
(Term I, 2021-22) **U**

14. The refractive index of flint glass is 1.65 and that for alcohol is 1.36 with respect to air. What is the refractive index of the flint glass with respect to alcohol ?
    (a) 0.82 (b) 1.21 (c) 1.11 (d) 1.01

    (Term I, 2021-22)

15.


The above lens has a focal length of 10 cm. The object of height 2 mm is placed at a distance of 5 cm from the pole. Find the height of the image.
(a) 4 cm (b) 6.67 mm
(c) 4 mm (d) 3.33 mm

(Term I, 2021-22)

16. **Case :** Noor, a young student, was trying to demonstrate some properties of light in her Science project work. She kept 'X' inside the box (as shown in the figure) and with the help of a laser pointer made light rays pass through the holes on one side of the box. She had a small butter-paper screen to see the spots of light being cast as they emerged.
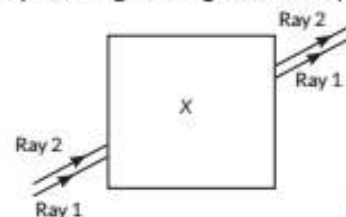
(Term I, 2021-22) **Cr**

(i) What could be the 'X' that she placed inside the box to make the rays behave as shown?
   (a) A converging lens
   (b) A parallel-sided glass block
   (c) A plane mirror
   (d) A triangular prism

(ii) She measured the angles of incidence for both the rays on the left side of the box to be 48.6°. She knew the refractive index of the material 'X' inside the box

(i) What is the magnification obtained by using the glass?

(ii) She keeps a book at a distance 10 cm from her eyes and tries to read. She is unable to read. What is the reason for this?

(b) Ravi kept a book at a distance of 10 cm from the eyes of his friend Hari. Hari is not able to read anything written in the book. Give reasons for this. (2022-23)

LA (4 marks)

21. **Case Based :** The below images are that of a specialized slide projector. Slides are small transparencies mounted in sturdy frames ideally suited to magnification and projection, since they have a very high resolution and a high image quality.

There is a tray where the slides are to be put into a particular orientation so that the viewers can see the enlarged erect images of the transparent slides.

This means that the slides will have to be inserted upside down in the projector tray.

To show her students the images of insects that she investigated in the lab, Mrs. Iyer brought a slide projector. Her slide projector produced a 500 times enlarged and inverted image of a slide on a screen 10 m away.

(a) Based on the text and data given in the above paragraph, what kind of lens must the slide projector have?

(b) If v is the symbol used for image distance and u for object distance then with one reason state what will be the sign for v/u in the given case?

(c) A slide projector has a convex lens with a focal length of 20 cm. The slide is placed upside down 21 cm from the lens. How far away should the screen be placed from the slide projector's lens so that the slide is in focus?

OR

(c) When a slide is placed 15 cm behind the lens in the projector, an image is formed 3 m in front of the lens. If the focal length of the lens is 14 cm, draw a ray diagram to show image formation. (not to scale) (2022-23)

Detailed SOLUTIONS

1. **(d):** The laws of reflection holds true for all reflecting surface.

2. Magnification of images formed by plane mirrors is unity because for plane mirrors, the size of the image formed is equal to that of the object.

3. **(b):** The image formed by a convex mirror is always erect and of smaller in size than object.

4. **(d):** Given, focal length, $f = 15$ cm
∴ Radius of curvature, $R = 30$ cm
As image size is same as that of object size, this condition is only valid when object is placed at C (centre of curvature) which means the distance between object and image is zero.

5. **(d):** It is valid for both concave mirrors and convex mirrors.

6. **(a):** Concave mirrors are the mirrors best suited in solar cookers because concave mirrors are convergent mirror and they are reflect sunlight towards a single focal point.

7. **(b):** Magnification : Sign-positive, value-more the 1 because the object is placed between the focus and the pole. So, magnified image will be formed on other side of

mirror. Hence, magnification of image formed will have positive sign and value more than one.

8. **(d):** Radius of curvature of a converging mirror, $R = 30$ cm
∴ focal length, $f = \dfrac{30}{2}$ cm $= 15$ cm
Thus, virtual image can be obtained from the mirror if an object is placed between pole and focus, i.e., between 0 cm and 15 cm.

9. **(b):** Image formed is enlarged is not true. When object is placed at C, image formed is real, inverted and of same size as object.

Concave mirror
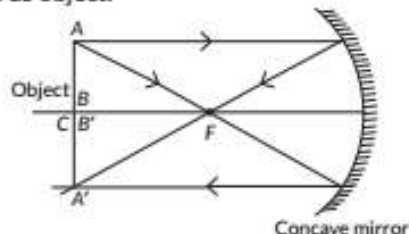
10. **(c):** Given, height of object $(h) = +4$ cm
Object distance $(u) = -30$ cm (object placed left side of the mirror)
Focal length, $f = +10$ cm
Mirror formula, $\dfrac{1}{f} = \dfrac{1}{v} + \dfrac{1}{u}$ or $v = \dfrac{uf}{u-f}$