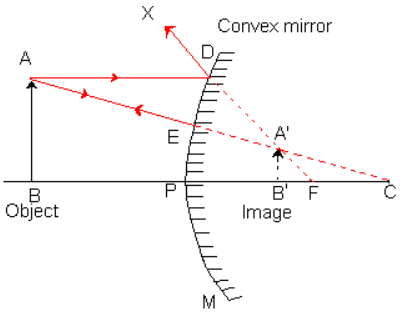
Solution

Class 10 - Science

LIGHT- REFLECTION AND REFRACTION

Section A

1. **(b)** A and the device X is a convex lens
   Explanation: Inverted, sharp and real image of distant tree is formed by a convex lens.
2. **(b)** C
   Explanation: Emergent light is parallel to the incident light and laterally displaced.
3. **(c)** 0.5 m
   Explanation: focal length =?
   Radius of curvature, R = 1 m (+ for convex mirrror)
   As f = $\frac{R}{2}$
   $\therefore$ f = $\frac{1}{2}$ = 0.5 m
4. **(b)** less than unity
   Explanation: Here the ray of light bends away from normal when it enters from medium A into medium B. This shows that medium B is optically rarer than medium A. Thorofore, spood of light in modium B is more than speod of light in medium A. So, ratio of speed of light in medium A to speed of light in medium B will be less than one.
5. **(d)** all mirrors irrespective of their shape
   Explanation: We know that from the laws of reflection, the incident ray, the reflected ray, and the normal to the reflecting surface all lie in the same plane. Also, the angle of reflection is equal to the angle of incidence.
   The laws of reflection hold good for all reflecting surfaces irrespective of their shapes whether plane or curved.
6. **(a)** i = r = 90^o
   Explanation: It is because when i is 90 degrees, it means incident ray is perpendicular to the refracting surface, and light travels in the shortest path that's why it bends towards the normal when it enters a denser medium. But we know that the shortest distance is perpendicular to the medium. So refracted ray doesn't bend and continues to move straight.
7. **(c)** light from sun
   Explanation: Larger the distance more sharper the image.
8. **(d)** $P_1 + P_2$
   Explanation: The net power of the lenses placed in contact is given by the algebraic powers of the individual powers.
   Net power of the lens combination, P = $P_1 + P_2$
9. **(d)** Concave mirror as well as concave lens
   Explanation: When point source of a light is focused to a convex or concave mirror emergent rays make a parallel beam of light.
10. **(c)** lens and the screen
    Explanation: The focal length of the lens, image distance should be known which is the distance between the lens and the screen.
11. **(b)** 11.0 cm
    Explanation: Distance of pole to focus is called focal length :
    $\therefore$ f = 15.6 - 4.6 = 11.0 cm
12. **(d)** a convex mirror
    Explanation:
    The field of a convex mirror is more than any type of mirror. Hence the full-length size of the building can be seen by using a convex mirror.



13. **(b)** I

    Explanation: It is most accurate since ∠e is (nearly) equal to ∠i. The correct value of ∠e = 60^{o}. .

14. **(d)** B

    Explanation: The mirror and the screen should be firmly placed for an accurate measure of the separation.

15. **(b)** three different points

    Explanation: Red, blue, and green lights have different wavelengths so they will be refracted accordingly. So three points of convergence on the principal axis exist.

16. **(c)** X and Z respectively

    Explanation: Angle of zero at normal will directly give the measure of the angles of incidence and reflection.

17. **(b)** IV

    Explanation: All parallel beams are to pass through the focus.

18. **(a)** away from principal axis

    Explanation: If these parallel beams non-parallel to the principal axis fall on the convex lens, one may pass through the optic centre and pass without any deviation. another may pass through focus and after refraction passes parallel to the principal axis. so they converge at a point away from the principal axis.

19. **(a)** neither the feet nor the heads of the images of pins P_3 and P_4 are in line with the feet and heads, respectively, of pins P_1 and P_2.

    Explanation: The emergent ray drawn by him is not parallel to the incident ray

20. **(c)** All of these

    Explanation: The focal length of the convex lens depends on the refractive index and radius of the surface (curvature) mainly. The color of the light passing through the lens is not a major factor but still, it counts.

21. **(c)** towards the screen

    Explanation: When the image distance increases, object distance decreases. Thus, the distance between the mirror and screen will decrease. So, the mirror should be moved towards the screen.

22. **(b)** a scale and a screen

    Explanation: Screen for image formation and scale to measure length are required.

23. **(d)** 2.5 cm

    Explanation: Since the distance of the object from the pole of the mirror is equal to the radius of curvature of the mirror, the object is kept at the centre of curvature of the mirror. When an object is kept at the centre of curvature of a concave mirror, the image is also formed at the centre of curvature.
    According to the mirror formula,
    $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$
    Given, u = -2f and f = -f
    $\therefore \frac{1}{v} = \frac{1}{f} - \frac{1}{u}$
    $\Rightarrow \frac{1}{v} = \frac{1}{(-f)} - \frac{1}{(-2f)}$
    $\therefore \frac{1}{v} = \frac{1}{2f} - \frac{1}{f}$ or v = -2f
    $m = \frac{\text{Height of the image (h')}}{\text{Height of the object (h)}} = \frac{\text{Image distance (v)}}{\text{Object distance (u)}} = 1$
    The size of the image is the same as that of the object i.e. 2.5 cm

24. **(c)** e = i
Explanation: For parallel surfaces, e = i should be obeyed.

25. **(a)** B
Explanation: Snell's law gives the relationship between angles of incidence and refraction for a wave impinging on an interface between two media with different indexes of refraction.
Thus, light bends towards normal when it passes from air to glass. Light bends away from normal when it passes from glass to air.

26. **(c)** lens and screen only
Explanation: Parallel rays get converged at the focus.

27. **(b)** C
Explanation: C has got $\angle e = \angle i$ and $\angle r < \angle i$ as these are to be satisfied for refraction in a glass slab.

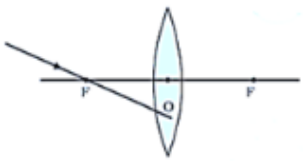
28. **(b)** < 1
Explanation: As light enters a rarer medium from a denser medium, it will bend away from the normal.

29. **(a)** convex mirror
Explanation: Both plane and convex mirror produce a virtual image. However, the image of a convex mirror is diminished always irrespective of the position of the object.

30. **(b)** $\frac{f_1 \times f_2}{f_1 + f_2}$
Explanation: The net power of the lenses placed in contact is given by the algebraic powers of the individual powers.
Equivalent power of the lens combination $P = P_1 + P_2$
$\therefore \frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$ where f_1 and f_2 are the focal lengths of the two lenses, and F is the focal length of the combination.
$\frac{1}{F} = \frac{f_1 + f_2}{f_1 \times f_2}$
$\Rightarrow F = \frac{f_1 \times f_2}{f_1 + f_2}$

31. **(a)** towards the screen
Explanation: The blurred image is seen only when the separation between the screen and mirror is less than the focal length.

32. **(b)** B
Explanation: The emergent ray, from the rectangular glass slab, is parallel to the incident ray and is laterally displaced to the left (or lower side) of the incident ray.

33. **(d)** 

Explanation: In the convex lens, incident ray passing through F goes parallel to the principal axis after refraction.

34. **(c)** converges at focus (f)
Explanation: The point of convergence of parallel beams from a distant object is called the focus.

35. **(c)** Convex lens
Explanation: Since a convex lens can converge the light rays at a point and emerged at point B. So, the convex lens is inside the box.

36. **(c)** Concave mirror, convex mirror, concave lens and convex lens
Explanation: In case of all of the above, when an object is at infinity, image is highly diminished and point sized.

37. **(c)** A is true but R is false.
Explanation: A is true but R is false. Image is formed behind the mirror as far as object is in front of the mirror. So R is false.

38. **(d)** A is true but R is false.
Explanation: A is true but R is false.

39. **(a)** Both A and R are true and R is the correct explanation of the assertion.
Explanation: Both A and R are true and R is the correct explanation of the assertion.

40. **(c)** A is true but R is false.
Explanation: In concave spherical mirrors, the real image may also form when object is placed in between F and P.

41. **(a)** Both A and R are true and R is the correct explanation of the assertion.
Explanation: According to new sign conventions, the height of an object above the principal axis is always taken as positive.

42. **(a)** Both A and R are true and R is the correct explanation of the assertion.
Explanation: A convex mirror is used as a driver mirror for rearview because it has a much larger field view as compared to plane mirror.

43. **(a)** Both A and R are true and R is the correct explanation of the assertion.
Explanation: The speeds of light in glass depend on the colour of light because we knew that, $v_g = \frac{c}{n_g}$.
So, Both A and R are true and R is the correct explanation of the assertion.

44. **(c)** A is true but R is false.
Explanation: Concave mirrors are used a makeup mirrors because when the face is held within the focus of a concave mirror, then the enlarged image of the face is seen in the concave mirror.

45. **(d)** A is false but R is true.
Explanation: We can see the virtual image when the object is in between f and P.

Section B

46. **(d)** B
Explanation: The larger separation between the pins will give a better reading for good observation, the angles should be in the ranges 30^o - 60^o.

47. **(a)** (20 cm, 20 cm) and (inverted, inverted)
Explanation: Since the object is distant, the nature of the image on the screen in case of both the convex lens and the concave mirror will be real, inverted, highly diminished, and point sized.
If the object is distant, then we get its image at focus on the other side of the convex lens. Therefore, d_1 will be 20cm.
In the case of the concave mirror, if the object is distant, then we get its image at the focus in front of the concave mirror. Therefore, d_2 will be 20 cm.

48. **(a)** C
Explanation: Angles between 30^o and 60^o are used for clear vision and the pins are fixed at larger separation as possible.

49. **(a)** an inverted image of the tree at the focus of the lens
Explanation: The screen is just a device or an instrument where the image formed is to be observed. If the screen is removed, the lens will continue to form the image on its focus. Thus, on removing the screen and on looking through the lens in the direction of the object the image of the distant tree is inverted and formed at the focus.

50. **(c)** (C)
Explanation: The angle of emergence and angle of incidence will be equal. Emergent ray is parallel to the incident ray along with original direction but it will be laterally displaced to the left of the incident ray.

51. **(b)** B, C, D
Explanation: Source of light is required. Needle cannot be used with the rest of the three.

52. **(d)** B and D
Explanation: On each of the sides, the normals are not required. Only on one side in each case, he should draw normals. The pins are to be placed little for from each other and not 1 cm.

53. **(b)** slightly nearer to the lens
Explanation: Image will be exactly at focus only when the object is at large distance.

54. **(a)** Case II
Explanation: A concave mirror is defined as a mirror which is bent inward in the middle. When the face is placed between the concave mirror and a focus, it reflects a magnified image. For the face, concave mirrors reflect even the pores of the skin.

55. **(b)** 15
Explanation: From observation third, distance of object from lens = distance of image from lens So, radius of curvature, R = 30 cm
Thus, focal length, f = R/2 = 30/2 = 15 cm

Section C

56. a. (d) S
b. (a) absolute refractive index
c. (a) 1.33
d. (a) 3×10^8 m/s
e. (b) more

57. i. (d) At the focus F
ii. (b) At C
iii. (c) Both (a) and (b)
iv. (a) at the focus F
v. (c) Highly enlarged

58. i. (a) parallel to incidence ray
ii. (b) refracted away from the normal
iii. (b) from rarer to denser medium
iv. (a) air
v. (b) greater

59. i. (c) spectacles for the correction of short sight
ii. (b) virtual, erect and diminished
iii. (a) concave lens
iv. (b) focal length
v. (a) converges, diverges

60. i. (c) less than 1, more than 1 or equal to 1
ii. (d) equal to one
iii. (b) at the centre of curvature
iv. (a) magnification
v. (a) virtual; erect