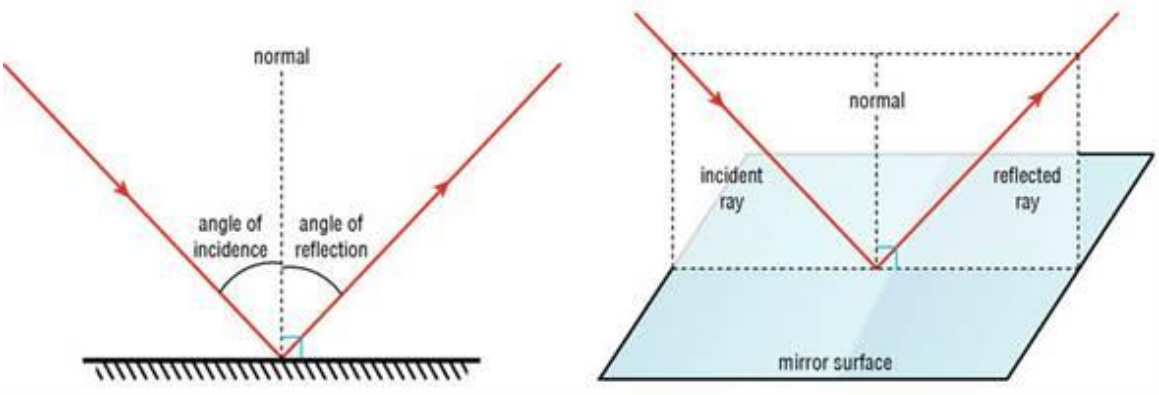
Reflection of Light by Different Surfaces

Improve your learning

Q. 1. State the laws of reflection of light. (AS1)

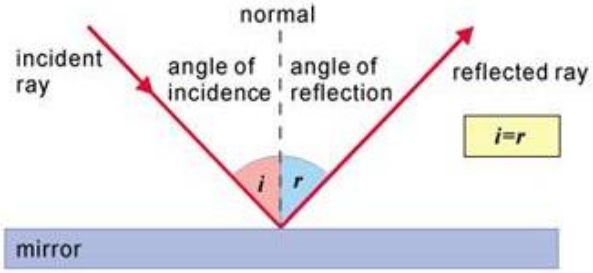
Answer : Laws of reflection holds for regular reflection only. The light ray is incident on a plane mirror and is reflected via another path as shown in the figure. The point where the light intersects the surface of the mirror is called the point of incidence. The line drawn through the point of incidence which is perpendicular to the mirror is called the normal. The angle formed by the incident ray & the normal is called angle of incidence (i). The angle subtended by the normal & the reflected ray is known as angle of reflection(r). We live in a three-dimensional space. But we experience some activities in two-dimensional space. This two-dimensional space is called plane.



The Laws of Reflection states that:

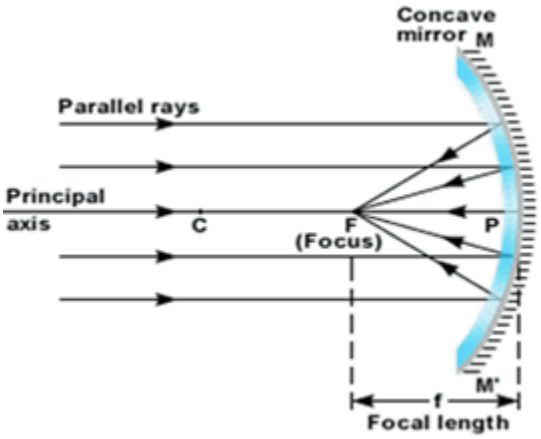
First law : The angle of incidence is equal to the angle of reflection (i = r).

Second law : The incident ray, reflected ray and the normal at the point of incidence are in the same plane. This plane is called the plane of incidence.



Q. 2. How do you find the focal length of a concave mirror? (AS1)

Answer : A mirror is called a concave mirror if its reflecting side bulges inwards. A concave mirror often referred as converging mirror as it converges the light rays after reflection.



Focus is the point where the incident parallel rays converge, after reflection from the mirror, at a distance of R/2 from the mirror where R = radius of curvature.
Focal length is defined as the image distance when the object is at infinity.

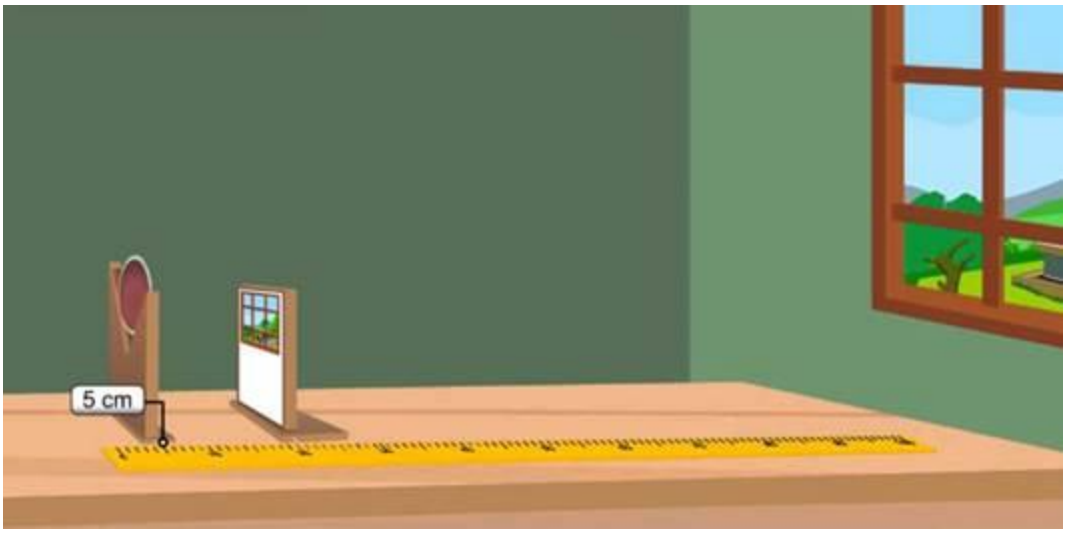
Aim: To find the focal length of a concave mirror

Apparatus required: concave mirror, meter scale, a white screen, Mirror holder, a distant object

Procedure: Set up the apparatus near a window so to get a distant object. Mount the concave mirror on the mirror holder. Now place the meter scale on the table and keep the mirror at a distance of 5 cm mark on the meter scale facing the object. Place the white screen in between the mirror and the distant object through the meter scale. Now move the screen until you get a sharp, diminished & inverted image of the distant object. Make sure the mirror & the screen have the same height. Mark the point on the scale where you get the desired image. The difference between the mirror mark & the screen mark will give the focal length.

Observation:

Position of concave mirror	Position of screen	Focal length
5 cm	20 cm	15 cm



Q. 3. Where will the image form when we place an object, on the principal axis of a concave mirror at a point between focus and center of curvature? (AS1)

Answer : To find the image, we have to use the graphical method which states the following rules:

• A ray parallel to the principal axis, after reflection, passes through the focus.

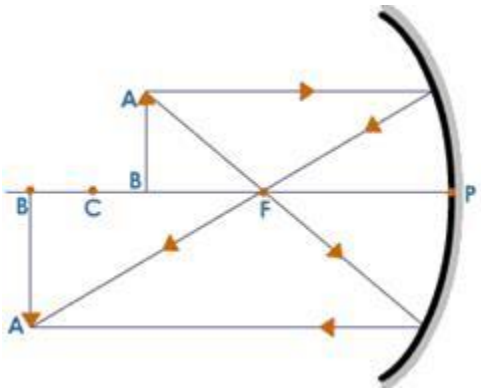
• A ray incident towards or away from the center of curvature is reflected back along its original path.

• A ray incident at pole at an angle i is reflected at an angle i.

• A ray through the focus is reflected parallel to the axis.

So following the above rules, draw the ray diagram of the convene mirror when the object is placed between focus & center of curvature.

Draw a ray parallel to the principal axis from the tip of the object AB. The reflected ray will pass through the focus. Now, draw a ray passing through focus and the reflected ray will be parallel to principal axis. Draw the image where the two reflected rays meet. In the figure, BA is the image formed. Through the ray diagram we get to know that when an object is placed between center of curvature (C) & focus (F) then image is formed between infinity & center of curvature. The nature of image is real, inverted & enlarged.



Q. 4. Find the distance of the image when an object is placed on the principal axis at a distance of 10cm in front of a concave mirror whose radius of curvature is 8 cm. (AS1)

Answer : object distance (u) = -10cm image distance (v) = ?

Radius of curvature (R) = -8cm

Focal length (f) = R/2 = -8/2 = -4cm

Using mirror formula:

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

$$\frac{1}{-4\text{cm}} = \frac{1}{-10\text{cm}} + \frac{1}{v}$$

$$\frac{1}{-4\text{cm}} - \frac{1}{-10\text{cm}} = \frac{1}{v}$$

$$\frac{1}{-4} + \frac{1}{10} = \frac{1}{v}$$

$$\frac{-10+4}{40} = \frac{1}{v}$$

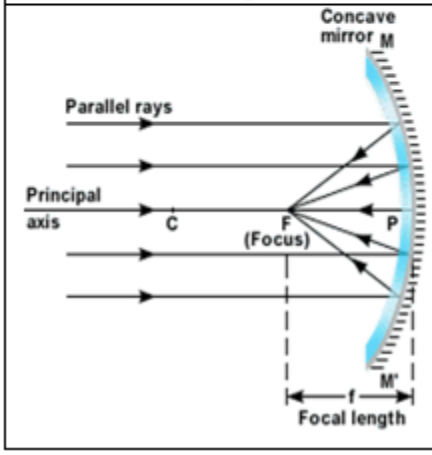
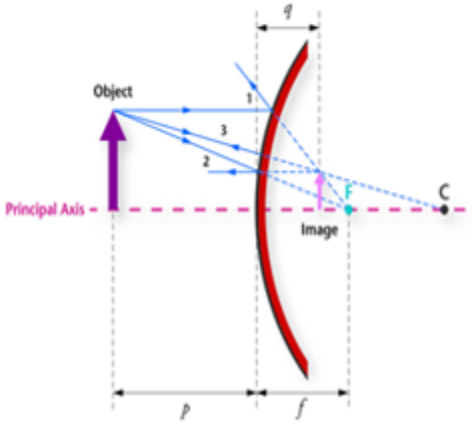
$$-\frac{6}{40} = \frac{1}{v}$$

v = -40/6 cm = -6.67cm

The negative sign denotes that the image will be formed on the left side of the mirror that is on the same side as that of the object.

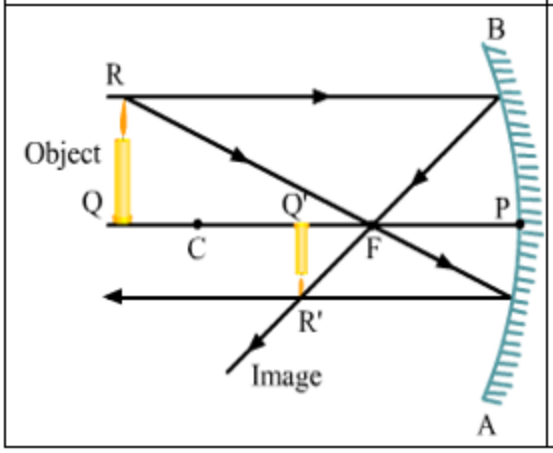
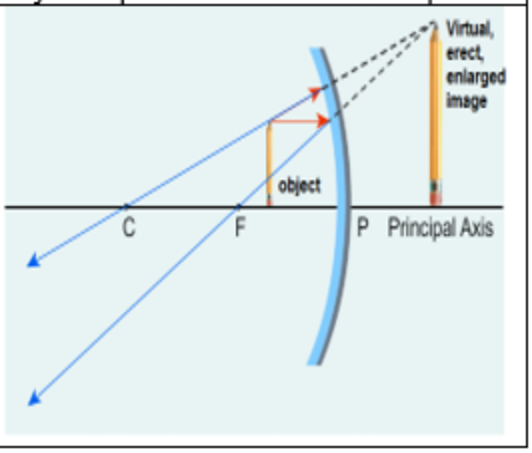
Q. 5. State the differences between convex and concave mirrors. (AS1)

Answer :

CONCAVE MIRROR	CONVEX MIRROR
1. A mirror is called concave mirror if its reflecting side is bulging inwards that is inner side of the spherical mirror. 2. When parallel rays are incident on the concave mirror, the reflected rays converge at the focus.	1. In a convex mirror, the outer side of the spherical mirror is reflecting. 2. When parallel rays are incident on the convex mirror, the reflected rays diverge from the focus.
3. A concave mirror forms real & inverted images except when the object is placed between focus & pole.	3. Convex mirror form virtual & erect image irrespective of the position.
4. Concave mirror magnifies the image of the object at all positions except when the object is placed at the center of curvature.	4. A convex mirror always produces a diminished image of the object.
5. The image formed by a concave mirror can be produced & seen on a screen.	5. The image formed by a convex mirror cannot be produced on a screen.
6. The examples of concave mirror include reflecting telescopes, torch light, automobile head lights.	6. The examples of convex mirror include calling bell, optical instruments, rear side view mirror in vehicles.
	

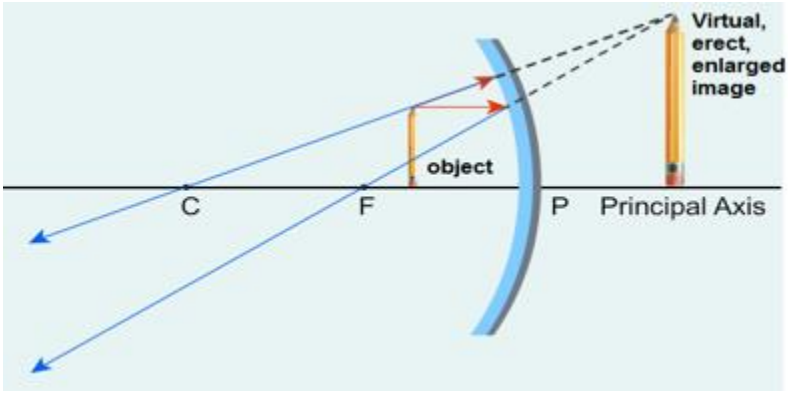
Q. 6. Distinguish between real and virtual images. (AS1)

Answer :

REAL IMAGES	VIRTUAL IMAGES
1. Real images are formed when the reflecting or the refracting rays actually meet at some point.	1. Virtual images are formed when the reflecting or the refracting rays do not actually meet but they appear to meet at some point.
2. It can be obtained on the screen.	2. It cannot be obtained on the screen.
3. It is inverted	3. It is erect & laterally inverted.
4. It is formed by a concave mirror when the object is not placed between focus & pole of the concave mirror.	4. It is formed by the convex mirror when the object is placed at any position and concave mirror when the object is placed between focus & pole.
	

Q. 7. How do you get a virtual image using a concave mirror? (AS1)

Answer : When the object is placed between focus and pole, then principal rays are drawn through the object. The first ray is drawn through the center of curvature and the second ray is incident parallel to the principal axis which passes through focus after reflection. Both the reflected rays when produced further does not meet at a point. So, both the reflected rays are produced backward beyond the mirror so as to meet at a point. At this point, we get an image which cannot be obtained on a screen. This image is virtual, erect and enlarged.



Q. 8. What do you know about the terms given below related to spherical mirrors? (AS1)

a) Pole: b) Centre of curvature:
c) Focus: d) Radius of curvature:
e) Focal length: f) Principle axis:
g) Object distance: h) Image distance:
i) Magnification:

Answer : a) Pole: Pole is the mid-point of the spherical mirror. It's a point where the principal axis meets the mirror.

b) Centre of curvature: It is the center of the sphere of which the mirror is a small section.

c) Focus: When parallel rays are incident on the mirror, the reflected rays converge to or diverge from a point. This point is called the focus.

d) Radius of curvature: It is the radius of the sphere of which the mirror is a small section.

e) Focal length: Focal length is the distance between the pole & the principal focus. Also, its half the radius of curvature.

f) Principle axis: The principle axis is the line passing through the center of curvature and the pole. It extends infinitely on both sides.

g) Object distance: The distance of the object from the pole is called the object distance.

h) Image distance: The distance of the image from the pole is called the image distance.

i) Magnification: It is defined as the ratio of image height to the object height.

Alternatively, it is the ratio of image distance to the object distance.

Q. 9. Write the rules for sign convention. (AS1)

Answer : The sign conventions which are used while studying positions of object & image differs from books to books. But most commonly, Cartesian sign conventions are used. The pole is taken as a reference point. The rules for sign conventions are:

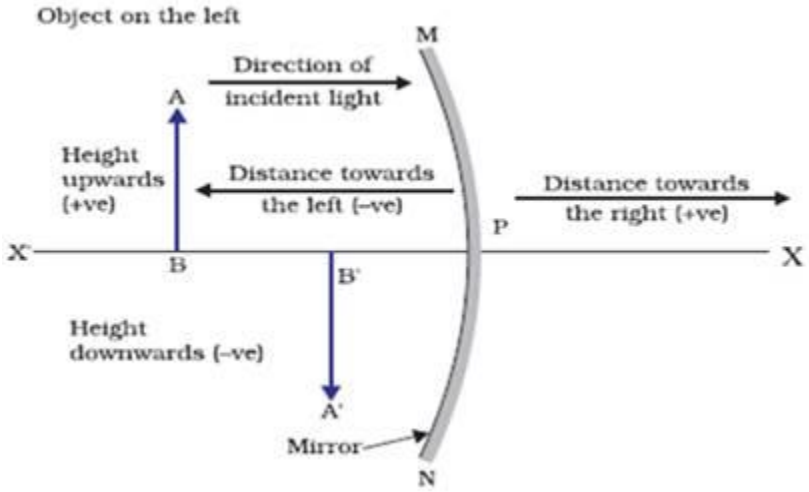
• The diagrams are drawn with the incident light travelling from left to right.

• The distances are measured by taking pole as the origin.

• The distances measured in the direction of incident light are taken positive while those measured in the direction opposite to it are taken as negative.

• Heights measured upward and perpendicular to the principal axis are taken as positive while those measured downwards are negative.

• Angles measured clockwise with optic axis as reference are negative and angles measured anti-clockwise as positive.

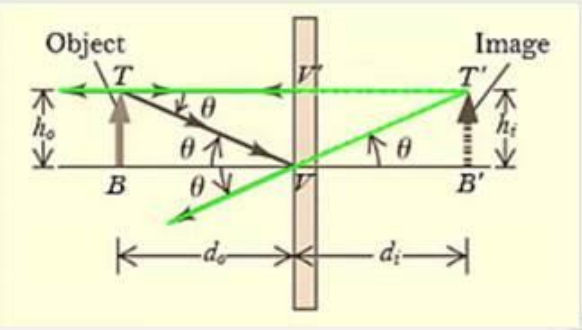


Q. 10. The magnification produced by a plane mirror is +1. What does this mean? (AS1)

Answer : Magnification refers to the ratio of image height to object height. In case of a plane mirror, the image produced is of the same size as that of the object. Also, the distance of the image behind the mirror is same as the distance of an object in front of the mirror.

Magnification:

$$m = \frac{\text{height of object}}{\text{object distance}}$$



Q. 11. Imagine that spherical mirrors were not known to human beings. Guess the consequences. (A52)

Answer : New inventions are discovered everyday in order to make life easy & comfortable while others are invented in order to fulfill our day to day needs. A world without spherical mirrors would be a world in dark. If spherical mirrors are not known to humans then the consequences are:

a. Convex mirrors are used in as the rear side view mirror so as to get a wider view of the vehicles coming behind. If plane mirrors are used instead of convex mirrors, we would not be able to get a wider view.

b. Plane mirror cannot magnify the image. Convex mirrors has the ability to magnify the image of the object. In the absence of it, magnifying glass cannot be made.

c. We will not be able to explore our galaxy if spherical mirrors are not discovered as telescopes use lenses which are made with the help of these mirrors.

d. Surveillance mirrors used in many showrooms to keep an eye on people are made up of spherical mirror. Thus, this application would not be available if these mirrors are not known.

e. Solar cookers use concave mirrors to concentrate the sun rays on a point. If concave mirrors were not known then we would not be able to use this conventional source of energy.

Q. 12. By observing steel vessels and different images in them; Surya, a third-class student, asked his elder sister Vidya some questions. What may be those questions? (AS2)

Answer : Surya must have observed different images at different distances. So, he may ask his sister:

1. Why my face is inverted when the inner side of the vessel is placed farther from my face?

2. Why my face is enlarged when observed on outer side of vessel?

3. Why my face is bulging inwards or outwards?

4. Can we use it as a mirror?

Q. 13. How do you verify the 1st law of reflection of light with an experiment? (AS3)

Answer : First law : The angle of incidence is equal to the angle of reflection (i = r).

Objective: To prove first law of reflection

Required Materials: mirror strip, soft board, white paper, protractor, pencil, pins, Ruler

Procedure:

1. Affix the white sheet on the board with the help of 4 pins.

2. Place the mirror strip on the paper & trace its edges.

3. Draw a line perpendicular to the edge of the mirror so that it can act as a normal.

4. Draw an angle i = 30 degree with respect to the normal which will act as an angle of incidence . Place the pins P & Q on this line.

5. Place your eye to the line coinciding with the image of the incident line and place the pins R & S.

6. Remove the pins R & Q and join the dots.

7. Measure the angle with respect to the normal. This angle will be angle of reflection r.

8. Repeat the experiment with angles I = 45-degree, 50 degree.

Q. 14. How do you verify the 2nd law of reflection of light with an experiment? (AS3)

Answer : Second law : The incident ray, reflected ray and the normal at the point of incidence are in the same plane. This plane is called the plane of incidence.

Objective: To prove second law of reflection

Required Materials: mirror strip, soft board, white paper, protractor, pencil, pins, Ruler

Procedure:

1. Pin the white sheet of paper on the drawing board. Place the plane mirror on it and trace its outline on the paper.

2. Draw a line perpendicular to the edge of the mirror so that it can act as a normal.

3. Now place the mirror again on the outline. The normal will be reflected clearly on the mirror.

4. Place two pins in a straight line on one side of the normal on the white sheet of paper.

5. Place two pins on the other side of the normal in such a way that these two pins are in a straight line with the reflection of the two pins on the other side of the normal.

6. Now remove the mirror and the pins and join the pin marks to the normal.

7. If we consider one line as incident ray & other as reflected ray then we conclude that the incident ray, the reflected ray & the normal all lie on the same plane.

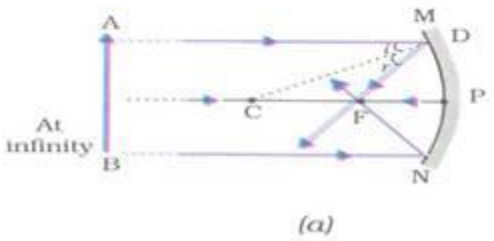
Q. 15. What do you infer from the experiment which you did with concave mirrors and measured the distance of object and distance of image? (A53)

Answer : We can draw the below inference from the experiment done with concave mirror & candle:

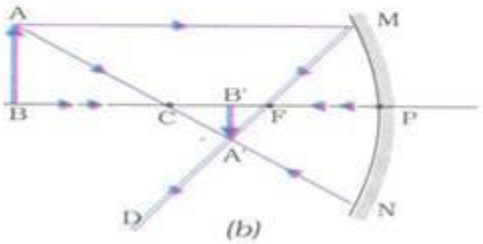
Position of candle(object)	**Position of Image**	**Enlarged/diminished**	**Inverted or erect**	**Real or virtual**
Between Mirror & focus	Image is formed behind the mirror	Enlarged	Erect	Virtual
At focal point	Image is formed at infinity.	Very much enlarged	Inverted	Real
Between F & C	Image is beyond C	Enlarged	Inverted	Real
At centre of curvature	Image at C	Same size as that of the object.	Inverted	Real
Beyond C	Image between F & C	Diminished	Inverted	Real

Image formation by Concave Mirror.

The following figures show the ray diagrams for the formation of image by a concave mirror for various positions of the object.



(a)



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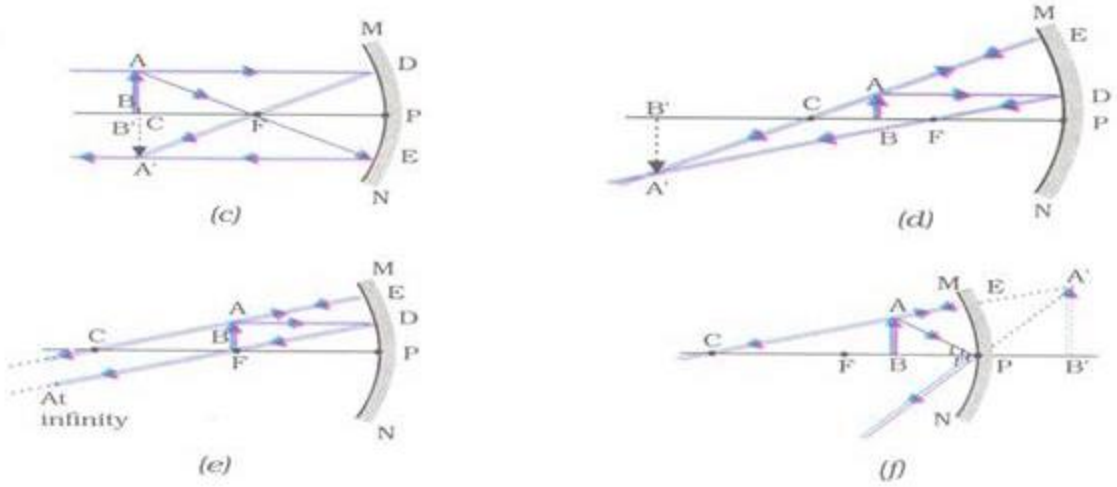


Q. 16. Find the plane of the reflection experimentally for the incident ray which passes through the heads of the pins pierced in front of the mirror. (AS3)

Answer : Objective: To find the plane of reflection

Required Materials: mirror strip, soft board, white paper, protractor, pencil, pins, Ruler

Procedure:

1. Pin the white sheet of paper on the drawing board. Place the plane mirror on it and trace its outline on the paper.

2. Draw a line perpendicular to the edge of the mirror so that it can act as a normal.

3. Now place the mirror again on the outline. The normal will be reflected clearly on the mirror.

4. Place two pins in a straight line on one side of the normal on the white sheet of paper.

5. Place two pins on the other side of the normal in such a way that these two pins are in a straight line with the reflection of the two pins on the other side of the normal.

6. Now remove the mirror and the pins and join the pin marks to the normal.

7. If we consider one line as incident ray & other as reflected ray then we conclude that the incident ray, the reflected ray & the normal all lie on the same plane and the sheet represents the plane of reflection.

Q. 17. Collect information about the history of spherical mirrors in human civilization. Display it in your class room. (AS4)

Answer :

1. In ancient times people used to see their reflection in water and thus use it to groom themselves.
2. In stone age, polished stones replaced the pool of water. Obsidian is the required stone which occur naturally in volcanic eruption.
3. When metals were found & people got to know about its usage, then these stones were replaced by metal mirrors. Mirrors of polished copper were crafted in Mesopotamia from 4000 B.C. and in ancient Egypt from around 3000 B.C.
4. As metal & stone mirrors does not provide the desired result hence Chinese people started making mirrors using silver mercury amalgams.
5. Venice in 16th century, became the centre of mirror production using this new technique.
6. Parabolic mirrors were described and studied in classical antiquity by the mathematician Diodes in his work on burning mirrors.
7. Ptolemy conducted a number of experiments with curved polished iron mirrors. He also discussed plane, convex, concave and spherical mirrors in his optics.

Q. 18. Think about the objects which act as a concave or convex mirrors in your surroundings. Make a table and display it in your class room. (AS4)

Answer :

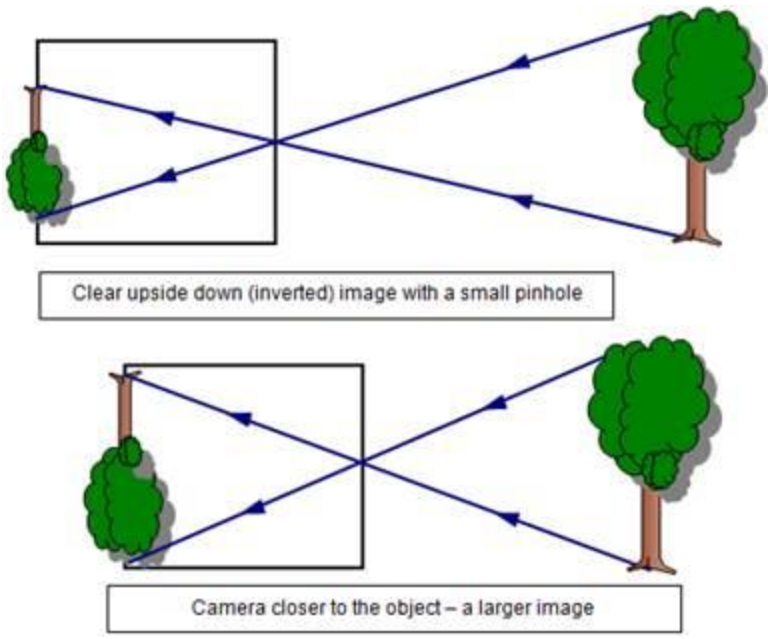
OBJECTS	USAGE	IMAGE
Rear view mirror of vehicles (convex mirror)	To get a wider view of the road	
Back side of spoon (Concave mirror)	To get practical knowledge of the concave mirror	
Surface of steel flask (convex mirror)	To get practical knowledge of the convex mirror	
Water surface in the glass (Convex mirror)		
Curved surface of a torch light (concave mirror)	To spread light on a wider surface	

Q. 19. How will our image be in concave and convex mirrors? Collect photographs and display in your class room. (AS4)

Answer : Concave & convex mirrors have certain properties. The size and position of images change in concave mirrors but in convex mirrors the size and position remain fixed that is erect & diminished. In museums, we see our image in these mirrors and laugh at our image as sometimes we appear large and sometimes a dwarf.

Q. 20. Draw and explain the process of formation of image with a pinhole camera'?

Answer : A pinhole camera is a simple camera without lens. It is made by taking a box in which is completely light proof that is dark with a small hole at one side. Light from the object enters this extremely small hole & projects an inverted image on the opposite side of the box. The size of the hole should be 1/100 or less of the distance between it and the projected image. If the hole is too small then it would result in diffraction and if it's too large then we will see the object as it is. Pin hole camera works on the principle called rectilinear theory of light which states that light travels in a straight path.



1. The tree is being enlightened by sunlight. So the whole tree act as a source of light.

2. Light from the top of the tree enters the hole and goes straight towards the bottom of the screen.

3. Light from the bottom of the tree enters the hole and goes straight towards the top of the screen.

4. So, in this way light coming from the tree which travels in a particular direction enters the pinhole & light which travels in other directions were blocked.

5. This creates a sharp inverted image of the object.

Q. 21. Draw suitable rays by which we can guess the position of the image formed by a concave mirror. (AS5)

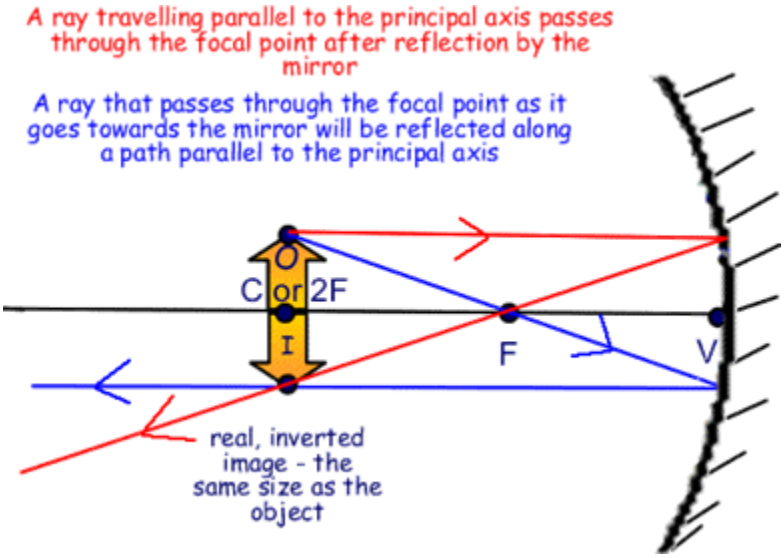
Answer : There are principal rays which help guessing the position of image. With the help of two principal rays we can guess the position of image as the reflected rays meet at the point of image formation. Those principal rays are:

• A ray parallel to the principal axis , after reflection, passes through the focus.

• A ray incident towards or away from the centre of curvature is reflected back along its original path.

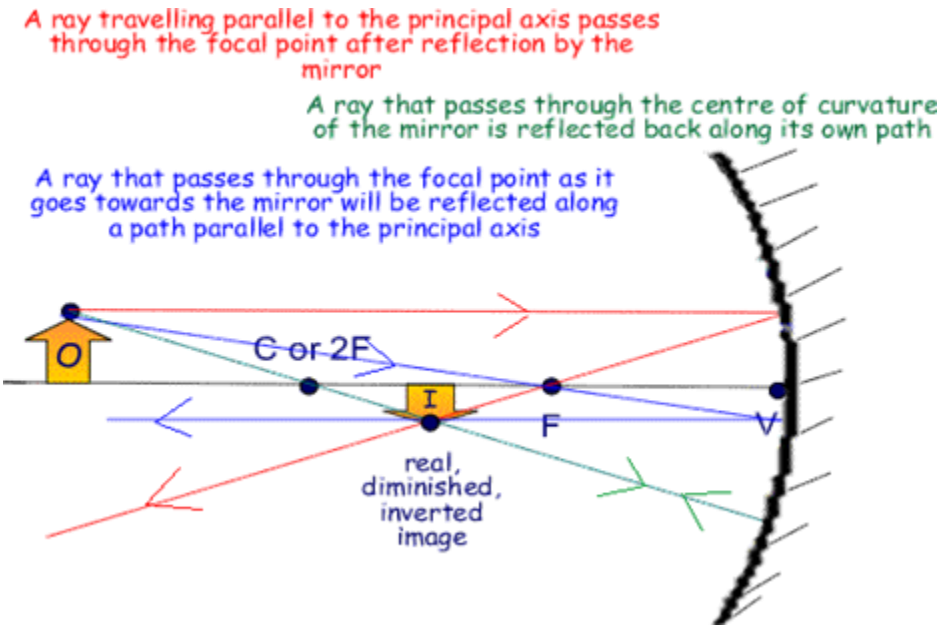
• A ray incident at pole at an angle i is reflected at an angle i.

• A ray through the focus is reflected parallel to the axis.



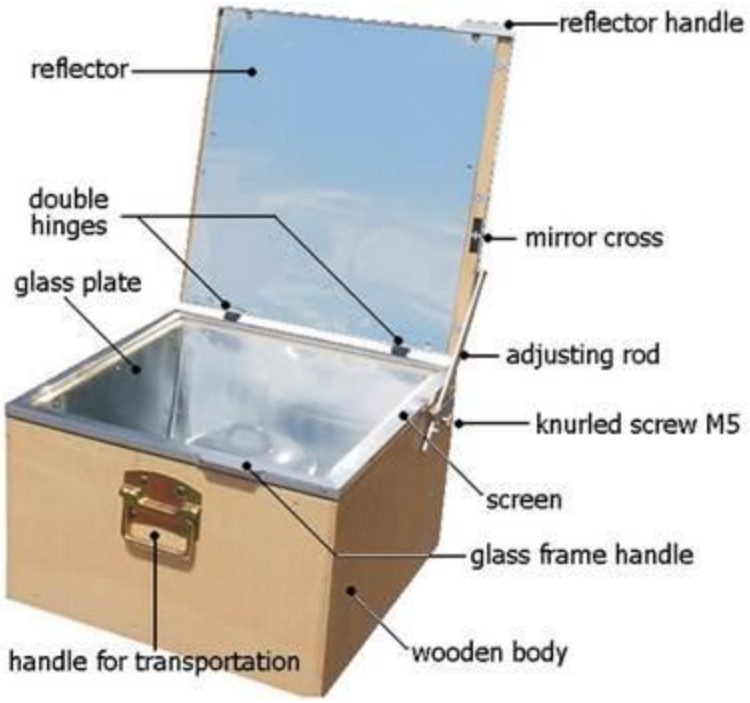
Q. 22. Show the formation image with a ray diagram when an object is placed on the principal axis of a concave mirror away from the center of curvature. (AS5)

Answer :



Q. 23. Make a solar heater/cooker and explain the process of making. (AS5)

Answer : Solar heater/cooker is exceptionally good medium to use solar energy. It is a conventional source of energy which reduces the consumption of non-conventional sources of energy like coal, natural gas etc.



Steps included to make a solar heater/cooker are:

• Take a wooden box which has handle for transportation and a lid is attached with this box with double hinges.

• Cover the inner side of the lid with aluminum foil/concave mirror which will act as a reflector. It will reflect the rays of the sun.

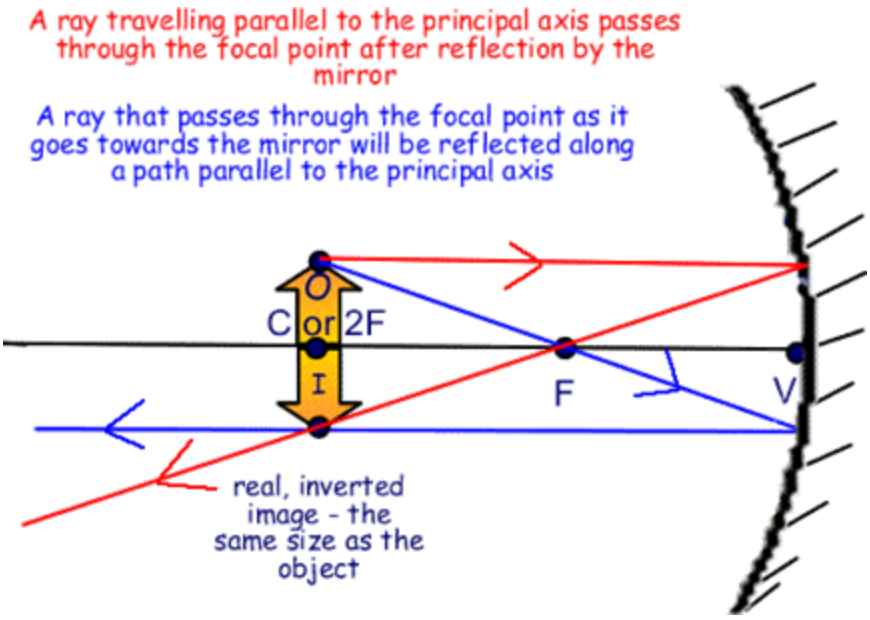
• Line the bottom of the box with black construction paper—black absorbs heat. The black surface is where the food will be set to cook.

• Affix glass plate on the inner side of the box in order to insulate the wooden box so that heat is trapped in the box.

• Place the food to be cooked inside the box and turn the reflector lid towards the sun.

Q. 24. To form the image on the object itself, how should we place the object in front of a concave mirror? Explain with a ray diagram. (AS5)

Answer :



When the object is placed on the center of curvature in front of the concave mirror, the rays parallel to the principal axis passes through the focus. Another incident ray which passes through the focus after reflection will be parallel to the principal axis. The two reflecting rays meet at center of curvature thus image is formed there.

Q. 25. How do you appreciate the role of spherical mirrors in daily life? (A S6)

Answer : Spherical mirrors plays an important role in our day to day life. Its uses includes:

• Concave mirrors are used in headlights of automobile, torch so that the light spreads on a wider surface thus creating wider vision.

• Solar cookers use concave mirror as reflectors to concentrate sun rays on a point to increase the temperature of the box

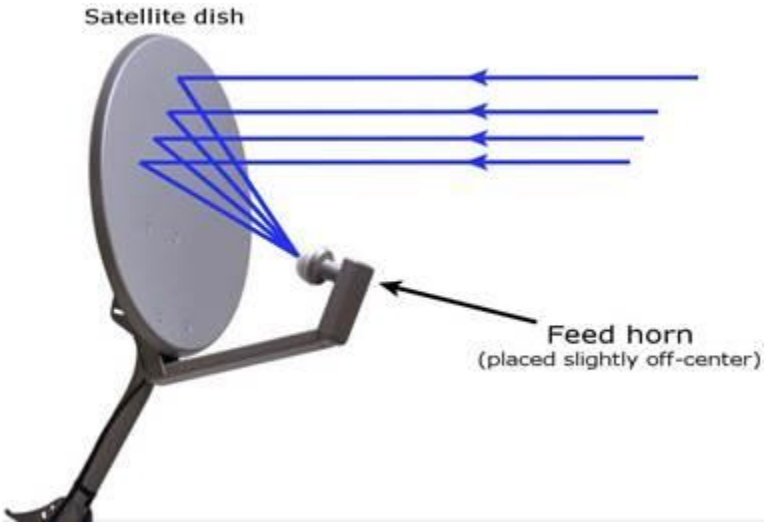
• Rear side view mirror uses convex lens to get a wider view of the road and vehicles coming behind.

• Concave mirrors are used in satellite dishes, They are used in telescopes , Dentist and ENT doctors use them to obtain a larger image than the original of the teeth , ear or skin etc .

• The convex mirror is suitable for convenient shop and big supermarket and any other corner where need anti-thief , It is used in the turning off the road and parking.

Q. 26. How do you appreciate the use of reflection of light by a concave mirror in making of TV antenna dishes? (AS6)

Answer : Light rays coming from very distant areas are considered as parallel rays. When parallel light rays are incident on the concave mirror, they are converged at the focus of the mirror. Antennas are used for communication and they use electromagnetic waves to communicate. So electromagnetic waves coming from satellites or other dish antennas located at long distances act as parallel waves and are incident on the TV dish antennas (concave mirror) and gets reflected towards focus. At the focal point, some circuit is present to absorb electromagnetic energy and converts the signal into voltage.



Q. 27. Have you ever observed the image of the sky in rain water pools on earth? Explain the reflection of light in this context. (AS6)

Answer : The surface of Rain water pools acts as a concave mirror. Light rays coming from the sky act as parallel rays and strike the surface of water. Thus, the image of sky appears diminished and often inverted.

Q. 28. Discuss the merits and demerits of using mirrors in building elevation. (AS7)

Answer : Now a day's mirrors are used in building elevation to make it look more attractive. But there are always pros & cons of using a thing. Similarly using mirrors in buildings also include some merits as well as demerits:

MERITS:

• Mirrors used on the walls of building helps in reflecting sunlight in order to keep the interior surface cool.

• It helps in keeping privacy. People moving outside will not be able to see what is happening inside the building.

• They do not rust in moist air. In rainy season,the water wll not get clogged on the surface

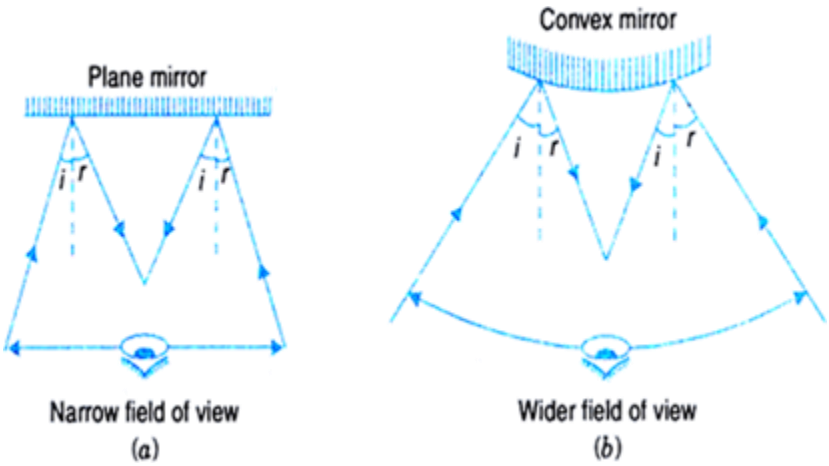
DEMERITS:

• Mirrors are expensive. So to cover the building is an expensive task.

• Mirrors are brittle in nature thus chances of accident increases.

Q. 29. Why do we prefer a convex mirror as a rear-view mirror in the vehicles? (AS7)

Answer : Convex mirror has an unusual property that is the object may be at any position but the image will be diminished & erect. If concave mirrors are used in rear view mirror then the position of image differs according to the position of the object. Moreover, the image may be enlarged & inverted which will create problem while driving. There is one more reason why convex mirrors are used in rear view mirror. It provides a wider view of the road behind the vehicle. Thus, the driver can analyze the road and the vehicles coming behind.



Q. 30. A convex mirror with a radius of curvature of 3m is tried as rear view in an automobile. If a bus is located at 5m from this mirror, find the position, nature and size of the image. (AS7)

Answer : Radius of curvature (R) = 3 m

Focal length (f) = R/2 = 3/2 m Image distance(v)= ?

Object image (u) = - 5 m

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

$$\frac{2}{3} = \frac{1}{-5} + \frac{1}{v}$$

$$\frac{2}{3} + \frac{1}{5} = \frac{1}{v}$$

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

$$\frac{13}{15} = \frac{1}{v}$$

v = 15/13 m = 1.15 m

Thus, the image will be formed behind the mirror at a distance of 1.15 m from the mirror. The image is virtual, erect & diminished.

Q. 31. An object is placed at a distance of 10cm from a convex mirror of focal length 15cm. Find the position and nature of the image. (AS7)

Answer : Focal length (f) = 15 cm

Image distance(v)= ?

Object image (u) = - 10cm

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

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

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

$$\frac{10+15}{150} = \frac{1}{v}$$

$$\frac{25}{150} = \frac{1}{v}$$

v = 150/25 cm = 6cm

Thus, the image will be formed behind the mirror at a distance of 6 cm from the mirror. The image is virtual, erect & diminished.