Light Reflection and Refraction

Previous Years' CBSE Board Questions

1. At what distance from a convex lens should an object be placed to get an image of the same size as that of the object on a screen? (2024)

(a) Beyond twice the focal length of the lens.
(b) At the principal focus of the lens.
(c) At twice the focal length of the lens.
(d) Between the optical centre of the lens and its principal focus.

Answer. (c) /At twice the focal length of the lens

2. The lens system of human eye forms an image on a light sensitive screen, which is called as : (2024)

(a) Cornea
(b) Ciliary muscles
(c) Optic nerves
(d) Retina

Answer. (d) /Retina

3. An object is placed at a distance of 10 cm from a convex mirror of focal length 15 cm. Find the position of the image formed by the mirror. (2024)

Answer.

$u = -10\text{cm}; f = +15\text{ cm}$

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

$$\frac{1}{15} = \frac{1}{v} + \frac{1}{-10\text{ cm}}$$

$$\frac{1}{v} = \frac{1}{15\text{ cm}} + \frac{1}{10\text{ cm}}$$

$$v = +6\text{ cm}$$

Image is formed behind the mirror.

4. Study the data given below showing the focal length of three concave mirrors A, B and C and the respective distances of objects placed in front of the mirrors: (2024)

Case	Mirror	Focal Length (cm)	Object Distance (cm)
1	A	20	45
2	B	15	30
3	C	30	20

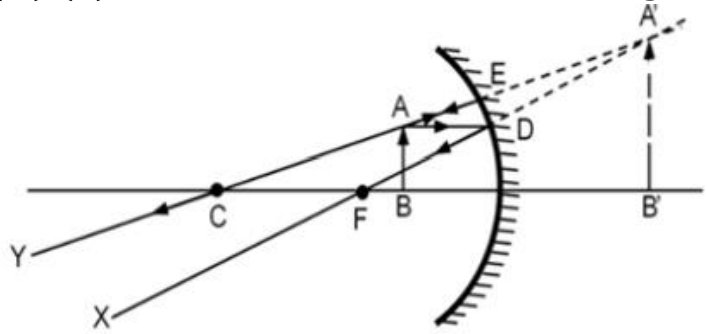
(i) In which one of the above cases the mirror will form a diminished image of the object? Justify your answer.
(ii) List two properties of the image formed in case 2.
(iii) (A) What is the nature and size of the image formed by mirror C ? Draw ray diagram to justify your answer.

OR

(iii) (B) An object is placed at a distance of 18 cm from the pole of a concave mirror of focal length 12 cm. Find the position of the image formed in this case.

Answer. (i)
• Mirror A.
• as the object is placed beyond the centre of curvature of the mirror.

(ii) Same size/ Real / Inverted (Any two)
(iii) (A) Nature-Virtual and erect Size-magnified



OR

(iii) (B) Here ƒ = –12 cm, u = –18 cm, v = ?

Mirror formula $\frac{1}{f}=\frac{1}{v}+\frac{1}{u}$ or $\frac{1}{v}=\frac{1}{f}-\frac{1}{u}$

$$\frac{1}{v}=\frac{1}{-12}-\frac{1}{-18}$$

v = - 36cm

In front of the mirror at a distance of 36 cm from the pole of the mirror.

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)

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
(c) plane mirror
(b) convex mirror
(d) convex lens. (Term I, 2021-22)

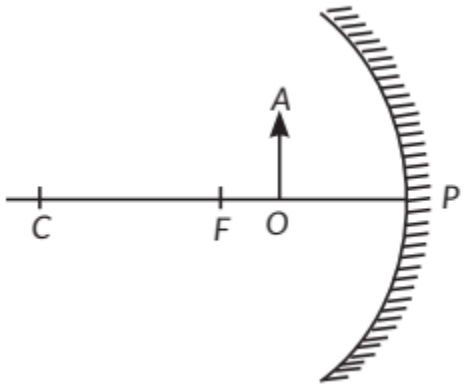
4. The image of an object placed in front of a concave mirror of focal length 15 cm is of the same size as the object. The distance between the object and its image is
(a) 15 cm
(c) 60 cm

(b) 30 cm
(d) zero. (Term I, 2021-22)

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)

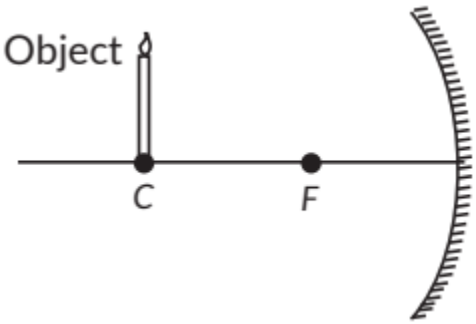
7.



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)

9.



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
(c) +1.0 cm
(b) +2.5 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)

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. (Al 2019)

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)

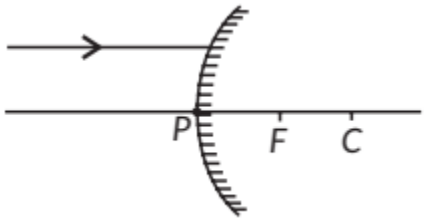
15. An object is placed at a distance of 30 cm in front of a convex mirror of focal length 15 cm. Write four characteristics of the image formed by the mirror. (Delhi 2017)

OR

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

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)

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.

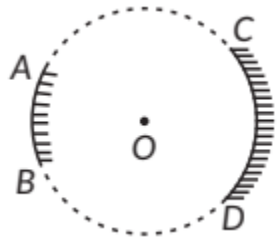


(Delhi 2016)

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

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

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)

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)

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. (Al 2014)

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)

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)
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)

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)

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)

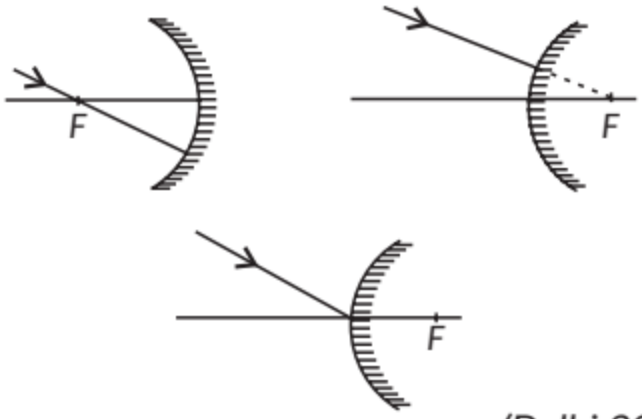
36. Where should an object be placed in front of a concave mirror of focal length 20 cm so as to obtain a two times magnified virtual image of the object? (2019 C)

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)

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)

39. An object 4 cm in height is placed at 15 cm in front of a concave mirror of focal length 10cm. 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. (Al 2016)

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, Al 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)

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 from the principal axis.

(b) is directed towards its principle focus.
(c) is parallel to its principal axis. (Foreign 2015)

46. Aspherical 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. Aspherical 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)

48. Aspherical 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)

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)

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)

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)

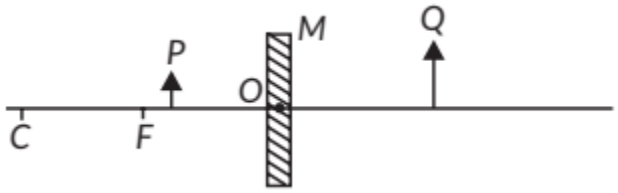
55. (a) A security mirror used in a big showroom has radius of curvature 5 m. If a customer is standing at a distance of 20 m from the cash counter, find the position, nature and size of the image formed in the security mirror.
(b) Neha visited a dentist in his clinic. She observed that the dentist was 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)

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. (Al 2017)

58. (a) Define the following terms in the context of spherical mirrors:
(i) Pole
(iii) Principal axis
(ii) Centre of curvature
(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)

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)

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)

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)

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
(c) convex lens
(b) concave mirror
(d) convex mirror. (Term I, 2021-22)

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 n33 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?

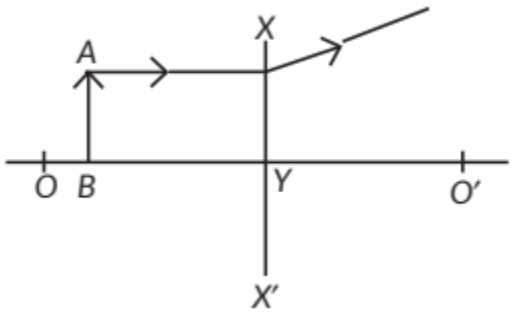
(a) $n_1<n<n3$
(b) $n_1 > n_2 > n3$
(c) $n_1 < n_2 = n3$
(d) $n_1 = n3 < n2$ (Term I, 2021-22)

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)

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)

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)

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)

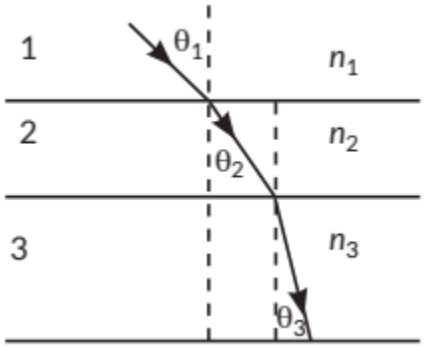
72. A ray of light starting from air passes through medium A of refractive index 1.50, enters medium B of refractive index 1.33 and finally enters medium C of refractive index 2.42. If this ray emerges out in air from C, then for which of the following pairs of media the bending of light is least?
(a)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

√Type equation here.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)

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?



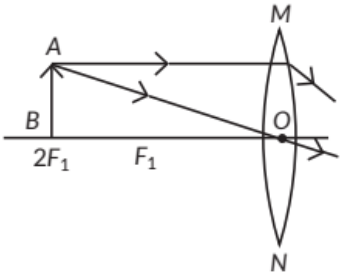
(a) $n_1 = n_2$ (b) $n_1 > n_2$
(c) $n_2 > n_3$ (d) $n_3 > n_1$

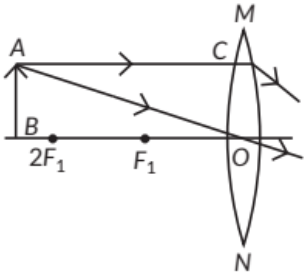
(Term I, 2021-22)

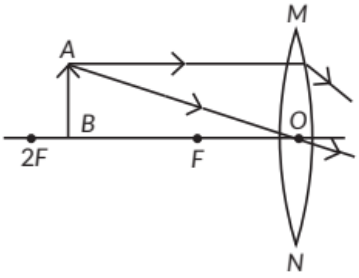
75. The refractive index of medium A is 1.5 and that of medium B is 1.33. If the speed of light in air is 3 x 10_8 m/s, what is the speed of light in medium A and B respectively?

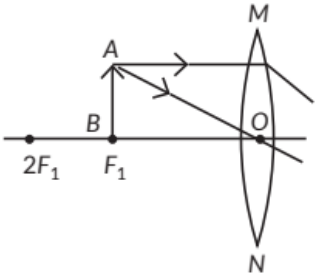
(a) 2 × 10_8 m/s and 1.33 × 10_8 m/s
(b) 1.33 x 10_8 m/s and 2 x 10_8 m/s
(c) 2.25 x 10_8 m/s and 2 × 10_8 m/s
(d) 2x 10_8 m/s and 2.25 x 10_8 m/s (Term I, 2021-22)

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)


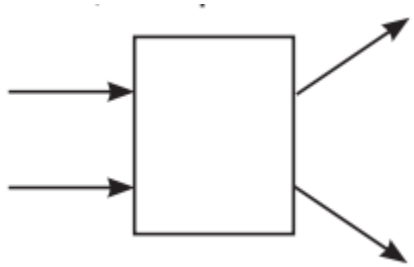
(b)


(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)

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)

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)

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)

VSA (1 mark)

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 SAI (2 marks)

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 x 108 m/s. (2019 C)

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)

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 2×108 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 2×108 m/s, calculate the speed of light in (i) vacuum, (ii) water. (AI 2015)

SA II (3 marks)

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)

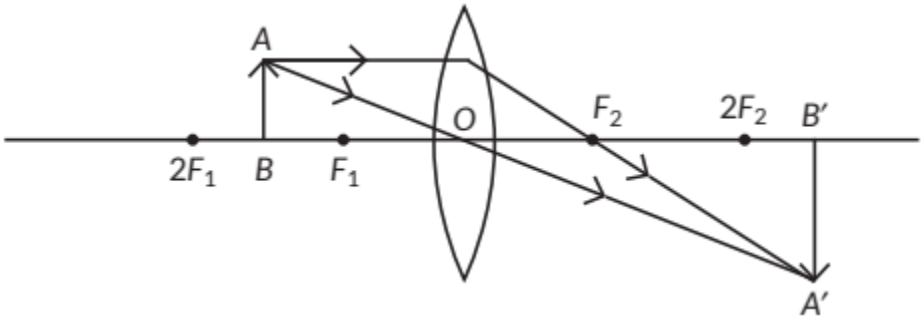
91. An object of height 10 cm is placed 25 cm away from the optical centre of a converging lens of focal length 15 cm. Calculate the image-distance and height of the image formed. (2023)

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)

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 x 108 m s^1, calculate the speed of light in medium 'y'. (2020)

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)

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)

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 (2018)

99. What is meant by power of a lens? Write its SI unit. A vaccum. 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. (Al 2017)

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)

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. (Al 2016)

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)

105. State the laws of refraction of light. If the speed of light in vacuum is 3 × 108 m/s, find the absolute refractive index of a medium in which light travels with a speed of 1.4 x 108 m/s. (Foreign 2015)

106. State the laws of refraction of light. If the speed of light in vacuum is 3 × 108 m s^{1}, find the speed of light in a medium of absolute refractive index 1.5. (Delhi 2014, Al 2014)

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)

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 x 108 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 0), then write the increasing order of the angle of refraction in these media.
(iii) The speed of light in glass is 2 × 108 m/s and in water is 2.25 × 108 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 x 108 m/s, find the speed of light in (i) vacuum and (ii) water. (2023)

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).

112. (a) Define the following terms:
(i) Power of lens (2020)
(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)

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)

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)

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)

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 20 cm. 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. (Al 2016)

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

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)

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 2×108 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. (Al 2015)

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. (Al 2015)

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)

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)

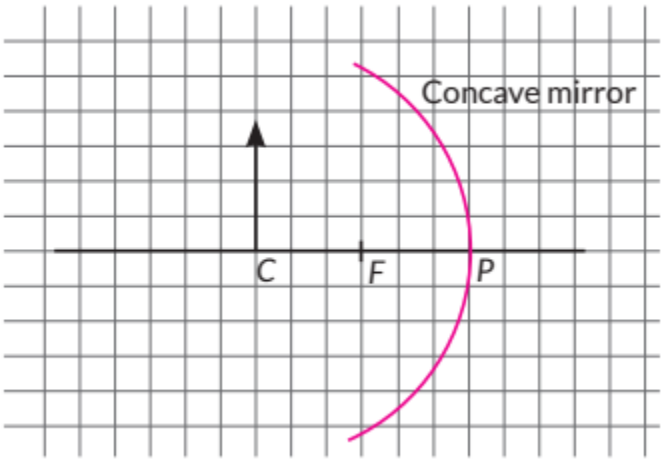
CBSE Sample Questions

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)

2.

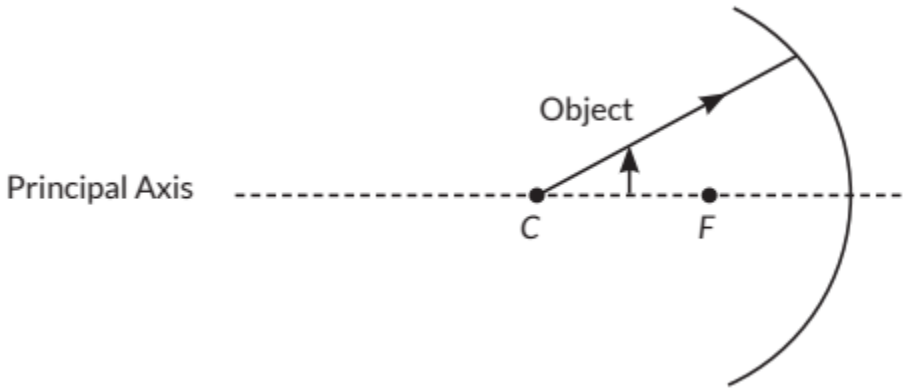


Examine the above figure and state which of the following option is correct? [One small box in the figure is equal to 1 cm.]
(a) The mirror has a focal length of -6 cm and will produce an image of magnification +1.
(b) The mirror has a focal length of -3 cm and will produce an image of magnification -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)

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.



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)

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)

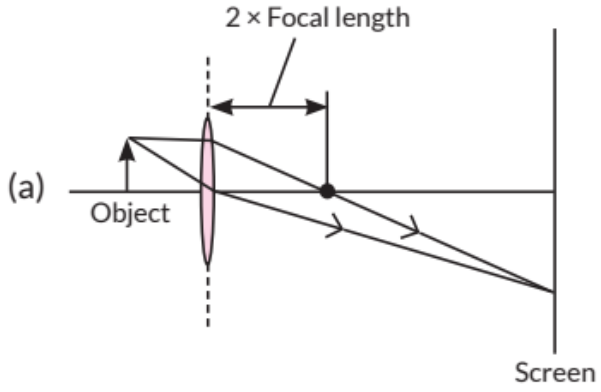
Rohit wants to have an erect image of an object using a converging mirror of focal length 40 cm.
(a) Specify the range of distance where the object can be placed in front of the mirror. Justify.
(b) Draw a ray diagram to show image formation in this case.

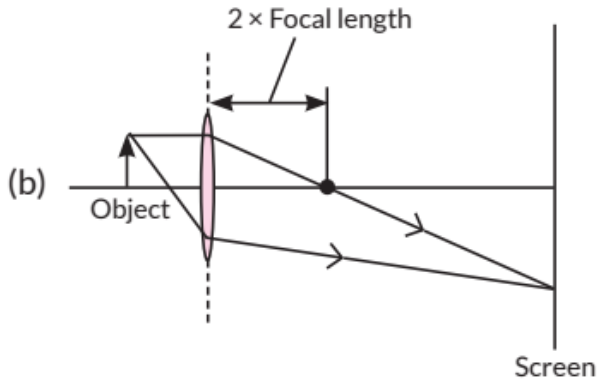
(c) State one use of the mirror based on the above kind of image formation. (2022-23)

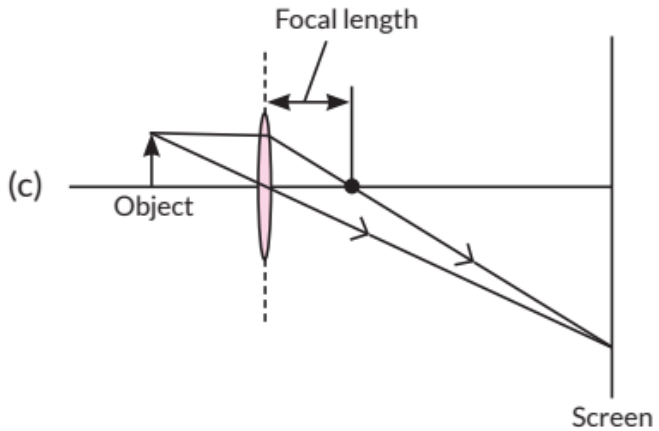
9.3 Refraction of Light

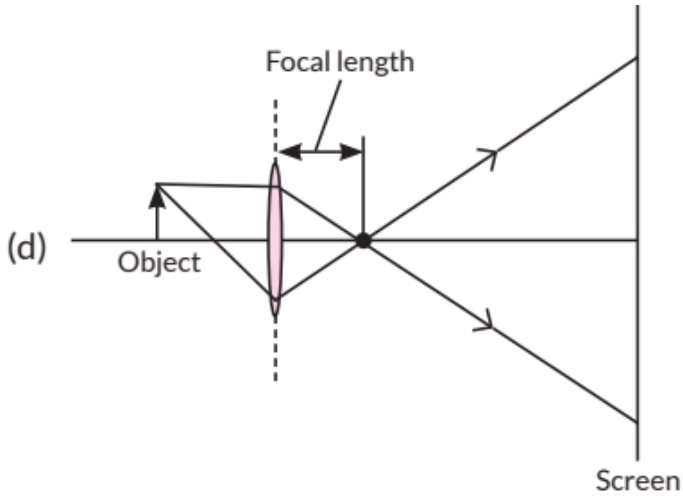
MCQ

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









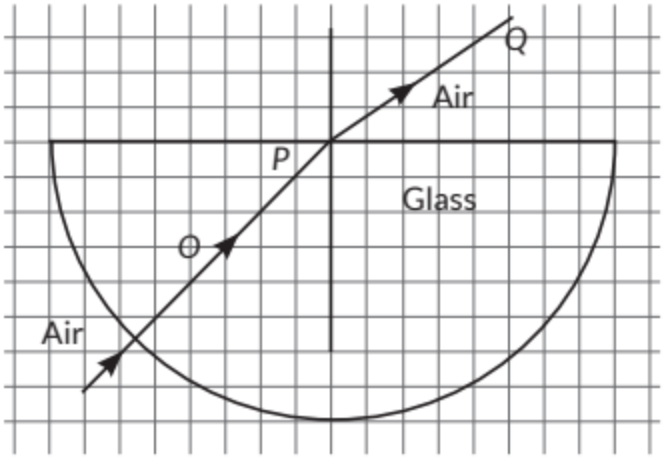
(Term I, 2021-22)

(Term I, 2021-22)

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)

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)

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

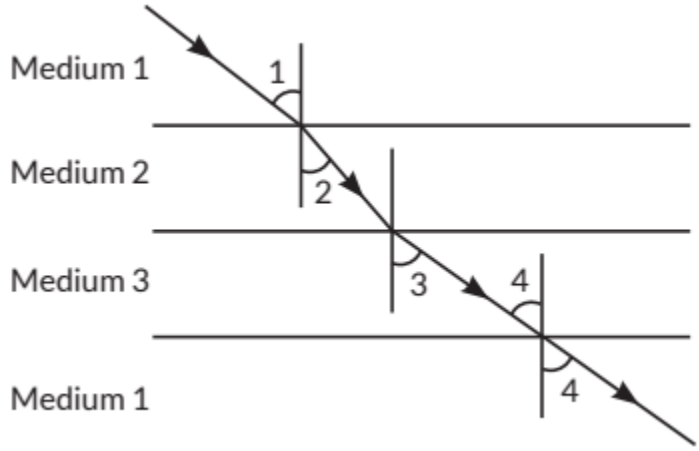


(a) 45°
(b) 0°
(c) 90°
(d) 180° (Term I, 2021-22)

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)

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

$\angle 1 = \angle 3 = \angle 4$ but $\angle 2 < \angle 1$. 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)

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?

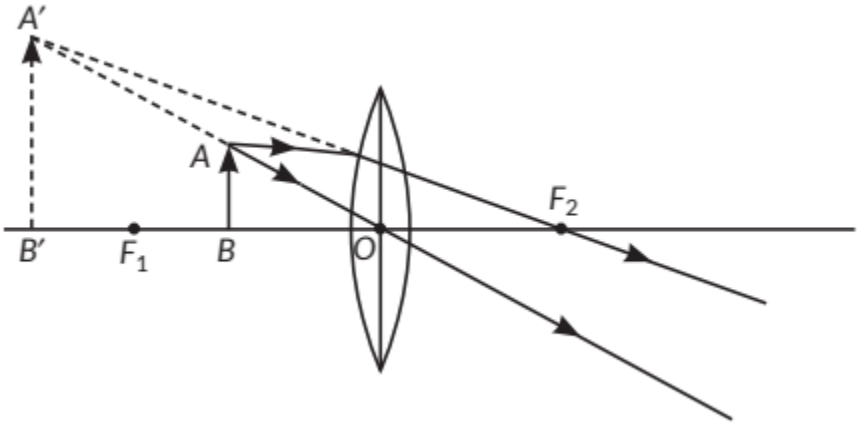
(a) 0.82

(b) 1.21

(c) 1.11

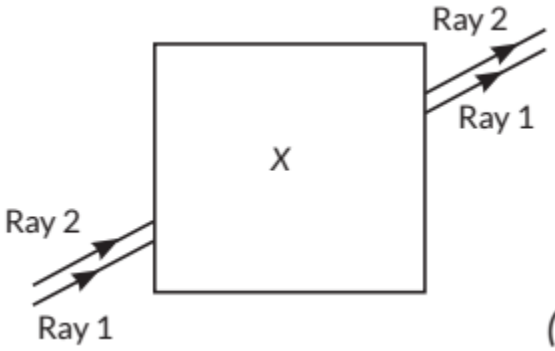
(d) 1.01 (Term 1, 2021-22)

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
(c) 4 mm
(b) 6.67 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.



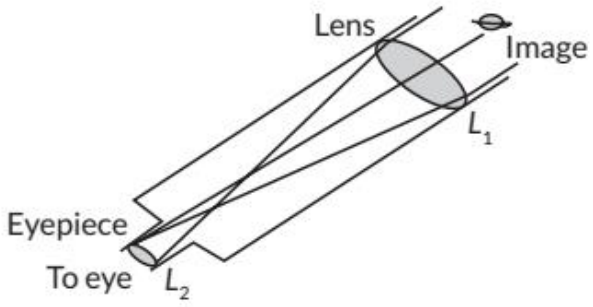
(Term I, 2021-22)

(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 was 1.5. What will be the approximate value of angle of refraction?
(a) 45°
(b) 40°
(c) 30°
(d) 60°
(Use the value: sin 48.6°≈ 0.75)
(iii) Her friend noted the following observations from this demonstration:
(i) Glass is optically rarer than air.
(ii) Air and glass allow light to pass through them with the same velocity.
(iii) Air is optically rarer than glass.
(iv) Speed of light through a denser medium is faster than that of a rarer medium.
(v) The ratio: sin of angle of incidence in the first medium to the ratio of sin of angle of refraction in the second medium, gives the refractive index of the second material with respect to the first one.
Which one of the combination of the above statements given below is correct?
(a) (ii), (iv) and (v) are correct
(b) (iii) and (iv) are correct
(c) (i), (iv) and (v) are correct
(d) (iii) and (v) are correct.
(iv) If the object inside the box was made of a material with a refractive index less than 1.5, then the
(a) lateral shift of the rays would have been less.
(b) lateral shift of the rays would have been more.
(c) lateral shift of the rays would remain the same as before.
(d) there is not enough information to comment on any of the above statements.

17. Read the following and answer any four questions from 17(i) to 17(v).
Sumati wanted to see the stars of the night sky. She knows that she needs a telescope to see those distant stars. She finds out that the telescopes, which are made of lenses, are called refracting telescopes and the ones which are made of mirrors are called reflecting telescopes. So she decided to make a refracting telescope. She bought two lenses, L1 and L2, out of which L_1 was

bigger and L2 was smaller. The larger lens gathers and bends the light, while the smaller lens magnifies the image. Big, thick lenses are more powerful. So to see far away, she needed a big powerful lens. Unfortunately, she realized that a big lens is very heavy. Heavy lenses are hard to make and difficult to hold in the right place. Also since the light is passing through the lens, the surface of the lens has to be extremely smooth. Any flaws in the lens will change the image. It would be like looking through a dirty window.



(2020-21)

(i) Based on the diagram shown, what kind of lenses would Sumati need to make the telescope?
(a) Concave lenses
(c) Bifocal lenses
(b) Convex lenses
(d) Flat lenses
(ii) If the powers of the lenses L_1 and L½ are in the ratio of 4:1, what would be the ratio of the focal length of L1 and L2?
(a) 4:1
(c) 2:1
(b) 1:4
(d) 1:1
(iii) What is the formula for magnification obtained with a lens?
(a) Ratio of height of image to height of object
(b) Double the focal length
(c) Inverse of the radius of curvature
(d) Inverse of the object distance
(iv) Sumati did some liminary experiment with the lenses and found out that the magnification of the eyepiece (L_2) is 3. If in her experiment with
L2 she found an image at 24 cm from the lens, at what distance did she put the object?

(a) 72 cm
(b) 12 cm
(c) 8 cm
(d) 6 cm

(v) Sumati bought not-so-thick lenses for the telescope and polished them. What advantages, if any, would she have with her choice of lenses?
(a) She will not have any advantage, as even thicker lenses would give clearer images.
(b) Thicker lenses would have made the telescope easier to handle.
(c) Not-so-thick lenses would not make the telescope very heavy and also allow considerable amount of light to pass.
(d) Not-so-thick lenses will give her more magnification.

VSA (1 mark)

18. Both a spherical mirror and a thin spherical lens have a focal length of (-) 15 cm. What type of mirror and lens are these? (2020-21)

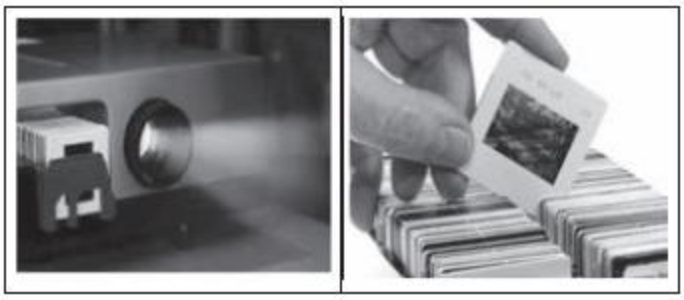
19. Name the part of a lens through which a ray of light passes without suffering any deviation. (2020-21)

SA II (3 marks)

20. (a) A lens of focal length 5 cm is being used by Debashree in the laboratory as a magnifying glass. Her least distance of distinct vision is 25 cm.
(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. lyer 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)

SOLUTIONS

Previous Years' CBSE Board Questions

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.

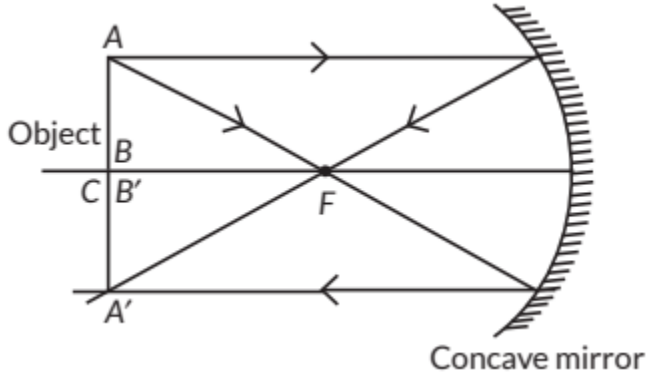
7. (b): Magnification: Sign-positive, value-more the 1 because the object is placed between the focus and the pole. So, magnified image will be formed on other side of mirror. Hence, magnification of image formed will have positive sign and value more than one.

8. (d): Radius of curvature of a converging mirror,
R = 30 cm

$$\text{focal length}, f = \frac{30}{2}\text{cm} = 15\text{ cm}$$

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.



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, $\frac{1}{f}=\frac{1}{v}+\frac{1}{u}$ or $v=\frac{uf}{u-f}$

$v=\frac{(-30)\times(10)}{(-30)-(10)}$ or $v=\frac{30}{4}=7.5\text{cm}$

Now, magnification $(m)=\frac{-v}{u}=\frac{h'}{h}$; $m=-\frac{\left(\frac{15}{2}\right)}{-30}=\frac{h'}{4}$

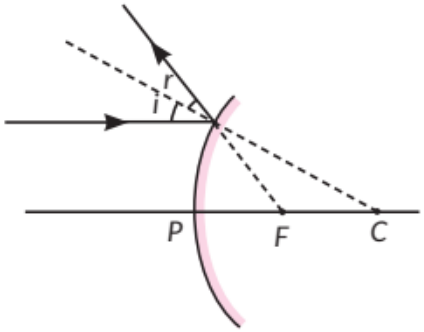
or $h' = 1$ cm

Hence, height of the image formed is 1 cm.

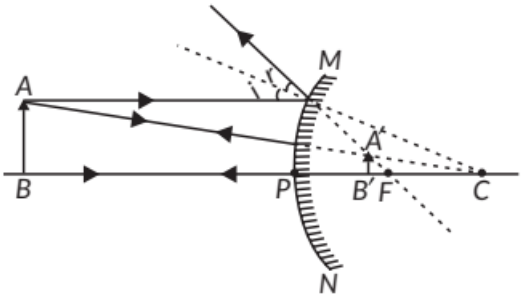
11. (d): When an object is placed between the principal focus and pole of a concave mirror, an enlarged virtual and erect image is formed behind the mirror.

12. The pole of a spherical mirror define the geometrical center of the spherical surface of the mirror. It is the center of reflecting surface of spherical mirror and lies on the surface of spherical mirror.

13.



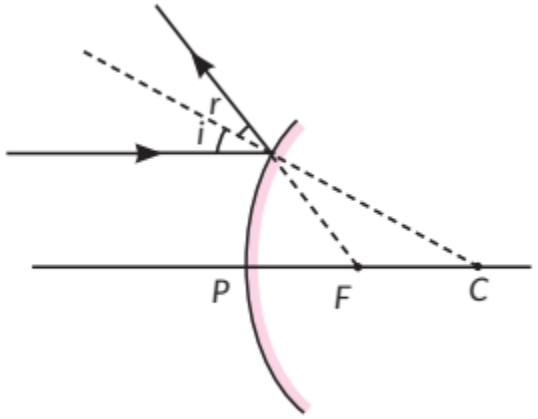
14. If the image formed by a spherical mirror is always erect and diminished then it is convex mirror.



15. Four characteristics of the image formed by the given convex mirror are :
(i) Virtual
(ii) Erect
(iii) Diminished
(iv) Image is always formed behind the mirror between pole and focus.

16. Radius of curvature (R) = 30 cm, object distance is 12 cm in front of the mirror. Thus we can say that object is placed between focus and pole. Four characteristics of the image formed by the given concave mirror when object is placed between pole and focus are:
(i) Virtual
(ii) Erect
(iii) Enlarged
(iv) Image is formed behind the mirror

17.



18. Concave mirrors are used in the designing of solar furnaces.
When a solar furnace is placed at the focus of a large concave mirror, it focuses a parallel beam of light on the furnace. Therefore, a high temperature is attained at the point after some time.

19. Negative sign of magnification indicates that the image is real and inverted. Since the image is real and inverted, the mirror is concave and magnification of -3 indicates that the image is magnified.

20. Focal length of a mirror is given by

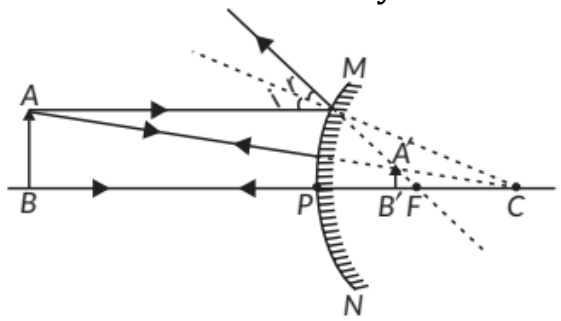
$$\text{Focal length} = \frac{\text{Radius of curvature}}{2}$$

Since both the mirrors have same radius of curvature, therefore focal length of the two mirrors will be same, i.e.,

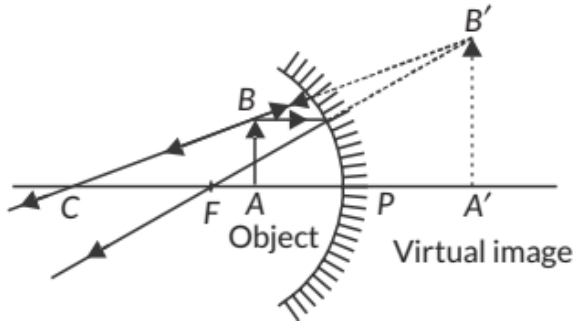
$$\frac{f_1}{f_2} = \frac{1}{1}$$

Since virtual image is always formed by convex mirror. The mirror AB will always form virtual image.

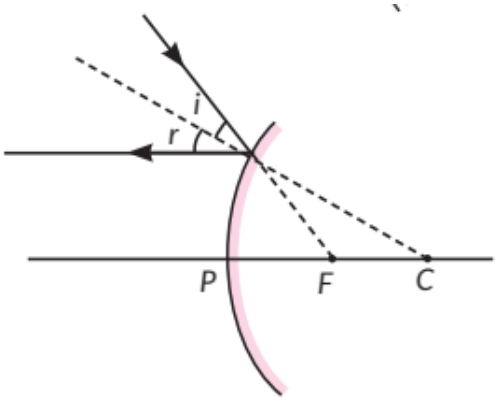
21. Convex mirrors always form diminished, virtual and erect images.



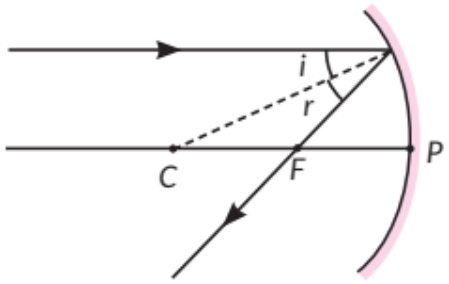
22. Positive value of the magnification indicates that image is virtual and erect.
(i) Since the image is magnified, the mirror is concave.
(ii) The object is between pole and focus of the mirror as shown



23.

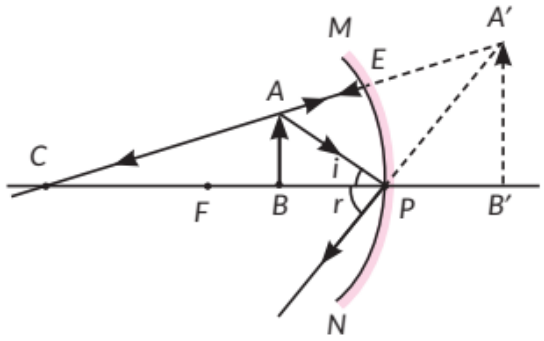


24.

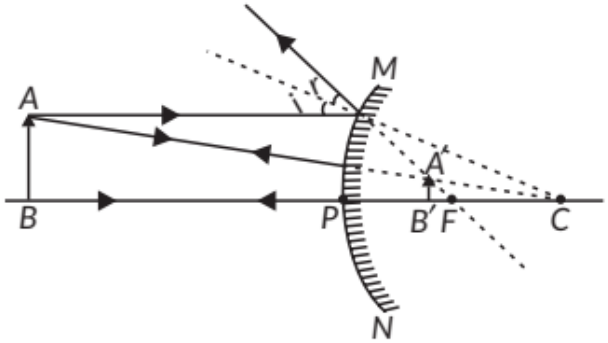


25. A concave mirror can produce a magnified image of an object when object is placed:
(1) In between its pole and its focus,
(2) In between its focus and its centre of curvature.
Difference between these two images:
The image produced in first case will be virtual and erect. The image produced in second case will be real and inverted.

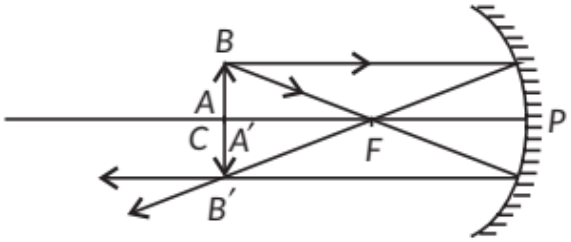
26. The position of the object should be between P and F



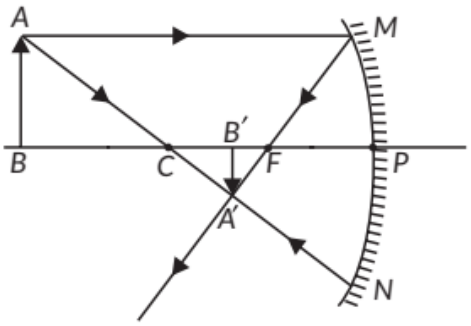
27. (i) Convex mirror
(ii) Between infinity and the pole of the mirror.



28. (i) Concave mirror because the image is real, inverted.
(ii) Object is placed at C.



29. (i) Concave mirror
(ii) Object is placed beyond C.



30. Here, object distance, u = -20 cm

$$\text{Magnification, } m = \frac{1}{2}$$

$$-\frac{v}{u} = \frac{1}{2} \text{ or } \frac{-v}{-20} = \frac{1}{2}$$

$$\Rightarrow \quad v = 10 \text{ cm}$$

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f} \text{ or } \frac{1}{10} + \frac{1}{-20} = \frac{1}{f}$$

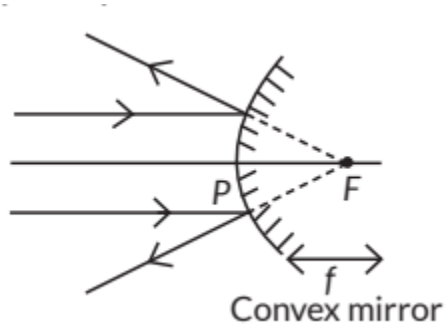
$$\Rightarrow \quad \frac{1}{20} = \frac{1}{f} \Rightarrow f = 20 \text{ cm}$$

$$\text{For } m = \frac{1}{3}, \ \frac{-v}{u} = \frac{1}{3} \text{ or } v = \frac{-u}{3}$$

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f} \text{ or } \frac{1}{-\frac{u}{3}} + \frac{1}{u} = \frac{1}{f}$$

$$\text{or } \frac{-2}{u} = \frac{1}{20} \text{ or } u = -40 \text{ cm}$$

31. (i) Principal focus : It is the point on the principle axis where rays incident parallel to the principal axis appear to diverge after reflection.
(ii) Focal length: The distance between the pole of mirror and the principal focus is called focal length.



Convex mirror

32. Given: ho= 3 cm, f= -12 cm,
u = -18 cm, v = ?, h; = ?

(i) Using mirror formula, $\frac{1}{v}+\frac{1}{u}=\frac{1}{f} \Rightarrow -\frac{1}{12}=\frac{1}{v}-\frac{1}{18}$

$$\frac{1}{v}=\frac{1}{18}-\frac{1}{12}=\frac{2-3}{36}=\frac{-1}{36}$$

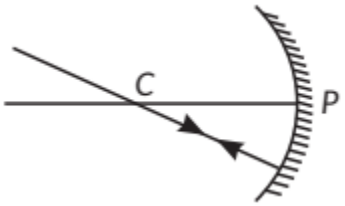
$\therefore \quad v = -36$ cm

So, the distance of image from the mirror is 36 cm.

(ii) $\frac{h_i}{h_o}=\frac{-v}{u} \Rightarrow \frac{h_i}{3}=\frac{-(-36)}{-18} \Rightarrow h_i=-6$ cm

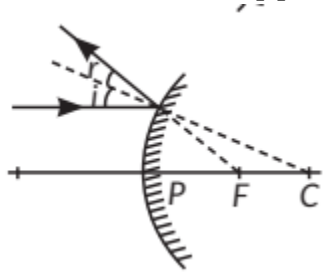
So, the height of image is 6 cm.

33. (i) Ray of light passing through centre of curvature of concave mirror, after reflection retraces its path.

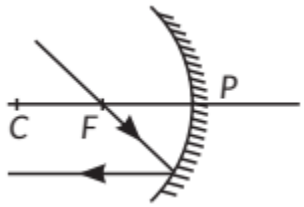


(ii) Ray of light parallel to the principal axis is incident on a convex mirror

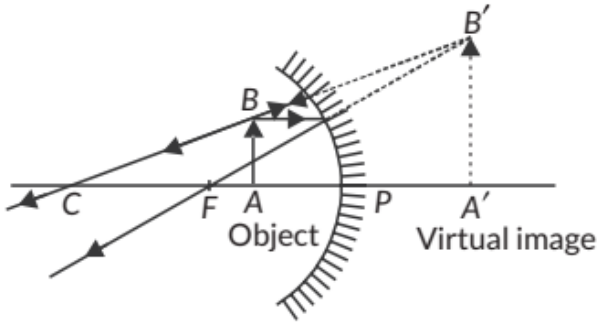
after reflection appear to diverge from the principal focus of a convex mirror.



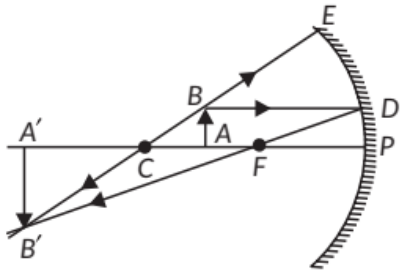
(iii) Ray of light passing through focus of a concave mirror after reflection will emerge parallel to the principal axis



34. Given, f= -15 cm, u = -10 cm.
Thus, the object is placed between the principal focus and pole of the mirror.
(a) The position of the image will be behind the mirror.
(b) The size of the image will be highly enlarged.
(c) The nature of the image will be virtual and erect.



35. (a) To get an enlarged, real and inverted image of an object by a concave mirror, we must placed on the object between the center of curvature and focal point of the mirror.



(b) If an object is placed at the centre of curvature of the mirror then, we get the magnification m = -1.

36. Focal length of concave mirror (f) = -20 cm Object is put from the concave mirror = 4 cm We require two times magnified virtual image of the object m = -2

So, $-\frac{v}{u}=-2$

Using mirror formula, $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$; $\frac{1}{v}+\frac{1}{u}=-\frac{1}{20}$

multiply by $-v$ to both sides :

$\frac{-v}{v}+\frac{(-v)}{u}=-\frac{(-v)}{20}$; $-1-2=\frac{v}{20} \Rightarrow -3=\frac{v}{20} \Rightarrow v = -60$ cm

$\because$ We know that $m=-\frac{v}{u}$

$m=-\frac{(-60)}{u} \Rightarrow -2=\frac{60}{u} \Rightarrow u = -30$ cm

37.

Given, $f = -20$ cm, $v = -30$ cm, $u = ?$

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

$\frac{1}{u}=\frac{1}{f}-\frac{1}{v}=\frac{1}{-20}-\frac{1}{-30}=\frac{-3+2}{60} \Rightarrow u=-60$ cm

Object placed at 60 cm from the mirror.

Also magnification, $m=\frac{h'}{h}=\frac{-v}{u} \Rightarrow h'=\frac{-(-30)}{-60}\times 4=-2$ cm

$\therefore$ The size of the image is 2 cm.

38. Given,
Object distance, u = - 30 cm, image size, h' = ?
Image distance, v = − 60 cm,
Object size, h = 2.4 cm, Focal length, f = ?
Using mirror formula,

$$\frac{1}{f}=\frac{1}{v}+\frac{1}{u} \quad \text{or} \quad \frac{1}{f}=\frac{-1-2}{60}=\frac{-3}{60}=-\frac{1}{20} \quad \text{or } f = -20 \text{ cm}$$

Hence, focal length is 20 cm

Also, magnification, $m=\frac{h'}{h}=\frac{-v}{u}$

or, $\quad m=-\frac{(-60)}{(-30)}=-2 \quad$ or $\quad \frac{h'}{h}=-2$

$h' = -2 \times 2.4 = -4.8$ cm

As the image formed is real, therefore the mirror is
concave. The height of the image is 4.8 cm. The image formed is enlarged and inverted.

39. Given, object distance, u = -15 cm,
Object height, h = 4 cm, focal length, f = -10 cm; Image
distance, v = ?
Using mirror formula,

$$\frac{1}{v}+\frac{1}{u}=\frac{1}{f} \quad \Rightarrow \quad \frac{1}{v}+\frac{1}{(-15)}=\frac{1}{-10} \quad \Rightarrow \quad \frac{1}{v}=\frac{1}{15}-\frac{1}{10}$$

$$\text{or} \quad \frac{1}{v}=\frac{10-15}{150}=\frac{-5}{150}=\frac{-1}{30} \quad \text{or } v = -30 \text{ cm}$$

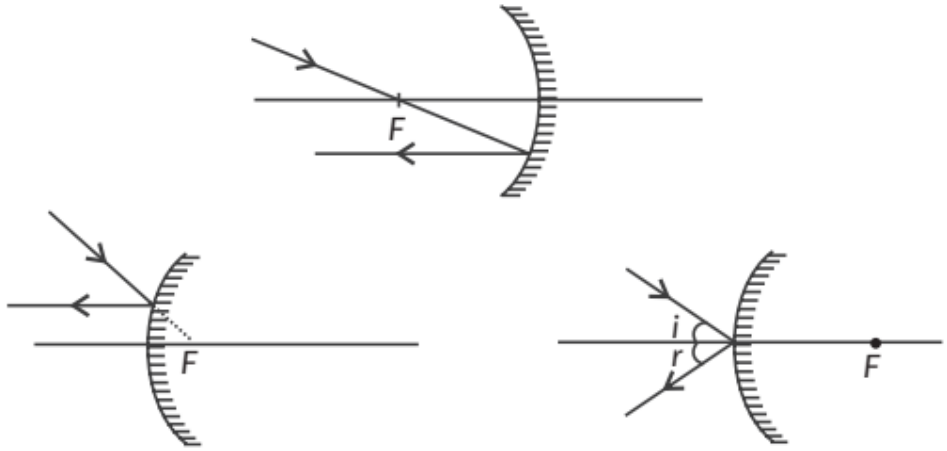
In order to obtain a sharp image of the object on the screen, screen should be placed at a distance of 30 cm in front of the mirror.

Also, magnification, $m=\frac{h'}{h}=\frac{-v}{u}$

$$\text{or} \quad \frac{h'}{4}=-\frac{(-30)}{(-15)} \quad \text{or} \quad h'=\frac{-(30)\times 4}{(15)}=-2\times 4 \quad \text{or } h' = -8 \text{ cm}$$

Thus, the height of the image is 8 cm.

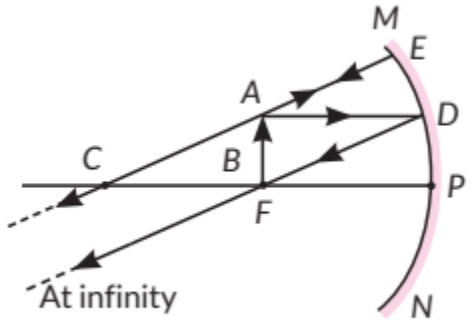
40. The path of the rays are shown in figure.



41. Since, the image formed by the mirror is real and inverted, therefore the mirror is concave and magnification of the mirror will be

$$m = -\frac{v}{u} \Rightarrow -1 = -\frac{v}{u} \quad \Rightarrow \quad v = u$$

i.e., object and image both are formed at the centre of curvature, i.e., 40 cm from the mirror. Now, if the object



is moved 20 cm towards the mirror, the object will be at the focus of the mirror and therefore the image will be formed at infinity.

42. Since, the image formed is real and inverted, the mirror is concave.

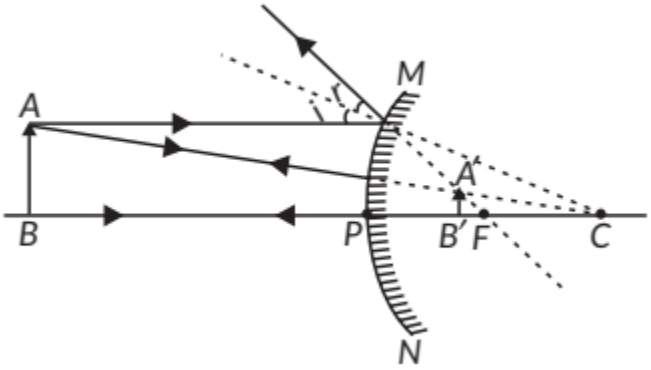
$$\text{Magnification}, m = \frac{-v}{u} \Rightarrow -2 = \frac{-v}{u} \quad \Rightarrow \quad v = 2u$$

Now, if v = - 30 cm then u = - 15 cm As focal length of the mirror is

$$f = \frac{uv}{u+v} = \frac{-15 \times -30}{-15-30} = f = \frac{450}{-45} = -10 \text{ cm}$$

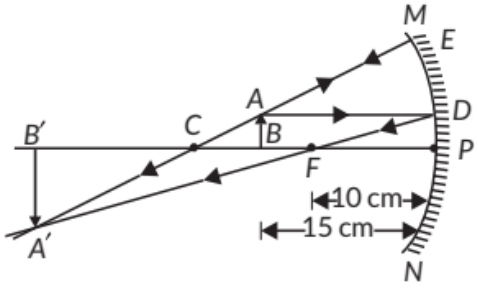
If the object is shifted 10 cm towards the mirror, then the object is between principal focus and the optical centre and the image formed will be virtual and erect.

43. If the image formed by a spherical mirror is always erect and diminished then it is convex mirror.



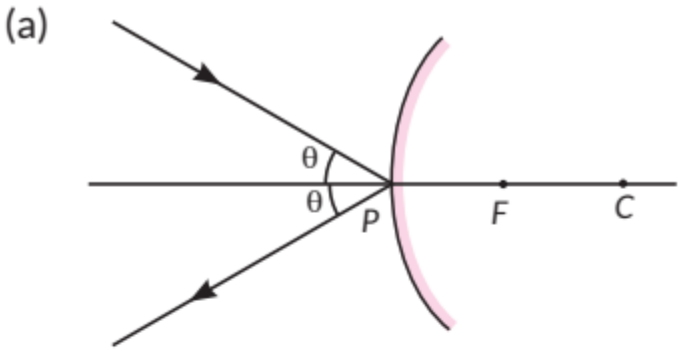
Convex mirrors are widely used as rear view mirrors in cars, motorcycles etc. It produces an erect image that is smaller in size than the object hence giving a wide view.

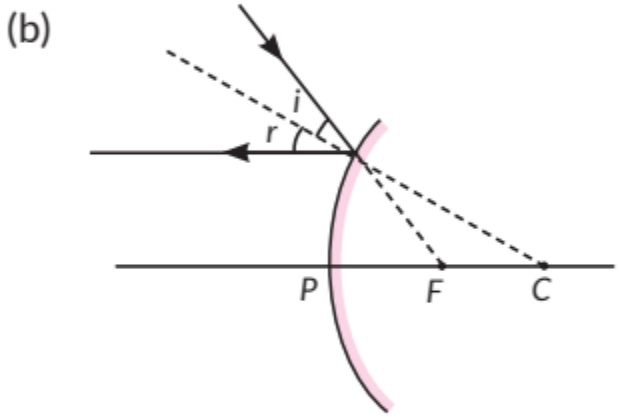
44. We use two rays of light, one passing through the centre of curvature of a concave mirror, and another is parallel to the principal axis. After reflection, the ray passing through the centre of a concave mirror is reflected back along the same path and the ray parallel to the principal axis will pass through the principal focus. u = -15 cm, f = -10 cm

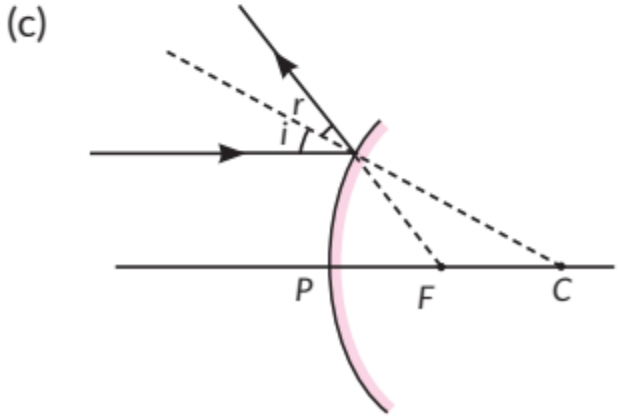


From ray diagram, v = -30 cm, i.e., beyond C Nature of image is real, inverted and magnified.

45.







46. (a) Concave mirror

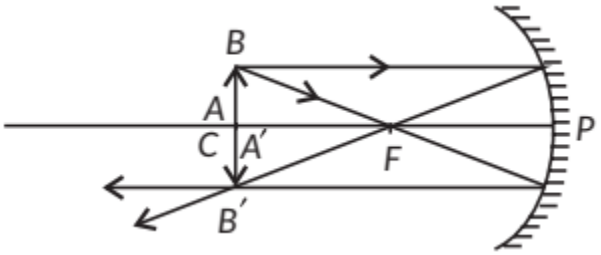
(b) Magnification, $m = -\frac{v}{u}$ or $v = u$

Distance of the image from the object is, v - u = 0

(c) As the image is formed at centre of curvature i.e., v = R.

$\therefore$ focal length of the mirror, $f = \frac{-50}{2} = -25\,\text{cm}$

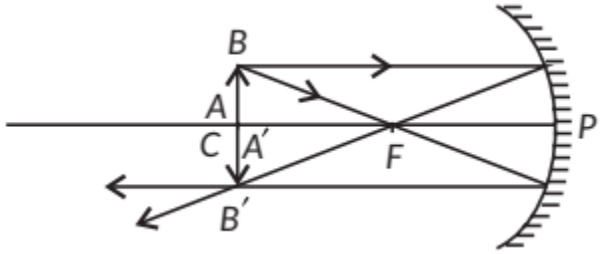
(d) Object is placed at C.



47. (i) This is a concave mirror.
(ii) The image is real and inverted and of same size.
(iii) As m = - 1

$$\therefore \quad m = \frac{-v}{u} \Rightarrow -1 = \frac{-v}{u} \Rightarrow u = v$$

Hence, object is located at centre of curvature i.e., at distance of 40 cm from the pole of the mirror.
(iv) Object is placed at C.



48. (i) The mirror is concave mirror.
(ii) Distance of the image from the mirror = - 30 cm

Magnification, $m = \frac{-v}{u}$. Here $m = -1$ and $v = -30$ cm

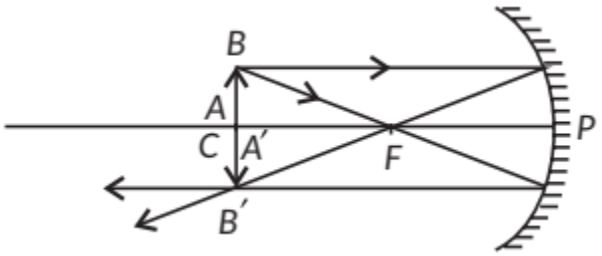
$$-1 = -\frac{(-30)}{u}$$

$\therefore \quad u = -30$ cm

As v = u, object is placed at centre of curvature.

Therefore, focal length of the mirror, $f = \frac{-30}{2} = -15$ cm

(iii) Image formed is real and inverted and of the same size of the object.
(iv) Object is placed at C.

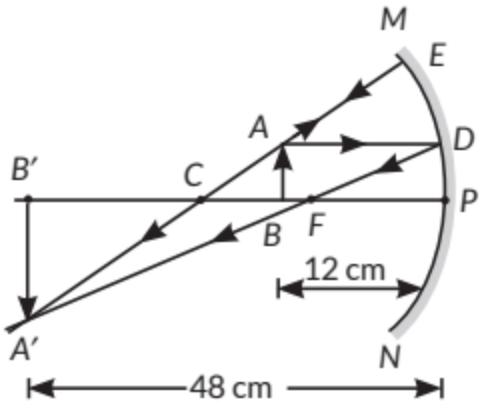


49. (a) Concave mirror

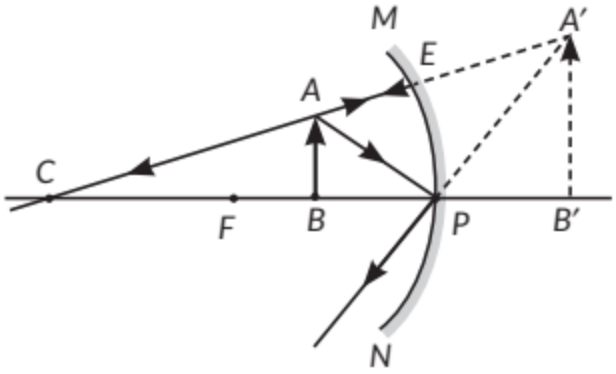
(b) Linear magnification, $m = \frac{-v}{u} = \frac{-(-48)}{-12} = -4$

(c) The distance between the image and the object = 48-12 = 36 cm

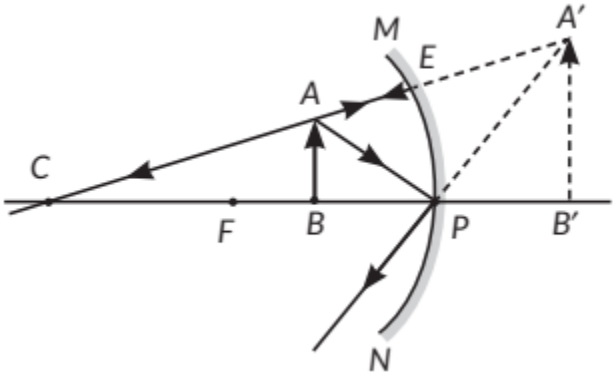
(d)



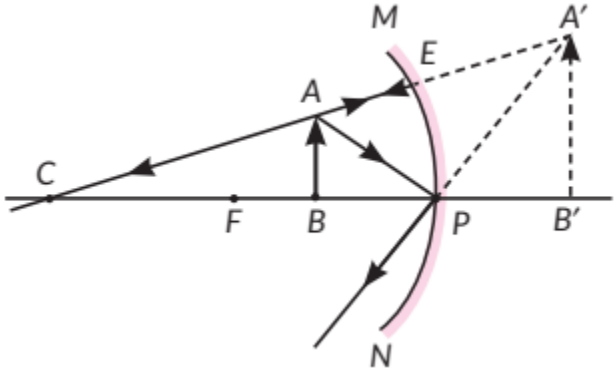
50. To obtain an erect image, the object is placed in between pole and the focus of the concave mirror. S range of distance of the candle flame from the mirror i in between 12 cm. Nature of the image = Virtual and erect. Size of the image = Enlarged



51. To obtain an erect image of an object, the object should be placed in between pole and focus. Range of distance of the candle flame from the mirror is in between 15 cm. Nature of the image = Virtual and erect Size of the image = Enlarged



52. Focal length of a concave mirror = 20 cm Range will be in between 20 cm. Nature of the image = Virtual and erect Size of the image = Enlarged



53. (i) Given, h = 4 cm,
u = -25 cm (concave mirror), f = -15 cm
Using mirror formula,

$$\frac{1}{f}=\frac{1}{v}+\frac{1}{u} \text{ or } \frac{1}{v}=\frac{1}{f}-\frac{1}{u}=\frac{1}{-15}-\frac{1}{-25}=\frac{-25+15}{15\times25}$$

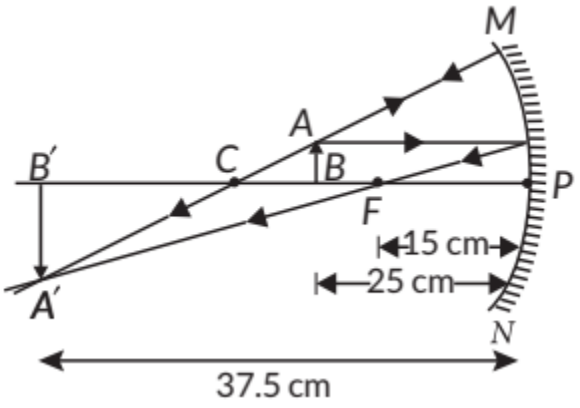
$$\therefore \quad v=\frac{15\times25}{-10}=-37.5 \text{ cm}$$

(ii) Magnification, $m=\frac{h'}{h}=\frac{-v}{u}$

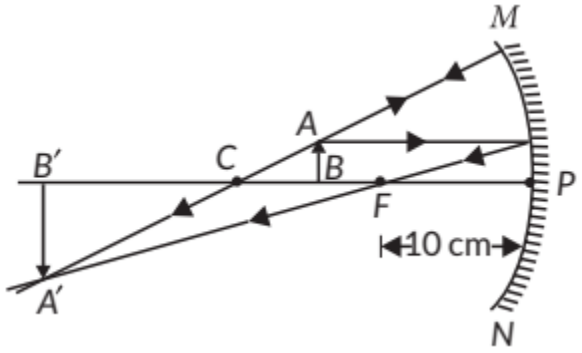
$$\therefore \quad h'=\frac{-v}{u}\times h=\frac{37.5}{-25}\times4=-6 \text{ cm}$$

Thus, the image is real and inverted.

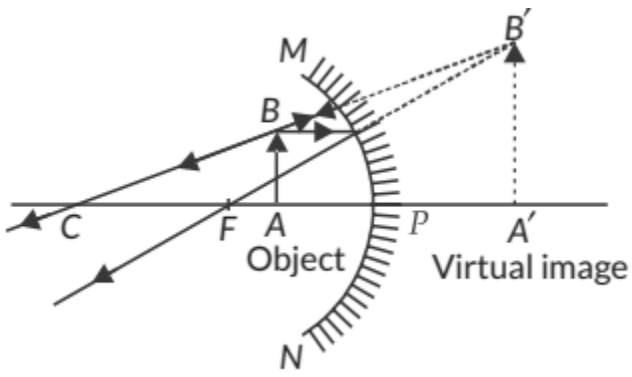
(iii)



54. (a) A magnified real image is produced in a concave mirror when the object is placed between principal focus and centre of curvature.



A magnified virtual image is produced in a concave mirror when the object is placed between the pole and the principal focus of the mirror.



(b) Given, f = +10 cm (convex mirror) and u = -10 cn From mirror formula,

$$\frac{1}{f}=\frac{1}{v}+\frac{1}{u} \text{ or } \frac{1}{v}=\frac{1}{f}-\frac{1}{u} \text{ or } \frac{1}{v}=\frac{1}{10}-\frac{1}{-10}=\frac{-10-10}{-100}$$

$$\therefore \quad v=\frac{-100}{-20}=5\text{cm} \text{ behind the mirror.}$$

55. (a) Given, radius of curvature of the mirror, R = 5 m

Focal length, f = R/2 = 2.5 m (convex mirror) and u = -20 m From mirror formula,

$$\frac{1}{f}=\frac{1}{v}+\frac{1}{u} \text{ or } \frac{1}{v}=\frac{1}{f}-\frac{1}{u}=\frac{1}{2.5}-\frac{1}{(-20)}=\frac{-20-2.5}{(-20)\times 2.5}$$

$$\therefore \quad v = 2.22 \text{ m}$$

Thus, the image is formed 2.22 m behind the mirror. The image is diminished, virtual and erect.
(b) Concave mirrors are used by dentist. Dentist use it as it is a converging mirror and when used at close range forms a highly enlarged, virtual and erect image of the object.

56. (a) Two lights rays whose path of reflection are priorly known are:
(i) When the incident ray passes through the centre of curvature of a concave mirror, it gets reflected in the same path.
(ii) When the ray is incident obliquely to the principal axis, towards the pole of mirror, it gets reflected back by making equal angles with the principal axis

(laws of reflections). Suppose an object is placed between focus and pole of the concave mirror. Then by using the above two rays, the image of the object can be located as

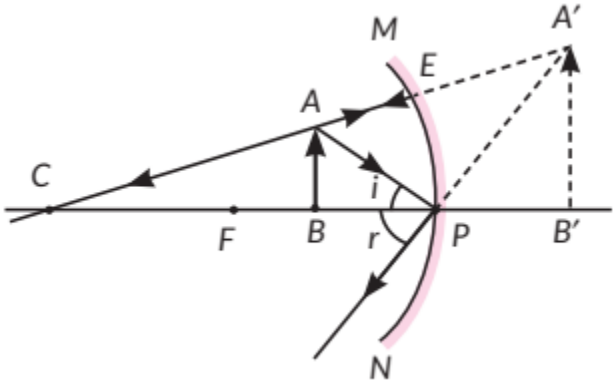
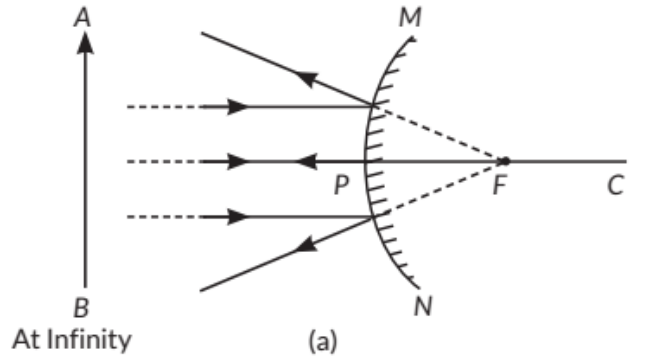


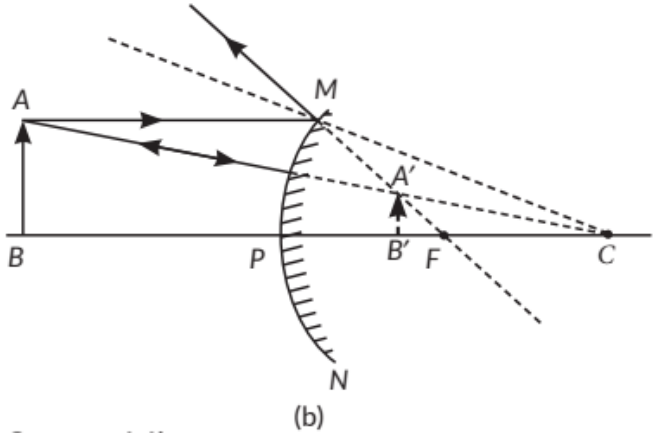
Image formed is virtual, erect, magnified and it is formed behind the mirror.
(b) Given, magnification, m = - 3
Object distance, u = - 20 cm

$$\text{Magnification, } m=\frac{-v}{u} \text{ or } -3=\frac{-v}{-20} \text{ or } v = -60 \text{ cm}$$

The screen is placed in front of the mirror at a distance of 60 cm from the pole. Thus, the screen is placed 40 cm (= 60 cm - 20 cm) away from the object.

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 then the mirror is convex mirror. The ray diagrams for the formation of image by a convex mirror for the first position when, the object is at infinity and the second position, when the object is at a finite distance from the mirror are shown.





Use of Convex Mirrors Convex mirrors are commonly used as rear-view (wing) mirrors in vehicles because they always give an erect, though diminished image. Also, they have a wider field of view as they are curved outwards. Thus, convex mirrors enable the driver to view a large area.
(b) Radius of Curvature: The radius of the sphere of which the reflecting surface of a spherical mirror forms a part, is called the radius of curvature of the mirror. It is represented by the letter R. The radius of curvature is equal to twice the focal length. R = 2f

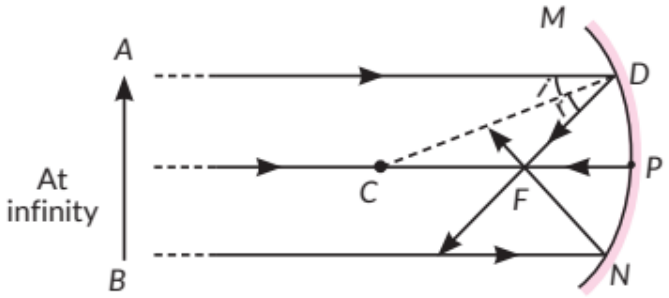
$$\text{If} \quad R = +24\ \text{cm} \quad \therefore \quad f = \frac{R}{2} = \frac{24}{2} = 12\ \text{cm}$$

Since, the radius of curvature is positive, the mirror is convex mirror. Hence, the nature of the image is virtual and erect.

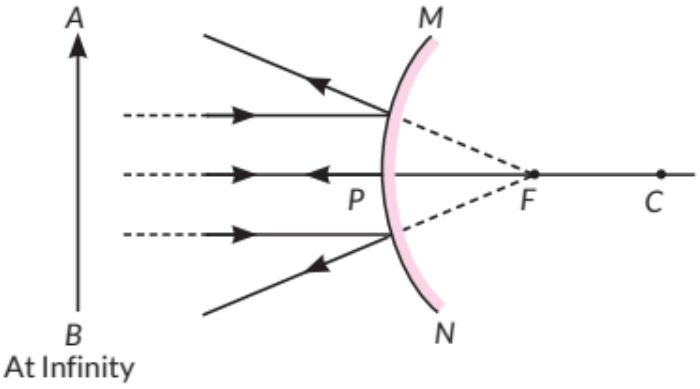
58. (a) (i) Pole : The centre of the reflecting surface of a spherical mirror is a point called the pole. It lies in the surface of the mirror and its represented by the letter P.
(ii) Centre of curvature: The reflecting surface of a spherical mirror is a part of a sphere which has a centre. This point is called the centre of curvature of

spherical mirror and is represented by the letter C.
(iii) Principal axis : An imaginary line passing through the pole and the centre of curvature of a spherical mirror and normal to the mirror at its pole is called principal axis.
(iv) Principal focus: Incident rays parallel to principal axis, after reflection either converge to as appear to diverge from a fixed point on the principal axis known as principal focus of the spherical mirror.

(b) (i)

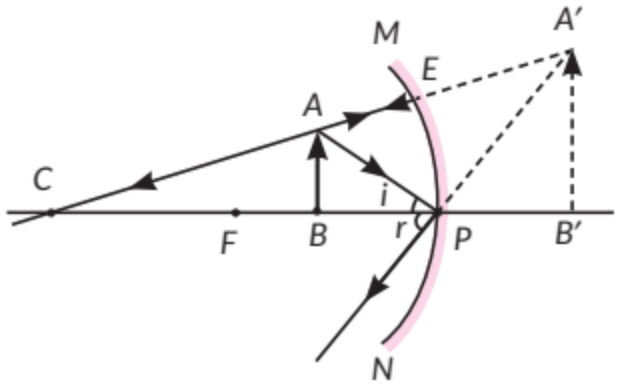


(ii)

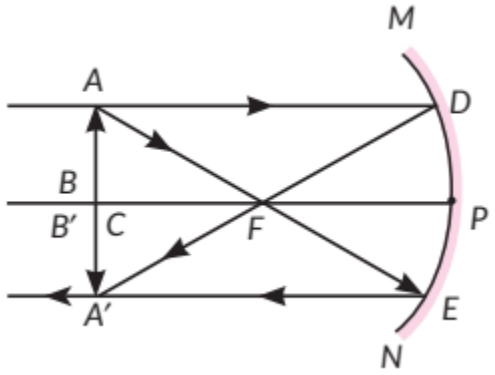


(c) The object is placed between focus and pole of the mirror and a magnified image is formed behind the mirror. The mirror is concave and image formed is virtual and erect.

59. Given, focal length of the concave mirror f = 12 cm
(i) If the object is placed between the pole and the focus of the concave mirror, then the image formed is virtual and erect. Therefore, the range of distance of the object should be $0 < u < 12$ cm.
(ii) The image formed will be enlarged as shown below.

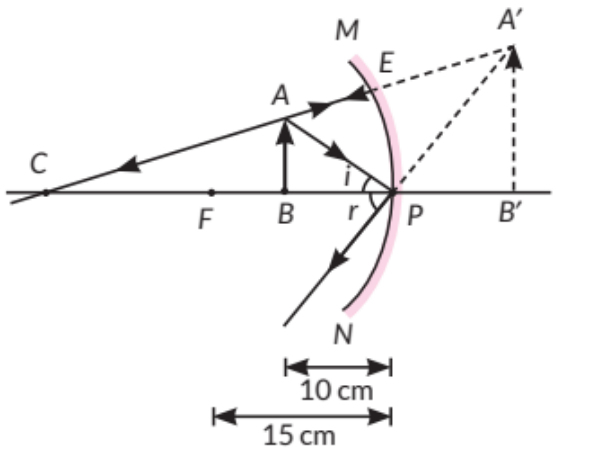


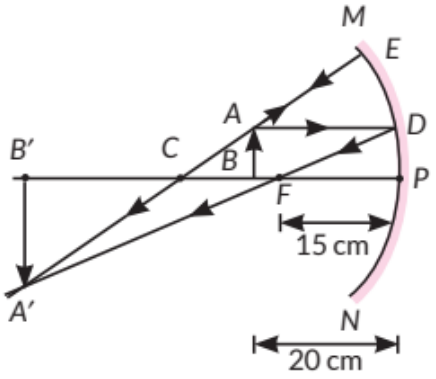
(iii) If the object is placed 24 cm in front of the mirror i.e., at the centre of the curvature then the image will also be formed at the centre of the curvature.



60. Given, $f_1 = 10$ cm, f = 15 cm, $f_1 = 20$ cm
$u_1 = 10$ cm, $u_2 = 20$ cm, $u_1 = 30$ cm
(a) Magnification of -1 implies that size of image is same as that of object or image is formed at the same distance as of the object. This is the case when the object distance, u = 2f, i.e., when the object is at the centre of the curvature. For fa, up and for fb, uc, we get magnification - 1.
(b) Concave mirror forms virtual, erect and magnified image when the object is between focus and pole of the mirror, i.e., direct distance should be less than the focal length of the mirror. For object distance 10 cm, mirrors of focal length
fb = 15 cm and fc = 20 cm can be used.

(c)





61. Given, focal length of the concave mirror, f = −12 cm Length of the flame, h = 1.5 cm Distance of flame from the mirror, u = -18 cm

(a) As, $\frac{1}{f}=\frac{1}{u}+\frac{1}{v}$

or $\frac{1}{v}=\frac{1}{f}-\frac{1}{u}=\frac{1}{-12}-\frac{1}{-18}=\frac{-3+2}{36}=\frac{-1}{36}$ or $v = -36$ cm

(b) Let h' be the length of the image.

$\because$ Magnification, $m = \frac{h'}{h}=\frac{-v}{u}$

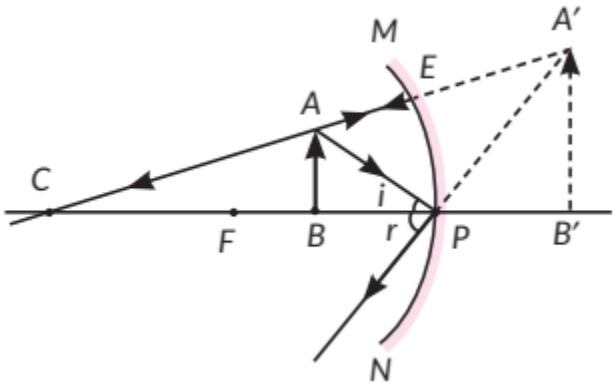
$\therefore$ $h' = \frac{-v\times h}{u}=\frac{-(-36)\times 1.5}{-18}=-3\,\text{cm}$

If the distance between the mirror and the flame is reduced to 10 cm, then

$$\frac{1}{v}=\frac{1}{f}-\frac{1}{u}=\frac{1}{-12}-\frac{1}{-10}=\frac{1}{60}$$

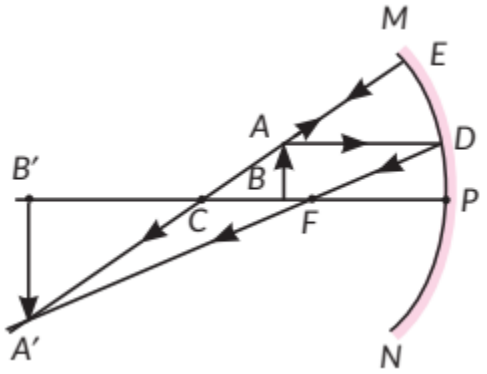
$\therefore \quad v = 60$ cm

Hence, image is formed behind the mirror.



62. (a) He should use concave mirror to get image of candle flame on the walls of school laboratory. Because concave mirror is a converging mirror and produce real image.
(b) He should place the candle flame in between centre of curvature C and principal focus F of the mirror to get the magnified image on the wall.

(c)



(d) Yes, he can use concave mirror to project a diminished image of the candle flame on the same wall. He has to place the candle flame beyond centre of curvature to get diminished image.

63. (a): As the focal length of a concave mirror and a concave lens is taken as negative, both are concave in nature.

64. (c): If the rays are travelling from far off distance and focussed on opposite side of the lens, this is only possible in convex lens.

65. (d): Here, medium A and C is same and B is glass. .. $n_1 = n_3 < n_2$

66. (c): The lens is convex and magnification is -3.

67. (c): Given, combined power = +1 D
Focal length of one lens, $f_1 = 20$ cm
Combined focal length, fcombined = 1 m = 100 cm

$$\frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2}\ ;\ \frac{1}{100}=\frac{1}{20}+\frac{1}{f_2}$$

Solving this equation, we get f_2 = -25 cm Focal length of other lens = -25 cm

68. (b): As the ray after passing XX' is diverging therefore, XX' is concave lens and image is formed between O and Y.

69. (c): Given, object height = 3.0 cm Let object distance is u and image distance is v. Case-1: u = -37.5 cm and v = 25 cm h = -2 cm (real and inverted)

From the lens formula, $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}=\frac{1}{25}-\left(-\frac{1}{37.5}\right)$

f = +15 cm

Case-2 : u = −25 cm, f = +15 cm (from (i))

By lens formula, $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$

$$\Rightarrow \frac{1}{15}=\frac{1}{v}-\left(-\frac{1}{25}\right)\Rightarrow v=+37.5\text{ cm}$$

Now, h_1 = 3 cm and h = ?

$\therefore$ Magnification, $m=\frac{v}{u}=\frac{h}{h_1}$

$$\therefore \quad \frac{+37.5}{-25}=\frac{h}{+3} \Rightarrow h=-4.5\text{ cm}$$

70. (c): Given, power of a lens = 4 D

$$\therefore \quad P=\frac{1}{f} \Rightarrow f=\frac{1}{P}=\frac{1}{4}=0.25 \text{ m}$$

Hence, given lens is convex lens of 0.25 m focal length.

71. (b): The image formed by of a concave lens is always virtual, diminished and erect.

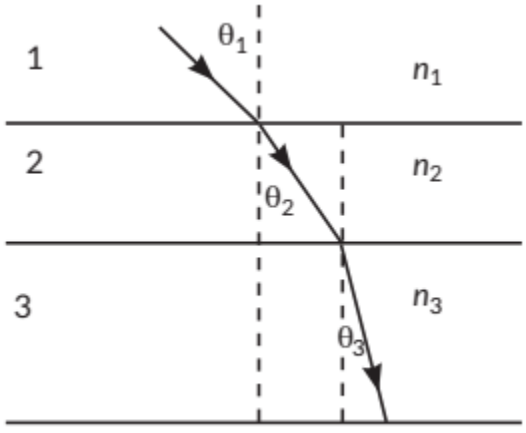
72. (b) As refractive index of a medium increases, more bending of light takes place. For AB, ratio of refractive indices of A and B is least, so least bending of light takes place for this pair of media.

Air
Medium A $\mu_A = 1.50$
Medium B $\mu_B = 1.33$
Medium C $\mu_C = 2.42$
Air

73. (c): In A, B and C transparent media, ≤1 > ≤2 as light bends towards the normal and 23 < 24 as light bends away from the normal. <3 = 2, because of alternate angles between two normals.

74.

(d):



In medium 2, the light ray bends towards the normal, so $n_2 > n_1$. Similarly, in medium 3, the light ray bends more towards the normal which indicate that refractive index of medium 3 is greater than medium 2. So, $n_3 > n_1$.

75. (d): Given, refractive index of medium A, $\mu A = 1.5$ Refractive index of medium B, $\mu B = 1.33$ Speed of light in air, $c = 3 \times 108$ m/s

$$\text{From, } \mu = \frac{\text{Speed of light in vacuum}}{\text{Speed of light in medium}} = \frac{c}{v}$$

$$\text{For medium } A,\ \mu_A = \frac{c}{v_A} \Rightarrow 1.5 = \frac{3\times10^8}{v_A} \text{m/s}$$

$$v_A = 2 \times 10^8 \text{ m/s}$$

$$\text{For medium } B,\ \mu_B = \frac{c}{v_B} \Rightarrow 1.33 = \frac{3\times10^8}{v_B} \text{m/s}$$

$$v_B = 2.25 \times 10^8 \text{ m/s}$$

Hence, speed of light in medium A is 2 x 108 m/s and in medium B is 2.25 x 108 m/s.

76. (c): The correct position of AB to obtain magnified image on screen is when the object is placed between 2F and F.

77. (b): As per the arrangement, an optical device to perform an experiment of light is likely to be a concave lens.

78. (c): Converging point, $f = 20$ cm Power $P = ?$ As we know that,

$$\text{Power of lens} = \frac{1}{\text{focal length (in m)}} \Rightarrow P = \frac{1}{f(\text{in m})}$$

$$P = \frac{100}{20} \Rightarrow P = +5 \text{ D}$$

Hence, power of convex lens is +5 D.

79. (d): Given, converging lens image is three times magnified, focal length, $f = 30$ cm. As we know, when a convex lens forms a magnified and real image, then the image is inverted i.e., magnification must be negative. Therefore,

magnification, m = -3

Using lens formula, $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$

we get, $\frac{v}{f}=1-m \Rightarrow \frac{v}{f}=1-(-3) \Rightarrow \frac{v}{30}=4 \Rightarrow v=120\,\text{cm}$

using, $m=\frac{v}{u} \Rightarrow -3=\frac{120}{u} \Rightarrow u = -40\ \text{cm}$

80. (c): The concave lens of very short focal length causes a higher divergence than the one with a longer focal length. So, assertion (A) is true. The power of lens is inversely proportional to its focal length. So, Reason (R) is false.

81. (c): The S.l. unit of power of lens is 'Dioptre. So, assertion (A) is true. The power of a concave lens is negative and that of a convex lens is positive. So, reason (R) is false.

82. It gives us the idea about the speed of light in the air and in the glass. It means that speed of light is 1.5 time more in air than the speed of light in the glass.

83. Power is the degree of convergence or divergence of light rays achieved by a lens. It is defined as the reciprocal of its focal length.

$i.e.,\ P=\frac{1}{f}$

84. Snell's law of refraction: The ratio of sine of angle of incidence to the sine of the angle of refraction is constant,

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

where i is the angle of incidence and r is the angle of refraction.
Let speed of light in air = c,
speed of light in medium = v

So, $\mu=\frac{c}{v}$.

85. Given, refractive index of air to glass = 1.50

Speed of light in the glass, $v = \frac{c}{n}$

Where, c = speed of light, n = refractive index

$$v = \frac{3 \times 10^8}{1.5} \Rightarrow v = 2 \times 10^8 \text{ m/s}$$

86. Given, object distance, u = − 15 cm
Focal length, f = + 20 cm
Using lens formula, As |u| < |f|
The object is placed between F and optical centre of lens. Thus, the four characteristics of the image formed by the convex lens are:
(i) Erect, (ii) Virtual, (iii) Enlarged image, (iv) Image is formed on the same side of the lens as the object.

87. Power is the degree of convergence or divergence of light rays achieved by a lens. It is defined as the reciprocal of its focal length.

$$i.e., P = \frac{1}{f}$$

Positive sign (+) of power indicates that lens is convex and negative sign (-) of power indicates that lens is concave. If focal length (f) is expressed in metres, then, power is expressed in dioptres. The SI unit of power is dioptre. Thus, 1 dioptre is the power of lens whose focal length is 1 metre. 1 D = 1m-1

88.

Given, ${}_an_g = \frac{3}{2}$, ${}_an_w = \frac{4}{3}$

Speed of light in glass, $v = 2 \times 10^8$ m/s

We know, ${}_an_g = \frac{\text{speed of light in air}}{\text{speed of light in medium}}$

$\Rightarrow \frac{3}{2} = \frac{c}{2\times10^8} \Rightarrow c = 3\times10^8$ m/s

Now, ${}_an_w = \frac{\text{speed of light in air}}{\text{speed of light in water}} \Rightarrow \frac{4}{3} = \frac{3\times10^8}{v}$

$\Rightarrow v = \frac{9}{4}\times10^8 \text{ m/s} = 2.25\times10^8 \text{ m/s}$

89.

Given that, $n_g = \frac{4}{3}$, $n_w = \frac{3}{2}$, $v_g = 2\times10^8$ m/s

Absolute refractive index of a medium, $n_m = \frac{c}{v}$

where, c is the speed of light in vacuum and v is the speed of light in medium.

(i) $\therefore n_g = \frac{c}{v_g}$

or $c = n_g \times v_g = \frac{4}{3}\times2\times10^8 = \frac{8}{3}\times10^8$ m/s

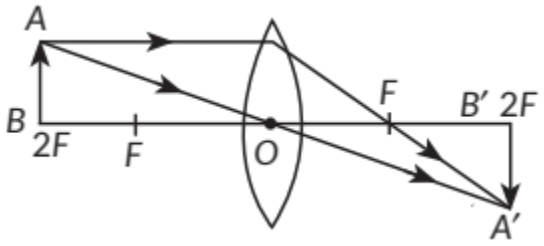
(ii) As, $n_{gw} = \frac{n_g}{n_w} = \frac{v_w}{v_g}$

$\therefore \frac{4/3}{3/2} = \frac{v_w}{2\times10^8}$ or $v_w = \frac{8}{9}\times2\times10^8 \Rightarrow v_w = \frac{16}{9}\times10^8$ m/s

90. Given: Power, P = +4 D Let focal length be f.

$P = \frac{100}{f(\text{cm})}$; $4 = \frac{100}{f(\text{cm})} \Rightarrow f = 25$ cm

Now, u = -50 cm, f = 25 cm
As the object is placed at 2F, so image is also formed at 2F and of same size as that of object. The image is real and inverted also.



u = -ve, v = +ve and f = +ve

91. Given: h = 10 cm, u = -25 cm, f = +15 cm

$$\frac{1}{f}=\frac{1}{v}-\frac{1}{u}\ ;\ \frac{1}{15}=\frac{1}{v}+\frac{1}{25}\ \Rightarrow\ \frac{1}{v}=\frac{1}{15}-\frac{1}{25}=\frac{5-3}{75}$$

$$v=\frac{75}{2}=37.5\,\text{cm}\ ;\ m=\frac{v}{u}=\frac{h_i}{h_o}$$

$$h_i=10\times\left(\frac{37.5}{-25}\right)=-15\,\text{cm}$$

Height of image = 15 cm, image distance = 37.5 cm

92. The ability of a lens to converge or diverge the rays of light is called power of lens. It is the reciprocal of focal length of lens.

$$P=\frac{1}{f\,(\text{cm})}=\frac{100}{f\,(\text{cm})}$$

Its SI unit is dioptre.

If $f = -10$ cm

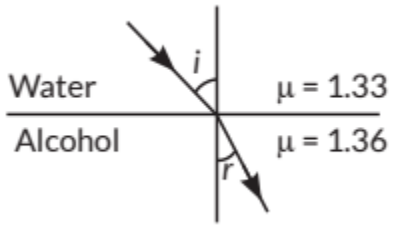
$$P=\frac{100}{f}=\frac{-100}{10}=-10\,\text{D}$$

So, lens is concave in nature.
u = -20 cm, f = -10 cm
As the object placed beyond F image is virtual and thus magnification is +ve.

93. (a) Here, alcohol is optically denser medium as its refractive index is higher than that of water. When we compare the two media, the one with

larger refractive index is called the optically denser medium than the other as the speed of light is lower in this medium.

(b) Since light is travelling from water (rarer medium) to alcohol (denser medium), it slows down and bends towards the normal. where i = angle of incidence and r = angle of refraction.



(c) According to Snell's law,

$$\frac{\sin i}{\sin r} = \frac{\mu_{alcohol}}{\mu_{water}} = \frac{1.36}{1.33} = 1.0225$$

$$\therefore \quad \sin i = 1.0225 \times \sin r$$

94. Given, refractive index of medium x with respect to y,

$$^{y}\mu_{x} = \frac{2}{3}$$

Refractive index of medium y with respect to z,

$$^{z}\mu_{y} = \frac{4}{3}$$

Refractive index of medium x with respect to z,

$$^{x}\mu_{z} = \frac{1}{^{z}\mu_{x}} = \frac{9}{8}$$

Now speed of light in x = 3 x 108 m/s Speed of light in y, vy = ?

$$\because \quad ^{y}\mu_{x} = \frac{\text{Speed of light in } y}{\text{Speed of light in } x} = \frac{v_y}{3\times10^{8}\ \text{m/s}}$$

$$\Rightarrow \quad v_y = \frac{2}{3}\times3\times10^{8} = 2\times10^{8}\ \text{m/s}$$

95. (a) We have used a converging lens.
(b) The characteristics of the image formed:
(i) It is real.
(ii) It is inverted
(iii) It is enlarged.
(c) We get the magnification of object, m = - 1 at the position 2F1.

96. Focal length of convex lens (f) = 20 cm Real image formed at a distance, (v) = 30 cm Height of image (h_1) = 4 cm Let the object distance be u.

$$\text{Lens formula, } \frac{1}{v}-\frac{1}{u}=\frac{1}{f} \Rightarrow \frac{1}{30}-\frac{1}{u}=\frac{1}{20} \text{ ; } u = -60 \text{ cm.}$$

$$\text{From, } m=-\frac{v}{u}=\frac{h_2}{h_1} \Rightarrow \frac{30}{60}=\frac{h_2}{4} \Rightarrow h_2 = 2 \text{ cm}$$

Hence, height of image of object is 2 cm.

97.

$$\text{Given, } h'=\frac{-2}{3}h, \; u=-12 \text{ cm}$$

$$\text{Magnification, } m=\frac{h'}{h}=\frac{v}{u}$$

$$\Rightarrow \; v=\frac{h'}{h}\times u=\frac{-\frac{2}{3}h}{h}\times(-12)=8 \text{ cm}$$

$$\text{Using lens formula, } \frac{1}{v}-\frac{1}{u}=\frac{1}{f}$$

$$\Rightarrow \; \frac{1}{f}=\frac{1}{8}-\frac{1}{-12}=\frac{3+2}{24} \Rightarrow f=4.8 \text{ cm}$$

Focal length of the convex lens = 4.8 cm

98. (a) Laws of refraction of light:
(i) The incident ray, the refracted ray and the normal to the interface of two transparent media at the point of incidence, all lie in the same plane.
(ii) The ratio of sine of angle of incidence to the sine of the angle of refraction is constant, for the light of a given colour and for the given pair of media. This law is also known as Snell's law of refraction.

$$\because \quad \frac{\sin i}{\sin r} = \text{constant},$$

where i is the angle of incidence and r is the angle of refraction. This constant value is called refractive index of the second medium with respect to the first when the light travels from first medium to second medium.

$$\Rightarrow \text{constant} = n_{21} = \frac{v_1}{v_2}$$

$$\therefore \frac{\sin i}{\sin r} = \frac{v_1}{v_2}$$

If n is the absolute refractive index of the medium, c is the velocity of light in vacuum and v is the speed of light in a given medium, then n = c/v.

99. Power is the degree of convergence or divergence of light rays achieved by a lens. It is defined as the reciprocal of its focal length.

$$i.e., \; P = \frac{1}{f}$$

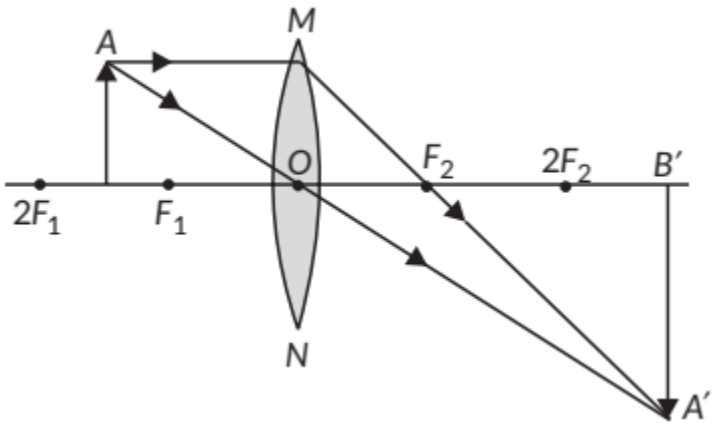
Positive sign (+) of power indicates that lens is convex and negative sign (-) of power indicates that lens is concave. If focal length (f) is expressed in metres, then, power is expressed in dioptres. The SI unit of power is dioptre. Thus, 1 dioptre is the power of lens whose focal length is
1 metre. 1 D = $1m^{-1}$
Given that, Focal length of lens A, $f_1 = +40$ cm
Focal length of lens B, fg = -20 cm
Lens A is converging. Lens B is diverging.

$$\text{Power of lens } A = \frac{100}{f_A (\text{in cm})} = \frac{100}{40} = +2.5\,\text{D}$$

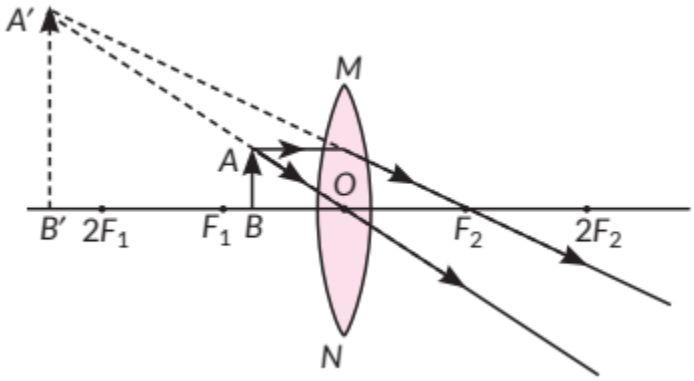
$$\text{Power of lens } B = \frac{100}{f_B (\text{in cm})} = \frac{100}{-20} = -5\,\text{D}$$

100.

(a)



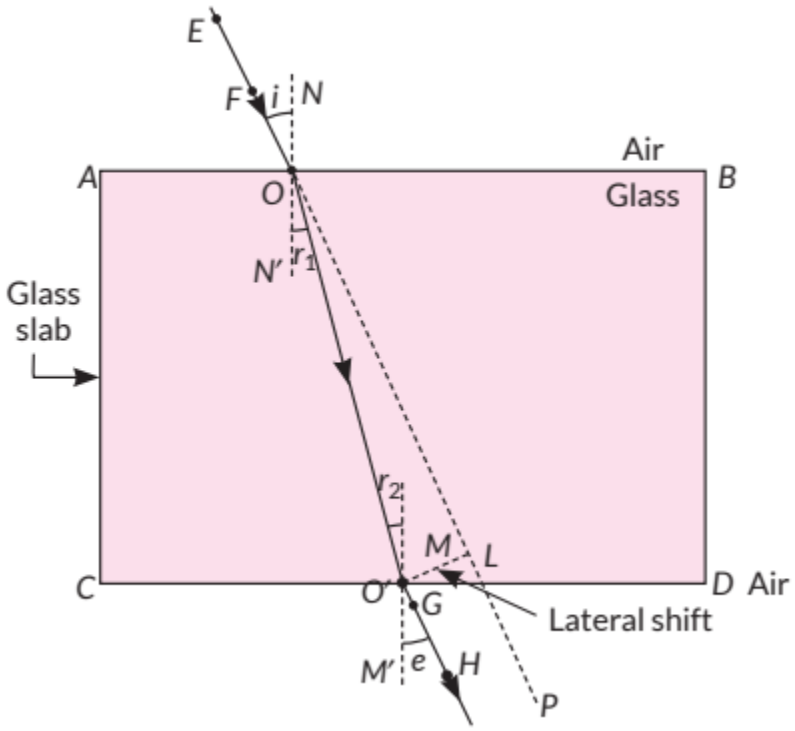
(b) Ray diagrams of an object placed between F_1 and optical centre O of lens can be drawn as follows:



(i) The image formed is virtual and erect.
(ii) Image is formed in front of the lens.
(iii) Image formed is enlarged.

101.

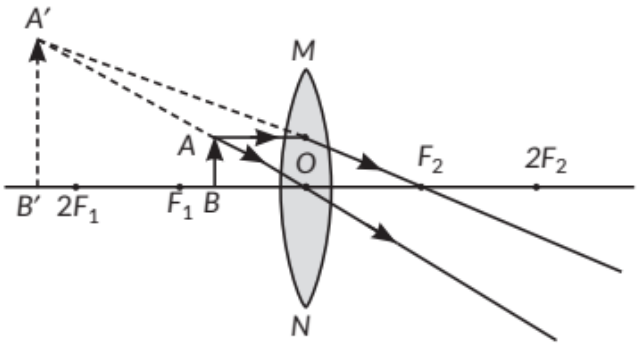
(a)



(b) Refractive index of glass w.r.t air is, ${}_gn_a = \frac{3}{2}$

$${}_an_g = \frac{1}{{}_gn_a} = \frac{1}{(3/2)} = \frac{2}{3}$$

102.Magnification of -1 indicates that the image is real and inverted and is of the same size as of the object. The object must be at 2f and image also at 2f on the other side. Total distance between image and object Also, 4f = 60 cm ⇒ f = 15 cm If object is moved 20 cm towards the lens, then the object will be between focus and optical centre of the lens and image formed will be virtual and erect and on the same side of the lens.



103. (a) Distance between the optical centre and the focus of the lens is known as the focal length of the lens.
(b) Given, f= - 30 cm, v = - 15 cm, h = 5 cm From the lens formula,

$$\frac{1}{v}-\frac{1}{u}=\frac{1}{f} \Rightarrow \frac{-1}{15}-\frac{1}{u}=\frac{-1}{30}$$

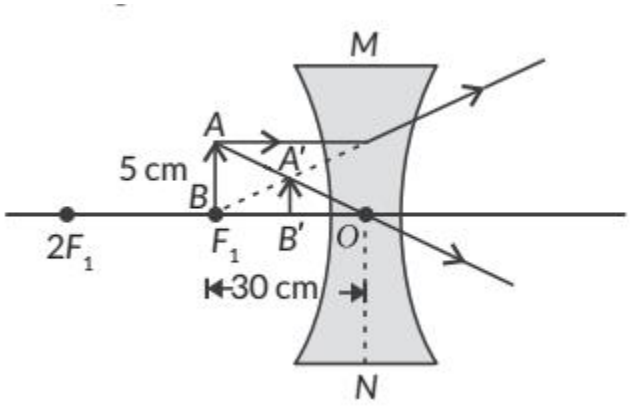
$$\Rightarrow \frac{-1}{u}=\frac{-1}{30}+\frac{1}{15}=\frac{-1+2}{30}=\frac{1}{30} \Rightarrow u=-30\,\text{cm}$$

Object should be placed 30 cm from the optical centre.

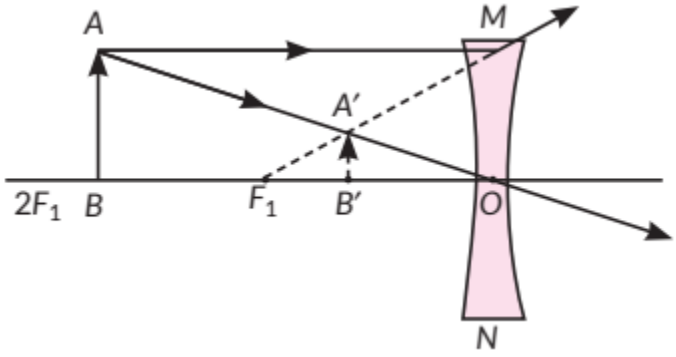
$$\text{Also } m=\frac{h'}{h}=\frac{v}{u} \Rightarrow h'=h\left(\frac{v}{u}\right) \text{ or } h'=5\times\frac{-15}{-30}=2.5\,\text{cm}$$

Size of image formed is 2.5 cm

(c)



104. Concave lens always forms virtual, erect and diminished image for all positions of the object.



Focal length of the concave lens, $f = -20$ cm $= \frac{-20}{100}$ m

Power of the lens, $P = \frac{1}{f(\text{in m})} = \frac{-100}{20\,\text{m}} = -5\text{D}$

105. Laws of refraction of light:
(i) The incident ray, the refracted ray and the normal to the interface of two transparent media at the point of incidence, all lie in the same plane.
(ii) The ratio of sine of angle of incidence to the sine of the angle of refraction is constant, for the light of a given colour and for the given pair of media. This law is also known as Snell's law of refraction.

$$\because \quad \frac{\sin i}{\sin r} = \text{constant},$$

where i is the angle of incidence and r is the angle of refraction. This constant value is called refractive index of the second medium with respect to the first when the light travels from first medium to second medium.

$$\Rightarrow \text{constant} = n_{21} = \frac{v_1}{v_2} \quad \therefore \quad \frac{\sin i}{\sin r} = \frac{v_1}{v_2}$$

If n is the absolute refractive index of the medium, c is the velocity of light in vacuum and v is the speed of light in a given medium, then n = c/v.

The speed of light in vacuum = 3×10^8 m/s
The speed of light in medium = 1.4×10^8 m/s
$\therefore$ Absolute refractive index

$$= \frac{\text{Speed of light in vacuum}}{\text{Speed of light in medium}};\ n = \frac{3 \times 10^8\ \text{m/s}}{1.4 \times 10^8\ \text{m/s}} = 2.14$$

106. Laws of refraction of light:
(i) The incident ray, the refracted ray and the normal to the interface of two transparent media at the point of incidence, all lie in the same plane.
(ii) The ratio of sine of angle of incidence to the sine of the angle of refraction is constant, for the light of a given colour and for the given pair of media. This law is also known as Snell's law of refraction.

$$\because \quad \frac{\sin i}{\sin r} = \text{constant},$$

where i is the angle of incidence and r is the angle of refraction. This constant value is called refractive index of the second medium with respect to the first when the light travels from first medium to second medium.

$$\Rightarrow \text{constant} = n_{21} = \frac{v_1}{v_2} \quad \therefore \quad \frac{\sin i}{\sin r} = \frac{v_1}{v_2}$$

If n is the absolute refractive index of the medium, c is the velocity of light in vacuum and v is the speed of light in a given medium, then n = c/v.

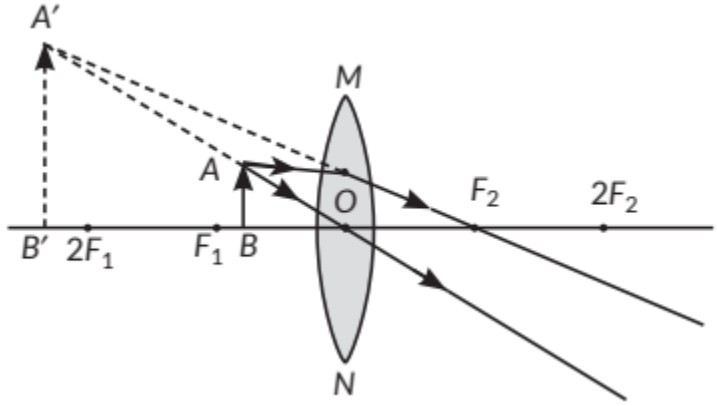
The speed of light in vacuum = 3 × 10^8 m/s
Absolute refractive index = 1.5
.. The speed of light in a medium

$$= \frac{\text{Speed of light in vacuum}}{\text{Absolute refractive index}} = \frac{3 \times 10^8 \text{ m/s}}{1.5} = 2 \times 10^8 \text{ m/s}$$

107. Given, u = -40 cm, v = 40 cm

$$\frac{1}{f} = \frac{1}{40} + \frac{1}{40} = \frac{2}{40} \quad \Rightarrow f = 20 \text{ cm}$$

Type of lens: Convex lens
Focal length = 20 cm
Nature of the image will be virtual and erect if the candle flame is shifted 25 cm towards the lens.



108. (i) Given: refractive index μd = 2.42, speed of light c = 3 x 10^8 m/s

$$\text{As, } \mu_d = \frac{c}{v};\ v = \frac{3\times10^8}{2.42} = 1.239\times10^8 \approx 1.24\times10^8 \text{ m/s}$$

(ii) Given: μg = 1.5, μw = 1.33, μcs_2' 1.62

$$\text{According to Snell's law, } \mu = \frac{\sin i}{\sin r}$$

$$\sin r \propto \frac{1}{\mu}$$

So, here, μcs,< μg < μw
So, rcs_2, >rg> rw
(iii) Given: vg = 2 × 10^8 m/s, Vw = 2.25 × 108 m/s
(a) The medium in which the speed is maximum, it is rarer and minimum it is denser. So, glass is denser than water.
(b) A water is rarer than glass, so when a ray of light travels from rarer medium to denser medium, the ray bends towards the normal.

OR

(iii) Given : $\mu_w = \frac{4}{3}, \mu_g = \frac{3}{2}$

$v_g = 2 \times 10^8$ m/s

(i) $\mu_g = \frac{c}{v_g} \Rightarrow c = \frac{3}{2}\times2\times10^8 \text{ m/s};\ c = 3 \times 10^8$ m/s

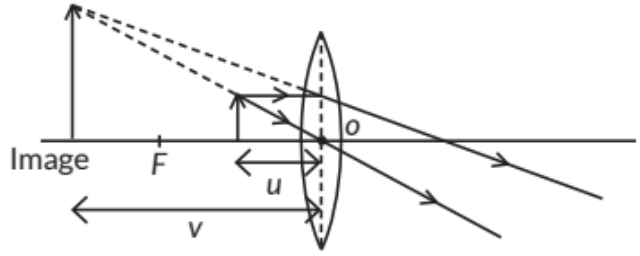
(ii) $v_w = \frac{3\times10^8\times3}{4} = 2.25\times10^8$ m/s

109. (a) Given: P_1 = 4 D, P_2 = -2 D
P=P_1+P_2 = 4D-2D
So the lens is convergent in nature.
(b) P= -2.5 D

$$P = \frac{100}{f\,(\text{cm})} \Rightarrow -2.5 = \frac{100}{f\,(\text{cm})} \Rightarrow f = -40\ \text{cm}$$

(c) $P = 0.1$ D, $u = -20$ cm

$$P = \frac{100}{f(\text{cm})} \Rightarrow 0.1 = \frac{100}{f} \Rightarrow f = 1000\ \text{cm}$$



As object placed between focus and optical centre, so image is virtual, erect and magnified and behind the lens.

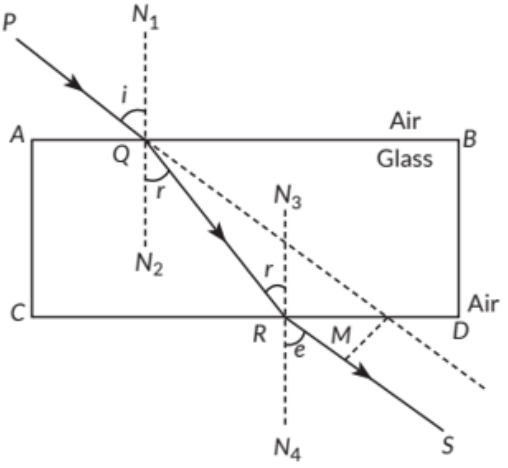
OR

(c) The virtual image formed by convex lens is enlarged and beyond the focus but the virtual image formed by the concave lens is smaller in size and between focus and optical centre. Convex lens forms a virtual image when object placed between focus and optical centre. Concave lens always forms a virtual image irrespective to the position of object.

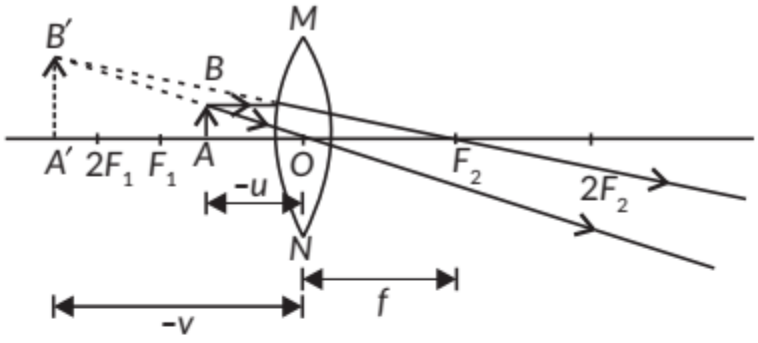
110. (a) According to Snell's law of refraction, the product of refractive index of sine of angle of incidence at a point in a medium is constant. It implies that when light travels from medium 1 to medium 2, then

$n_1 \sin i = n_2 \sin r$

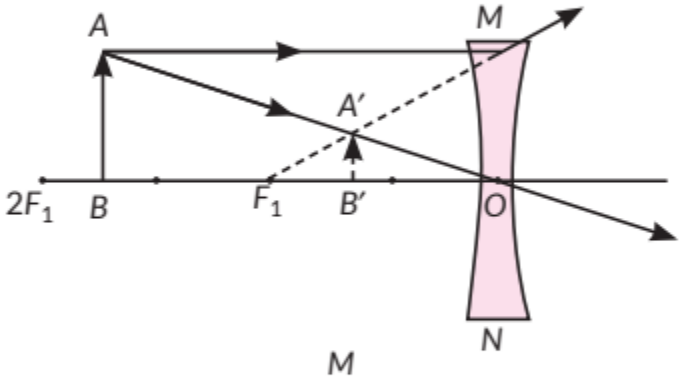
$$\frac{\sin i}{\sin r} = \frac{n_2}{n_1} = 1n_2$$



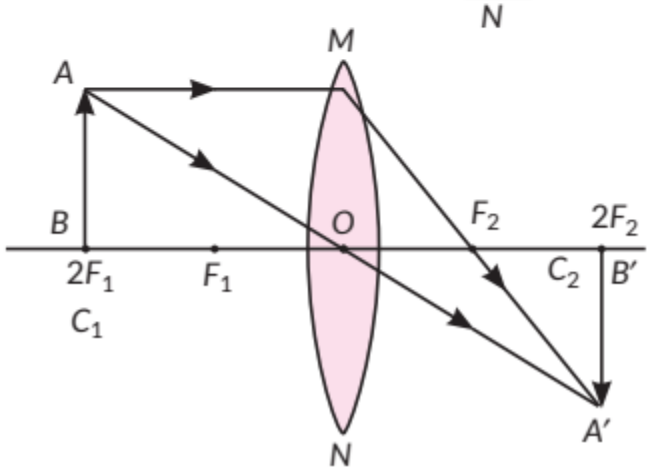
111. (i) When an object is placed between F_1 and optical centre, O of a convex lens, it forms a virtual and erect image. The ray diagram for this situation can be drawn as follows:



(ii)



(iii)



In case (i), the magnification, m is given by,

$$m = \frac{v}{u} = \frac{-v}{-u} = \text{positive}$$

i.e., the image formed virtual and erect.

In case (ii), the magnification, $m = \frac{v}{u} = \frac{-v}{-u} =$ positive

i.e., the image formed is virtual and erect.

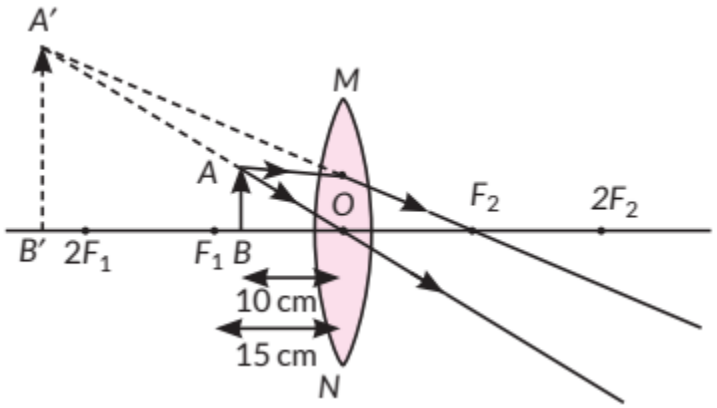
112. (a) (i) Power is the degree of convergence or divergence of light rays achieved by a lens. It is defined as the reciprocal of its focal length.

$$i.e., \; P = \frac{1}{f}$$

(ii) Principal focus : Incident rays parallel to principal axis, after reflection either converge to as appear to diverge from a fixed point on the principal axis known as principal focus of the spherical mirror.
(b) (i) For a spherical lens, according to lens formula,

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

where f is the focal length of the mirror, v is the image distance and u is the object distance.
(c) Given focal length,
f = +15 cm (convex lens) and u = -10 cm



113. (i) The lens used here is a convex lens and it is used as a magnifying glass because at close range, i.e., when the object is placed between optical centre and principal focus it forms an enlarged, virtual and erect image of the object.
(ii) When this lens is placed such that the object is between the centre of curvature and the principal focus, the palmist obtain a real and magnified

image.
(iii) Given, focal length, f = 10 cm and u = -5 cm According to lens formula,

$$\frac{1}{f}=\frac{1}{v}-\frac{1}{u} \text{ or } \frac{1}{v}=\frac{1}{f}+\frac{1}{u} \text{ or } \frac{1}{v}=\frac{1}{10}+\frac{1}{-5}=\frac{-5+10}{-50}$$

$$\therefore \quad v=\frac{-50}{5}=-10 \text{ cm}$$

Thus, the image will be formed at 10 cm on the same side of the palm and the size of the image will be enlarged.

114.(i) Given, f = -30 cm, u = −60 cm, v = ?

Using lens formula, $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$ or $\frac{1}{v}=\frac{1}{f}+\frac{1}{u}$

$$\frac{1}{v}=\frac{1}{-30}-\frac{1}{60}=-\frac{3}{60} \Rightarrow v=-20 \text{ cm}$$

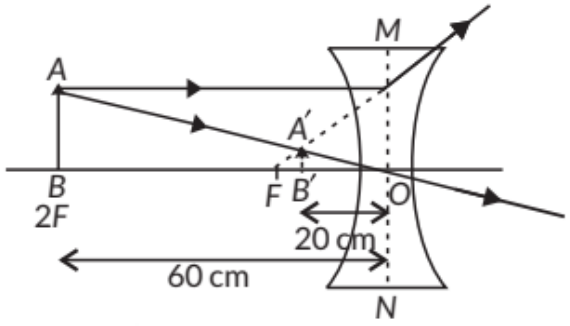
(ii) (a) The image is virtual in nature.
(b) The image is formed at a distance of 20 cm on the left from the concave lens.

(c) Magnification, $m=\frac{v}{u}$. Here, v = – 20 cm; u = – 60 cm

So, $m=\frac{20}{60}=\frac{1}{3}=+0.3$

Since, value of magnification is less than 1, therefore the image is diminished.
(d) The plus sign for the magnification shows that the image is erect.

(iii)



115. (a) Given, h = 5 cm, f = 20 cm, u = -30 cm

Using lens formula, $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$

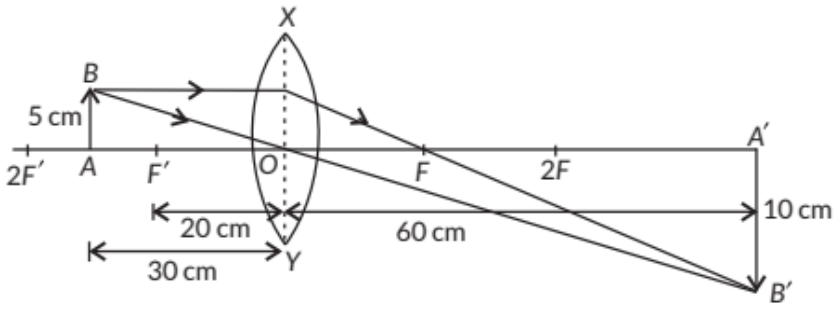
$$\frac{1}{v}=\frac{1}{u}+\frac{1}{f}=\frac{1}{-30}+\frac{1}{20}=\frac{-2+3}{60}=\frac{1}{60} \Rightarrow v=60\text{ cm}$$

Now, magnification,

$$m=\frac{h'}{h}=\frac{v}{u} \Rightarrow h'=\frac{v}{u}\times h=\frac{60}{-30}\times 5=-10\text{ cm}$$

Hence, the image formed at 60 cm, which is real and magnified.

(b)



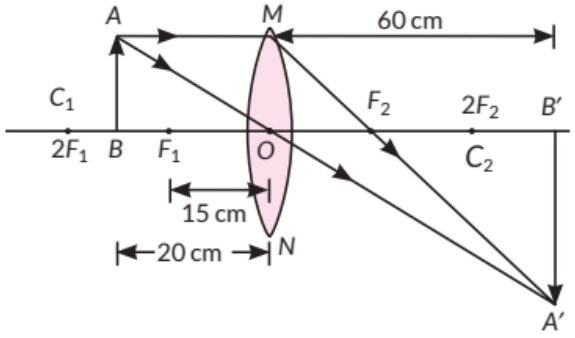
116. (a) When an object placed at 2F from a convex lens, then its image is formed on the other side of the lens at the same distance from the lens. Thus from S. No.(3) we can say that.

$$\therefore \quad f=v/2 \Rightarrow f=\frac{30}{2}=+15\text{ cm}$$

Thus, the focal length is + 15 cm.

(b) In this case S.No. (6) is incorrect as the object distance is between focus and pole, for such case, the image formed is virtual and on the same side as the object, hence image distance is negative.

(c) The approximate value of magnification for object distance -20 cm and image distance + 60 cm is -3.

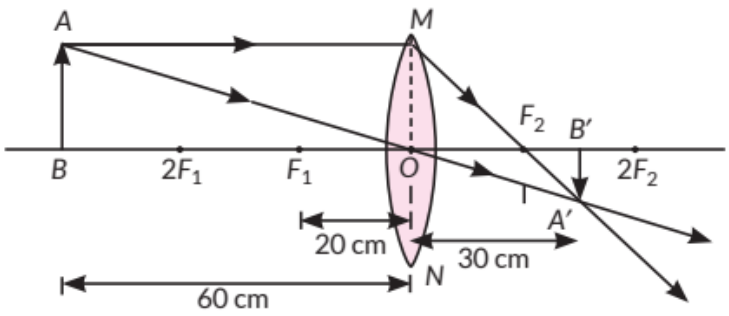


117. (a) When an object is placed at 2F from the convex lens, then its image is formed on the other side of the lens at the same distance from the lens. Thus from S.No. (3), we can say that

$$\therefore \quad f = \frac{v}{2} = \frac{40}{2} = 20\,\text{cm}$$

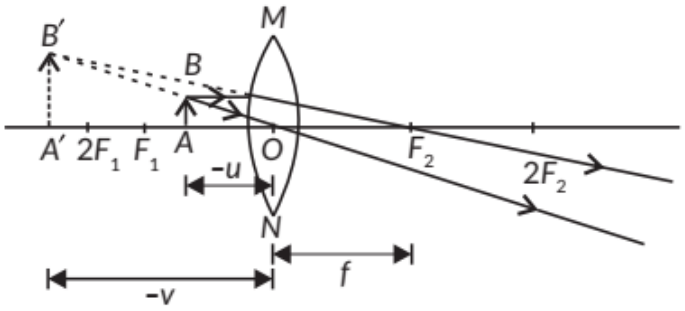
(b) In this case, S. No. (6) is incorrect as the object distance is between focus and optical centre for such cases, the image formed is virtual and image distance is negative.

(c)



The approximate value of magnification for object distance -60 cm and image distance +30 cm is -1/2.

118. (a) When an object is placed between F_1 and optical centre, O of a convex lens, it forms a virtual and erect image. The ray diagram for this situation can be drawn as follows:



(b) The lens formula is given as

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

(c) Magnification of the lens is given by

$$m=\frac{v}{u} \quad \Rightarrow \quad -1=\frac{v}{-20} \quad [\because u=-20\,\text{cm}]$$

v = 20 cm

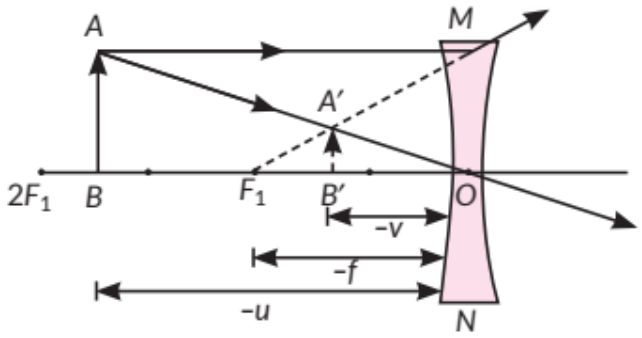
As $v = u$ then

$$\therefore \quad f=\frac{20}{2}\text{cm} = 10\text{ cm} = 0.1\text{ m}$$

$$\text{Power of the lens, } P=\frac{1}{f(\text{in m})}\text{D}=\frac{1}{0.1}\text{D}=10\,\text{D}$$

119.

(a)



(b) The lens formula is given by, $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$

(c) Since, the nature of the image is real and inverted therefore the lens is convex. Now magnification of the lens is

$$m=\frac{v}{u} \quad \Rightarrow \quad -1=\frac{v}{u} \quad \Rightarrow \quad v=-u$$

Now, from lens formula, $\frac{1}{v}-\frac{1}{u}=\frac{1}{f} \Rightarrow \frac{1}{40}-\frac{1}{(-40)}=\frac{1}{f}$

$\Rightarrow \quad f = 20\text{ cm} \Rightarrow \quad f = 0.2\text{ m}$

$$\text{Power of the lens, } P=\frac{1}{f(\text{in m})}=\frac{1}{0.2\,\text{m}}=5\,\text{D}$$

120. (a) Optical centre is the central part of the lens through which a ray of light passes without suffering any deviation. It is usually represented by the letter O.

(b) Given : $f = -20$ cm, $h = 4$ cm, $v = -10$ cm

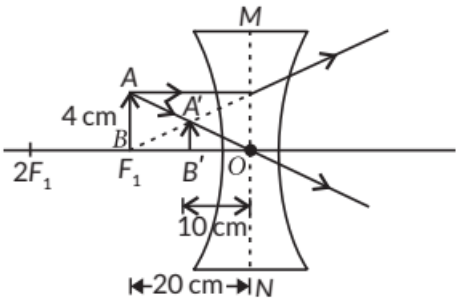
From lens formula, $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{-10} - \frac{1}{u} = \frac{1}{(-20)} \Rightarrow \frac{1}{u} = \frac{-1}{10} + \frac{1}{20} \Rightarrow u = -20\,\text{cm}$$

Also, magnification of the lens,

$$m = \frac{h'}{h} = \frac{v}{u} \Rightarrow h' = \frac{10}{20} \times 4 \Rightarrow h' = 2\,\text{cm}$$

(c)



121. (a) Distance between the principal focus and the optical centre is known as the focal length of the lens.

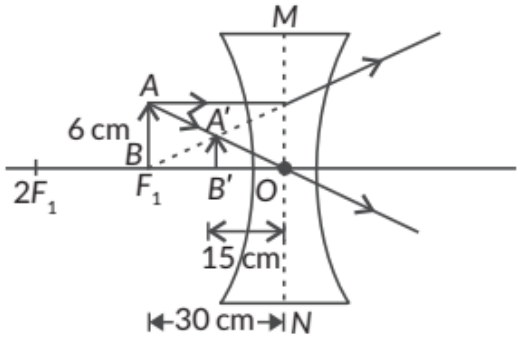
(b) Given, f = -30 cm, v = -15 cm, h = 6 cm

Now, from lens formula, $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow \frac{-1}{30} = \frac{-1}{15} - \frac{1}{u}$

$$\frac{1}{u} = \frac{-1}{15} + \frac{1}{30} \Rightarrow u = -30\,\text{cm}$$

$$m = \frac{h'}{h} = \frac{v}{u} \Rightarrow h' = \left(\frac{v}{u}\right)h \Rightarrow h' = \frac{-15}{-30} \times 6\,\text{cm} = 3\,\text{cm}$$

(c)



122. Focal length of concave lens, f = -20 cm

Height of the object, h = 6 cm

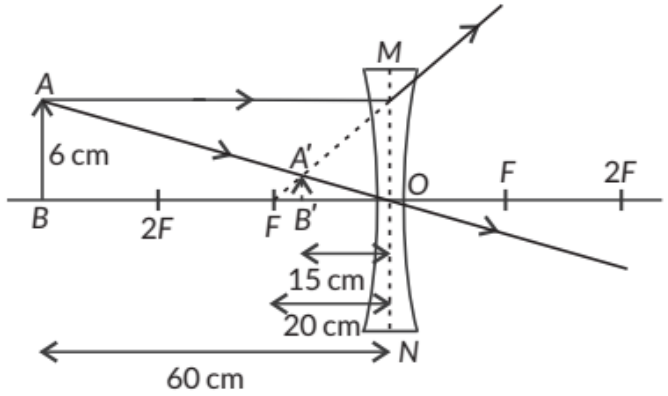
Image distance, v = -15 cm

From lens formula, $\frac{1}{v}-\frac{1}{u}=\frac{1}{f} \Rightarrow \frac{1}{-15}-\frac{1}{u}=\frac{1}{-20}$

$\Rightarrow \quad -\frac{1}{u}=-\frac{1}{20}+\frac{1}{15}=\frac{1}{60} \quad \Rightarrow \quad u=-60\,\text{cm}$

Magnification, $m=\frac{h'}{h}=\frac{v}{u}$

$\Rightarrow \quad h'=h\left(\frac{v}{u}\right)=6\times\left(\frac{-15}{-60}\right)=\frac{3}{2}\,\text{cm} \Rightarrow h' = 1.5\ \text{cm}$



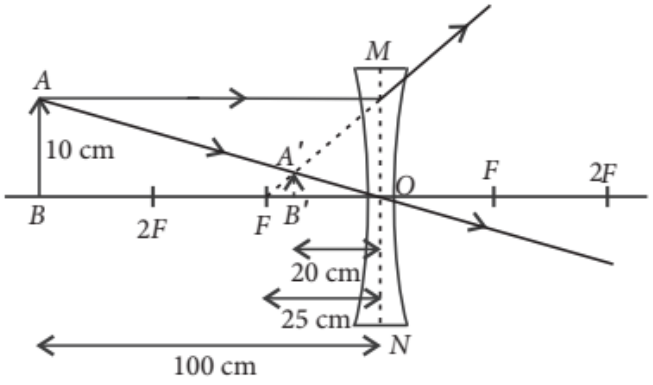
123. Focal length of concave lens, f = − 25 cm
Image distance, v = -20 cm
Height of the object, h = 10 cm Now, from lens formula,

$$\frac{1}{v}-\frac{1}{u}=\frac{1}{f} \Rightarrow -\frac{1}{20}-\frac{1}{u}=-\frac{1}{25} \Rightarrow -\frac{1}{u}=-\frac{1}{25}+\frac{1}{20}$$

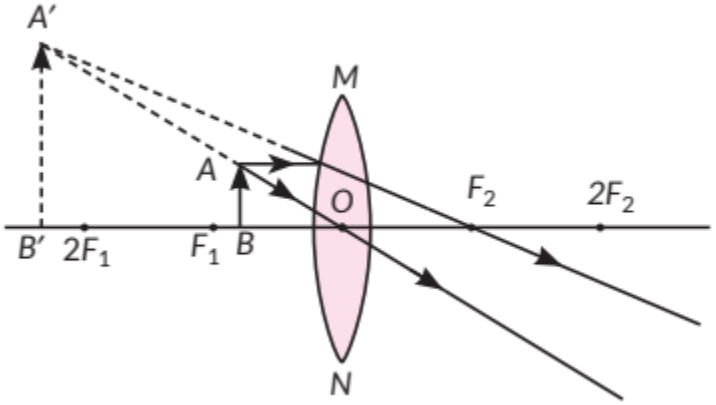
$$=-\frac{1}{u}=\frac{-4+5}{100} \Rightarrow u=-100\,\text{cm}$$

Also, magnification, $m=\frac{v}{u}=\frac{h'}{h}$

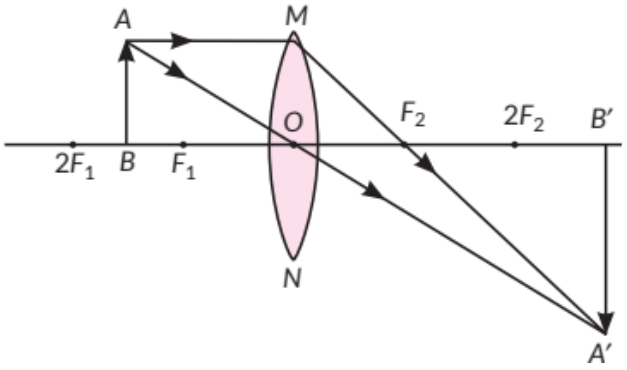
$$\Rightarrow h'=h\left(\frac{v}{u}\right)=10\left(\frac{-20}{-100}\right)=2\,\text{cm}$$



124. Magnified erect image:



Magnified inverted image:



Given that h = 4 cm, u = -20 cm, f = -10 cm

Lens formula, $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$ $\therefore$ $\frac{1}{v}-\frac{1}{(-20)}=\frac{1}{(-10)}$

or $\frac{1}{v}=\frac{-1}{10}-\frac{1}{20}=\frac{-2-1}{20}=\frac{-3}{20}$ or $v=\frac{-20}{3}$ cm

125. Given that u = -30 cm, v = 60 cm, h = 3 cm

Lens Formula, $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$

$\therefore$ $\frac{1}{60}-\frac{1}{(-30)}=\frac{1}{f}$ $\Rightarrow$ $\frac{1+2}{60}=\frac{1}{f}=\frac{3}{60}=\frac{1}{20}$ or f = 20 cm

As focal length is positive, hence lens is convex lens.

Magnification, $m=\frac{v}{u}=\frac{h'}{h}$

$\therefore$ $\frac{60}{-30}=\frac{h'}{3}$ or $h'=\frac{-60\times3}{30}=-6$ cm

The height of image is 6 cm and negative sign shows that the image is real and inverted.

126. (a) Laws of refraction of light:
(i) The incident ray, the refracted ray and the normal to the interface of two transparent media at the point of incidence, all lie in the same plane.
(ii) The ratio of sine of angle of incidence to the sine of the angle of refraction is constant, for the light of a given colour and for the given pair of media. This law is also known as Snell's law of refraction.

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

where i is the angle of incidence and r is the angle of refraction. This constant value is called refractive index of the second medium with respect to the first when the light travels from first medium to second medium.

$$\Rightarrow \text{constant} = n_{21} = \frac{v_1}{v_2} \quad \therefore \quad \frac{\sin i}{\sin r} = \frac{v_1}{v_2}$$

If n is the absolute refractive index of the medium, c is the velocity of light in vacuum and v is the speed of light in a given medium, then n = c/v.

(b) Given that $nA = 2.0$, $n_B = 1.5$, $V_B = 2 \times 10^8$ m/s

(i) $n_B = \frac{c}{v_B}$, where c is the speed of light in vacuum

$$1.5 = \frac{c}{2 \times 10^8} \text{ or } c = 1.5 \times 2 \times 10^8 = 3 \times 10^8 \text{ m/s}$$

(ii) $n_{AB} = \frac{n_A}{n_B} = \frac{v_B}{v_A}$

$$\therefore \quad \frac{2.0}{1.5} = \frac{2 \times 10^8}{v_A} \quad \text{or} \quad v_A = 1.5 \times 10^8 \text{ m/s}$$

127. Power is the degree of convergence or divergence of light rays achieved by a lens. It is defined as the reciprocal of its focal length.

$$i.e., \; P = \frac{1}{f}$$

Positive sign (+) of power indicates that lens is convex and negative sign (-) of power indicates that lens is concave. If focal length (f) is expressed in metres, then, power is expressed in dioptres. The SI unit of power is dioptre.

Thus, 1 dioptre is the power of lens whose focal length is

1 metre. $1\ D = 1m^{21}$

Given that,

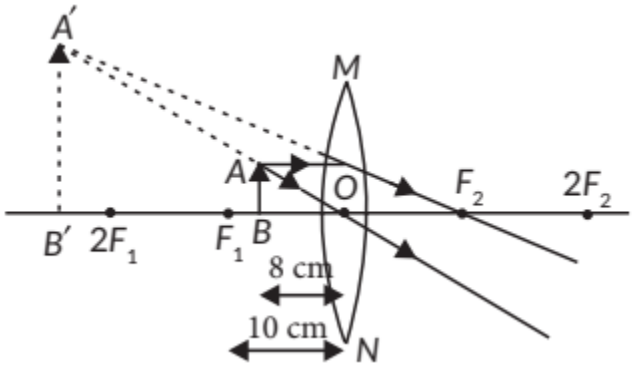
Focal length of lens f_A, $f_A = +10$ cm

Focal length of lens B, fg = -10 cm
Lens A is convex lens and Lens B is concave lens,

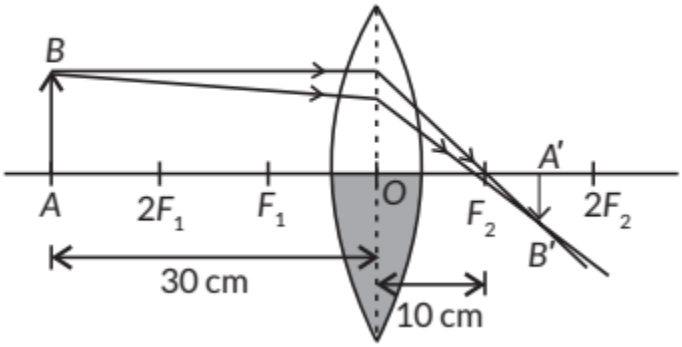
$$\text{Power of lens } A = \frac{100}{f_A(\text{in cm})} = \frac{100}{10} = +10\,\text{D}$$

$$\text{Power of lens } B = \frac{100}{f_B(\text{in cm})} = \frac{100}{-10} = -10\,\text{D}$$

Lens A will form a virtual and magnified image.



128. Yes, the lens will produce an image of complete object.



Given that h = 4 cm, f = 20 cm, u = −15 cm

$$\text{Lens formula: } \frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\therefore \frac{1}{v} - \frac{1}{(-15)} = \frac{1}{20} \text{ or } \frac{1}{v} = \frac{1}{20} - \frac{1}{15} = \frac{-1}{60} \Rightarrow v = -60 \text{ cm}$$

$$\text{Magnification, } m = \frac{v}{u} = \frac{-60}{-15} = 4$$

129. Power is the degree of convergence or divergence of light rays achieved by a lens. It is defined as the reciprocal of its focal length.

$$i.e.,\ P=\frac{1}{f}$$

Positive sign (+) of power indicates that lens is convex and negative sign (-) of power indicates that lens is concave. If focal length (f) is expressed in metres, then, power is expressed in dioptres. The SI unit of power is dioptre. Thus, 1 dioptre is the power of lens whose focal length is 1 metre. 1 D = $1m^{-1}$ Convex lens has positive power. Since the image of an object formed by a lens is real, inverted and of the same size as the object. Given, Size of object = Size of image and h′ = -h

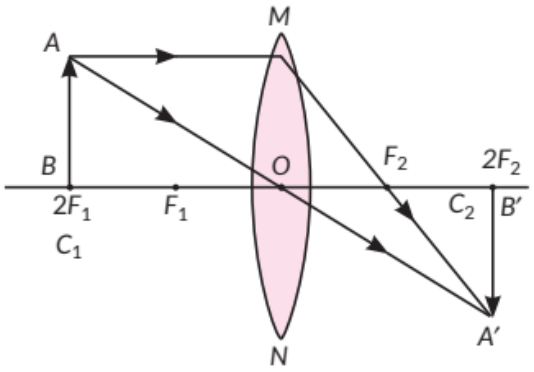
$$\therefore \quad \text{Magnification, } m = \frac{h'}{h}=\frac{-h}{h}=-1$$

$$\therefore \quad -1=\frac{v}{u} \quad \text{or} \quad v=-u$$

$$\text{Focal length of the lens, } \frac{1}{f}=\frac{1}{v}-\frac{1}{u} \Rightarrow \frac{1}{f}=\frac{1}{40}-\frac{1}{-40}=\frac{2}{40}$$

$$\therefore \quad f=20\,\text{cm}=\frac{20}{100}\ \text{m}$$

$$\text{Power of the lens, } P=\frac{1}{f(\text{in m})}=\frac{100}{20}\text{D}=5\text{D}$$



130. (a) (i) Optical centre: The centre point of a lens is known as the optical centre. It always lies inside the lens. A light beam passing through the optical centre without any deviation.

(ii) Centre of curvature: It is defined as the centre of the sphere of which the lens is originally a part of. Since, the spherical lens consists of two spherical surfaces, the lens has two centre of curvature.

(iii) Principal axis: A straight line passing through the optical centre and principal focus of a spherical lens. This line is called the principal axis.
(iv) Aperture: The diameter of the reflecting surface of spherical lens is called its aperture.
(v) Principal focus: A number of rays parallel to the principal axis are falling on a lens. These rays, after refraction from the lens, are appearing to converge to or diverge from a point on the principal axis. This point on the principal axis is called the principal focus of the lens.
(vi) Focal length: The distance between the optical centre and the principal focus of a spherical lens is called the focal length. It is represented by the letter f.

(b) Given, f = 12 cm, v = 48 cm, u = ?

Using lens formula, $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$; $\frac{1}{12}=\frac{1}{u}+\frac{1}{48}$ or $\frac{1}{12}-\frac{1}{48}=\frac{1}{u}$

$\Rightarrow \quad \frac{4-1}{48}=\frac{1}{u}=\frac{3}{48}$ or u = 16 cm

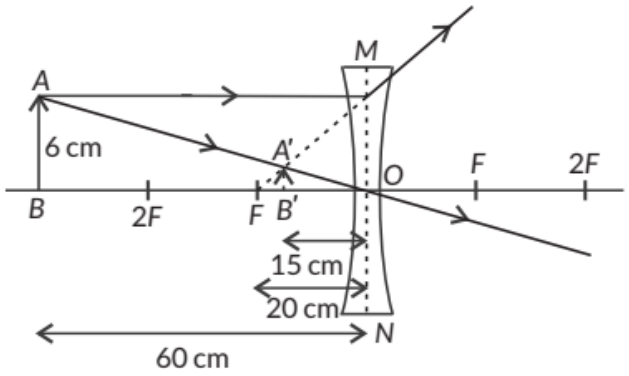
131.(i) Optical centre: The centre point of a lens is known as the optical centre. It always lies inside the lens. A light beam passing through the optical centre without any deviation.
(ii) Focal length of concave lens, f = -20 cm
Height of the object, h = 6 cm
Image distance, v = -15 cm

From lens formula, $\frac{1}{v}-\frac{1}{u}=\frac{1}{f} \Rightarrow \frac{1}{-15}-\frac{1}{u}=\frac{1}{-20}$

$\Rightarrow \quad -\frac{1}{u}=-\frac{1}{20}+\frac{1}{15}=\frac{1}{60} \quad \Rightarrow \quad u=-60\,\text{cm}$

Magnification, $m=\frac{h'}{h}=\frac{v}{u}$

$\Rightarrow \quad h'=h\left(\frac{v}{u}\right)=6\times\left(\frac{-15}{-60}\right)=\frac{3}{2}\,\text{cm} \Rightarrow h'$ = 1.5 cm



132. Power is the degree of convergence or divergence of light rays achieved by a lens. It is defined as the reciprocal of its focal length.

i.e., $P=\frac{1}{f}$

Positive sign (+) of power indicates that lens is convex and negative sign (-) of power indicates that lens is concave. If focal length (f) is expressed in metres, then, power is expressed in dioptres. The SI unit of power is dioptre. Thus, 1 dioptre is the power of lens whose focal length is 1 metre. 1 D = 1 m^{-1} A convex lens has the focal length +50 cm.

$\therefore \text{ power}=\frac{1}{f}=\frac{+100}{50}=+2\,\text{D}$

A concave lens has the focal length −50 cm.

$\therefore \text{ power}=\frac{1}{f}=\frac{-100}{50}=-2\,\text{D}$

Concave lens always gives a virtual, erect and diminished image irrespective of the position of the object.

CBSE Sample Questions

1. (c): Concave mirror is used by a dentist to examine a small cavity in a patient's teeth. (0.80)

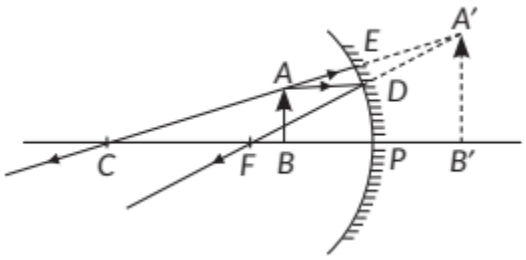
2. (b): It is clear from the figure, the mirror has a focal length of -3 cm as the object has been placed at distance 2F, so the image produced will be of magnification -1. (0.80)

3. (a): Rays from sun converge at a point 15 cm in front of the mirror, so f = -15 cm. For a concave mirror, magnification is unity if the object is placed at distance 2f. So, the object must be placed at 30 cm in front of the mirror. (0.80)

4. (c): For a concave mirror, focal length is negative. In the given case, as the object has been placed at centre of curvature so the image formed will be real, inverted at centre of curvature. (0.80)

5. The given object must be in between the principal focus and the centre of curvature. (1)
(a) The object has to be placed at a distance between 0 - 40 cm. This is because image is virtual, erect and magnified when the object is placed between F and P. (1)

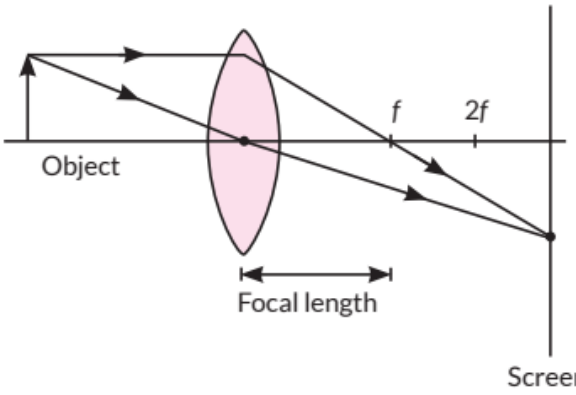
(b)



(1)

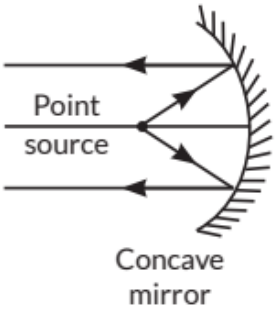
(c)Used as shaving mirror or used by dentists to get enlarged image of teeth.

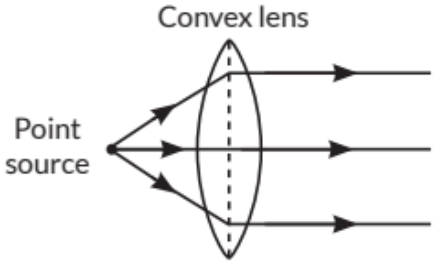
7. (c): For a convex lens, a ray incident on the lens in a direction parallel to the principal axis of convex lens, after refraction passes through second principal focus of the lens.



(0.80)

8. (a): Concave mirror as well as convex lens make a parallel beam of light when light from a point source is incident on it.





(0.80)

9.

(c): Refractive index, $n = \frac{c}{v}$

Larger the value of n, smaller is the value of v. Therefore, $V_{air} > V_{water} > V_{glass}$ is the decreasing order of speed of light through them. (0.80)

10. (b): Angle of incidence on hemispherical surface is 0°.

11. (c): Given, P = -4.0 D (0.80)

Negative sign of focal length indicates that lens is concave.

12. (d): Magnification of a lens,

$$m = \frac{v}{u} \qquad \text{...(i)}$$

where v and u denotes image distance and object distance from the lens, respectively.

Given: m = -3; v = 80 cm; u = ?

From eq. (i), $-3=\frac{80}{u}$ or $u=\frac{-80}{3}$ cm (0.80)

13. (d): Ray while travelling from medium 3 to medium 1, doesn't undergo any deviation. Therefore, refractive index for medium 1 and medium 3 is same. Now, 221, therefore medium 2 is optically denser than medium 1. Hence, option (d) is correct.

14. (b): Refractive index of glass w.r.t. alcohol (0.80)

$$=\frac{\text{R.I. of glass w.r.t. air}}{\text{R.I of alcohol w.r.t. air}}=\frac{1.65}{1.36}=1.21 \quad (0.80)$$

15.

(c): Using lens formula, $\frac{1}{v}=\frac{1}{f}+\frac{1}{u}$

or $\frac{1}{v}=\frac{1}{10}+\frac{1}{-5}$ or $v=-10$ cm

Now, magnification $m=\frac{v}{u}=\frac{h_i}{h_o}$

$\therefore \quad h_i=\frac{v}{u}h_o=\frac{-10}{-5}\times 2=4$ mm

16. (i) (b): For a parallel sided glass block, emergent rays are parallel but laterally shifted to incident rays. (0.80)

(ii) (c): Using Snell's law of refraction, $\frac{\sin i}{\sin r}=\frac{\mu_2}{\mu_1}$

or $\sin r=\frac{\mu_1}{\mu_2}\sin i=\frac{1}{1.5}\times\sin 48.6°$ or $r = 30°$ (0.80)

(iii) (d): As refractive index of glass is greater than that of air. So, air is optically rare than glass.

We know, refractive index = $\frac{\text{Speed of light in vacuum}}{\text{Speed of light in medium}}$

Hence, (iii) is correct. Therefore, we can say that light will travel slower in medium then air or vacuum. Hence, (iv) is incorrect. From given values, statement (v) can be proved. (0.80)

(iv) (a): For lesser refractive index, angle of refraction increases and hence lateral shift decreases.

17. (i) (b): Convex lenses
(ii) (b): Power, $P = 1/f$
(0.80) (1)
So, $P_1 = 1/f_1$ and $P_2 = 1/f_2$
Now, $P_1/P_2 = 4/1$, hence $(1/f_1)/(1/f_2) = 4/1$
$f_1/f_2 = 1/4$ (1)
(iii) (a): Magnification of a lens is given by ratio of height of image to height of object.
(iv) (c): Magnification of a lens $m = v/u$ (1)

$$\text{or} \quad 3 = \frac{24}{u}$$

Hence, $u = 8$ cm

(v) (c): Not-so-thick lenses would not make the telescope very heavy and they will also allow considerable amount of light to pass through them. (1)

18. Both are concave. A plano-concave lens also diverges the parallel rays falling on it. Therefore the lens can be plano-concave too. (1)

19. Rays of light passing through optical centre goes out with any deviation.(1)

20. (a) (i) Given, image distance, $v = -25$ cm, focal length, $f = 5$ cm, magnification, $m = ?$

From lens formula, $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow \frac{1}{u} = \frac{1}{v} - \frac{1}{f}$

$$\frac{1}{u} = \frac{1}{-25} - \frac{1}{5} = \frac{-1-5}{25} = \frac{-6}{25}$$

Object distance, $u = \frac{-25}{6}$ cm.

We know that, $m = \frac{v}{u} = \frac{-25 \times 6}{-25} = 6$

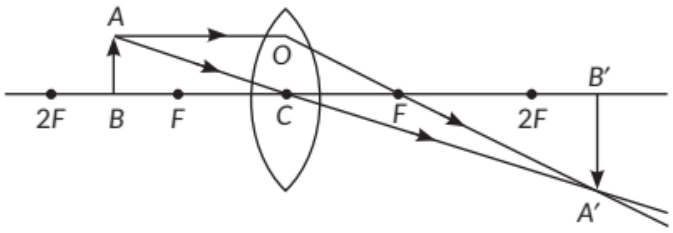
(ii) Since, her least distance of distinct vision is 25 cm, therefore she would not be able to read the book placed at a distance 10 cm from her eyes. V
(b) This is because the least distance of distinct vision is 25 cm.(1)

21. (a) Convex lens used in projector (1)
(b) Negative as the image is real and inverted. (1)

(c) $\frac{1}{f}=\frac{1}{v}-\frac{1}{u} \Rightarrow \frac{1}{20}=\frac{1}{v}-\frac{1}{-21}$

$\frac{1}{v}=\frac{1}{20}-\frac{1}{21}=\frac{21-20}{420} \Rightarrow v=\frac{420}{1}=420 \text{ cm}$

OR



(2)