Grade X - Science

Lesson 9. Light Reflection and Refraction

Objective Type Questions

(1 Mark each)

I. Multiple choice questions

1. The laws of reflection hold true for:
   a. Plane mirror only
   b. Concave mirrors only
   c. Convex mirror only
   d. All reflecting surface
2. Consider the following properties of virtual images:
   (i) Cannot be obtained on the screen
   (ii) Are formed by both concave and convex lens
   (iii) Are always inverted
   (iv) Are always inverted
   The correct properties are:
   a. (i) and (iv) b. (i) and (ii) **c. (i), (ii) and (iii)** d. (i), (ii) and (iv)
3. A real image is formed by the light rays after reflection or refraction when they:
   (i) Actually meet or intersect with each other
   (ii) Actually converge at a point.
   (iii) Appear to meet when they are produced in the backward direction.
   (iv) Appear to diverge from a point.
   Which of the above statement are correct?
   a. (i) and (iv) b. (ii) and (iv) **c. (i) and (ii)** d. (ii) and (iii)
4. A student obtained a sharp image of a candle flame placed at the distant end of the laboratory table on a screen using a concave mirror to determine its focal length. The teacher suggested him to focus a distant building about 1 km far from the laboratory, for getting more correct value of the focal length. In order to focus the distant building on the same screen the student should slightly move the:

a. Mirror away from the screen

b. Screen away from the mirror

c. Screen towards the mirror

d. Screen towards the building

5. To determine the approximate value of the focal length of a given concave mirror, you focus the image of the distant object formed by the mirror on a screen. The image obtained on the screen, as compared to the object is always:

a. Laterally inverted and diminished

b. Inverted and diminished

c. Erect and highly diminished

d. Erect and diminished

6. Rays from sun converge at a point 15 cm in front of a concave mirror. Where an object should be placed so that size of its image is equal to the size of the object:

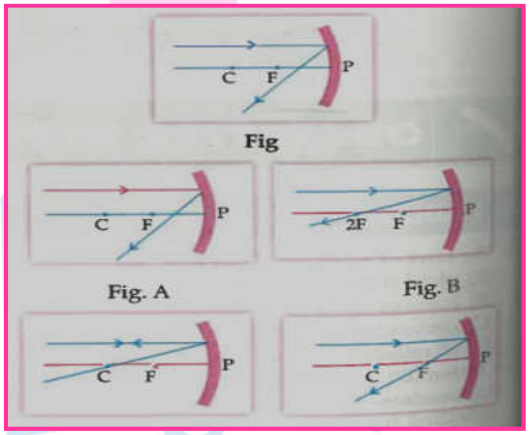
a. 15 cm in front of the mirror

b. 30 cm 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

8. Which f the following ray diagrams is correct for the ray of light incident on a concave mirror as show in figure:



a. Fig. A b. Fig. B c. Fig. C **d. Fig. D**

9. 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 building

II. Multiple choice questions

1. An object is placed at a distance of 0.25 m in front of a plane mirror. The distance between the object and image will be.

a. 0.25 m b. 1.0 m **c. 0.5 m** d. 0.125 m

2. The angle of incidence for a ray of light having zero reflection angle is

a. 0 b. 30^0 c. 45^0 d. 90^0

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

a. Plane mirror **b. Concave mirror**

c. Combination of convex and concave mirror d. Concave lens

4. An object at a distance of 30 cm from a concave mirror gets its image at the same point. The focal length of the mirror is

a. – 30 cm b. 30 cm **c. – 15 cm** d. + 15 cm

5. An object at a distance of +15 cm is slowly moved towards the pole of a convex mirror. The image will get.

a. shortened and reel b. enlarged and reel

c. enlarge and virtual **d. diminished and virtual**

6. A concave mirror of focal length 20 cm forms an image having twice the size of object, the position of object will be at

a. 25 cm b. 40 cm **c. 10 cm** d. At infinity

7. The image formed by concave mirror is real, inverted and of the same size as that of the object. The position of object should be

a. at the focus b. at the centre of curvature

c. between focus and centre of curvature d. beyond centre of curvature

8. The nature of the image formed by concave mirror when the object is placed between the focus (F) and centre of curvature(C) of the mirror observed by us is

a. real, inverted and diminished

b. virtual, erect and smaller in size

c. real, inverted and enlarged

d. virtual, upright and enlarged

9. The nature of image formed by a convex mirror when the object distance from the mirror is less than the distance between pole and focal point

a. real, inverted and diminished in size

b. real, inverted and enlarged in size

c. virtual, upright and diminished in size

d. virtual, upright and enlarge in size

10. If a man's face is 25 cm in front of concave shaving mirror producing erect image 1.5 times the size of face, focal length of the mirror would be

a. 75 cm b. 25 cm c. 15 cm d. 60 cm

11. When object moves closer to convex lens, the image formed by it shift

a. away from the lens

b. towards the lens

c. first towards and then away from the lens

d. first towards and then away on the side of object

12. As light travels from a rarer to a denser medium it will have

a. increased velocity b. decreased velocity

c. decreased wavelength **d. both (b) and (c)**

13. The angle of incidence / and refraction r are equal in a transparent slab when the value of i is

a. depend on the material of the slab b. 0^0 c. 45^0 d. 90^0

14. The refractive index of transparent medium is greater than one because

a. Speed of light in vacuum < speed of light in transparent medium

b. Speed of light in vacuum > speed of light in transparent medium

c. Speed flight in vacuum = speed of light in transparent medium

d. Frequency of light wave changes when it moves from rarer to denser medium

15. The refractive index of water is 1.33. The speed of light in water will be

a. 1.33 X 10^8 m/s
b. 3 X 10^8 m/s
c. 2.26 X 10^8 m/s
d. 2.66 X 10^8 m/s

16. You are given three media A, B and C of refractive index 1.33, 1.65 and 1.46. The medium in which the light will travel faster is

a. A b. B c. C d. equal in all three media

17. Light from the sun falling on a convex lens will converge at a point called

a. centre of curvature
b. focus
c. radius of curvature
d. optical centre

18. Large number of thin stripes of black paint are made on the surface of a convex lens of focal length 20 cm to catch the image of a white horse. The image will be

a. a zebra of black stripes
b. a horse of black stripes
c. a horse of less brightness
d. a zebra of less brightness

19. A divergent lens will produce

a. always real image
b. always virtual image
c. both real and virtual image
d. none of these

20. When object moves closer to a concave lens the image by it shift

a. away from the lens
b. towards the lens
c. first towards and then away from the lens
d. first away and then towards the lens

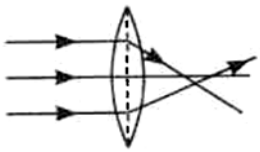
21. When object moves closer to a concave lens the image by it shift

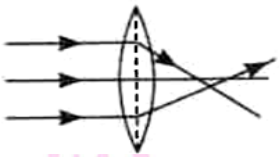
a. away from the lens
b. towards then lens
c. first towards and then away from the lens
d. first away and then towards the lens

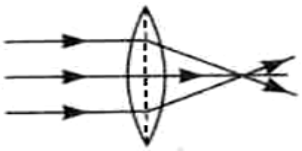
22. A magnified real image is formed by a convex lens when the object is at

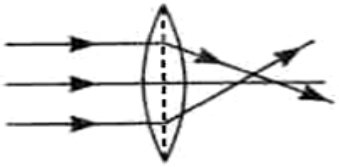
a. F b. between F and 2F c. 2F **d. only (a) and (b) both**

23. The distance between the optical centre and point of convergence is called focal length in which of the following cases?

a. 

b. 

c. 

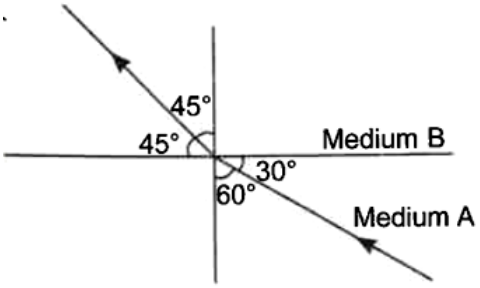
d. 

Ans : C

24. A 10 mm long awl pin is placed vertically in front of a concave mirror. A 5 mm long image of the awl pin is formed at 30 cm in front of the mirror. The focal length of this mirror is

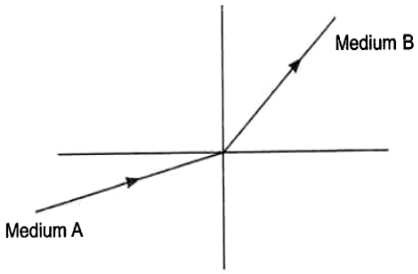
a. – 30 cm b. – 20 cm c. – 40 cm d. – 60 cm

26. Figure shows a ray of light as it travels from medium A to medium B. Refractive index of the medium B relative to medium A is



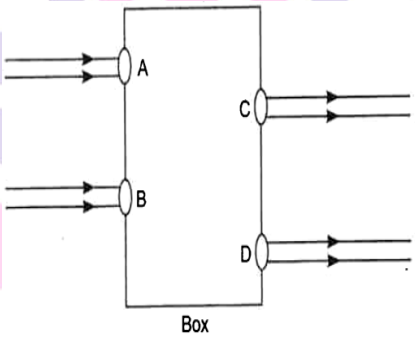
a. $\frac{\sqrt{3}}{\sqrt{2}}$ b. $\frac{\sqrt{2}}{3}$ c. $\frac{1}{\sqrt{2}}$ d. $\sqrt{2}$

27. A light ray enters from medium A to medium B as shown in figure. The refractive index of medium B relative to A will be



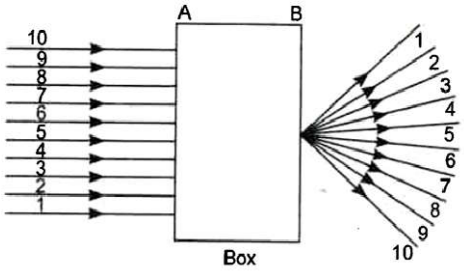
a. greater than unity
b. less than unity
c. equal to unity
d. zero

28. Beams of light are incident through the holes A and B and emerge out of box through the holes C and D respectively as shown in the figure. Which of the following could be inside the box?



a. **A rectangular glass slab**
b. A convex lens
c. A concave lens
d. A prism

29. A beam of light is incident through the holes on side A and emerges out of the hole on the other face of the box as shown in the figure. Which of the following could be inside the box?



a. Concave lens
b. Rectangular glass slab
c. Prism
d. Convex lens

30. Which of the following statement is/are true?

a. A convex lens has 4 dioptre power having a focal length 0.25 m

b. A convex lens has -4 dioptre power having a focal length 0.25 m

c. A concave lens has 4 dioptre power having a focal length 0.25 m

d. A concave lens has -4 dioptre having a focal 0.25 m

31. Magnification produced by a rear view mirror fitted in vehicles

a. is less than one

b. is more than one

c. is equal to one

d. can be more than or less than one depending upon the position of the object in front of it.

32. A full length image of a distant tall building can definitely be seen by using

a. a concave mirror

b. a convex mirror

c. a plane mirror

c. both concave as well as plane mirror

33. In torches, search lights and headlights of vehicles the bulb is placed

a. between the pole and the focus of the reflector

b. very near to the focus of the reflector

c. between the focus and centre of curvature of the reflector

d. at the centre of curvature of the reflector

34. The law of reflection hold good for

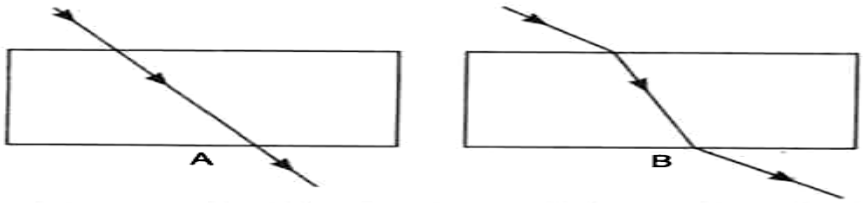
a. plane mirror only

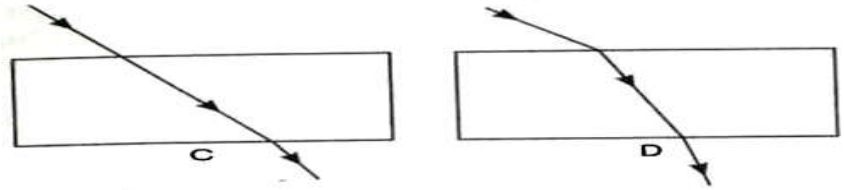
b. concave mirror only

c. **all mirrors irrespective of their shape**

d. convex mirror only

35. The path of a ray of light coming from air passing through a rectangular glass slab traced by four students are shown as A, B, C and D in figure. Which one of them is correct.





a. A **b. B** c. C d. D

36. In which of the following, the image of an object placed at infinity will be highly diminished and point sized?

a. Concave mirror only

b. Convex mirror only

c. Convex lens only

d. Concave mirror, convex mirror, concave lens and convex lens

III. Multiple choice questions (1 Mark each)

1. The correct sequencing of angle of incidence, angle of emergence, angle of refraction and lateral displacement shown in the following diagram by digits 1, 2, 3 and 4 is:

a. 2, 4, 1, 3 **b. 2, 1, 4, 3** c. 1, 2, 4, 3 d. 2, 1, 3, 4

2. Select from the following the best experimental set – up tracing the path of a ray of light passing through a rectangular glass slab:

a. P b. Q c. R **d. S**

3. In your laboratory you trace the path of light rays through a glass slab for different values of angle of incidence ($< i$) and in each case measure the values of the corresponding angle of refraction ($< r$) and angle of emergence ($< e$).

On the basic of your observation your correct conclusion is:

a. $< i$ is more than $< r$, but nearly equal to $< e$

b. $< i$ is less than $< r$, but nearly equal to $< e$

c. $< i$ *is more tha* $< e$, but nearly equal to $< r$

d. $< i$ is less than $< e$, but nearly equal to $< r$

4. Which of the following can make a parallel beam of 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 mirror paced at 90^0 to each other

   d. Concave mirror as well as concave lens.

5. A student obtains a blurred image of a distant object on a screen using a convex lens. To obtains a distinct image on the screen he should move the lens.

   a. Away from the screen

   b. Towards the screen

   c. To a position very far away from the screen

   d. Either towards or away from the screen depending upon the position of the object.

6. A student very cautiously traces the path of a ray through a glass slab for different values of the angle of incidence ($< i$). He then measure the corresponding values of the angle of refraction ($< r$) and the angle of emergence ($< e$) for every value of the angle of incidence. On analysing this measurement of angles, his conclusion would be

   a. ∠i > ∠r > ∠e

   b. ∠i = ∠e > ∠r

   b. ∠i < ∠r < ∠e

   d. ∠i = ∠e < ∠r

7. A student obtains a blurred image of a distant object on a screen using a convex lens. To obtain a distinct image on the screen he should move the lens:

   a. always from the screen

   b. towards the screen

   c. to a position very far away from the screen

   d. either towards or away from the screen depending upon the position of the object.

8. A teacher sets up the stand carrying a convex lens of focal length 15 cm at 42.7 cm mark on the optical bench. He asks four students A, B, C and D to suggest the position of screen on the optical bench so that a distinct image of a distant tree is obtained almost immediately on it. The positions suggested by the students were as:

   (i) 12.7 cm (ii) 29.7 cm (iii) 57.7 cm (iv) 72.7 cm

   The correct position of the screen was suggested by

a. (i) b. (ii) **c. (iii)** d. iv

9. Suppose you have focussed on a screen the image of candle flame placed at the farthest end of the laboratory table using a convex lens. If your teacher suggest you to focus the parallel rays of sun, reaching your laboratory table, on the same screen, What you are expected to do is to move the:

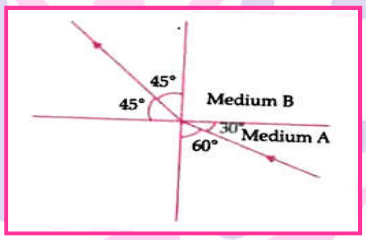
a. lens slightly towards the screen

b. lens slightly away from the screen

c. lens slightly towards the sun

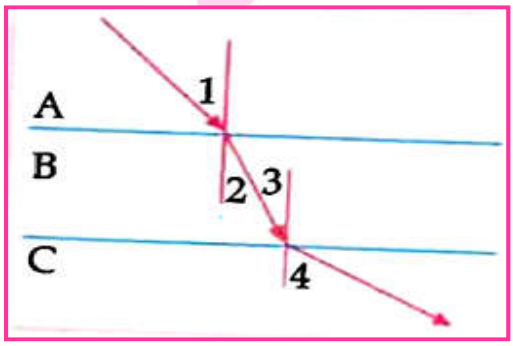
d. lens and screen both towards the sun

10. Figure shows a ray of light as it travels from medium A to medium B. Refractive index of the medium B relative to medium A is



a. $\frac{\sqrt{3}}{\sqrt{2}}$ b. $\frac{\sqrt{2}}{\sqrt{3}}$ c. $\frac{1}{\sqrt{2}}$ d. $\sqrt{2}$

11. 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. $\angle 1 < \angle 4$ **c. $\angle 3 = \angle 2$** d. $\angle 3 > \angle 4$

12. The refractive index of medium A is 1.5 and that of medium B is 1.33. if the speed of light in air is 3×10^8 , what is the speed of light in medium A and B respectively?

a. 2×10^8 m/s and 1.33×10^8m/s

b. 1.33 X 10^8 = m/s and 2X10^8 m/s

c. 2.25 X 10^8= m/s and 2X10^8 m/s

d. 2 X 10^8 = m/s and 2X10^8 m/s

I Assertion & Reason

Directions : in the following questions, A statement of Assertion (A) is followed by a statement of Reason (R). Mark the correct choice as.

(A) Both assertion (A) and reason (R) are true and assertion (R) is the correct explanation of (A).

(B) Both assertion (A) and reason (R) are true but assertion (R) is NOT the correct explanation of (A).

(C) Assertion (A) is true but reason (R) is false.

(D) Assertion (A) is false and reason (R) is true.

1. **Assertion (A)** : If the rays are diverging after emerging from a lens; the must be concave.

   Reason (R) : The convex lens can give diverging rays.

   Ans. Option (D) is correct.

2. **Assertion (A)** : Refractive index glass with respect to air is different for red light and violet light.

   Reason (R) : Refractive index of a pair of media depends on the wavelength of light used

   Ans. Option (A) is correct.

3. **Assertion (A)** : The refractive index of diamond is $\sqrt{6}$ and refractive index of a liquid is $\sqrt{3}$. If the light travels from diamond to the liquid, it will be initially reflected when the angle of incidence is 30^0.

   Reason (R) : $\mu = \frac{1}{\sin C}$, where μ is the refractive index of diamond with respect to liquid.

   Ans. Option (A) is correct.

II. Assertion & Reason

Directions: In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as.

(A) Both assertion (A) and reason (R) are true and assertion (R) is the correct explanation of (A).

(B) Both assertion (A) and reason (R) are true but assertion (R) is NOT the correct explanation of (A).

(C) Assertion (A) is true but reason (R) is false.

(D) Assertion (A) is false and reason (R) is true.

1. **Assertion** : Incident light is reflected in only one direction from a smooth surface.

   Reason : Since the angle of incidence and the angle of reflection are same, a beam of parallel ray of light falling on a smooth surface is reflected as a beam of parallel light rays in one direction only.

   Ans . Option (A) is correct.

2. **Assertion** : The word AMBULANCE on the hospital vans is written in the form of its mirror same size vans is written in the form of its mirror as

   ƎNAJUBMA

   Reason : The image formed in a place mirror is same size of the object.

   Ans. Option (B) is correct

3. **Assertion** : cannot see the distant object clearly.

   Reason : The far point of an eye suffering from myopia is less than infinity.

   Ans. Option (B) is correct.

4. **Assertion** : Pupil is black in colour.

   Reason : Pupil is black in colour as no light is reflected in it.

   Ans. Option (A) is correct.

5. **Assertion** : The rainbow is manmade spectrum of sunlight in the sky.

   Reason : The rainbow is formed in the sky when the sun is shining and it is raining at the same time.

   Ans. Option (A) is correct.

III. Assertion & Reason

Directions: In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as.

(A) Both assertion (A) and reason (R) are true and assertion (R) is the correct explanation of (A).

(B) Both assertion (A) and reason (R) are true but assertion (R) is NOT the correct explanation of (A).

(C) Assertion (A) is true but reason (R) is false.

(D) Assertion (A) is false and reason (R) is true.

1. **Assertion (A)** : Plane mirror may form real image.

   Reason (R) : Plane mirror forms virtual image, if object is real.

Ans. Option (B) is correct.

2. **Assertion (A)** : The focal length of the convex mirror will increase, if mirror is placed in water.

   Reason (R) : The focal length of a convex mirror of radius R is equal to , f = $\frac{R}{2}$.

Ans. Option (D) is correct.

3. **Assertion (A)** : The image formed by a concave mirror is certainly real if the object is virtual.

   Reason (R) : The image formed by a concave mirror is certainly virtual if the object is real.

4. **Assertion (A)** : An object is placed at a distance of f from a convex mirror can never be infinity.

   Reason (R) : The distance of image in convex mirror can never be infinity

Ans. Option (D) is correct.

Fill in the blanks

1. The _____ is where the respiratory and digestive passage come together.

   Ans. Pharynx

2. The conditions necessary for photosynthesis to take place are _____, _____, _____ and _____.

   Ans. Sunlight, chlorophyll, carbon dioxide and water.

3. _____ mirror is used as security mirror in shops and on roads are sharp bends and concealed entrances.

   Ans. Convex.

4. The refractive index of a transparent medium is the ration of the speed of light in _____ to that in the _____.

   Ans. Vacuum, medium

5. If the magnification has a minus sing, then the image is _____ and _____.

   Ans. Real, inverted

6. The focal length of a lens is the distance between _____ and _____ of the lens.

   Ans. Optical centre, principal focus.

7. In order to calculate the power of a lens we need its focal length in _____.

   Ans. Negative.

8. In order to calculate the power of a lens, we need it focal length in _____.

   Ans. Metre.

True or False

1. Angle of refraction cannot exceed 90^0

   Ans. True.

2. When incident angle I satisfies n = $\frac{1}{\sin i}$, the refracted light will pass along the surface.

   Ans. True.

3. A person standing in front of a mirror finds his image larger than himself. This shows that mirror is convex in nature.

Ans. False.

4. Lateral displacement increases with the thickness of the given slab.

Ans. True.

5. Nature of image formed by mirror gives an ideal about nature of mirror.

Ans. True.

6. A convex lens (n_g = 3/2) When placed in water (n_w = 4/3) has increased focal length.

Ans. True.

7. A convex and a concave lens of equal focal length behave as a regular glass slab receiving light normally.

Ans. False.

8. Concave lens and convex mirror diverge the rays which fall parallel to the principal axis.

Ans. True.

9. The power of a concave lens is positive.

Ans. False.

Match the following

Column I	Column II
(i) Ray through centre of curvature	(A) Reflected parallel principal axis
(ii) Ray through focus	(B) Converge at focus
(iii) Rays from infinite distance	(C) Emerge through focus
(iv) Refracted rays to infinity	

Ans. (i) (B), (ii) (A), (iii) (B), (iv) (C)

Very short Answer Type Questions (1 mark each)

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

Ans. Both are concave.

Alternative answer that should be given credit: Plano-concave lens.

2. The image formed by a concave mirror is observed to be real, inverted and larger than the object. Where is the object placed?

Ans. Between the principal focus and the centre of curvature.

3. Define the term principal axis of a spherical mirror.

Ans. The line which joins the pole and the centre of curvature of a spherical mirror, is the principal axis of a spherical mirror.

4. We prefer a convex mirror as a rear view mirror in vehicles. Why?

Ans. Due to its wide field of view.

5. What is the magnification of the images formed y plane mirror and why?

Ans. Its magnification is +1 because plane mirror always form image equal to object's size.

6. What is light?

Ans. Light is a form of energy. It brings the sensation of sight. It is a form of electromagnetic radiation. It also provides us means of communication (fibre – optics).

7.Write any one observation from everyday life which show us that light travels in a straight line.

Ans. A small source of light cots a sharp shadow of an opaque object tells us that light travels in a straight line.

8. What is beam?

Ans. A bundle of rays originating from the same source of light in a particular direction is called beam of light.

9. Explain why a ray of light passing through the centre of curvature of a concave mirror, gets reflected along the same path.

Ans. The ray passing through the centre of curvature incident to the mirror along its normal, so $\angle i = \angle r = 0$. Therefore, the ray retraces its path.

10. Is light a ray or a wave?

Ans. It is considered in both the forms.

11. What are the characters associated with light as a wave?

Ans. Frequency and wavelength.

12. What is spherical mirror?

Ans. A reflecting surface which is of the form of a sphere(hollow) in which inner or outer surface is reflecting.

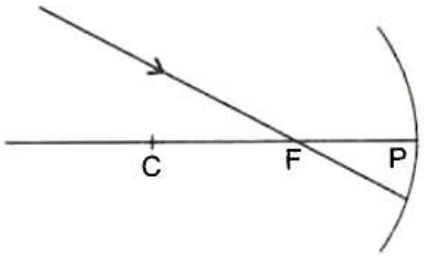
13. What is the relation connecting focal length and radius of a spherical mirror?

Ans. F = $\frac{R}{2}$

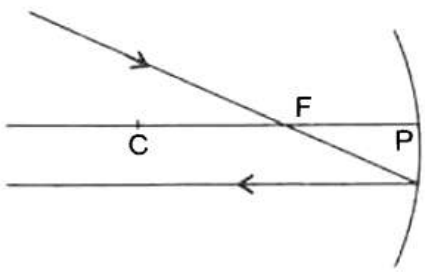
14. can any spherical surface act as a reflector?

Ans. Yes, polished surface can be better reflectors.

15.Redraw the diagram given below in your answer book and show the direction of the light ray after reflection from the mirror.



Ans.



16. For what position of object, a concave mirror forms a real image equal to sic of object?

Ans. When object is placed at the centre of curvature (C) same size real image is formed by concave mirror.

17. A concave forms a sharp image of a distant tree. What name is given to the distance between the concave mirror and screen on which sharp image is formed?

Ans. Focal length.

18. In what condition, the image formed by a concave mirror is virtual?

Ans. When the object is placed between the focus and the pole of a concave mirror, a virtual image is obtained.

19. Specified the size of image formed by concave mirror when m>1.

Ans. The image is enlarged.

20. Name the mirror that can be used to check theft in shops.

Ans. Convex mirror.

21. What is the position of the object placed on the side of reflecting surface of a concave mirror of focal length 15 cm if the image is formed at he distance of 30 cm from the mirror?

Ans. 30 cm

22. Which mirror, concave or convex always converges the light rays?

Ans. Concave mirror.

23. For what position of the object does a concave mirror form a real image which is highly enlarged?

Ans. At C.

24. What focal length can be assigned to a plane mirror?

Ans. Infinity.

25. Size of the image formed on a concave mirror is highly diminished, state the postion of object and image.

Ans. Position of object: at infinity

Position of image : at the focus F

26. For what position of the object does a convex mirror forms a virtual and erect image which is highly diminished?

Ans. At infinity.

27. Name the type of mirror used in the following and reason for using it:

(a) Solar furnace.

(b) Rear view mirror in a vehicle.

Ans. (a) concave mirror.

(b) convex mirror.

28. Name the type of spherical mirror which

(a) has positive focal length.

(b) always forms a virtual image.

Ans. (a) Convex mirror.

(b) Convex mirror.

29. Write tow different uses of concave mirror.

Ans. (i) In solar furnace.

(ii) In shaving mirror.

30. If angle of incidence is 0^0, what is the angle of reflection?

Ans. 0^0

31. What is the magnification of the image formed by plane mirror and why?

Ans. The magnification of the images formed by plane mirrors is 1 as the size of the image is equal to the size of object.

32. When light undergoes refraction at the surface of two medias, what happens to the speed of light?

Ans. When light enters obliquely from a rarer medium into a denser medium, the speed of light decreases. Also, when light gets into the rarer medium from the denser medium, the speed of light increases.

33. can absolute refraction index of any material be less than one?

Ans. No, the velocity of light in the medium is always less than the velocity of light in vacuum.

34. Why does a rays in the medium and to reduce the time taken to travel the same.

Ans. Due to change in velocity of light rays I the medium and to reduce the time taken to travel the same.

35. Does the value of speed of light change with medium?

Ans. Yes, in denser medium, it becomes less than that in free space.

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

Ans. Due to change in velocity of light rays in the medium and to reduce the time taken to travel the same.

37. The following table gives the value of refractive indices of a few media.

S.No	Medium	Refractive Index
1	Water	1.33
2	Crown glass	1.52
3	Rock salt	1.54
4	Ruby	1.71
5	Diamond	2.42

Use this table to give an example of a medium pair so the light speeds up when it goes from one of these media to another.

Ans. When a ray of light passes from an optically denser (higher refractive index) to a rare medium (lower refractive index), its speed increase. For example, crown glass to water.

38. Find the value of angle of emergence when an incident ray makes an angle of 40^0 with a normal to the air glass interface of the rectangular glass slab.

Ans. 40^0, as angle of emergence = angle of incidence

39. How is the refractive index of the medium related to the speed of light through it?

Ans. Refractive index of a medium

$$= \frac{\text{Speed of light in vacuum}}{\text{Speed of light in medium}}$$

40. What happens to a ray of light when it travels from one medium related to the speed of light through it?

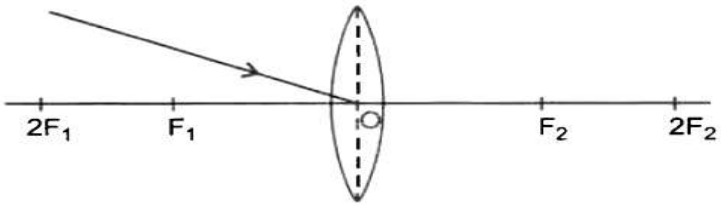
Ans, The light ray will continue to travel in the save path as there will be no refraction when both the medium having equal refractive index.

41. The speed of light in a transparent medium is 0.6 times that of its speed in vacuum. What is the refractive index of the medium?

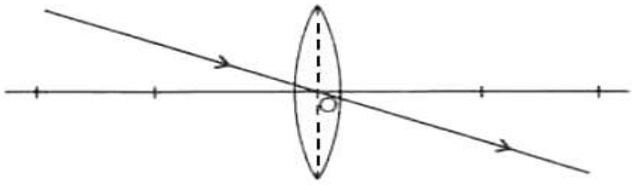
Ans. Since $n = \frac{c}{v}$, we get

$N = \frac{c}{0.6c} = \frac{1}{0.6} = 1.66.$

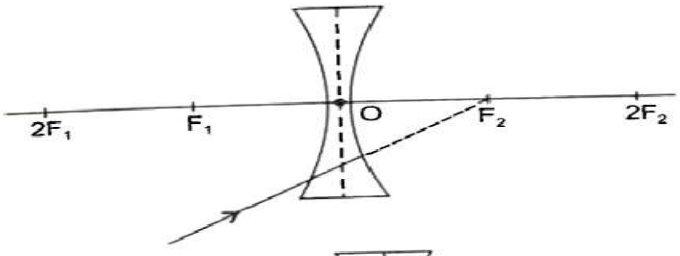
42. Redraw the given diagram and show the path of the refracted ray.



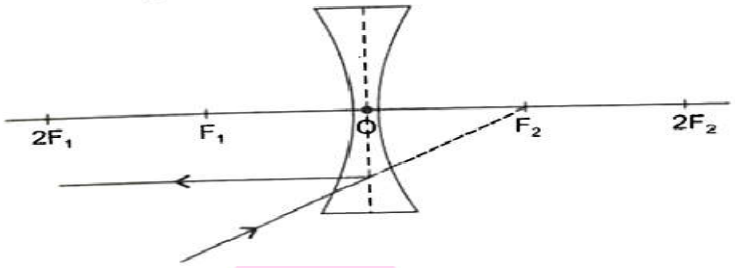
Ans.



43. Redraw the diagram given below in your answer book and show the direction of the light ray after refraction from the lens.



Ans.



44. A girl was playing with a thin beam of light from her laser torch by directing it from different directions on a convex lens held vertically. She was surprised to see that in a particular direction the beam of light continues to move along the same direction after passing through the lens. State the reason for this observation.

Ans. A ray of light passing through the optical centre of the convex lens will continue to move along the same direction after refracting through the lens.

45. Name the spherical mirror and lens form(s) a virtual and erect image for all position of object.

Ans. Convex mirror and concave lens.

46. Write the relationship of object distance, image distance and focal length of lenser and mirrors.

Ans. For lenses $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

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

47. When is the magnitude of the power of a lens equal to ifs focal length?

Ans. When the focal of the lens is one metre.

48. Size of the image and that of the object are equal in convex lens, what can you say about the position of the object?

Ans. At 2 F_1

49. Image formed by a convex lens of an object is virtual and erect, what can you say about the position of object?

Ans. It is placed between focus, F_1 and optical centre O.

50. Size of the image formed on convex lens is highly enlarged, state the position of the image.

Ans. At infinity.

51. Write the relative size and nature of the image, when the object is placed between infinity and optical centre O, of a concave lens.

Ans. The image formed is virtual, erect and diminished.

52. Define power of lens.

Ans. The ability of lens to converge or diverge the ray of light is called power of lens. It is equal to the reciprocal of focal length. i.e. P = $\frac{1}{f}$

53. What is meant by power of a lens?

Ans. The ability of a lens to converge or diverge the rays of light, is called power of a lens, is called power of lens. It is equal to the reciprocal of the focal length (i.e., p = $\frac{1}{f}$).

54.How does the size of the image change as the object is brought closer from infinity towards the convert lens?

Ans. The size of the image is formed keeps in increasing as the object is brought closer towards the convex lens.

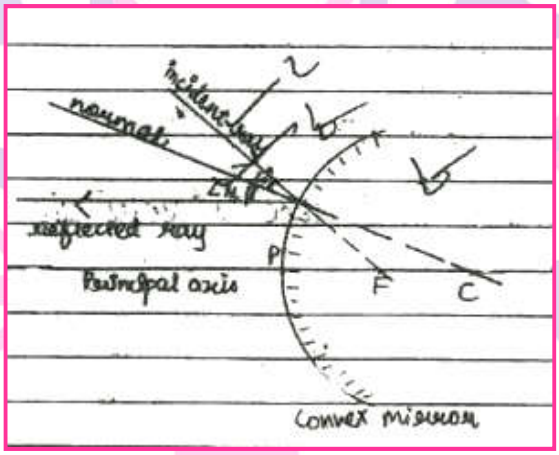
55. The refractive index of diamond is 2.42. What is the meaning of this statement?

Ans. The refractive index of diamond 2-42 suggests that the speed of light in diamond will reduce by a factor 2.42 as compared with its speed in air.

Short Answer Type Questions - I

(2 Marks each)

1. Draw a labelled ray diagram to show the path of the reflected ray corresponding to the ray which is directed towards the principal focus of a convex mirror. Mark the angle of incidence and angle of reflection on it.



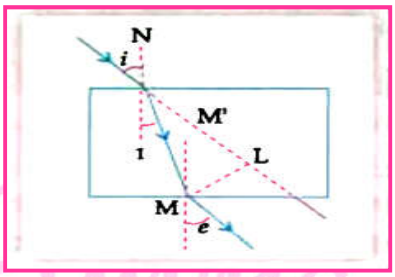
$\angle I$ = angle of incidence

$\angle R$ = angle of reflection

The ray of right directed forwards focus will bounce back and move parallel to the principal axis after reflection.

2. Draw the path of a ray of light when it enters one of the faces of a glass slab at an angle of nearly 45^0. Label on it (i) angle of refraction, (ii) angle of emergence and (iii) lateral displacement.

Ans.



Labelling

Angle or refraction (r_1)

Angle of emergence (e)

Lateral displacement (ML)

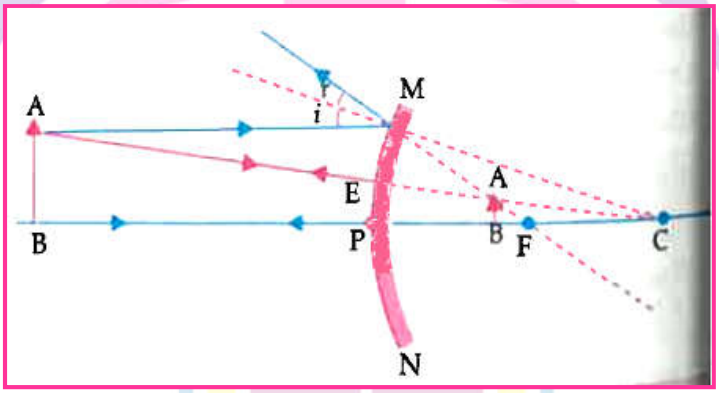
3. If the image formed by a spherical mirror for all position of the object placed in front of it is always erect and diminished, what type of mirror is it?

Draw a labelled ray diagram to support your answer.

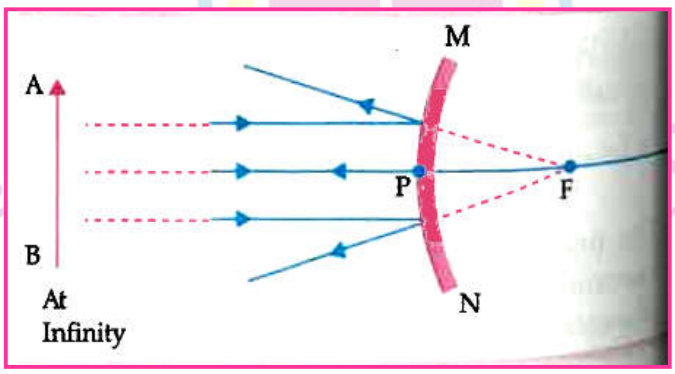
Ans.

Convex Mirror

Labelled Ray diagram for any position of object.



OR



4. Object is placed at a distance of 30 cm in front of a convex mirror of focal length 15 cm. Write four characteristic of the image formed by the mirror.

Ans. Virtual, erect, diminished, laterally inverted.

Detailed Answer:

Four properties of image formed by the given convex mirror are:

(i) Image is always erect.

(ii) Small in size

(iii) Virtual

(iv) Laterally Inverted.

5. **State two positions in which a concave mirror produces a magnified image of a given object. List two differences between the two images.**

Ans. Two positions:

(i) between its pole and focus

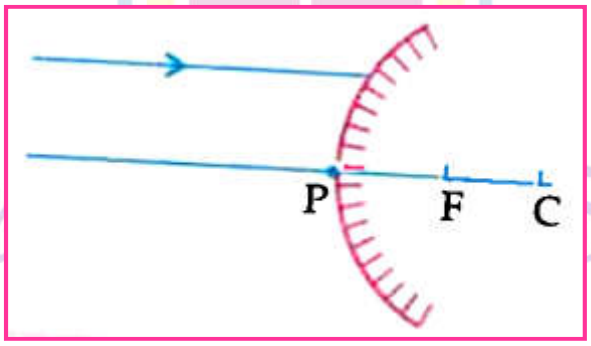
(ii) between the focus and centre of curvature

Two differences:

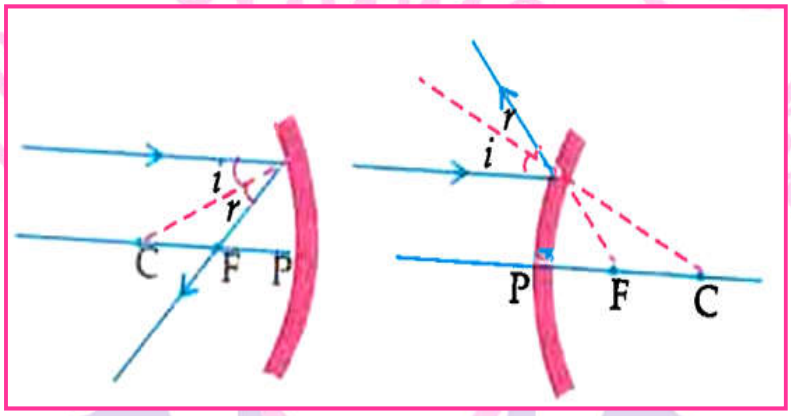
(i) the image is virtual and erect

(ii) the image is real and inverted

6. 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.



Ans.



8. "The magnification produced by a spherical mirror is -3". List four information you obtain from this statement about the mirror/image.

Ans. (i) Magnified (ii) inverted (iii) Concave mirror (iv) real image

9. Teacher gives a convex lens and a concave mirror of focal length of 20 cm each to his student and asks him to find their focal lengths by obtaining the image of a distant object. The student uses a distant tree as the object and obtains its sharp image, one by one, on a screen.

The distances d_1 and d_2 between the lens/ST and the screen in the two cases and the nature of their respective sharp image are likely to be

a. (20 cm, 40 cm) and (erect and erect)

b. (20 cm, 40 cm) and (inverted and inverted)

c. (20 cm, 20 cm) and (inverted and inverted)

d. (20 cm, 40 cm) and (erect and inverted)

Ans:

c. (20 cm, 20 cm) and (inverted and inverted) is correct as focal length remains the same.

The convex lens and concave mirror always form real and inverted images exception a few rare cases.

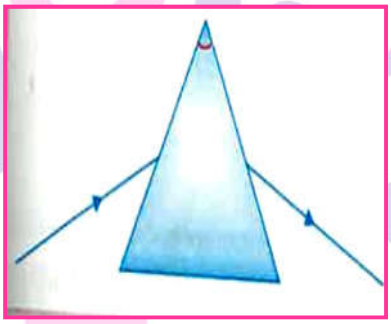
Since the object is a distant one, the image obtain on the screen will be the focus and when calculated focal length remains the same i.e. 20 cm.

10. List four precautions which a student should observe while determining the focal length of a given convex lens by obtaining image of distant object on a screen.

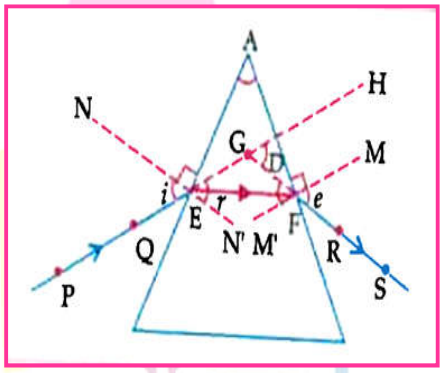
Ans. Precautions:

1. Lens should be held in vertical position with its faces parallel to the screen.
2. Clear and sharpest images should be obtained by adjusting the position of lens.
3. Three observations should be taken at least.
4. Base of lens, screen and measuring scale should be in straight line.

11. A student traces the path of a ray of light through a glass prism as shown in the diagram but leaves it incomplete and unlabelled. Redraw and complete the diagram, also label on it ∠i, ∠e, ∠r and ∠D.



Ans.



12. The power of a lens is +5 dioptre. What is the nature and focal length of this lens? At what distance from this lens should an object be placed so as to get its inverted image of the same size?

Ans. P = +5D

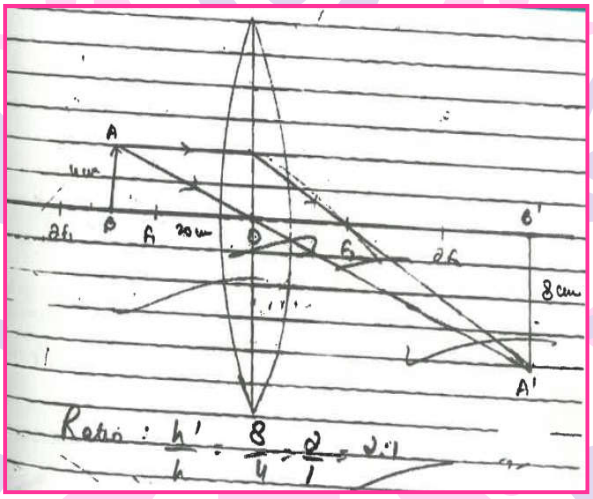
F = 1/p = 100/5 = 20cm

Nature of lens = convex (converging)

Distance is 40 cm (at C)

5. **An object of height 4.0 cm is placed at a distance of 30 cm from the optical centre 'O' of a convex lens of focal length 20 cm. Draw a ray diagram to find the position and size of the image formed. Mark optical centre 'O' and principal focus 'F' on the diagram. Also find the approximate ration of size of the image to the size of the object.**

Ans.



6. **Ans. object is placed at a distance of 30 cm from a concave lens of focal length 15 cm. List four characteristics (nature, position, etc.) of the image formed by the lens.**

Ans. (a) Virtual

(b) Erect

(c)Diminished

(d) On the same side as the object / or any other characteristic.

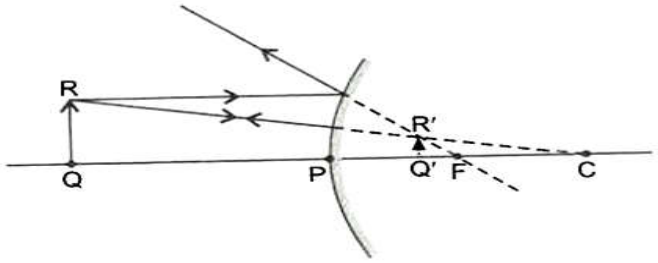
7. **"The linear magnification produced by a spherical mirror is +1/3. Analysing this value state the (i) type of mirror and (ii) position of object with respect to the pole of mirror. Draw ray diagram to justify your answer.**

Ans. (i) Since the magnification is $+\frac{1}{3}$, The image is virtual, It is a convex mirror.

(ii) $$M = \frac{\text{Image distance}}{\text{Object distance}} = \frac{\text{height of image}}{\text{height of object}}$$

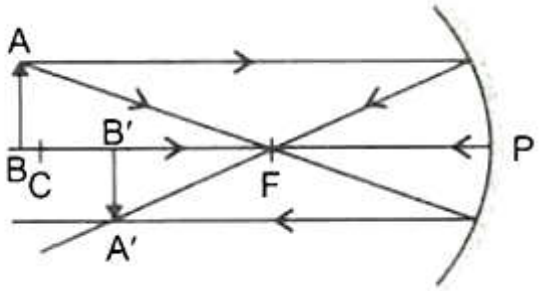
$= \frac{h_i}{h_o} = +\frac{1}{3}$

The image formed is of smaller size than the size of object is placed anywhere between the pole (P) of the mirror and infinity.



8. The linear magnification produced by a spherical mirror is $-\frac{1}{5}$. 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.

Ans. (i) Since the magnification is $-\frac{1}{5}$.



9. To construct a ray diagram, we use two light rays which are so chosen that it is easy to know their directions after refraction from the lens. List these two rays and state the path of these rays after refraction. Use these two rays to locate the image of an object placed between 'F' and '2F' of a convex lens.

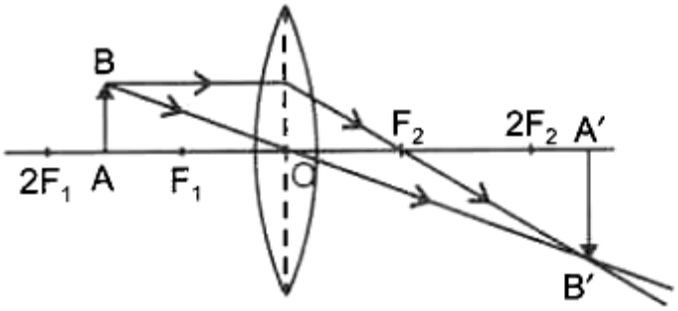
Ans. List of two light parallel to the principal axis.

(ii) A ray of light passing through the optical centre of a lens.

Path of these rays after refraction

In case of a convex lens, the ray parallel to principal axis, after refraction, it will pass through the principal focus positioned on the same side of the object.

A ray of light passing through the optical centre of a lens will emerge from the lens without any deviation in the path.



10. (a) List four characteristics the image formed by plane mirrors.

(b) If a light ray IM is incident on the surface AB as shown, identify the correct emergent ray.

Ans. (a) The following are the four characteristics of the images formed by a plane mirror.

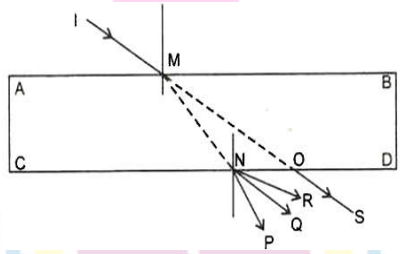
(i) The image is ways virtual and erect.

(ii) The size of image is equal to that of the object.

(iii) The image is formed at the same distance behind the mirror as the object is in front of the mirror.

(iv) The image is laterally inverted.

(b) QN as it has to be parallel to OS.



11. (a) state two positions in which a concave mirror produces a magnified image of a given object. List two differences between the two images.

(b) Focal length by a concave mirror is 20 cm. What is the natural of image is the nature of image is an object is place at 60 cm?

Ans. (b) The two position in which a concave mirror produces a magnified image of the given object , are: when the object is placed between (i) focus (F) and centre of curvature (C) (ii) focus (F) and pole (P)

Two differences between the two images are that the image formed in case (i) is a real and inverted, whereas in case (ii) it is virtual and smaller.

12. (a) List four specific characteristics of the images of the object formed by convex mirrors.

(b) The angle between incident ray and reflected ray is 60^0. What is the angle of incidence?

Ans. (a) Properties of image formed by a convex mirror:

(i) It always formed behind the mirror, between the pole and its focus.

(ii) The image is always virtual and erect.

(iii) The size of image is always smaller than the object.

(iv) Magnification is always positive.

(b) Since $\angle i + \angle r = 60^0$ but $\angle i = \angle r$, so $\angle I = 30^0$.

13. (a) " Vehicles in this mirror are closer than they appear". Why is this warning printed on the side view mirror of most vehicles?

(b) Why do we not see the actual depth of a lake?

Ans. (a) The phrase **"vehicles in this mirror are closer than they appear"** is a safety warning printed on the side view mirror of most vehicles. It is present because the side view mirror is a convex mirror and it gives a virtual image of wide field behind the vehicle and appears the objects smaller and farther away than they actually are, smaller and the angular size of the object. During the lane change, a driver assumes that an adjacent vehicle is at a safe distance behind, when in fact it is quite a bit closer. There warning serves as a remainder to the driver of the potential problem.

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

(b) How does a light ray bend when it travels from (i) a denser to a rarer medium, and (ii) a rarer to a denser medium?

Ans. (a) Magnification, m = + 6 means the image formed is on a concave mirror.

The two characteristics are as follows:

(i) The image is sex times enlarged.

(ii) The nature of the image is virtual and erect.

(b) (i) Bend always from the normal.

(ii) Bends towards the normal.

15. (a) What should be the position of the object, when a concave mirror is used:

(i) as a shaving mirror?

(ii) in torches as reflecting mirror?

(b) Name the kind of lens that can form

(i) Virtual, erect and magnified image

(ii) Virtual, erect and diminished image

Ans. (a) (i) object should be placed between pole and focus.

(ii) Object should be placed at focus.

(b) (i) Convex lens

(ii) Concave lens

16. (a) Find the absolute refractive index of a medium in which light travels with a speed of 1.4 X 10^8 m/s.

(b) How do we distinguish a medium to be rarer or denser? Give two reasons.

Ans. (a) absolute refractive index of the medium is given by

$$n_m = \frac{\text{Speed of light in vacuum (c)}}{\text{Speed of light in medium (v)}}$$

i.e. $n_m = \frac{C}{V}$

Given: c = 3 X 10^8 m/s, v = 1.4 X 10^8 m/s

$$\therefore\ n_m = \frac{c}{v} = \frac{3X10^8}{1.4\ X\ 10^8} = \frac{3}{1.4} = 2.14$$

(b) (i) Based on the bending of light.

(ii) Based on the velocity of light in the medium or by knowing its refractive index.

17. (a) A real image, $\frac{1}{5}$ the size of object is formed at a distance of 18 cm from a mirror. What is the nature of mirror? Calculate its focal length.

(b) Name the kind of lens that can form

(i) Real, inverted and diminished image

(ii) Real, inverted and enlarge image

Ans. (a) Concave mirror as its for a real image and v-18 cm

Given $h_1 = \frac{1}{5} h_0$ and v = -18 cm

$\therefore$ m = $-\frac{v}{u} = -\frac{1}{5}$

$\Rightarrow \left(-\frac{18}{u}\right) = -\frac{1}{5} \Rightarrow$ u = -90 cm

Using $\frac{1}{f} = \frac{1}{v} + \frac{1}{u} = \frac{1}{-18} + \frac{1}{-90}$

$= \frac{5}{=90} - \frac{1}{90}$

$= -\frac{6}{90} = -\frac{1}{15}$

f = - 15 cm

Since focal length is negative, therefore spherical mirror is concave mirror.

(b) (i) Convex lens

(ii) Convex lens

18. (a) Draw a ray diagram to show the formation of image of an object placed between the pole and principal focus of a concave mirror. How will the nature and size of the image formed change, if the mirror is replaced by converging lens of same focal length?

(b) "A concave mirror of focal length 15 cm form a magnified erect as well as inverted image of an object with respect to the pole of the mirror in both cases for obtaining the images.

Ans. (a) When an object is placed between the pole and the principal focus of a concave mirror, a virtual, erect and enlarged image is formed behind the concave mirror as shown in the adjoining figure.

If the concave mirror is replaced by a converging lens of the same focal length, a virtual, erect and enlarge image is formed on the same side of object for the same position of object, i.e between principal focus and the optical centre of the lens.

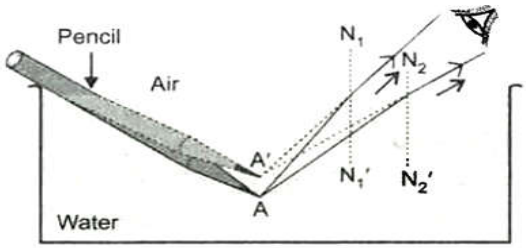
(b) (i) When the object is placed between p)pole) and F (focal length) of the concave mirror, we get a magnified and erect image.

(ii) When the object is placed between C (centre of curvature) and F (focal length), we get a magnified and inverted image.

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

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

Ans. (a) the light different points on the pencil, immersed in water, refract and appear to come from a point above the original position.



(b) Given: air $_{air}n_{ice}$ = 1.31, $_{air}n_{rock}$ = 1.54

$$_{ice}n_{rick} = \frac{air\ ^{n}rock}{air\ ^{n}ice} = \frac{1.54}{1.31} = 1.18$$

20. (a) The refractive index of a medium 'x' with respect to 'y' is 2/3 and the refractive index of medium 'z' is 4/3. Calculate the refractive index to medium 'z' with respect of 'x'.

(b) When sunlight is concentrated on a paper placed at the principal focus of a convex lens, what happens to the paper and why?

Ans. (a) Given $n_{xy} = \frac{2}{3}$, $n_{xy} = \frac{4}{3}$, n_{xy}

We know that,

$n_{xy} \times n_{xy} \times n_{zx} = 1$

$\Rightarrow \frac{2}{3} \times \frac{4}{3} \times n_{zy} = 1 \Rightarrow n_{zx} = \frac{9}{8}$

(b) The paper will burn, because the heat energy of the sun is also concentrated on a small part of paper, i.e. at the principal focus, where the convex form a sharp image of the sun.

21. (a) For the same angle of incidence in media p, Q and R, the angles of refraction are 45^0, 35^0 and 15^0 respectively. In which medium will the velocity of light be (a) minimum (b) maximum? Give reason for you answer.

(b) When light enters from air to glass, the angles of incidence and refraction in air

and glass are 45° and 30^0 respectively. Find the refractive index of glass. air and glass.

(Given that sin 45^0 = $\frac{1}{\sqrt{2}}$, sin 30^0 = $\frac{1}{2}$)

Ans. (a) From snell's law, n = $\frac{\sin i}{\sin r}$

Also, n = $\frac{c}{v}$, $\frac{\sin i}{\sin r}$

Since c and sin i are constant, Therefore, sin r α v.

Since the value of sin r will be least for 15^0 and maximum for 45^0 among the three, the velocity of light will be minimum in medium R. (b) maximum in P.

(b) Using Snell's law,

N_{ga} = $\frac{\sin i}{\sin r}$ = sin $\frac{\sin 45^0}{\sin 30^0}$

$\Rightarrow$ n_{ga} = $\frac{\frac{1}{\sqrt{2}}}{\frac{1}{2}}$ = $\sqrt{2}$ = 1.41

22. (a) How can we differentiate between convex and concave lenses without touching them.

(b) Two thin lenses of power +3.5 D and – 2.5 D are placed in contact. Find the power and focal length of the lens combination.

Ans. (a) Keep the lens close to the printed page of the book observed the image of the printed letters through the lens. If the printed letters appear enlarged, then the lens is convex and if they appears diminished, then the lens is concave.

(b) Given: P_1 = 3.5 D, P_2 = - 2.5 D

Total power = P = P_1 + P_2 = 3.5 – 2.5

= 1 dioptre = + 1 D

Focal length of combination,

f = $\frac{1}{p}$ = $\frac{100}{p}$ cm = $\frac{100}{1}$cm

f = 100 cm

23. (a) " A convex of focal length 'f' can form a magnified erect as well inverted image." Justify this statement stating the position of the object with respect to the lens in each case for obtaining these images.

(b) A convex lens of focal length 25 cm and a concave lens of focal length 10 cm are placed in close contact with each other. Calculate the lens power of this combination.

Ans. (a) A convex lens of focal length 'f' can form:

(i) A magnified and erect image only, when the object is placed between the focus and the optical centre of the lens.

(ii) An inverted image, when the object is placed beyond the focus of the lens.

(b) Given: f = 25 cm (convex), f= -10 (concave)

Power of the combination= p = P_1+ P_2

$= \frac{100}{25} + \frac{100}{-10}$ = 4 – 10 = - 6 D

24. (a) The power of a combination of two lenses XY is 5D if the focal length of lens X is 15 cm. State the nature and focal length of lens Y.

(a) When object is placed between infinity and the pole of the mirror, where is the image formed? Convex.

Ans. (a) Power of a combination of two lenses X and Y = 5D

$\therefore P = P_x + P_y$

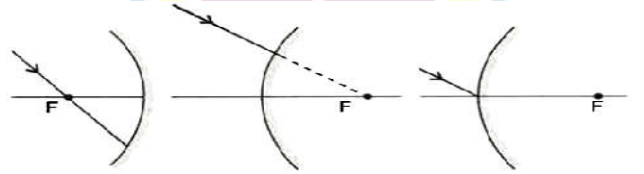
$\therefore 5 = \frac{100}{15} + \frac{1}{fy}$ $(\because f_x = 15 \text{ cm})$

$\Rightarrow \frac{1}{fx} = 5 - \frac{100}{15} = -\frac{25}{15}$

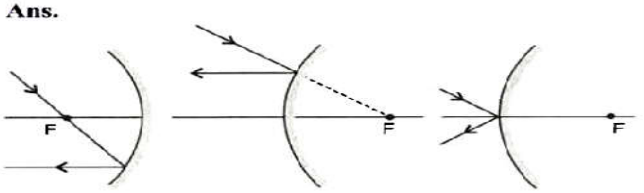
$\therefore fy = -\frac{15}{25} = -0.6 \text{ m} = -60 \text{ cm}$

Therefore, the focal length of given lens Y is 60 cm and it is a concave lens.

25. 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.



Ans.



26. 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.

Ans. Given: Magnification of spherical mirror = -1, Image distance, v = -40 cm

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

$\Rightarrow$ u = $-\frac{v}{m} = \frac{-40}{-1}$ = 40 cm

Therefore, the object is placed at a distance of 40 cm in front of the spherical mirror.

Case 1 : When u = -40 cm and v = -40 cm,

Using mirror formula, we get

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

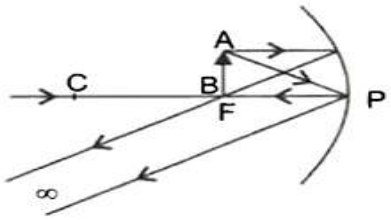
$\Rightarrow \frac{1}{f} = \frac{1}{-40} + \frac{1}{-40} = -\frac{2}{40}$

$\Rightarrow$ f = $-\frac{40}{2}$ = - 20 cm

Hence the focal length of the mirror is 20 cm , and the negative focal length shows that it is a concave mirror.

The new position of the object when it moves 20 cm toward the concave mirror, u′ = -(40 – 20) = -20 cm.

Case II: u′ = - 20 cm, f = - 20 cm, v′ = ?



From mirror formula,

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

$\Rightarrow \frac{1}{-20} = \frac{1}{v'} + \frac{1}{-20}$

$\Rightarrow \frac{1}{v'} = -\frac{1}{20} + \frac{1}{20}$

= - $(\frac{1}{20} - \frac{1}{20}) = -\frac{0}{20}$

$\Rightarrow$ v′ = $-\frac{20}{0}$ = - ∞ (infinity)

Thus, the image is formed at infinity.

Hence when the object is moved 20 cm towards the mirror, a real, inverted and highly enlarged image is formed at infinity.

27. A Spherical mirror produces an image of magnification -1 on a screen placed at a distance of 50 cm from the mirror.

(a) Write the type of mirror.

(b) Find the distance of the image from the object.

(c) What is the focal length of the mirror?

(d) Draw the ray diagram to show the image formation in this case.

Ans. (a) As magnification is negative, the image formed is real. Hence, it is a concave mirror.

(b) $\therefore$ m = $\frac{-v}{u}$ = - 1

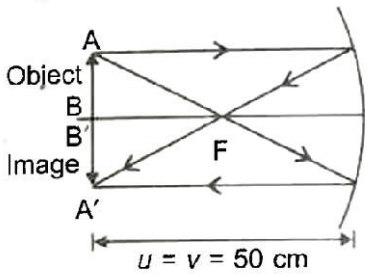
$\therefore$ u = v = -50 cm

$\therefore$ u = v = - 50 cm

$\therefore$ Distance of the image from the object is zero. This happens when the object is placed at the centre of curvature of the concave mirror. The image is also formula at '*C*'.

(c) Using mirror formula,

$\frac{1}{f} = \frac{1}{v} + \frac{1}{u} = \frac{1}{(-50)} + = \frac{1}{(-50)} = \frac{-1}{25}$



28. A student wants to project the image of a candle flame on a screen 80 cm in front of a mirror by keeping the candle flame at a distance of 20 cm from its pole.

(i) Which type of mirror should the student use?

(ii) Find the magnification of the image produced.

(iii) Draw a ray diagram to show the image formation in this case and mark the distance between the object and its image.

(iv) Draw a ray diagram to show the image formation in this case and mark distance between the object and its image.

Ans. (i) Concave mirror, as it forms real image on the same side of the mirror.

(ii) Magnification, m = $\frac{v}{u}$ = - $\frac{-80}{-20}$ = -4

The negative sign in magnification shows that the image formed is real and inverted.

(iii) Distance between the object and its image = 80 – 20 = 60 cm.

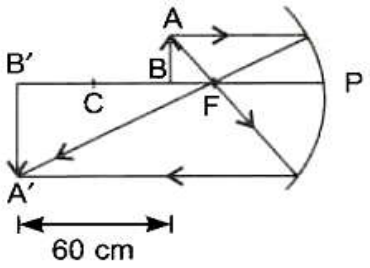
(iv) The focal length of the concave mirror is given by.

$\frac{1}{f} = \frac{1}{v} + \frac{1}{u} = \frac{1}{-80} + \frac{1}{-20}$

$= -\frac{5}{80} = -\frac{1}{16}$

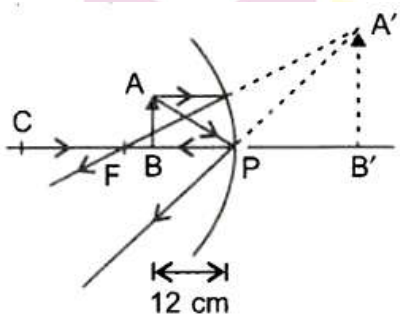
$\therefore$ f = - 16 cm, R = 2f = - 32 cm

Since u = - 20 cm, it implies that the object lies between F and C, so image if formed beyond the centre of curvature as show below:



The image is real, inverted and enlarge.

29. 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 object from the mirror? State the nature and size of the image he is likely to observe. Draw a ray diagram to justify your answer.



Ans. If a student wants to obtains an erect image of an object using a concave mirror of 12 cm focal length. He should keep the object between the pole and the focus of the mirror, therefore, a virtual, erect and enlarged image will be formed behind the mirror.

30. For the given data showing the focal lengths of three concave mirrors A,B and C, and the respective distances of different objects from these mirrors.

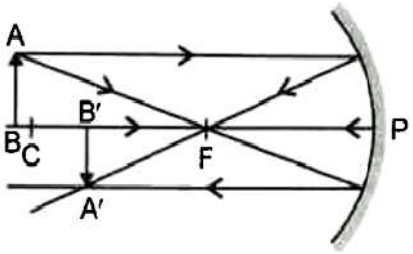
S.No	Object distance (cm)	Focal length (cm)
A	45	20
B	30	15
C	20	30

Answer the following questions:

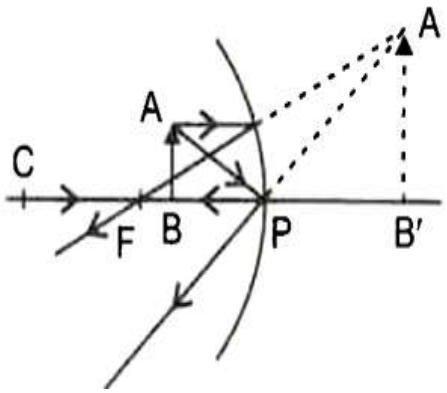
(i) In the given position of object from the mirrors, which mirror will form a diminished image of the object. Draw a ray diagram for image formation by this mirror.

(ii) Which mirror can be conveniently used as a make-up mirror? Draw a ray diagram to illustrate this function.

Ans. (i) Concave mirror A will form the diminished image of the object as the object is place Beyond the centre of curvature (>2f) of the mirror.



(ii) Concave mirror 'C' can be used as a make- up mirror as the object distance is less than the focal length of concave mirror, i.e. when the object is placed between the focus 'F' and the pole 'P' of the concave mirror, a virtual, erect and enlarged image if formed.



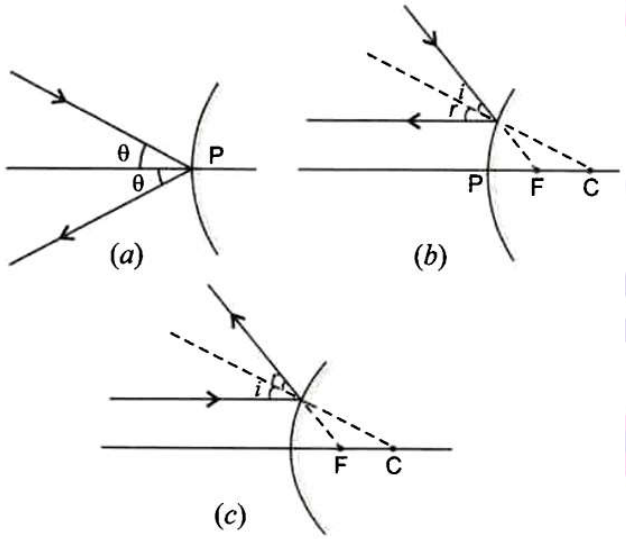
31. Draw a ray diagram to show the path of the reflected ray in each of the following case. A ray of light incident on a convex mirror.

(a) strikes at its pole making n angle θ from the principal axis.

(b) is directed towards its principal focus.

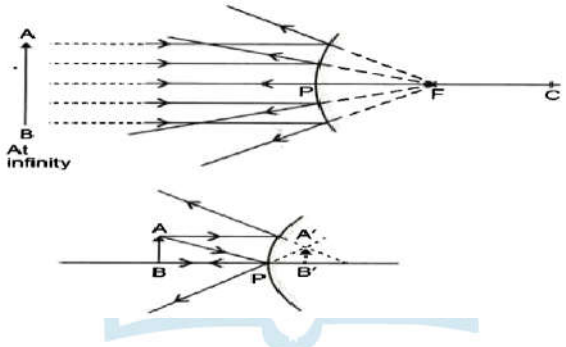
(c) is parallel to its principal axis.

Ans.



32. If the mage 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?

Ans. Convex Mirror



A convex mirror is commonly used as a rear-view mirror in vehicles because it always produces a virtual and erect image whose size is smaller than the object. Therefore, it enables the driver to see a wide field of view of the traffic behind the vehicle in a small mirror.

33. A 4.5 cm needle is placed 12 cm away from a convex mirror of focal length 15 cm. Give the location of the image and magnification. Describe what happens as the needle is moved farther from the mirror?

Ans. Given: h_0 = + 4.5 cm, u = -2 cm, f = + 15 cm from mirror equation,

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

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

$$= \frac{1}{+15} + \frac{1}{12} = \frac{3}{20}$$

$$v = + \frac{20}{3} = + 6.7 \text{ cm}$$

Also, magnification,

$$m = \frac{h_i}{h_o} = -\frac{v}{u} = - \frac{(20|3)}{-12}$$

$$\therefore \frac{h_i}{h_0} = \frac{20}{3\ X\ 12} \Rightarrow h_i = \frac{20\ X h_0}{3\ X\ 12}$$

$$\Rightarrow h_i = \frac{20\ X\ 4.5}{3\ X\ 12} = \frac{5}{2} = 2.5 \text{ cm}$$

$\therefore$ A virtual and diminished image is formed by a convex mirror at a distance of 6.7 cm behind the mirror and the size of image is reduced to 2.5 cm.

As the needle is moved farther from the mirror, the image moves towards the focus and will gradually reduce in size further.

34. An object is placed at a distance of 30 cm from a convex mirror, the magnification produced is 1/2. Where should the object be placed to get the magnification of 1/3?

Ans. Given: u = - 30 cm, m = $\frac{1}{2}$

Using the formula, m

$= -\frac{v}{u}$ (For a convex spherical mirror)

$$\therefore \quad \frac{1}{2} = \frac{v}{-30} \Rightarrow \quad v = + 15 \text{ cm}$$

Using mirror formula,

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

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

$$\therefore \quad f = + 30 \text{ cm}$$

Again, $m' = -\frac{v'}{u'}$

$\frac{1}{3} = -\frac{v'}{u'} \Rightarrow u' = -\frac{u'}{3}$

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

$\therefore \quad \frac{1}{30} = \frac{3}{u'} + \frac{1}{u'} = -\frac{2}{u'}$

$\Rightarrow$ u' = - 60 cm

Hence the object should be placed at a distance of 60 cm in front of a convex mirror to get the magnification of 1/3.

35. An object is kept in front of a concave mirror of focal length 30 cm. The image is three times the size of the object. Calculate two possible distances of the object from the mirror.

Ans. Given: f = - 20 cm, $h_i = 3h_0$

For a real image:

$M = -\frac{v}{u} = -3 \Rightarrow v = 3u$

Using mirror formula,

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

$\Rightarrow \quad \frac{1}{-30} = \frac{1}{3u} + \frac{1}{u}$

$\Rightarrow$ u = - 40 cm

For a virtual image: $m = -\frac{v}{u} = +3 \Rightarrow v = -3u$

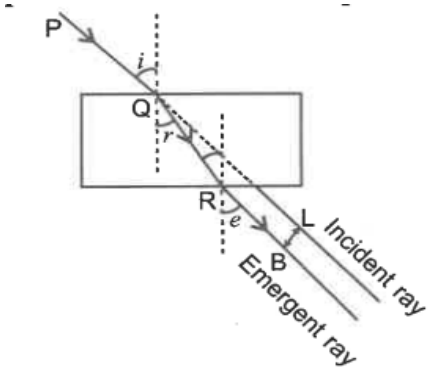
Using mirror formula,

$\frac{1}{f} = \frac{1}{v} + \frac{1}{u} \Rightarrow \frac{1}{-30} = \frac{1}{-3u} + \frac{1}{u}$

$\Rightarrow$ u = - 20 cm

The two possible positions of the object are 40 cm and 20 cm in front of a concave mirror.

36. What is understood by lateral displacement of light? Illustrate it with help of a diagram. List any two factors on which the lateral displacement of a particular substance depends.



Ans. Lateral displacement is the perpendicular distance between the incident ray produced emergent ray. The lateral displacement in the given diagram is BL.

The lateral displacement depends on the thickness of the slab, the incident angle and the refractive index of the material.

37. 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.

Ans. Law of refraction of light:

(a) The incident ray, the normal at the point of incidence and the refracted ray, all lie in the same lane for the two given transparent media.

(b) The ration of sine of angle of incidence, i.e sin i to the sine of angle of refraction, i.e. sin r is always constant, for the light of a given colour and for the given pair of media.

Mathematically, $\frac{\sin i}{\sin r}$ = constant = n_{21}

The constant n_{21} is called the refractive index of the second medium with respect to the first medium.

Absolute Refractive Index: The refractive index of medium 2 with respect to vacuum or air is considered to be its absolute refractive index. It is represented by n_2. It is also equal to the speed of light in vacuum to the speed of light in the medium.

i.e. $n_2 = \frac{\text{Speed of light in air or vacuum (c)}}{\text{Speed of light in the medium (v)}}$

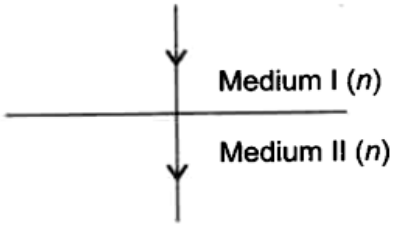
$= \frac{c}{v}$

38. (a) Draw a ray diagram to show the path of a light ray passes from one medium to another if the two media are optically exactly the same.

(b) Absolute refractive indices of medium 'A' and medium 'B' are 'n_a' and 'n_b' respectively. What is the refractive index of medium 'B' with respect to medium 'A'.

(c) How does the velocity of light vary with change in the optical density of the media?

Ans. (a) Since two media are optically exactly the same, no bending of the rays occurs when they pass from one medium to another as their refractive indices are equal.



(b) Refractive index of medium 'B' with respect to 'A' is

$$n_{BA} = \frac{n_B}{n_A}$$

(c) Refractive index of the medium n_m is given by

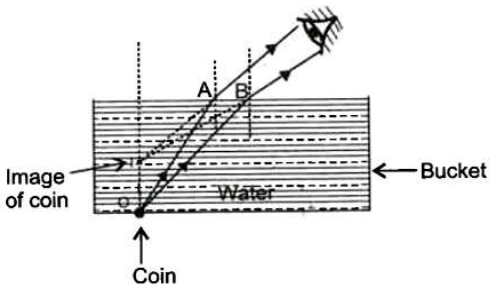
$$N_m = \frac{\text{Speed of light in air}}{\text{Speed of light in medium}} = \frac{c}{v}$$

or $$u = \frac{c}{n_m}$$

It is obvious from the above relation, that the speed of light decreases with the increase in optical density, i.e. refractive indices of the media.

39. A coin is kept at the bottom of an empty bucket. A student standing near to it cannot see the coin. Another student pours some water into the bucket without disturbing the coin. Now, the first student is able to see the coin from the same position. Explain how it become possible to see the coin now? Draw a ray diagram to illustrate it.

Ans. When the coin is under water, then due to refraction of light, a virtual image of the coin is formed which is slightly above its actual position nearer to the water surface as shown in the figure. Thus, the coin becomes visible again on pouring some water into the bucket.



40. (a) Differentiate between reflection and refraction.

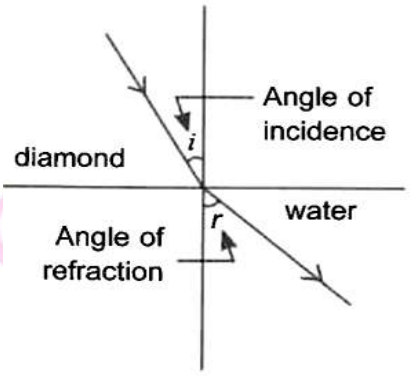
(b) A lemon kept in water in a glass tumbler appears to be bigger than its actual size, when views from the sides. Explain why it so appears.

Ans. (a) Difference between reflection and refraction

Reflection	**Refraction**
(i) It is the phenomenon of change in the path of light rays in a particular direction into the same medium again is called reflection. (ii) The reflecting surface of all types, obey the laws of reflection.	(i) When a ray of light enters from one medium into another obliquely, the direction of propagation of the light in the second medium changes. This is called the refraction of light (ii) The refracting surfaces obey the laws of refraction.

(b) As the ray of light comes into air from the different points on the surface of a lemon kept in water in a glass tumbler, it bends away from the normal, i.e. there is a change in the direction of propagation of light due to refraction. So, the ray of light appears to come from a point different from that of the actual point. Therefore, the lemon in water appears to be bigger than its actual size, when viewed from the sides of the glass tumbler.

41. A ray of light is incident on the interface separating diamond and water. Given that refractive indices of diamond and water with respect to air are 2.42 and 1.33 respectively, complete the diagram by showing a refracted ray and mark the angles of incidence and refraction.



42. An object of height 6 cm is placed perpendicular to the principal axis of a concave lens of focal length 5 cm. Use lens formula to determine the position, size and nature of the image if the distance of the object from the lens is 10 cm.

Ans. Given: h_0 = 6 cm, f = -5 cm, u = - 10 cm

Using lens formula,

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

$$\therefore \quad \frac{1}{-5} = \frac{1}{v} - \frac{1}{-10}$$

or $$\frac{1}{v} = \frac{1}{-5} - \frac{1}{10} = \frac{-2-1}{10}$$

$$\frac{1}{v} = \frac{1}{-5} - \frac{1}{-10} = \frac{-2-1}{10}$$

$$\frac{1}{v} = \frac{-3}{10}$$

$$V = -\frac{10}{3} cm$$

Thus, the image is formed on the same side of the object at a distance of $-\frac{10}{3}$ cm from the optical centre of the lens. The negative sign indicates that the image is virtual.

Using the formula,

$$m = \frac{h_i}{h_o} = \frac{v}{u}$$

$\Rightarrow$ $h_i = \frac{v}{u} \times h_0$

$= \frac{-10}{3\ X\ (-10)} \times 6 = +2$ cm

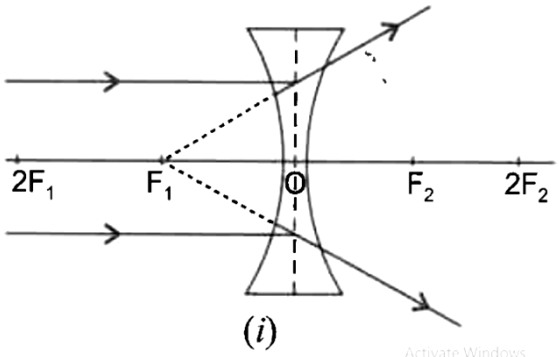
The positive sign indicated that the image is erect.

43. If the image formed by a lens for all positions of the object placed in fri=ont 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 numberical value of focal length of such a lens is 20 cm, find its power in new cartesian sign conventions.

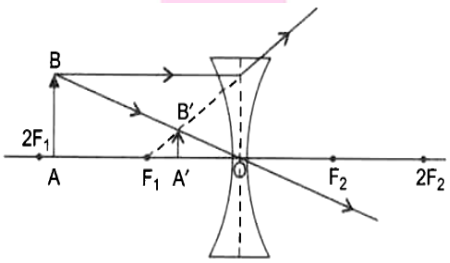
Ans. Concave lens.

(i) When an object is placed at infinity.

(ii) When an object is placed between F_1 and $2F_{1=}$.



(i)



(ii)

Thus, from the above figures, it is clear that whatever be the position of the object in front of a concave lens, the image formed is always virtual, erect and diminished.

The power of the given lens is calculated as

$P = \frac{1}{f(m)} = \frac{100\ cm}{-\ 20\ cm} = -5$

$\Rightarrow$ P = -5D

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

Ans. Power of Lens: The ability of a lens to converge or diverge the ray of light after refraction, is called power (P) of the lens. It is defined as the reciprocal of the focal length, i.e P = $\frac{1}{f}$.

The SI unit of power of alens is 'dioptre'. A lens of focal length 100 cm has a power of 1 dioptre = 1 m^{-1}.

Power of lens A, $P_A = \frac{1}{f_4} = \frac{1}{0.40} = +2.5$ D

Power of lens B, $P_B = \frac{1}{f_B} = \frac{1}{-0.20} = -5$ D

Hence, the nature of lens A is convex with power + 2.5D and lens B is concave with power - 5D.

45. An object of height 5 cm is placed perpendicular to the principal axis of a conave lens of focal length 10 cm. If the distance of the object from the optical centre of the lens is 20 cm, determine the position, nature and size of the image.

Ans. Given: h_0 = + 5 cm, f = -10 cm, u = - 20 cm, u = ?, h_i = ?

Using lens formula,

$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$, we get

$\frac{1}{-10} = \frac{1}{v} - -\frac{1}{20} = \frac{1}{v} + \frac{1}{20}$

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

$\therefore \frac{1}{v} = -\frac{20}{3} = -6.67$ cm

So, the image is formed on the same side of the object at a distacne of 6.67 cm. The negative sign indicates that the image is virtual.

Also $|v| < |u|$, so the image is diminished.

$\therefore$ m = $\frac{v}{u} = \frac{h_j}{h_0}$

or $\frac{-20/3}{-20} = \frac{h_j}{5}$

or $h_i = \frac{5}{3} = 1.66$ cm

So, the image is virtual, erect, diminished and of size 1.66 cm.

46. Draw a ray diagram to show tha pth of the refracted ray eachof the following cases:

A ray of light incient on a concave lens is

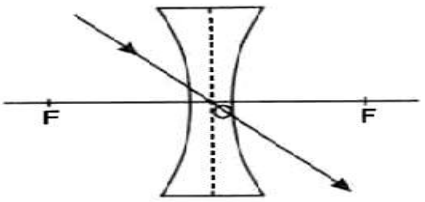
(i) Passing through its optical centre.

(ii) Parallel to its optical axis.

(iii) directed towards its principal focus.

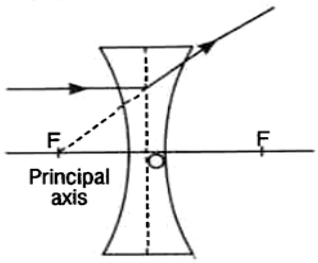
Ans.

(i)



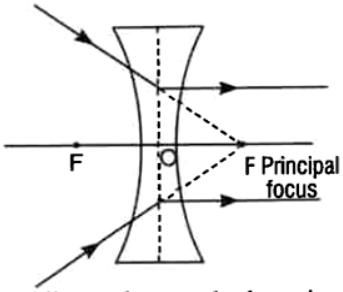
Ray passing through the optical centre of a concave lens

(ii)



Ray parallel to the principal axis of a concave lens

(iii)



Rays directed towards the principal focus of a concave lens

47. 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.

Ans. Given: u = - 30 cm, u = + 60 cm, h_0 = + 3 cm

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

$= \frac{1}{60} \quad \frac{1}{-30} = \frac{1}{60} + \frac{1}{30} = \frac{1}{30} = \frac{1}{20}$

The positive sign of the focal length indicates that the given lens is convex in nature whose focal length is 20 cm.

Again, m = $\frac{h_i}{h_0} = \frac{v}{u}$

or $h_i = \frac{v}{u} \times h_0 = \frac{+60}{-30} \times 3 = -6$ cm

So, the height of image is 6 cm. The negative that the given lens is convex in nature whose focal length is 20 cm.

Again, m= $\frac{h_i}{h_0} = \frac{v}{u}$

or $h_i = \frac{v}{u} \times h_0 = \frac{-30}{-10} \times 6 = +18$ cm

So, the image is three times larger than the size of the object, i.e. 18 cm.

The positive sign indicates that the image is erect.

48. A convex lens has a focal length of 10 cm. At what distance from the lens should the object be placed so that it forms a real and inverted image 20 cm away from the lens? What would be the size of the image formed if the object is 2 cm high? With the help of a ray diagram show the formation of the image by the lens in this case.

Ans. Given: f = + 10 cm, v = + 20 cm as image is real and inverted.

Height of the object = 2 cm (Say +ve)

Using lens formula,

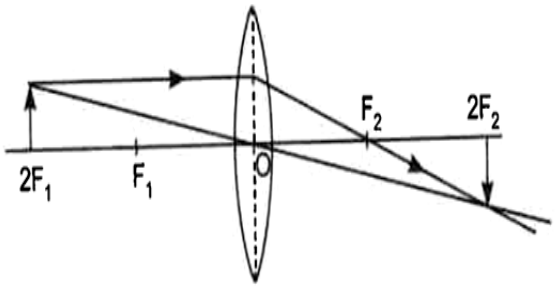
$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$; we get

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

$= \frac{1}{+20} - \frac{1}{10} = \frac{+1-2}{20} = -\frac{1}{20}$

$\therefore$ u = -20 cm (= 2f)

Hence the object is placed at $2F_1$, the image is also formed at $2F_2$ on the other size of the lens. So, the image will be of the same size as the objects as $|u| = |v|$ and therefore, the height of the image will be 2 cm.



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

Ans. Given: h_1 = + 4 cm, f = -10 cm, u = -15 cm, v = ? and h_2 = ?

Using spherical mirror formula, we get

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

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

$$\frac{1}{v} = \frac{1}{-10} - \frac{1}{-15} = \frac{-3+2}{30} = -\frac{1}{30}$$

$\therefore$ V = - 30 cm

Thus, screen should be placed at a distance of 30 cm on the same side of the objects to obtain its sharp image.

Now, $\frac{h_2}{h_1} = -\frac{v}{u}$

$\therefore \quad h_2 = -\frac{v}{u} \times h_1 = = \frac{-30\ cm}{-15\ cm} \times 4$ cm

= - 8 cm

The height of real and inverted image is 8 cm.

50. An object placed on a metre scale at 18 cm mark was focussed on a white screen placed at 92 cm mark, using a converging lens placed on the scale at 50 cm mark.

(i) Find the focal length of converging lens.

(ii) Find the position of the image formed if the objects are shifted towards the lens at a position of 29.0 cm.

(iii) State the nature of the image formed if the object is further shifted towards the lens.

Ans, (i) ∴ u = - (50 – 8) = -42 cm,

V = 92 – 50 = 42 cm

Focal length of converging lens (convex lens)

is given by

$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ (lens formula)

$\frac{1}{f} = \frac{1}{42} - \frac{1}{-42} = \frac{2}{42} = \frac{1}{21}$

∴ f = 21 cm

(ii) Now, the object is shifted towards the lens at a position of 29.0 cm. Therefore, new object distance, u' = (50 – 29) = 21 cm.

Again lens formula,

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

$\frac{1}{21} = \frac{1}{v'} - \frac{1}{-21}$

$= \frac{1}{v'} + \frac{1}{21}$

$\therefore \frac{1}{v'} = \frac{1}{21} - \frac{1}{21} = 0$

or $v' = \frac{1}{0} = \infty$

So, the image will be formed at infinity.

(iii) If the object is further shifted towards the lens, the object is now within the focus of a convex lens so the nature of image formed is

- Virtual and erect, and
- Enlarged or magnified, i.e. larger than the size of the size of the object.

51. The magnification of an image formed by a lens is -1. If the distance of the image from the optical centre of the lens is 25 cm, where is the object placed? Find the nature and focal length of the lens. If the object is displaced 15 cm towards the lens. If the object is displaced 15 cm towards the optical centre of the lens, where would the image be formed? Draw a ray diagram to justify your answer.

Ans. For real image, m = -1

Therefore, $m = \frac{v}{u} = -1$

or u = -v, v = -u, -u = v = -25

Using lens formula,

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

$= \frac{1}{25} - \frac{1}{-25} = \frac{2}{25} = \frac{1}{12.5}$

f = +12.5 cm

Thus, the positive focal length shows that the given lens is a convex lens of focal length 12.5 cm.

If the object is now displaced 15 cm towards the optical centre of the lens i.e. object is now placed at a distance of 25 – 15 = 10 cm from the optical centre.

Therefore u = 10 cm, and f = +12.5 cm.

Using lens formula again,

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

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

$= \frac{2}{25} + \frac{1}{-10}$

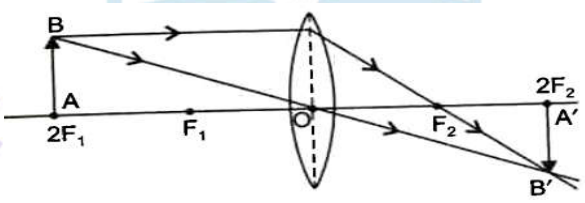
$= \frac{2}{25} - \frac{1}{10} = \frac{-1}{50}$

$v = -50cm$

So, in this case, virtual image is formed on the same side of the object at a distance of 50 cm from the optical centre of the lens as shown in figure.

52. An object 2 cm high is placed at a distance of 64 cm from a white screen. On placing a convex lens at a distance of 32 cm from the object is formed on the screen. What is the focal length of the convex lens and size of the image formed on the screen? Draw a ray diagram to show the formation of the image in this position of the object with respect to the lens.

Ans. Since the object- screen distance is double of the object –lens separation, the object is at a distance of 2f from the lens and the image should be of the same size of the object formed at $2f_2$ on the screen.

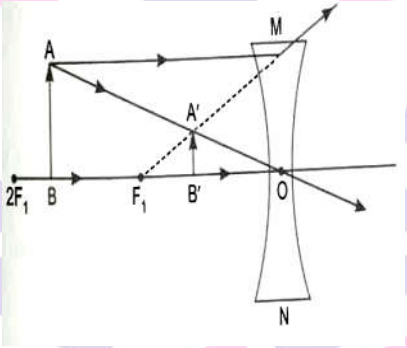


So, 2f = 32 $\Rightarrow$ f = 16 cm

Height of image = Height of object = 2cm

53. If the image formed by a lens for all positions of an object placed in front of it is always erect and diminished, what is the nature of this lens? Draw a ray diagram to justify your answer. If the numerical value of the power of this lens is 10 D, what is its focal length in the Cartesian system?

Ans. It is a concave or diverging lens



f = $\frac{1}{p}$,

p = - 10D,

f = $\frac{1}{-10D}$ = -0.1 m

or f = - 10 cm

54. An object is kept at a distance of 18 cm, 20 cm, 22 cm and 30 cm respectively from a lens of power + 5D.

(i) In Which case or cases would you get a magnified image?

(ii) Which of the magnified image can be got on a screen?

Ans. ∴ Power of lens = + 5 D

∴ f = $\frac{1}{p}$ = $\frac{1}{+5}$ = +0.2 m = + 20 cm

(i) We would get a magnified image only when the object is kept at a distance of 18 cm, 20 cm and 22 cm respectively.

(ii) The object at the positions of 20 cm and 22 cm will produce a magnified image on a screen.

Reason:

(i) A magnified virtual image is formed by a convex lens when the object lies between the focus and the optical centre of the lens.

(ii) A magnified real image is formed by a convex lens when the object is at F or between F and 2F.

55. What is mean by power of lens? You have three lenses L_1 , L_2 and L_3 of power + 10 D, +5 D and – 10 D respectively. State the nature and focal length of each lens. Explain which of the three lenses will from a virtual and magnified image of an object placed at 15 cm from the lens. Draw the ray diagram in support of your answer.

Ans. Power of lens : It is the degree of convergence or divergence of light rays after refraction through a spherical lens is called power of lens. It is the reciprocal of its focal length.

$$\therefore \text{ Power} = \frac{1}{\text{Focal length(in metre)}}$$

$$\Rightarrow \quad P = \frac{1}{f(m)} = \frac{100}{f(cm)}$$

For lens L_1; $f_1 = \frac{100}{P_1} = \frac{100}{+P}$

= +10 cm (convex)

For lens L_2; $f_2 = \frac{100}{P_2} = \frac{100}{+5}$

= + 20 cm (convex lens)

For lens L_3; $f_3 = \frac{100}{-10} = \frac{100}{-10}$ = -10 cm (convex lens)

When object is placed between focus and optical centre of convex lens, virtual erect and magnified image is formed on the same side of the lens.

Hence, for the object distance of 15 cm , Lens L_2 will form the same.

56. We wish to obtain an equal sized inverted image of a candle flame on a screen kept at distance of 4 m from the candle flame.

(a) Name the type of lens that should be used.

(b) What should be the focal length of the lens and at what distance from the candle flame the lens be placed.

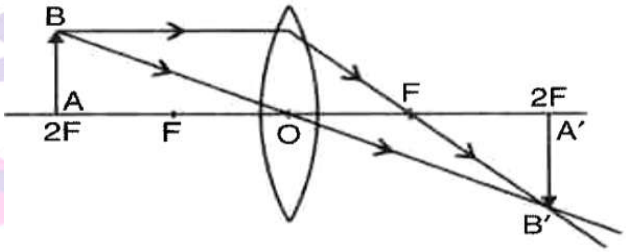
(c) Draw a labelled diagram to show the image formation in this case.

Ans. (a) Convex lens.

(b) $2F = 4 \Rightarrow f = 2$ m

Distance of candle flame from the lens = 4 m.

(c)



57. A 5 cm tall object is placed at a distance of 30 cm from a convex mirror of focal length 15 cm. Find the position, size and nature of the image formed.

Ans. Given: $h_1 = +5$ cm; $u = -30$ cm, $f = +15$ cm , $v = ?$

Using mirror equation,

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

$$\therefore \quad \frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{+15} - \frac{1}{-30}$$

$$= \frac{1}{15} + \frac{1}{30} = \frac{2+1}{30} = \frac{1}{10}$$

$$\therefore \quad V = +10 \text{ cm}$$

Hence, the image is forced behind the convex mirror at a distance of 10 cm

Now, $= = \frac{h_2}{h_1} = -\frac{v}{u}$

$$\Rightarrow \quad h_2 = \frac{+10}{-20} \times (+5) = +\frac{5}{3}$$

$$= +1.66 \text{ cm}$$

Positive sign indicates that image is virtual, erect and diminished.

58. Define the term magnification as referred to spherical mirror. If a concave mirror forms a real image 40 cm from the mirror, when the object is placed at a distance of 20 cm from its pole, find the focal length of the mirror.

Ans. Magnification of spherical mirror (m): It is equal to the ration of size (height) of the image to the size (height) of the object. Thus,

$$m = \frac{\text{Size of image } (h_2)}{\text{Size of object } (h_1)}$$

Given: for concave mirror u = - 20 cm, v = - 40 cm,

or $\frac{1}{f} = \frac{1}{-40} + \frac{1}{20}$

$= -(\frac{1}{40} + \frac{1}{20})$

$= -\frac{3}{40}$

$F = -\frac{40}{3}$

59. State Snell's law of refraction of light. Express it mathematically. Write the relationship between absolute refractive index a medium and speed of light in vacuum.

Ans. Snell's Law: The ration of sine of angle of incidence (i.e. sin i) to the sine of angle of refraction (i.e. sin r) is always constant for the light of given colour and for the given pair of media.

Mathematically, $\frac{\sin i}{\sin r}$ = constant = n_{21}

The constant n_{21} is called refractive index of the second medium with respect to the first medium.

Absolute refractive index of the medium is given by

$$n_m = \frac{\text{Speed of light in vacuum } (c)}{\text{Speed of light in medium } (v)} = \frac{c}{v}$$

60. Name the type of mirror used (i) by dentists and (ii) shaving mirrors, Give two reasons why such mirrors are used in each case.

Ans. (i) Dentists use a concave mirror because it converge the light and when the object lies between its pole and principal focus, it forms a virtual, erect and enlarged image behind it.

Hence they use the concave mirror so that they could see the cavity or plaque clrarly, which is inside the teeth.

(ii) When the object lies between the pole and the principal focus of a concave mirror, it forms a virtual, erect and enlarge image behind it. So, the concave mirror can be used as a shaving mirror to see a large image of the face.

Short Answer Type Questions - II

1. A Student holding a mirror in his hand, directed the reflecting surface of the mirror towards the Sun. He then directed the reflected light on to a sheet of paper held close to the mirror.

(a) What should he do to burn the paper?

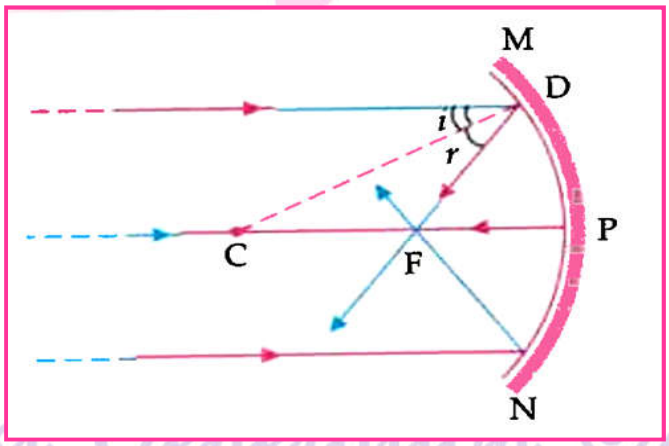
(b) Which type of mirror does he have?

(c) Will he be able to determine the approximate value of focal length of this mirror from this activity? Give reason and draw ray diagram to justify your answer in this case.

Ans. (a) Move the mirror/paper to focus the rays at one point.

(b) Concave mirror.

(c)Yes, distance between mirror and the point the sharp focussed image of sun formed gives approximate focal length.



Detailed Answer.

(a) He should move the sheet of paper back and forth gradually until he finds a bright and sharp spot of lights. He should hold the mirror and paper in the same position for a few minutes to burn the paper.

(b) He has concave mirror.

(c) Yes, he will be able to determine the approximate value of focal length of this mirror from this activity because the spot of light is the image of the sun which is at the focus of the concave mirror. Therefore, the distance of this image from the position of this mirror gives the approximate value of focal length of this mirror.

Ray diagram: Same in marking scheme answer.

2. A 5 cm tall object is placed at a distance of 30 cm from a convex mirror of focal length 15 cm. Find the position, size and nature of the image formed.

Ans. h = + 5 cm; u = - 30 cm; f = + 15 cm; v = ?

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

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{(+15)} - \frac{1}{(-30)}$$

$$= \frac{1}{15} + \frac{1}{30} = \frac{2+1}{30} = \frac{3}{30} = \frac{1}{10}$$

V = + 10 cm

$$\frac{h2}{h1} = -\frac{v}{u}$$

$h_2 = \frac{(+10)}{(-30)} \times (+5) = +\frac{5}{7}$ cm

Nature = virtual, erect

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

Ans. Here, h_1 = + 4 cm, f = - 10 cm, u = - 15 cm, v = ?, h_2

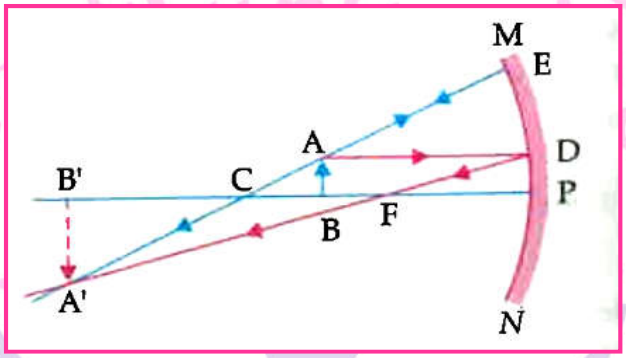
$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

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

as, $\frac{1}{v} = \frac{1}{-10\ cm} - \frac{1}{-15\ cm}$

$\therefore$ v = - 20 cm

Detailed Answer :



Using the mirror formula,

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

Or, $\frac{1}{v} + \frac{1}{-15} = \frac{1}{-10}$

Or, $\frac{1}{v} = \frac{1}{-10} + \frac{1}{15}$

Or, $\frac{1}{v} = \frac{(-15+10)}{150}$

Or, $\frac{1}{v} = \frac{-5}{150}$

V = - 30 cm

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

Magnification,

$m = \frac{-v}{-u} = \frac{h_i}{h_0}$

Or, $m = -\left(\frac{-30}{-15}\right) = -2$

Or, $-2 = \frac{h_i}{4}$

$\therefore\ h_i = -8$ cm

-ve sign indicates image will be inverted Hence, the height of image will be 8 cm.

4. The image of 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 2.5 cm, find the height of the flame is 2.4 cm, find the height of its image. State whether the image formed is erect or inverted.

Ans. The nature of the mirror is concave since the image formed is real.

Given, u = - 30 cm, v = - 60 cm, h = 2.4 cm, using mirror formula,

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

$$\frac{1}{f} = \frac{1}{-60} + \frac{1}{-30}$$

$$= -\frac{1}{60} - \frac{1}{30}$$

$$= -\frac{3}{60} = -\frac{1}{20}$$

Therefore; f = - 20 cm

Magnification, $m = \frac{v}{u} = -\frac{Height\ of\ image}{Height\ of\ object}$

$$\frac{v}{u} = \frac{-60}{-30} = \frac{h'}{2.4}$$

$$h' = \frac{60}{-30} \times 2.4 = -4.8 \text{ cm}$$

The required height of the image is – 4.8 cm

The image formed by the mirror is inverted.

5. A 3 cm tall object is placed 18 cm in front of a concave mirror of focal length 12 cm. At what distance from the mirror should a screen be placed to see a sharp image of the object on the screen. Also calculate the height of the image formed.

Ans. h_1 = + 3 cm, f = - 12 cm, u = - 8 cm, v = ? , h_2 = ?

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

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

or, $\frac{1}{v} = \frac{1}{-12\ cm} - \frac{1}{-18cm}$

v = - 36 cm

m = $\frac{h_2}{h_1}$ = - $\frac{v}{u}$

h_2 = - $\frac{v}{u}$ X h_1

= - $\frac{-36cm}{-18cm}$ x 3 = - 6 cm

6. 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 it 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.

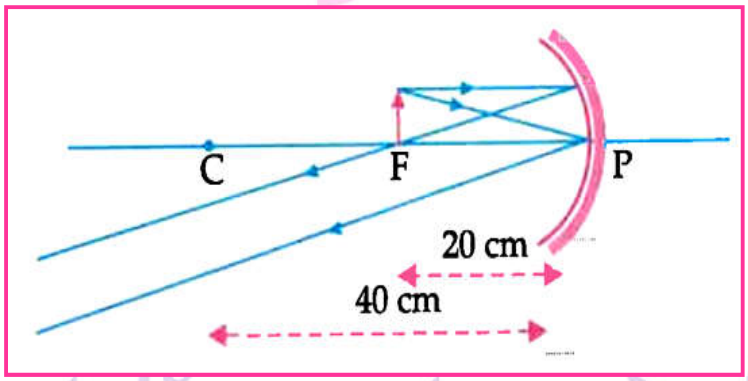
Ans. Object position: At C (Centre of curvature)

Object distance = 40 cm

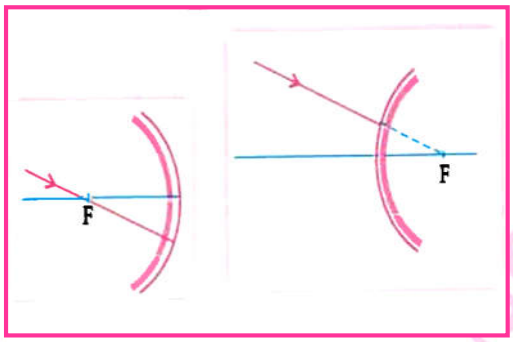
Position of the image – at infinity,

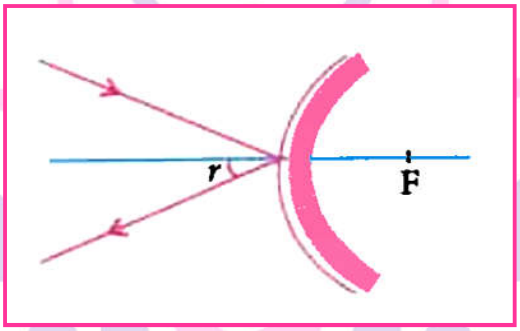
Reason: Focal length of the mirror = 20 cm,

If the object is moved 20 cm towards the mirror then its new position would be at the focus of the mirror.

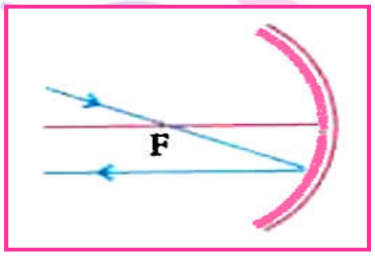


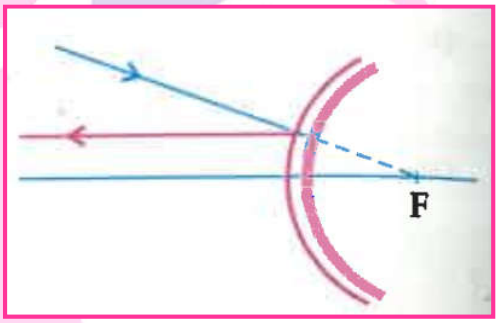
7. Draw the following diagram, in which a ray of light is incident on a concave/convex mirror, on your answer sheet. Show the path of this ray, after reflection, in each case.

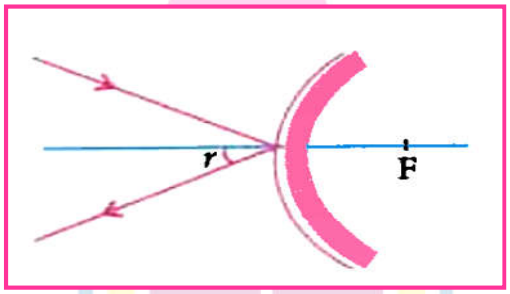




Ans:







8. The image formed by a spherical mirror is real, inverted and is of magnification -2. If the image is at a distance of 30 cm from the mirror, where is the object placed? Fine the focal length of the mirror. List two characteristic of the image formed if the object is moved 10 cm towards the mirror.

Ans. m = -2 , $\frac{v}{u}$ = 2, v = - 30 cm, u = - 15

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

= $\frac{-15cm\ X-30\ cm}{-15cm+(-30)cm}$ = $\frac{450}{-45}$

= - 10 cm

If the object is shifted 10 cm towards the mirror u = - 5 cm

Therefore the object is between pole and focus and the image is

(i) Virtual

(ii) Erect

(iii) Magnified

9. A student wants to project the image of a candle flame on a screen 80 cm in front of a mirror by keeping the candle flame at a distance of 30 cm from its pole.

(a) Which type of mirror should the student use?

(b) Find the magnification of the image produced.

(c) Find the distance between the object and its image.

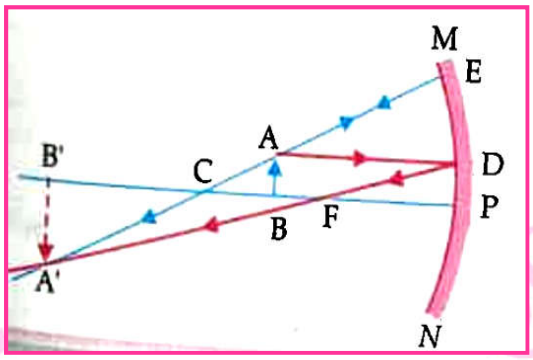
(d) Draw a ray diagram to show the image formation in this case and mark the distance between the object and its image.

Ans. (a) Concave mirror

(b) u = -20 cm, v = - 80 cm and m = ?

m = $\frac{-v}{u}$ = $\frac{-(-80cm)}{(-20\ cm)}$ = -4

(c) v – u = - 60 cm



In diagram B' to B = 60 cm (distance between object and image)

10. 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.

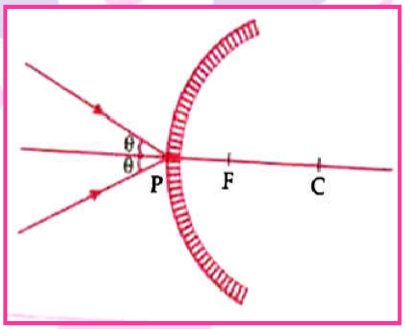
(a) Strikes at its pole making an angle 0 from the principal axis.

(b) Is directed towards it principal focus.

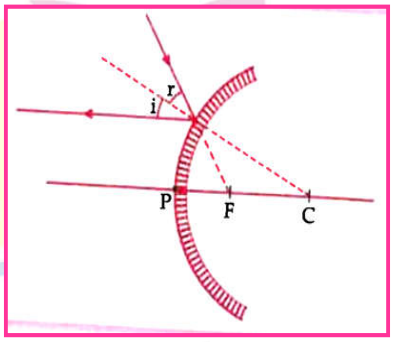
(c) Is parallel to its principal axis.

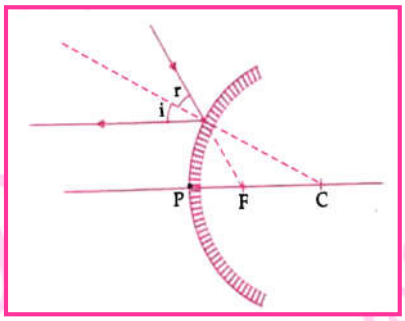
Ans.

(a)



(b)





(c)

11. **Refractive index of water with respect to air is 1.33 and that of diamond is 2.42.**

(i) in which medium does the light move faster, water or diamond?

(ii) What is the refractive index of diamond with respect to water?

Ans. (i) Refractive index = speed of light in vacuum/ speed of light in medium.

Since the refractive index of diamond is more, hence the speed of light is lesser in diamond.

(i) Let speed of light in water V_w and in diamond by V_d.

(ii) Refractive index of diamond w.r.t. water is wsay n =

(iii) Speed of light in water/speed of light in diamond.

$N = v_w/v_d$

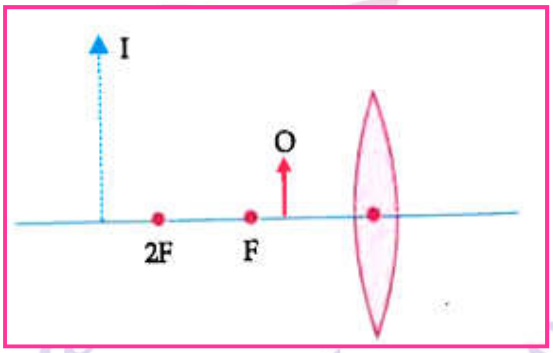
Dividing both numerator and denominator by speed of light(c) we get

$$n = \frac{v_{w/c}}{v_{d/c}}$$

$\therefore$ n = 2.42/1.33 = 1.82(approx.)

12. **The diagram given below shows an object O and its image I.**

Without actually drawing the ray diagram state following:



(i) Type of lens (Converging / Diverging)

(ii) Name two optical instruments where such an image is obtained.

(iii) List three characteristic of the image formed if this lens is replaced by a concave mirror of focal length f and an object is placed at a distance f/2 in front of the mirror.

Ans. (i) Converging lens

(ii) Microscope and Telescope

(iii) Characteristic of the image formed are:

(a) Virtual image

(b) Magnified image

(c) Image behind the mirror

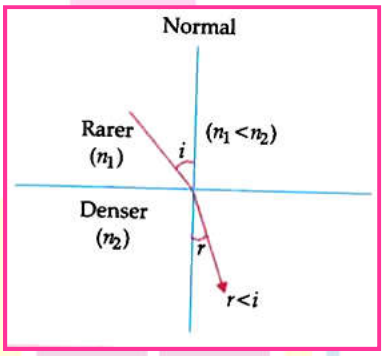
13. (a) Water has refractive index 1.33 and alcohol has refractive index 1.36 which of the two medium is optically denser? Give reason for your answer.

(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.

Ans. (a) Refractive index of alcohol > refractive index of water. So, alcohol is optically denser than water.

(b) When a ray of light enters from water to alcohol, it bend towards the normal.



(c) Angle of incidence is greater than angle of refraction.

14. A 10 cm tall object is placed perpendicular to the principal axis of a convex lens of focal length 12 cm. The distance of the object from the lend in 18 cm. Find the nature, position and size of the image formed.

Ans. $\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \therefore \frac{1}{v} = \frac{1}{f} + \frac{1}{u}$

$\frac{1}{v} = \frac{1}{12} + \frac{1}{(-18)}$

$\therefore$ V= 36 cm

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

$\Rightarrow \therefore$ m = $\frac{36}{-18} = \frac{h'}{10}$

$\Rightarrow$ h^1 = - 20 cm (size of the image)

Nature of image: Real and inverted

Detailed Answer:

Given, object size, h = +10 cm ; focal length, f = +12 cm (f is positive for a convex lens); object distance, u = - 18 cm

Using lens formula,

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

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

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

$\frac{1}{v} = \frac{1}{36}$

Therefore, v= 36 cm ⟶ Image distance

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

Therefore, m = $\frac{36\ cm}{-18\ cm}$ = -2

So, image size $h' = \frac{vX\ h}{u}$

$= \frac{36X\ 10}{(-18)}$ = -20

That image is 36 cm on right side of lens. So, the image is real.

Negative sign of h' signifies that the image is inverted. The image is two times enlarged in size than the object.

15. What is meant by power of a lens? Write the SI unit. A student uses a lens of focal length 40 cm and another of – 20 cm. Write the nature and power of each lens.

Ans. Power of lens = ability to converge/diverge light rays passing through it/reciprocal of the focal length in meters $\frac{1}{f}$ (in meters),

SI unit of power is Dioptre

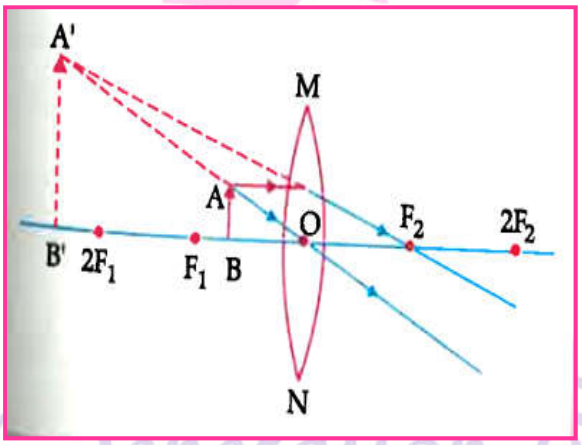
Power of 1st lens $p_1 = \frac{100}{f} = \frac{100}{40\ cm}$ = + 2.5D

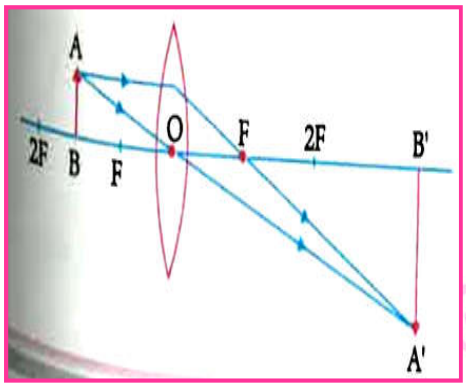
Nature: Converging lens/Convex lens,

Power of 2nd lens $P_2 = \frac{100}{f} = \frac{100}{-\ 20\ cm}$ = -5D

Nature: Diverging lens / Concave lens

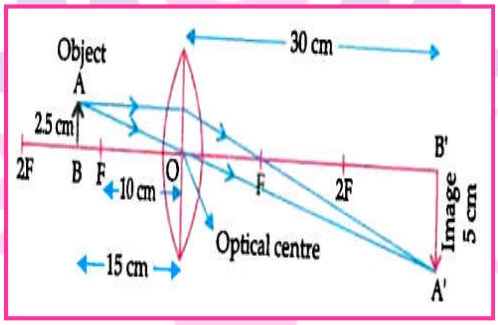
16. "A lens can from a magnified erect image as well as magnified inverted image of an object placed in front of it. "state the nature of this lens and draw ray diagram to justify the above statement. Mark the position of O,F and 2F in the diagram.





17. An object of height 2.5 cm is placed at a distance of 15 cm from the optical centre 'O' of a convex lens of focal length 10 cm. Draw a ray diagram to find the position and size of the image formed. Mark optical centre 'O', principal focus F and height of the image on the diagram.

Ans.



(5 Mark each)

Long Answer Type Questions

1. (a) A security mirror used in a big showroom has radius of curvatures 5 m. If a customer is standing at a distance of 30 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.

Ans. (a) Given, R = 5 m, f = $\frac{5}{2}$ m, u = - 20 m and v = ?

Hence, on applying the values,

$$\frac{2}{R} = \frac{1}{v} + \frac{1}{u}$$

$\frac{2}{5} = \frac{1}{v} - \frac{1}{20}$

or $\frac{1}{v} = \frac{2}{5} + \frac{1}{20}$

or $\frac{1}{v} = \frac{8+1}{20}$

or $\frac{1}{v} = \frac{9}{20}$

or $v = \frac{20}{9}$

$\therefore$ v = 2.2 m

Nature of the image: Erect, virtual, small and diminished.

(b) Mirror used by dentist is: Concave mirror.

Reason: It produces enlarged, erect and virtual image of the object, so it is used to see the large image of teeth of patients.

2. (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. List two such rays and state the path of these rays after reflection in case of concave 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 produced three time magnified image on a screen. If the object is placed 20 cm in front of the mirror, how far is the screen from the object.

Ans. (a) (i) Listing of any two (out of four) rays and stating their path after reflection from a concave mirror.

(ii) Ray diagram:

Using these two rays for the ray diagram when the object is in between the pole and the focus of the mirror.

(b) u = - 20 cm, m = -3

$M = \frac{-v}{u}$

$- \quad 3 = \left(\frac{v}{-20}\right)$

V = -3 X 20 = - 60 cm

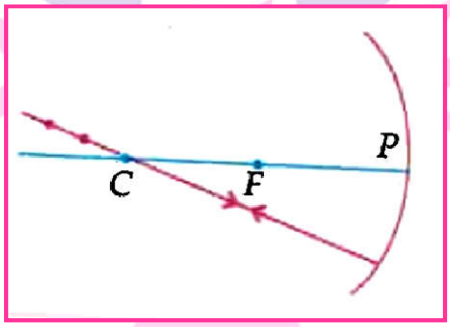
Distance between the object and the screen is 40 cm

= - 60 cm (-20cm) = -40 cm

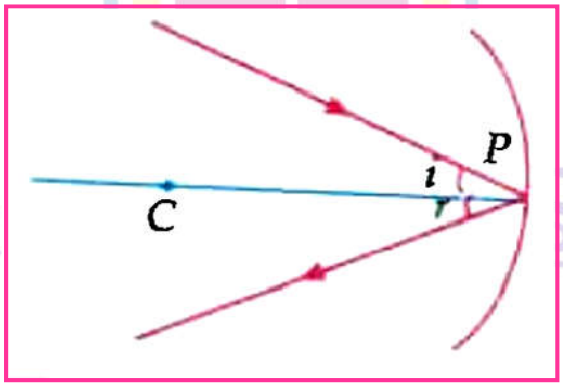
Detailed Answer:

(a) Two light rays whose path of reflection are known are

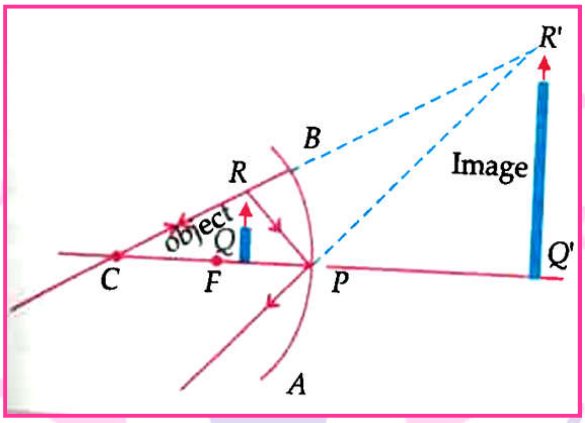
(i) The incident ray passing through the centre of curvature: In this case, light after reflecting from the concave mirror moves back in the same path. This happens because light is incident perpendicular on the mirror surface.



(ii) The ray incident obliquely to the principal axis: In this case, the incident ray will be reflected back by the reflecting surface of the concave mirror obliquely and making equal angle with the principal axis.



Let an object is placed between the focus and pole of the concave mirror. Then using above two rays, image of the candle can be located as shown below:



The image is formed behind the mirror. The image is virtual, erect and magnified.

(b) Given, m = -3, u = - 20 cm, v = ?

As we know,

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

$$-3 = -\left(\frac{v}{-20}\right)$$

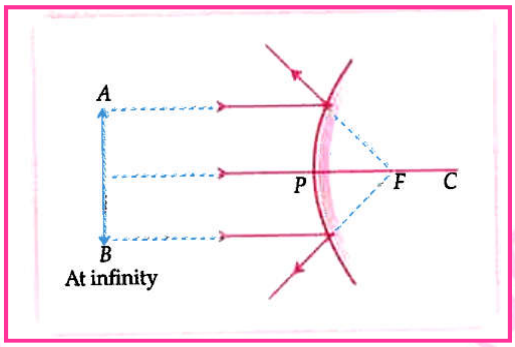
$$V = -60cm$$

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

3. (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 of such mirror is put to any why.

(b) Define the radius of curvature of spherical mirror. Fine the nature and focal length of a spherical mirror whose radius of curvature is + 24 cm.

Ans. (a) A convex mirror form an erect, diminished and virtual image for all the positions of the object placed in front of it.



Convex mirrors are commonly used reflecting surface o spherical mirror in vehicles as they always give an erect, diminished image.

(b) The radius of the sphere of which the reflecting surface of spherical mirror form a part is called the radius of curvature of the mirror.

F= $\frac{R}{2}$

Radius of curvature,

R = 24 cm

So, $f = \frac{+24}{2} = +12$ cm

Thus, the focal length of a convex spherical mirror is +12 cm. and convex is nature.

4. Suppose you have three concave mirrors A, B and C focal length 10 cm and 20 cm. For each concave mirror, you perform the experiment of image formation for three values of object distance of 10 cm, 20 cm and 30 cm. By giving reason, answer the following:

(i) For the three object distance, identify the mirror/mirrors which will form an image of magnification -1.

(ii) Out of the three mirrors identify the mirror which would be preferred to be used for shaving purpose / makeup.

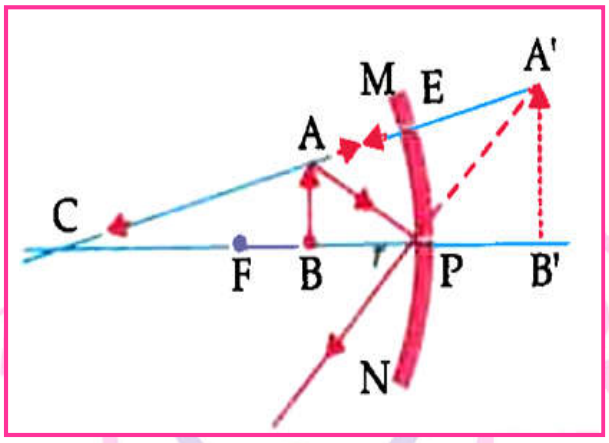
(iii) For the mirror B draw ray diagram for image formation for object distance 10 cm and 20 cm.

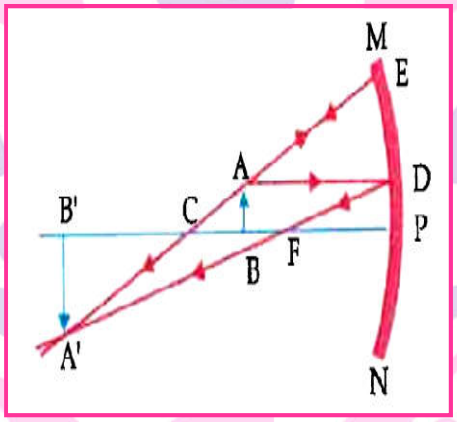
Ans. F_2 = - 10 cm, f_b = - 15 cm ; f_c = - 20 cm

u_1 = - 10 cm ; u_2 = -20 cm; u_2 = -30

(iv) Mirror A will form image of m = -1 for object distance 20 cm since u_2 = -30

(v) Mirror B or C – distance should be less than focal length for erect and magnified image, face is generally kept at a distance more than 10 cm.





5. (a) A security mirror used in a big showroom has radius of curvature 5 m. If a customer is standing at a distance of 30 m from the cash counter, find the position, nature and size of the image formed in the security mirror.

(b) Neha visited 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.

Ans. (a) It is an convex mirror. So focal length should be positive.

Radius of curvature R = +5 m

$\therefore$ Focal length $f = \frac{5}{2} + 2.5$ m

Object distance $u = -20$ m

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

$$\frac{1}{2} + \frac{1}{-20} = \frac{1}{2.5}$$

$$\frac{1}{v} = \frac{1}{20} + \frac{1}{2.5}$$

$$\frac{1}{v} = \frac{1}{20} + \frac{10}{25}$$

$$\frac{1}{v} = \frac{5+40}{100} = \frac{45}{100}$$

$$V = \frac{100}{45} = \frac{20}{9} = +2.2 \text{ m}$$

- Nature of image = virtual and erect image
- Size of image : diminished image

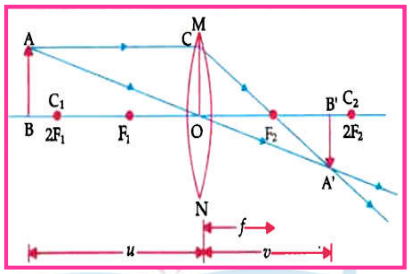
(b) Concave Mirror

Reason : to obtain erect and enlarged image of teeth

6. (a) A lens produces a magnification of -0.5. Is this a converging or diverging lens? If the focal length of the lens is 6 cm, draw a ray diagram showing the image formation in this case.

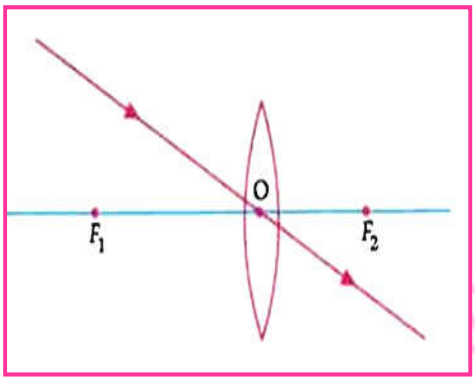
(b) **A girl was playing with a thin beam of light from a laser torch by directing it from different directions on a convex lens held vertically. She was surprised to see that in a particular direction, the beam of light continues to move along the same direction after passing** through the lens. State the reason for her observation. Draw a ray diagram to support your answer.

Ans. (a) The image will be real and inverted, since the magnification has negative value. The lens that can produce a real and inverted image is a converging /convex lens.



In the figure $OF_1 = OF_2 = 6$cm.

(b) The girl must have directed the ray of light along the direction of the optical centre of the lens because the ray of light passes straight through the optical centre of the lens.



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

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

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

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

Ans. (a) Convex lens to get a magnified image of the lines on the palm.

(b) Between F and 2F of the lens/ or at F of the lens

(c) focal length f = +10 cm

Object distance u = -5 cm

Lens formula:

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

$$\frac{1}{v} - \frac{1}{-5} = \frac{1}{10}$$

$$\frac{1}{v} + \frac{1}{5} = \frac{1}{10}$$

$$\frac{1}{v} = \frac{1}{10} - \frac{1}{5} = \frac{1-2}{10}$$

$$\frac{1}{v} = \frac{-1}{10}$$

V = - 10 cm

$$M = \frac{h_{image}}{h_{object}} = \frac{v}{u}$$

$$= \frac{-10}{-5} = 2$$

Size of image is 2 times the size of object.

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

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

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

(c) Draw ray diagram to justify your answer of part (ii).

Ans. (a) u = -60 cm, f = -30 cm, v = ?

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

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

$$\frac{1}{v} = \frac{1}{(-30\ cm)} + \frac{1}{(-60 cm)} = \frac{-3}{60}$$

$\therefore$ v = - 20 cm

$$m = \frac{v}{u} = \frac{-20\ cm}{-60\ cm} = \frac{1}{3}$$

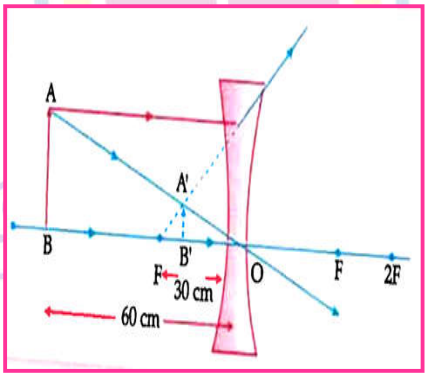
Distance of the image will be 20 cm in front of lens.

(b) Nature: Virtual

Position: 20 cm from lens on the same side as the object

Size: Diminished

Erect/Inverted: Erect



9. **Analyse the following observation table showing variation of image-distance (v) with object-distance (u) in case of convex lens and answer the question 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.

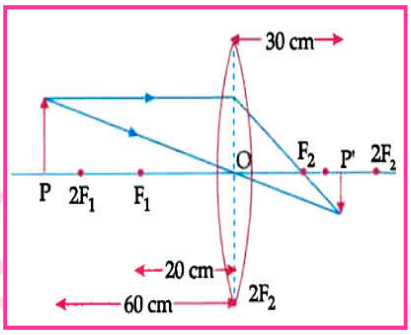
(b) Write the serial number of the observation which is not correct. On what basis have you arrived at this conclusion?

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

Ans. (a) The focal length of the convex lens can be calculated from S.No. 3 as when an object is placed at a distance from the convex lens, its image is formed on the other side of the lens at the same distance from the lens. So, the focal length is + 20 cm.

(b) S.No. 6 is incorrect as the object distance is between focus and pole and here the real image is formed as the image distance is positive. But in such situation virtual image should from.

(c) Approximate value magnification for object distance – 60 cm and image distance +30 cm is -0.5.



10. (a) Name the type of the mirrors used in design of solar furnaces. Explain how high temperature is achieved by this device?

(b) The focal length of a convex mirror is 12.5 cm. How far is its centre of curvature (i) from the pole (ii) from the focus.

(c) Is it possible to form a real image using a real object with a concave lens?

Ans. (a) Concave mirror is used in design of solar furnaces. High temperature achieved by this device is by focussing the sunlight incident o a concave mirror of its focal point.

(b) The centre of curvature of mirrors is a always located at a distance equals to its radius of curvature which is twice of its focal length. So, (i) the centre of curvature is 25 cm away from its pole and (ii) from the focus, it is 12.5 cm away.

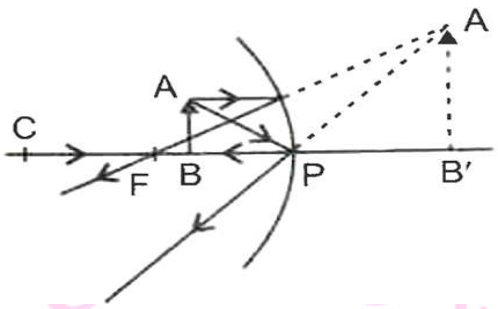
(c) No, it is not possible because the concave lens always form a virtual image.

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

(b) The mirror 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 ray diagram to show the formation of image in this case.

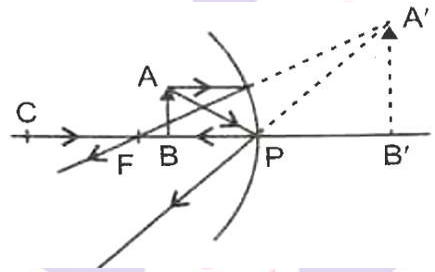
(c) an object is placed at a distance of 30 cm in front of a convex mirror of focal length 15 cm. Write four characteristics of the image formed by the mirror.

Ans. (a) Two ray are required.



(b) The linear magnification produced by a spherical mirror is +3. It shows that the

- Size of image is three times the size of object,
- Image is virtual and erect and formed behind the mirror . Hence



(i) The mirror is a concave mirror, and

(ii) The object is placed between the pole and the focus of a concave mirror.

(c) The four characteristics of the image formed by the convex mirror and virtual, erect, diminished and laterally inverted.

12.(a) Write refractive index in two different forms.

Ans. (a) Two different forms of refractive index are as follows:

(i) $n = \frac{\sin i}{\sin r}$ and

(ii) $n = \frac{c}{v}$

Where c – velocity of light in free space

i – incident angle

r – refraction angle

u – velocity of light in medium

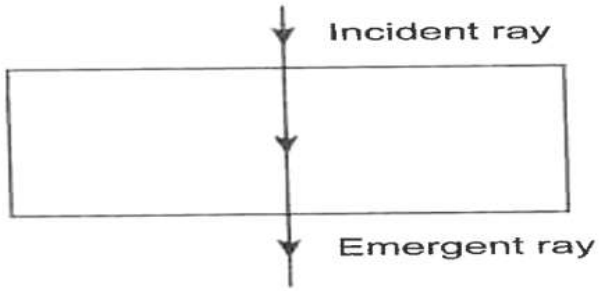
(b) Arrange the following media in the order of increasing denser nature. Given the refractive index of air, glass, kerosene, diamond is 1, 1.5, 1.44, and 2.42 respectively. Is a denser or rarer nature relative or absolute?

(b) It is relative in nature.

air < kerosene < glass < diamond when refractive index is considered.

(c) A ray of light falls normally on the surface of a transparent glass slab. Draw a ray diagram to show its path and also mark angle of incidence and angle of emergence.

(c)



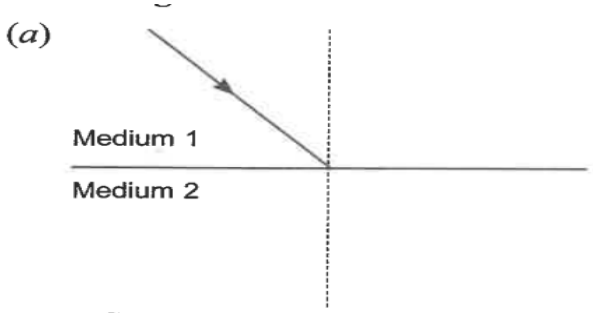
If the ray of light falls normally on the surface of glass slab, it will not refract deviate and thus, $\angle i = \angle e = 0^0$.

13. (a) For the following two case, state whether the obliquely incident ray light on interface of medium 1 and medium 2 will bend towards or away from the normal after refraction, in medium 2.

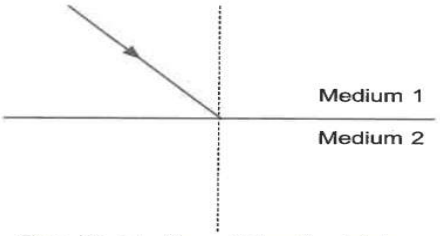
(b) Prove that refraction will not take place at the boundary that separates two media of equal refractive indices. Draw ray diagram to justify this statement

(c) In an experiment with rectangular glass slab, a student observed that a ray of light incident at an angle of 55^0 with the normal on one face of the slab, after refraction strikes the opposite face of the slab before emerging out into air making an angle of 40^0 with the normal. Draw a labelled diagram to show the path of this ray. What would you assign to the angle of refraction and angle of emergence?

Ans. (a)



Case I: (medium I having higher refractive index)



Case II: (medium II having higher refractive index)

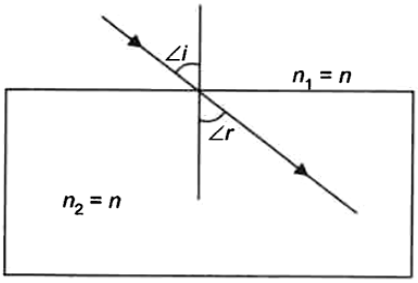
(b) When the refractive index of medium 1 is equal to the refractive index of medium 2, i.e. $n_1 = n_2$, then according to Snell's law,

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

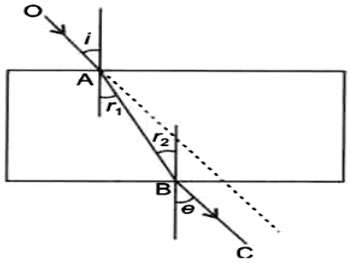
$\Rightarrow$ sin i = sin r

$\Rightarrow$ i = r

This shows that there will be no refraction at the boundary of two media of equal refractive indices as shown in the figure given below.



(c)



OA – incident ray

I is the angle of incidence = 55^0

Given: $r_2 = 40^0$

$\therefore$ r_1 and r_2 are the alternate interior angles.

$\therefore$ $\angle r_1 = \angle r_2 = 40^0$

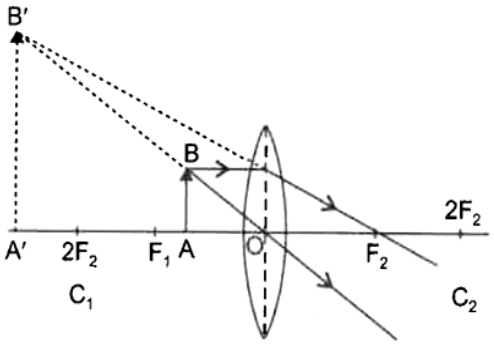
Since the emergent ray is parallel to the incident ray, the angle of emergent must be equal to the angle of incidence, i.e. $\angle e = \angle i = 55^0$.

14. (a) A child reads words of a book with the help of a convex lens keeping it close to book. He find words enlarged and erect when he gradually withdraws the lens away from the book. At one position, the word again become distinctly visible but this time, these are enlarged and inverted. Explain this difference with the help of ray diagram for both cases.

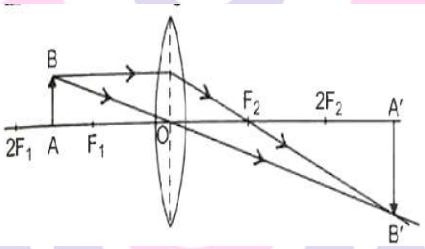
(b) State the meaning of linear magnification. How is it related to object and image distance? When is magnification positive or negative?

(c)An object is held at the principal focus of a concave lens of focal length f. Where the image will form?

Ans. (a) When the child holds the book between the optical centre O and F_1 , an enlarged, virtual and erect image is formed as shown below.



Again when the child holds the book between F_1 and 2F, words again become distinctly visible as the image if formed beyond $2F_1$, and is real, inverted and enlarged as shown below.



(b) Linear magnification is the ration of the height of the image to the height of the object. It is represented by the letter 'm'

$$m = \frac{\text{Height of image } (h_1)}{\text{Height of object}(h_0)} = \frac{h_i}{h_0}$$

Where h_i is the height of the image and h_0 is the height of the object.

If he image formed is virtual and erect, then the magnification is positive and of the image formed is real and inverted, then the magnification is negative.

(c) Between the optical centre (O) and its focus (F).

15. (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. List two such rays and state the path of these rays after reflection in case of concave mirrors. 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 produced three times magnified image on a screen. If the object is placed 20 cm in front of the mirror, how far is the screen from the object?

Ans. Ray which are chosen to construct a ray diagram for reflection are:

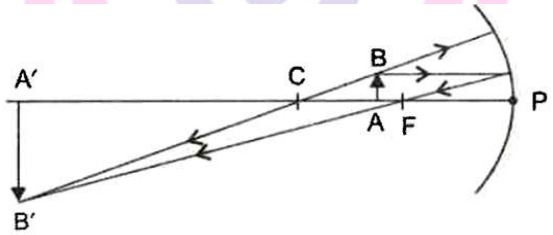
(i) A ray parallel to the principal axis and

(ii) A ray passing through the centre of curvature of a concave mirror.

Path of these through the principal focus of a concave mirror.

(i) It will through the principal focus of a concave mirror.

(ii) It gets reflected back along the same path. When an object is placed between the pole and the principal focus of concave mirror, a virtual, erect and enlarged image is formed behind the concave mirror as shown in the figure.



(b) Given: u = -20 cm and m = 3

Magnification, m, is given by

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

$\therefore \quad v = -m \times u$

= - (-3) (-20 cm) = -60 cm

Distance between the object and the screen is

= - 60 cm – (-20 cm)

= - 40 cm.

16. (a) Define the following terms in the context of spherical mirrors:

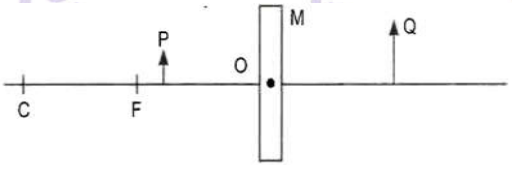
(i) Pole

(ii) Centre of curvature

(iii) 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 characteristics property of the image Q.

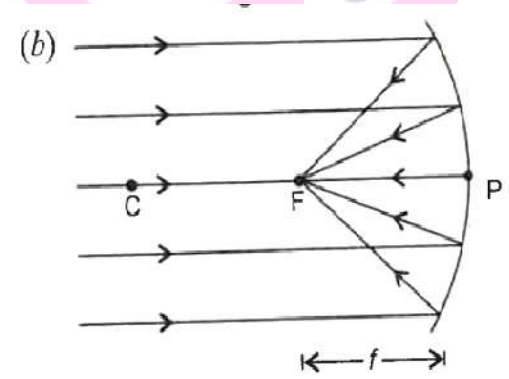
Ans. (a) Pole: The central point of the reflecting spherical surface is called the pole (P). It lies on the surface of the mirror.

Centre of curvature: The centre of the hollow sphere of which the spherical mirror is a part, is called the centre of curvature (C).

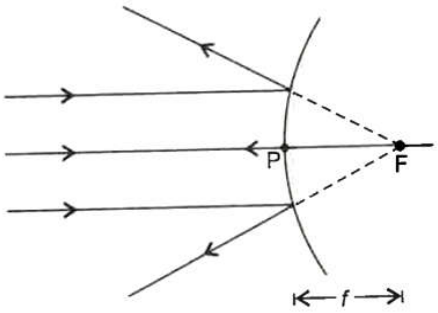
Principal Axis: The straight line joining the pole and the centre of curvature is called the principal axis.

Principal Focus: The point 'F' on the principal axis, where the incident light rays parallel to the principal axis actually meet(Converge) (in case of a concave mirror) or appear to diverge or come from (in case of a convex mirror) after reflection, is called its principal focus (F).

For a concave mirror, the focus lies on the same side of the reflecting surface, whereas in case of a convex mirror, it lies on the opposite side of the reflecting surface.



Focus of concave mirror



Focus of convex mirror

(c) The given mirror M is a concave spherical mirror. When the object lies between the pole and the focus of the concave mirror, an erect, virtual and enlarge image is formed. So one characteristics property of the image Q formed in the given figure is that it is virtual.

17. Analyse the following observation table showing variation of image – distance (v) with object – distance (u) in case of a convex lens and answer the question (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 the find the approximate value of magnification.

Ans. (a) The focal length of the convex lens is f = 20 cm.

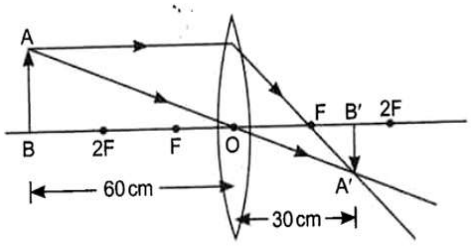
Reason : Object as S.NO.3 indicates that u = -40 cm, v = +40 cm

Thus, object is at 2F.

(b) Observation at S.NO. 6 is not correct.

The value, u = -15 cm, indicates that the object is in between the optical centre and the focus (i.e., less than the focal length) of the lens and hence, the image should be on the same side as the object. Accordingly, the image distance should be negative and cannot be positive (+120 cm) as shown in table.

(c) Ray diagram for the observation at S.No.2: Given: u = -60 cm; v = +30 ; f=20 cm



Magnification, m = $\frac{v}{u} = \frac{30cm}{-60cm}$

$= -\frac{1}{2}$ = -0.5

18. List the new Cartesian sign convention for reflection of light by spherical mirrors. Draw a diagram and apply these conventions for calculating the focal length and nature of a spherical mirror which forms a 1/3 times magnified virtual image of an object placed 18 cm in front of it.

Ans. New Cartesian sign convention for reflection of light by spherical mirrors:

(i) The object is always placed to the left of the mirror.

(ii) All the distances parallel to the principal axis are always measured from the pole of the spherical mirror.

(iii) All the distances measured along the direction of incident light, i.e. along –ve x-axis, the corresponding quantities are considered to be positive

(iv) All the distances measured in opposite to the direction of incident light, i.e. along –ve x-axis, the corresponding quantities are taken as negative

(v) The distance measured upward direction, i.e. perpendicular to and above the principal axis along +ve y-axis, are taken as Positive

(vi) The distances measured in the downward direction, along –ve y-zxis, i.e. perpendicular to and below the principal axis, are taken as negative.

According to question, for a virtual image

$m = +\frac{1}{3},\ u = -18\ cm$

But, $m = -\frac{v}{u} = +\frac{1}{3}$

$\Rightarrow \quad v = -\frac{u}{3} = -\frac{-18}{3} = +6$ cm

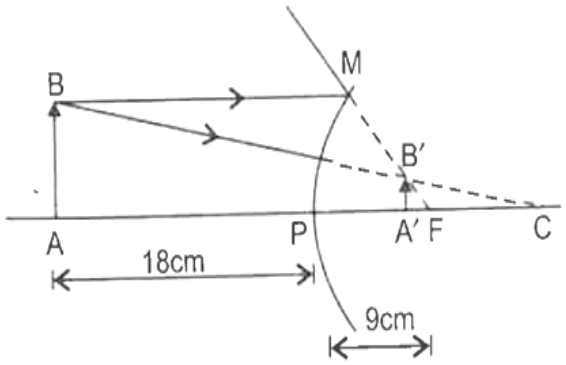
Using mirror formula, $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

$= \frac{1}{6} + \frac{1}{-18} = \frac{1}{6} - \frac{1}{18}$

$= \frac{3-1}{18} = \frac{2}{18} = \frac{1}{9}$

$\therefore \quad F = +9$ cm

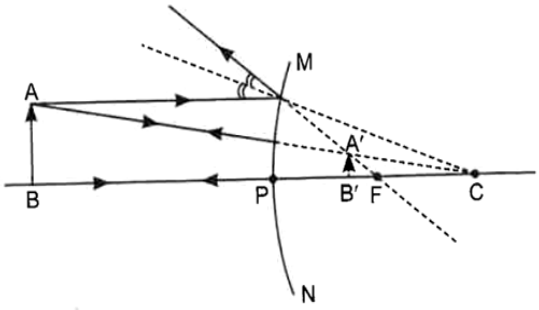
So the focal length of the given spherical mirror is 9 cm. The positive sign shows the given mirror is convex in nature.



19. (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.

Ans. (a) convex (diverging) mirror



Use: The convex mirror can be used as a rear view mirror.

Reason:

(i) It always produced a virtual and erect image.

(ii) The size of image formed is smaller than the object.

Therefore, it enables the driver to see a wide field view of the traffic behind the vehicle in a small mirror.

(b) Radius of curvature: The separation between the pole and the centre of curvature Or the radius of the hollow sphere, of which the mirror is part, is called radius of curvature (R), i.e., PC =R.

Since focal length of the mirror is +24 cm. It indicates that nature of h=the given spherical mirror is convex/diverging mirror.

As R = 2f = 24 cm

Therefore, f = + 12 cm

20. 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. 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 purpose/make – up.

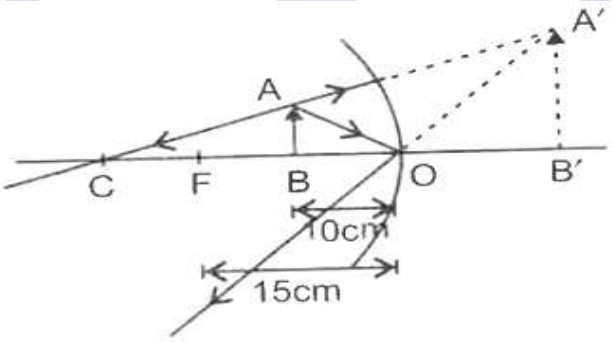
(c) For the mirror B draw ray diagram for image formation for object distances 10 cm and 20 cm.

Ans. (a) A real, inverted and same size image as that of the object formed by the concave mirror will form an image the object is placed at C (R = 2f). Hence for the object distances of 20 cm and 30 cm, the concave mirrors 'A' and 'B' will from the real, inverted and same size image as that of the object. Therefore, the concave mirrors 'A' and 'B' will form an image of magnification 'A' and 'B' will form an image of magnification -1.

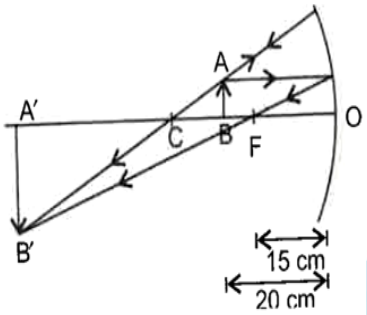
(b) The concave mirror 'C' of focal length 20 cm will be preferred to be used for shaving purposes/ make- up. This is because when we bring our face within its focal length, it forms a virtual, erect and enlarged image of our face.

(c)Ray diagram for image formation by mirror B

(i) For object distance 10 cm



(iii) For object distance 20 cm



21. A student has focussed 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 flame is reduced to 10 cm, then what would be observed on the screen? Draw ray diagram to justify your answer for this situation.

Ans. Given: h_0 = + 1.5 cm, f = -12 cm, u = - 18 cm

(a) For a concave mirror, using mirror formula

$\frac{1}{f} = \frac{1}{\upsilon} + \frac{1}{u}$, *we get*

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

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

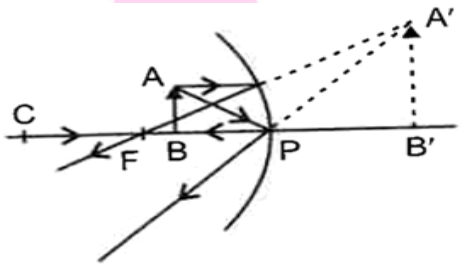
$= -\frac{1}{12} + \frac{1}{18} = \frac{-3+2}{36}$

or $\frac{1}{v} = -\frac{1}{36}$

or υ = -36 cm

So, the distance of the image from the mirror is 36 cm, the negative sign indicate that the image is formed on the same side of the object.

(b) Using the formula m $= \frac{h_i}{h_o} = -\frac{v}{u}$



Or h_i = - $\frac{v}{u}$ x h_0

= – $\frac{-36}{-18}$ x 1.5 = - 3.0 cm.

So, the length of the image is 3.0 cm.

If the distance between the mirror and the flame is reduced to 10 cm, no image is formed on the screen as the object lies between the focus and the pole of the mirror.

So, a virtual image behind the mirror is obtained as shown in the image behind the mirror is obtained as shown in the adjoining figure.

22. (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 X 10^8 m/s, calculate the speed of light in:

(i) vacuum, (ii) medium 'A'

Ans. Law of refraction of light:

(a) The incident ray, the normal at the point of incidence and the refracted ray, all lie in the same lane for the two given transparent media.

(b) The ration of sine of angle of incidence, i.e sin i to the sine of angle of refraction, i.e. sin r is always constant, for the light of a given colour and for the given pair of media.

Mathematically, $\frac{\sin i}{\sin r}$ = constant = n_{21}

The constant n_{21} is called the refractive index of the second medium with respect to the first medium.

Absolute Refractive Index: The refractive index of medium 2 with respect to vacuum or air is considered to be its absolute refractive index. It is represented by n_2. It is also equal to the speed of light in vacuum to the speed of light in the medium.

i.e. $n_2 = \frac{\text{Speed of light in air or vacuum (c)}}{\text{Speed of light in the medium (v)}}$

$= \frac{c}{v}$

(b) Given: $n_A = 2.0$, $n_B = 1.5$

From the above relation

(i) $n_B = \frac{C}{v_B}$,

Where c = speed of light in vacuum.

And v_B = speed of light in medium 'B' = 2 x 10^8 ms^{-1}

So, the speed of light in vacuum is

3 X 10^8 ms^{-1}

(ii) Again, $n_A = \frac{c}{v_A}$ Where n_A = absolute refractive index of medium A.

V_A = speed of light in medium A.

$\therefore$ 2.0 = $\frac{3 X 10^8}{v_A}$

or $v_A = \frac{3X10^8}{v_A}$

or $v_A = \frac{3 X 10^8}{2.0} = 1.5x\ 10^8\ ms^{-1}$

So, the speed of light in medium 'A' is $1.5 \times 10^8\ ms^{-1}$

20. (a) Explain the following terms related to spherical lenses:

(i) Optical centre: The centre point of a lens I known as its optical centre. It always lies inside the lens. A light beam passing through the optical emerges out without any deviation after refraction.

(ii) Aperture : This is the length of the lens through which refraction takes place.

(iii)Focal length : The distance of the principal focus from the optical centre of the spherical lens is called the focal length (f) of the lens.

(b) Focal length of the converging lens.

F = + 12 cm

Image distance, v = + 48 cm (+ ve sign is taken because of sign convention)

Using lens formula,

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

$\Rightarrow \frac{1}{+12} = \frac{1}{+48} - \frac{1}{u}$

$\therefore \frac{1}{u} = \frac{1}{+48} - \frac{1}{12} = \frac{-3}{48}$

u = - 16 cm

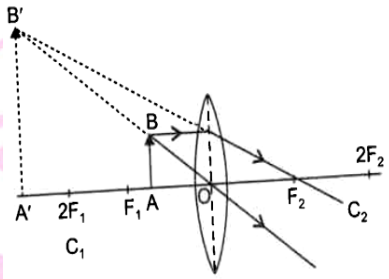
So, the distance of the object from the lens is 16 cm.

23. (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.

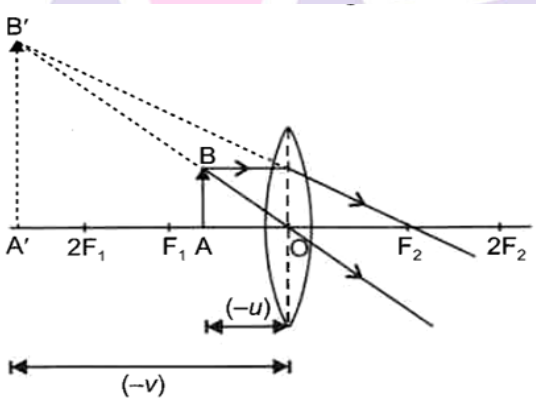
(c) Find power of a convex lens which forms a real, and inverted image of magnification -1 of an object placed at a distance of 20 cm from its optical centre.

Ans. (a) 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) According to the new Cartesian sign convention, the object distance 'u' and image distance 'v' both are negative as they are measured opposite to the direction of incident ray.

The object distance (u), image- distance (v) and the focal length (f) of a convex lens is in the above case are related as given below.



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

(c) Given: u = -20 cm, v = ?, m = -1

For a spherical lens, linear magnification is given by

$m = \frac{v}{u}$

$\Rightarrow \quad -1 = \frac{v}{-20}$

$\Rightarrow \quad v = +20 \text{ cm}$

Using lens formula,

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

$= \frac{1}{20} - \frac{1}{-20} = \frac{1}{10}$

$\Rightarrow \quad f = 10\ cm$

Therefore, the power of the given convex lens is calculated as

$$P = \frac{1}{f(m)} = \frac{100cm}{10cm}$$

$$= +10$$

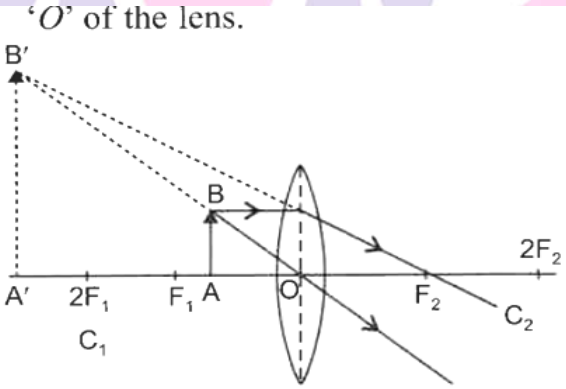
$$P = +10\ D$$

24. "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 starting 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.

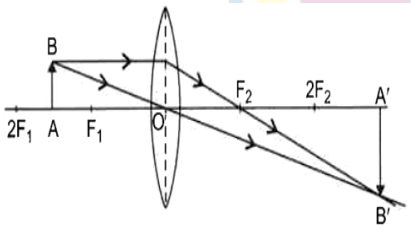
Ans. A convex lens of focal length 'f' can form

(a) A magnified and erect image only when the object is placed between its focus 'F' and optical centre 'O" of the lens.

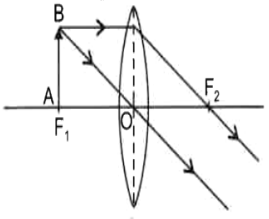


(b) A magnified an inverted image when an object is placed in the following positions:

(i) Between F_1 and $2F_1$



(ii) At focus 'F_1'.



Therefore, for the given positions of the object with respect to convex lens, the given statement is justified.

For concave lens

Given: h_0 = +4 cm, u = - 20 cm , f=-10 cm, υ = ?

Using lens formula,

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

or $\frac{1}{\upsilon} = \frac{1}{f} + \frac{1}{u}$

$= \frac{1}{-10} + \frac{1}{-20} = \frac{1}{10} - \frac{1}{20}$

$= \frac{-2-1}{20} = -\frac{3}{20}$

Or $\upsilon = -\frac{20}{3}$ = -6.67 cm

So, the image is formed on the same side of the object at 6.67 cm from optical centre of a concave lens.

25. A student wants to project the image of a candle flame on the walls of school laboratory by using a lens.

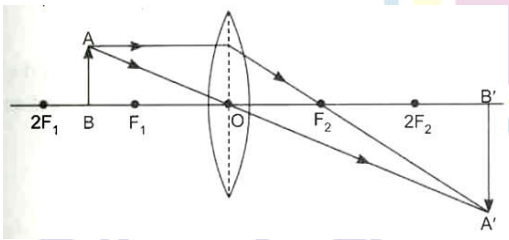
(a) Which type of lens should he use and why?

(b) At what distance in terms of focal length 'f' of the les should he place the candle Flame so as to get (i) a magnified, and (ii) a diminished image respectively on the wall?

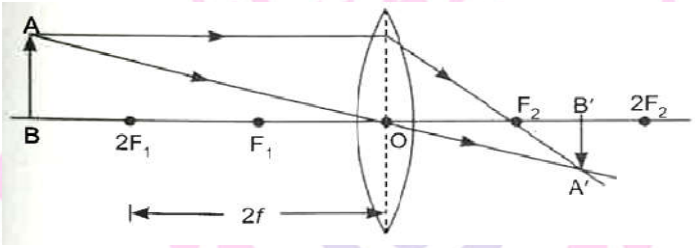
(c) Draw ray diagram to show the formation of image in each case.

Ans. (a) He should use a convex lens flame between F_1 and $2F_1$ (the focus and the centre of curvature of the lens) to get the magnified image on the wall, while the diminished image is obtained when the object is located at a distance greater than 2f.

(b) (i) Ray diagram for a magnified image.



(ii) Ray diagram for a diminished image



26. (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.

Ans. (a) Optical centre: The central point 'O' on the principal axis of the lens, thorough which an incident ray of light passes (refracted0 without suffering any deviation, is called optical centre of the lens.

(c) Given: f = - 20 cm, h_0 = 4 cm , v = - 10 cm

Using lens formula,

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

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

$$= \frac{1}{-10} - \frac{1}{20} = -\frac{1}{20}$$

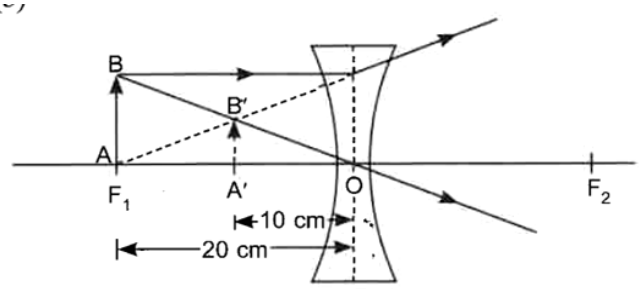
$$\Rightarrow \quad u = -20\ cn$$

$$\therefore m = \frac{h_i}{h_0} = \frac{v}{u}$$

$$\therefore h_i = \frac{v}{u}\ X\ h_0$$

$$= \frac{-10}{-20}\ x\ 4 = +2$$

Therefore, a diminished virtual image is formed and its size is 2 cm.



(c)

AB = Object height = +4cm

A'B' = Image height = +2cm

25. 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.

Ans. Given; f = - 20 cm, h_0 = 6 cm, v = -15 cm

Using lens formula,

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

$$\Rightarrow \frac{1}{u} = \frac{1}{v} - \frac{1}{f} = \frac{1}{-15} - \frac{1}{-20} = -\frac{1}{60}$$

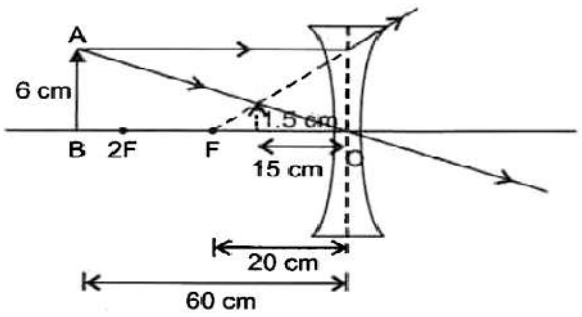
$$\Rightarrow u = -60\ cm$$

Using the formula, m

$$\frac{h_i}{h_0} = \frac{v}{u}$$

$$\Rightarrow h_i = \frac{v}{u} X\ h_0 = \frac{-15}{-60} X\ 6 = +1.5$$

Therefore, a diminished image is formed and its size is 1.5 cm.



26. (a) If the image formed by a lens is diminished in size and erect for all positions of the object, what type of lens is it?

(b) Name the point on the lens through which a ray of light passes undeviated.

(c)An 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 (i) the position (ii) the magnification and (iii) the nature of the image formed.

Ans. (a) Concave lens.

(b) Optical centre.

(c)Given: u = - 30 cm, f = +20 cm

(i) Using lens formula,

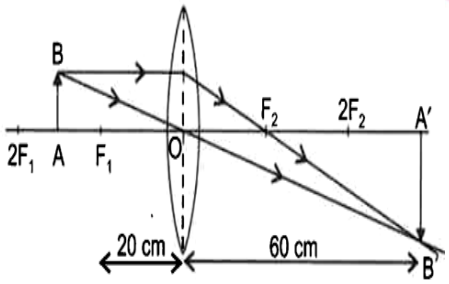
$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ we get,

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

$= \frac{1}{20} + \frac{1}{-30} = \frac{3-2}{60}$

$\Rightarrow \quad \upsilon$ = 60 cm

The image is formed at a distance 60 cm from the lens on the side.



(ii) $\therefore \quad m = \frac{v}{u} = \frac{60}{-30} = -2$

So, the image is inverted and double the size of the object.

(iii) The image is real as $\upsilon > 0$, inverted and enlarged.

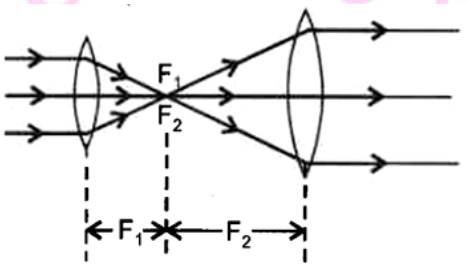
27. (a) Under what condition will a glass lens placed in a transparent liquid become invisible?

(b) Describe and illustrate with a diagram , how we should arrange two converging lenses so that a parallel beam of light entering one lens emerges as parallel beam after passing through the second lens.

(c) An object is placed at a distance of 3 cm from a concave lens of focal length 12 cm. Find the (i) Position and (ii) nature of the image formed.

Ans.

(a) When the refractive index of a glass lens becomes equal to the refractive index of transparent liquid, the glass lens will become invisible.



(b) A parallel beam converges at focus of the first lens and emerges parallel as it is at the focus of second lens.

(c) Given: f = - 12 cm, u = -3 cm

(i) Using mirror formula,

$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}, we\ get$

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

$= \frac{1}{-12} - \frac{1}{3} = \frac{-1-4}{12}$

$\Rightarrow \upsilon = -\frac{12}{5}\ cm$

(ii) $\upsilon < 0$, so the image is virtual.

$|\upsilon| < |u|$, so the image is diminished.

$\therefore m = \frac{v}{u} = \frac{-\frac{12}{5}}{-3} = \frac{4}{5}$

Since m > 0 but $|m| < 1, so\ the\ image\ is\ erect\ and\ dimished.$

28. **An object is placed at a distance of 60 cm from a concave lens of focus 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 the case.

(iii) Draw ray diagram to justify your answer of part

Ans. (i)

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

$$\frac{1}{-30} = \frac{2}{v} - \frac{1}{-60} = \frac{1}{v} + \frac{1}{60}$$

$\therefore \frac{1}{v} = -\frac{1}{30} - \frac{1}{60} = -\frac{3}{60} = -\frac{1}{20}$

$\therefore \ v = -20\ cm$

(ii) Nature of image: Virtual

Position of image : Between optical centre and focus of concave lens.

Size of image: Smaller than the object using

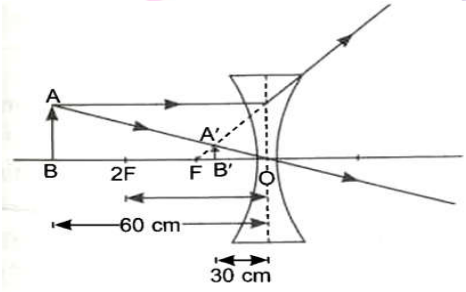
$$m = \frac{h_i}{h_0} = \frac{v}{u} \qquad (h_{i=+\frac{h_0}{3}})$$

$$h_i = \frac{v}{u}\ X\ h_0 = \frac{-20}{-60}\ X\ h_0 = \frac{h_0}{3}$$

So size of image is one third of the object.

- Erect/ inverted: Erect image

(iii)

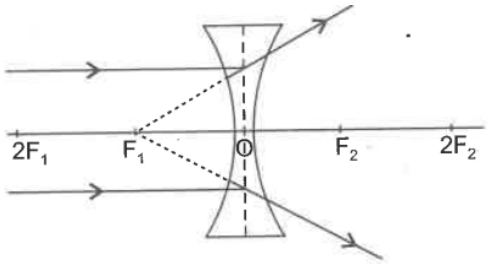


28. (a) A concave lens is called a diverging lens. Explain this property with the help of diagram.

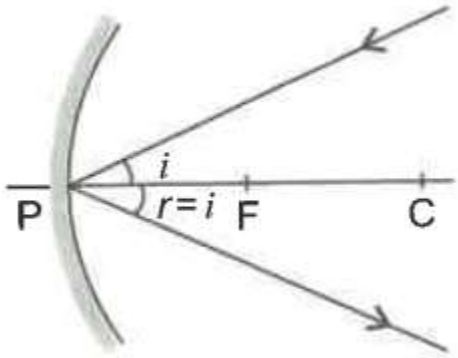
(b) For a concave mirror draw a ray diagram to show the reflected ray when the ray of light incident obliquely on the pole of mirror.

(c)What is the difference between virtual images produced by concave, plane and convex mirrors?

Ans (a) A beam of light from an object at infinity, parallel to the principal axis, falls on a concave lens. After refraction through it, the light appears to come from a fixed point on the same side of an objects as shown, i.e. the concave lens spreads out parallel beam of light. Due to this property, the concave lens is called a diverging lens.



(b)



(d) Difference between virtual image produced by

(i) Concave mirror: magnified

(ii) Plane mirror: Same size

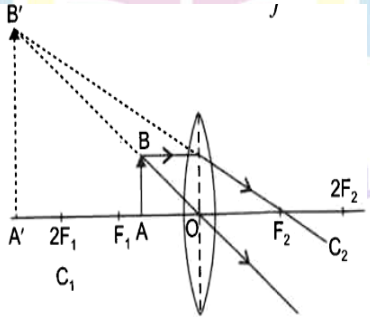
(iii) Convex mirror: diminished

29. What is meant by power of a lens? Define its S.I. unit.

You have two lenses A and B focal lengths +10 cm 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.

Ans. Power of a Lens: The ability of a lens, to converge or diverge the ray of light after refraction, is called power (P) of the lens. It is defined as the reciprocal of the focal length, i.e. P = $\frac{1}{f}$



The SI unit of power of a lens is 'dioptre'. A lens of focal length 100 cm has a power of 1 dioptre, i.e 1 dioptre = $1m^{-1}$.

Given: f_A = + 10 cm, f_B = -10 cm

So the nature of lens A is convex and lens B is concave.

Power of lens A, $P_A = \frac{100}{f_B} = \frac{100}{10}$ = -10 D

Convex lens will form a virtual and magnified image of an object placed 8 cm from the lens, because the object distance is less than that of the focal length of convex lens.

30. (a) Draw labelled ray diagram for each of the following cases to show the position, Nature and size of the image formed by a convex lens when the object is placed.

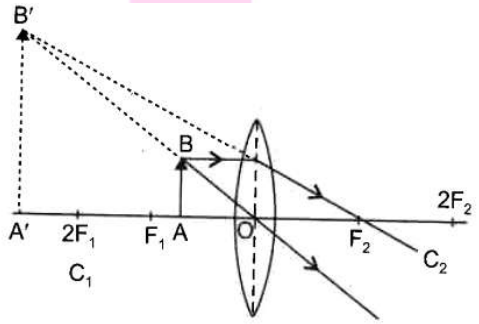
(i) Between its optical centre (O) and principal focus (F)

(ii) between F and 2F

(b) How will the nature and size of the image formed in the above two cases, (i) and (ii) change, if the convex lens is replaced by a concave lens of same focal lens.

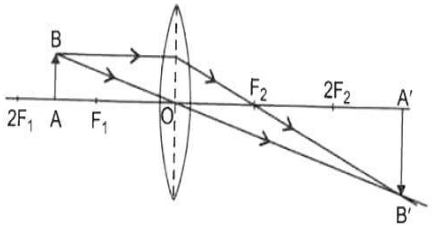
Ans. (a) Convex lens of focal length 'f' can form

(i) A magnified erect image only when the object is placed between its focus 'F' and optical centre 'O' of the lens.



(ii) A magnified and inverted image when an object is placed in the following positions:

Between F_1 and $2F_1$



(b)Whatever is the position of object as given in case (i) and (ii), the image formed by the concave lens is always virtual, erect and diminished.

31. State the laws that are followed when light is reflected by spherical mirrors. Draw a ray diagram to show the formation of image of an object placed in front of a convex mirror. List two characteristics of the image formed. List two characteristics of the image formed. Briefly explain one use of convex mirror.

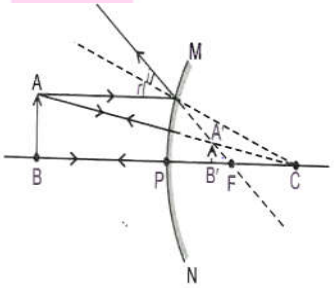
Ans. The two law of reflection of light are:

(i) The angle of incidence is equal to the angle of reflection.

(ii)The incident ray, the normal to the reflecting surface at the point of incidence and the reflected ray from that point, all lie in the same plane.

(i) Image formed is behind the mirror between pole (P) and focus (F).

(ii) Virtual, erect and diminished image is formed.



(iii) Rear- view mirror of vehicles: Convex mirror Convex mirror is used because it always produces a virtual and erect image whose size is smaller than the object. Therefore, it enables the driver to see wide field view of the traffic behind the vehicle in a small mirror.

32. The image of a candle flame formed by a lens is obtained on a screen placed on the other side of the lens. If the image s three times the size of the flame and the distance between lens and image is 80 cm, at the distance should the candle be placed from the lens? What is the nature of the image at a distance of 80 cm and the lens?

Ans. $\therefore\ m = \frac{h_i}{h_0} = \frac{v}{u}$ for a lens

$\therefore$ image is real.

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

With υ = 80 cm, u = $\frac{v}{-3} = \frac{80}{-3}$ cm and the lens will be convex.

Therefore, the candle should be placed at a distance of $\frac{80}{3}$ = 26.6 cm to the left of the convex lens to form the real image at a distance of 80 cm on the right side of the lens.

33. The size of image of an object by a mirror having a focal length of 20 cm is observed to be reduced to 1/3rd of its size. At What distance the object has been placed from the mirror? What is the nature of the image and the mirror?

Ans. If the image is real (as in concave mirror),

m= $\frac{1}{3}$, Therefore, $-\frac{v}{u} = -\frac{1}{3}$.

Using mirror formula. $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}, we\ get$

$\frac{1}{-20} = \frac{1}{\frac{u}{3}} + \frac{1}{u} = \frac{3}{u} + \frac{1}{u} = \frac{4}{u} \Rightarrow$ u = -80 cm

$If\ the\ image\ is\ virtual\ (as\ in\ convex\ mirror).$

$m = \frac{1}{3}, Therefore, \frac{v}{u} = \frac{1}{3}.$

Using mirror formula, $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$, we get

$\frac{1}{20} = \frac{1}{(\frac{-u}{3})} + \frac{1}{u} = \frac{1}{u}(1-3) = -\frac{2}{u}$

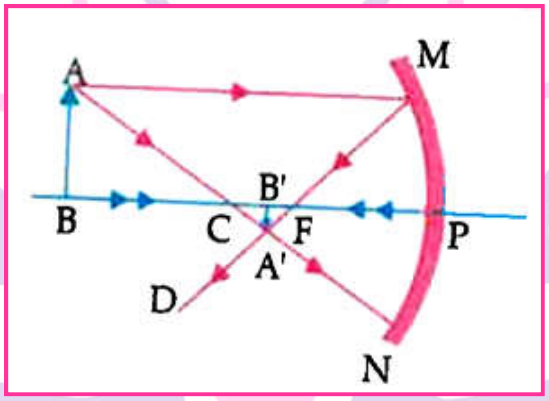
$\Rightarrow$ u = -40 cm

Competency Based questions

(4 mark each)

I. Read the following passage and answer any four questions from Q.1 to Q.5.

Following figure illustrates the ray diagram for the formation of image by a concave mirror. The position of the object is beyond the centre of curvature of the concave mirror. On the basis of given diagram answer any four questions from Q.1 to Q.5



1. If the focal length of the concave mirror is 10 cm, the image formed will be at a distance _____.

a. Between 10 cm and 15 cm

b. Between 10 cm and 20 cm

c. Beyond 20 cm

d. At 20 cm

2. In case of concave mirror, the image distance is _____ when image is formed in front of the mirror and _____ when the image is formed behind the mirror.

a. Positive, negative

b. negative, negative

c. negative, positive

d. positive, positive

3. If the size of the object in the given figure is 5 cm and the magnification produced is-0.5. The size of the image is (in cm) _____

a. -2.5

b. -0.1

c. 2.5

d. 0.1

4. A negative sign in the magnification value indicate that the image is _____

a. Real and inverted

b. Real and erect

c. Virtual and erect

d. Virtual and inverted.

5. An image formed by concave mirror is virtual, when the object is placed:

a. at infinity

b. at C

c. Between C and F

d. Between P and F

II. Read the following passage and answer any four questions from Q.1 to 5.

A student wants to project the image of a candle flame on the walls of the school laboratory by using a mirror.

1. Which type of mirror should he use and why?

a. convex mirror, it forms virtual image

b. Concave mirror, it forms virtual image

c. Concave mirror, it forms real image

d. Convex mirror, it forms real image

2. At what distance, in terms of focal length 'f' of the mirror, should he place the candle flame to get the magnified image on the wall?

a. At F **b. Between F and C** c. At C d. At infinity

3. To get the diminished image of the candle flame, the object must be placed at:

a. infinity b. at C c. between F and C d. At F

4. If the image formed by this mirror is inverted and real, the magnification will be:

a. Positive b. Negative c. Either of them d. None of the above

5. A virtual image formed by concave mirror is:

a. erect enlarged

b. erect and diminished

c. inverted and diminished

d. inverted and enlarged

III. Read the passage and not the following observation. Answer any four questions from Q.1 to Q.5.

A student focussed the image of candle flame on a white screen by lacing the flame at various distances from a convex lens. He noted his observations as:

S.no	Distance of flame from the lens(cm)	Distance of the screen from the lens (cm)
(a)	60	20
(b)	40	24
(c)	30	30
(d)	24	40
(e)	15	70

1. From the above table, find the local length of lens without using lens formula:

a. 15 cm b. 30 cm c. 40 cm d. 60 cm

2. Which set of observation is incorrect

a. (a) b. (c) c. (e) d. (d)

3. In which case, the size of the object and image will be same:

a. In (d) case b. In (b) case **c. In (c) case** d. In (a) case

4. What is the change in image observed as the object is moved from infinity towards the concave lens?

a. Size of image decreases

b. Size of image becomes highly diminished

c. Size of the image remains unchanged

d. Size of the image increases slightly

5. Convex lens always forms real, inverted and enlarged images.

a. It forms real, inverted and diminished image

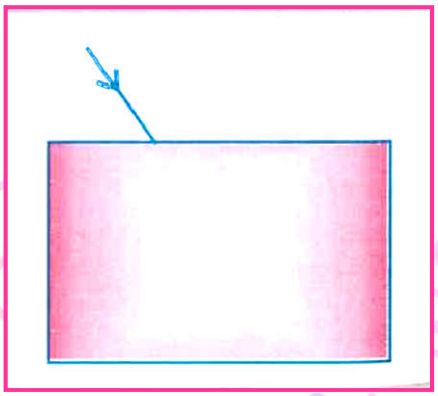
b. It forms virtual erect and enlarged image

c. It forms virtual, erect and diminished image

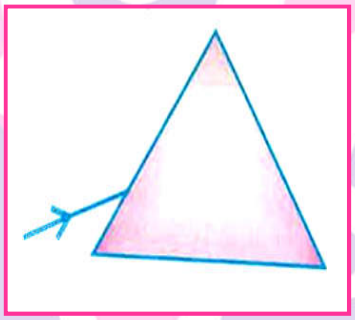
d. It forms real, inverted and enlarged image

IV. Study the given diagram and answer any four questions from Q.1 to A.5.

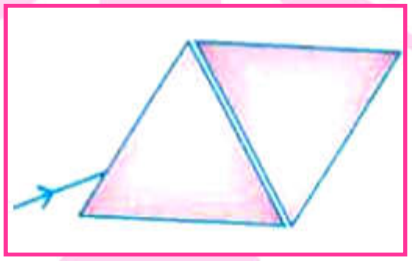
A very thin narrow beam of white light is made incident on three glass objects shown below. Study the nature and behaviour of the emergent beam in all the three cases.



(i)



(ii)



(iii)

1. Following are the possibility of two emergent beams being similar. Choose the correct answer.

a. (i) and (ii) **b. (i) and (iii)** c. (ii) and (iii) d. No similar emergent beams

2. When light enters from air to glass, the angle of incidence and refraction in air and glass are 45^0 and 30^0, respectively. Find the refractive index of glass.

(Given that $\sin 45^0 = \frac{1}{\sqrt{2}}$; $\sin 30^0 = \frac{1}{2}$)

a. $\sqrt{2}$ b. $2\sqrt{2}$ c. $1/\sqrt{2}$ d. 1

3. What do we call the change in path of light when it travels from one medium to another?

a. Reflection **b. Refraction** c. Scattering d. None of the above

4. What is the unit of refractive index?

a. Pascal b. Joule **c. No unit** d. μ m

5. In which of the following will the light waves travel faster? Air/ Glass?

a. Air b. Vacuum c. Glass d. diamond