3. Light

Multiple Choice Questions

1. Question

The field of view * is maximum for _____

(* FOV is the extent of the observable area that is seen at any given instant)

A. plane mirror

B. concave mirror

C. convex mirror

Answer

The field of view is maximum for b)convex mirror because it always forms virtual ,erect .small sized image of object. That is the reason we use convex mirror in our vehicles.

(A) This is incorrect because –

plane mirror always form equal size image of object ,this is the reason we not prefer plan mirror for large field of view.

(B) This is incorrect because-

Concave mirror has small field of view then convex mirror .

2. Question

When a ray of light passes from one medium to another medium, refraction takes place when angle of incidence is

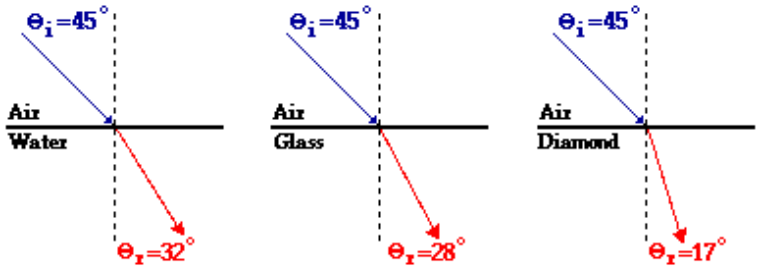
A. 0°

B. 45°

C. 90°

Answer

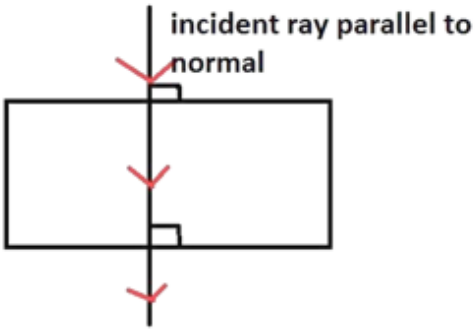
45 , if ray is travelling from lighter to denser medium then after refraction it bend towards the normal between the surfaces.



(a) If angle of incident is 0. Then the ray will go on its own path it will not show any deflection . so there is no refraction.

SEE the figure below to get an idea how ray will travel when angle of incident is zero.

So this option is incorrect



(c)As angle of incident is 90 , there is also no refraction.

3. Question

_____ is used as reflectors in torchlight

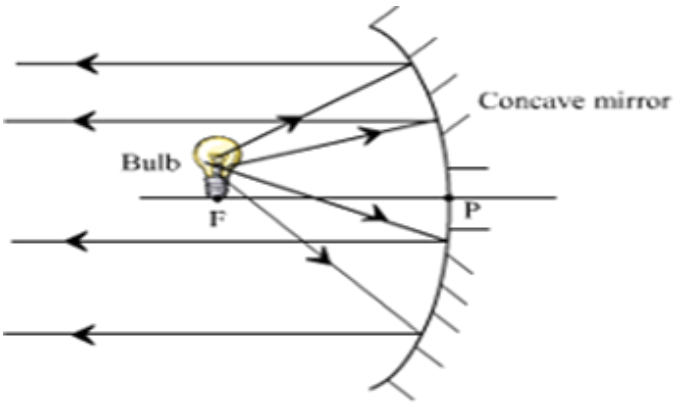
A. concave mirror

B. convex mirror

C. plane mirror

Answer

Because when the bulb of torchlight is placed at focus of concave mirror, it allows the light to spread out to infinity (longer distances).



(b)this is incorrect because

convex mirror always forms virtual images so we can not put light bulb on virtual position so we can't use convex mirror in torch light.

(c)this is incorrect because –

plane mirror can not spread light falling on it so we not use it in torch light.

4. Question

We can create enlarged, virtual images with

A. concave mirror

B. convex mirror

C. plane mirror

Answer

 A virtual image formed by a concave mirror is always enlarged.

 When an object is placed between a concave mirror and its focal point, the image is virtual.

(b) This is incorrect because-

the convex mirror forms virtual images, but it is not enlarged.

(b) This is incorrect because-

Plane mirror always forms equal sized images.

5. Question

When the reflecting surface is curved outwards the mirror formed will be

A. concave mirror

B. convex mirror

C. plane mirror

Answer

(b)This incorrect because the concave mirror is curved inwards.

(c) this is incorrect because the plane mirror is plane.

6. Question

The focal length of a concave mirror is 5cm. Its radius of curvature is

A. 5 cm

B. 10 cm

C. 2.5 cm

Answer

Focal length of a mirror is given by the following formula.

f=R/2

Where R=radius of the mirror

So R=5× 2 = b)10 cm

(a)&(c) not have the value equal to 10cm so both are incorrect .

7. Question

When a beam of white light passes through a prism it gets

A. Reflected

B. deviated and dispersed

C. only deviated

Answer

When the light ray passes through prism its is deviated and dispersed due to refraction of light.

Option (a)&(c) are incorrect

Only (b) is correct

8. Question

The speed of light is maximum in

A. vacuum

B. glass

C. diamond

Answer

vacuum , the refractive index in vacuum is 1.

(b)&(c) is incorrect because the refractive index in both cases is higher then 1.

9. Question

A real and enlarged image can be obtained by using a

A. convex mirror

B. plane mirror

C. concave mirror

Answer

(b)This is incorrect because the plane mirror always form equal sized image .

(a) This is incorrect because convex mirror always forms virtual images .

10. Question

Which of the following statements about total internal reflection is true?

A. angle of incidence should be greater than critical angle

B. light must travel from a medium of higher refractive index to a medium of lower refractive index

C. both (a) and (b)

Answer

Because we know that Two important conditions for total internal reflection are:

• Angle of incidence (i) should be greater than critical angle (i_c).

• Ray should travel from denser medium to rarer medium.

True or False

1. Question

The angle of deviation depends on the refractive index of the glass

Answer

TRUE

2. Question

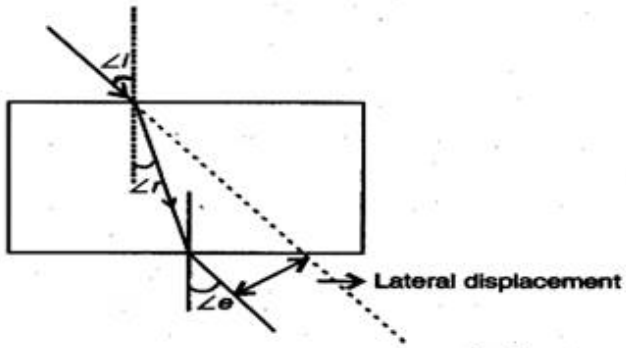
If a ray of light passes obliquely from one medium to another, it does not suffer any deviation.

Answer

FALSE

It will show deviation due to the difference between the REFRACTIVE INDEX of two medium.

The ray diagram is as shown :



The required formula is ${}_{a}n_{g} = \frac{\sin i}{\sin r}$.

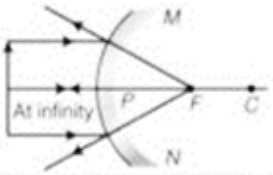
3. Question

If the object is at infinity in front of a convex mirror the image is formed at infinity.

Answer

false

The image will form at principal focus , the image will be virtual and point sized.

Position of object	Ray diagram	Position of image	Nature and Size of image
At infinity		At the principal focus	Virtual, erect and extremely diminished

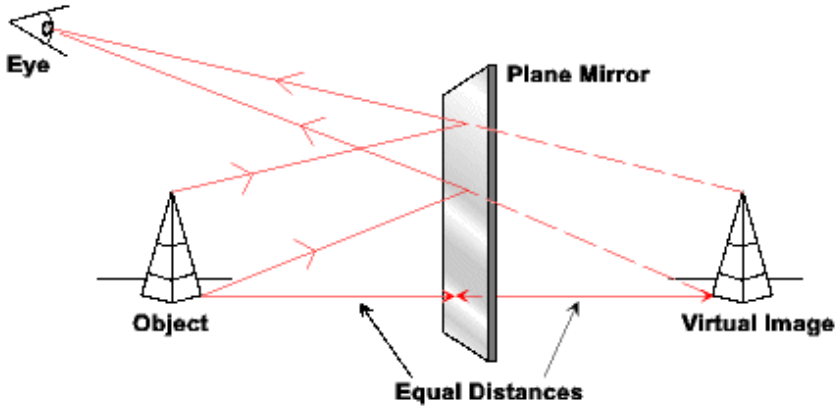
4. Question

An object is placed at distance of 3 cm from a plane mirror. The distance of the object and image is 3 cm.

Answer

FALSE

THE distance between the plane mirror and object will be same as the distance between plane mirror and image . The distance between object and image will be 6 cm.



5. Question

The convex mirror always produces a virtual, diminished and erect image of the object.

Answer

TRUE

6. Question

The distance from centre of curvature of the mirror to the pole is called the focal length of the mirror.

Answer

false , its called the radius of curvature

7. Question

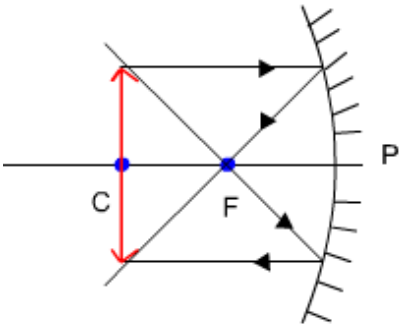
When an object is at the centre of curvature of concave mirror the image formed will be virtual and erect.

Answer

false

The image is at the centre of curvature itself. It is i) Real, ii) inverted and

iii) same size as the object.



8. Question

Light is one of the slowest travelling energy with a speed of 3×10^{-8} ms^{-1}

Answer

false ,speed of light is fasted it is 3×10^{8} ms^{-1}

9. Question

The angle of incidence at which the angle of refraction is 0° is called the critical angle.

Answer

false , Critical angle has angle of incidence 90°.

10. Question

The reason for brilliance of diamonds is mainly due to total internal reflection of light.

Answer

True

Fill In the Blanks

1. Question

In going from a rarer to denser medium, the ray of light bends _____

Answer

In going from a rarer to denser medium, the ray of light bends TOWARDS THE NORMAL

2. Question

The ratio of sine of the angle of incidence to the sine of _____ is a constant.

Answer

The ratio of sine of the angle of incidence to the sine of ANGLE OF REFRACTION is a constant.

3. Question

The mirror used in search light is _____.

Answer

The mirror used in search light is CONCAVE.

4. Question

The angle of deviation of light ray in a prism depends on the angle of ____.

Answer

The angle of deviation of light ray in a prism depends on the angle of PRISM.

5. Question

The radius of curvature of a concave mirror whose focal length is 5cm is ____.

Answer

The radius of curvature of a concave mirror whose focal length is 5cm is 10cm.

6. Question

A spherical mirror whose reflecting surface is curved outwards is called _____mirror

Answer

A spherical mirror whose reflecting surface is curved outwards is called CONVEX mirror

7. Question

Large _____ mirrors are used to concentrate sunlight to produce heat in solar furnaces

Answer

Large CONCAVE mirrors are used to concentrate sunlight to produce heat in solar furnaces

8. Question

All distances parallel to the principal axis are measured from the _____ of the mirror

Answer

All distances parallel to the principal axis are measured from the principal axis of the mirror

9. Question

A negative sign in the value of magnification indicates that the image is _____.

Answer

A negative sign in the value of magnification indicates that the image is REAL.

10. Question

Light is refracted or bent while going from one medium to another because its _____ changes.

Answer

Light is refracted or bent while going from one medium to another because its REFRACTIVE INDEX changes.

Match The Following

1. Question

Match the following:

i) List I	List II
1. Ratio of height of image to height of object.	1. concave mirror
2. Used in hairpin bends in mountains	2. total internal reflection
3. Coin inside water appearing slightly raised	3. magnification
4. Mirage	4. convex mirror
5. Used as Dentist's mirror	5. refraction

Answer

i) List I	List II
1. Ratio of height of image to height of object.	3. magnification
2. Used in hairpin bends in mountains	4. convex mirror
3. Coin inside water appearing slightly raised	5. refraction
4. Mirage	2. total internal reflection
5. Used as Dentist's mirror	1. concave mirror

Assertion and Reason Type

1. Question

In the following questions, the statement of assertion is followed by a reason. Mark the correct choice as:

Assertion: For observing the traffic at a hairpin bend in mountain paths a plane mirror is preferred over convex mirror and concave mirror.

Reason: A convex mirror has a much larger field of view than a plane mirror or a concave mirror.

A. If both assertion and reason are true and reason is the correct explanation

B. If assertion is true but reason is false.

C. If assertion is false but reason is true.

Answer

C) Assertion is false because –

CONVEX MIRROR IS USED INSTEAD OF PLANE MIRROR

2. Question

In the following questions, the statement of assertion is followed by a reason. Mark the correct choice as:

Assertion: Incident ray is directed towards the centre of curvature of spherical mirror. After reflection it retraces its path.

Reason: Angle of incidence i = Angle of reflection r = 0^o.

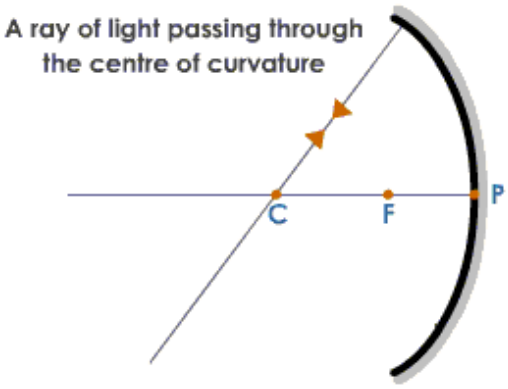
A. If both assertion and reason are true and reason is the correct explanation

B. If assertion is true but reason is false.

C. If assertion is false but reason is true.

Answer

A)you can clearly see in the figure how ray will travel.



Very Short Answer Type

1. Question

Give two examples of transparent medium that are denser than air.

Answer

1) glass 2) water

2. Question

According to cartesion sign convention, which mirror and which lens has negative focal length?

Answer

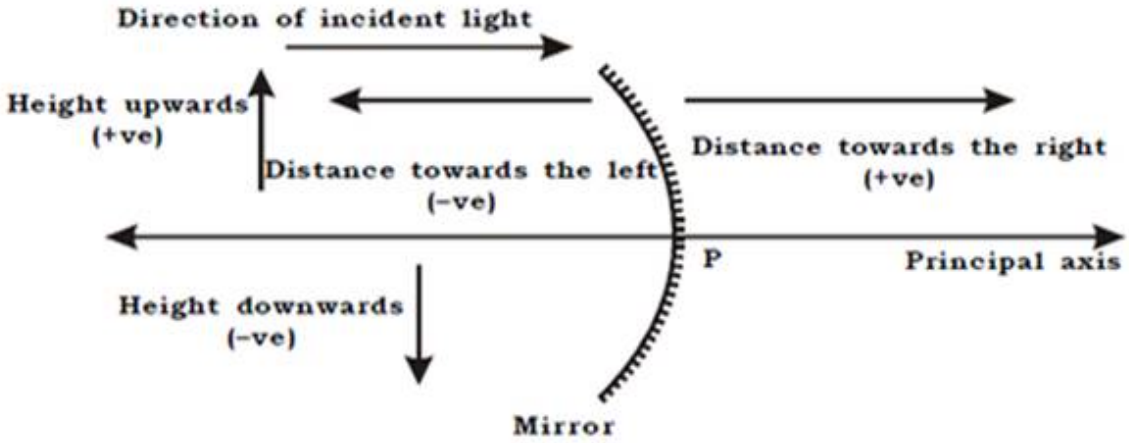
According to Cartesian sign convention, object distances (u) are always negative as the object is placed to the left of the mirror/lens.

• Focal length (f) is positive for a convex lens and convex mirror.

• Focal length is negative for concave lens and concave mirror.Image distance (v) can be both positive and negative for convex lens and concave mirror depending on the position of the object.

• Image distance is always negative for a concave lens.

• Image distance is always positive for a convex mirror.



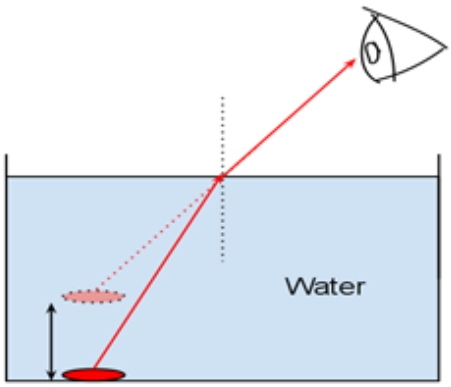
Representation of sign conventions

3. Question

A coin in a glass beaker appears to rise as the beaker is slowly filled with water, why?

Answer

It happens due to the, phenomenon of refraction of light. When the rays of light from the coin, in the denser medium which is water, fall on the interface separating the two media, the rays of light move away from the normal after refraction. The point from which the refracted rays appear to come gives the apparent position of the coin. As the rays appear to come from a point above the coin, therefore, the coin appears some distance above the base of beaker.

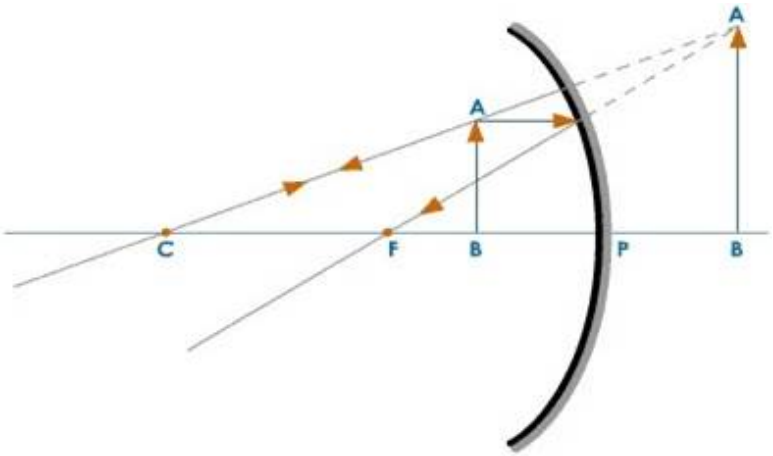


4. Question

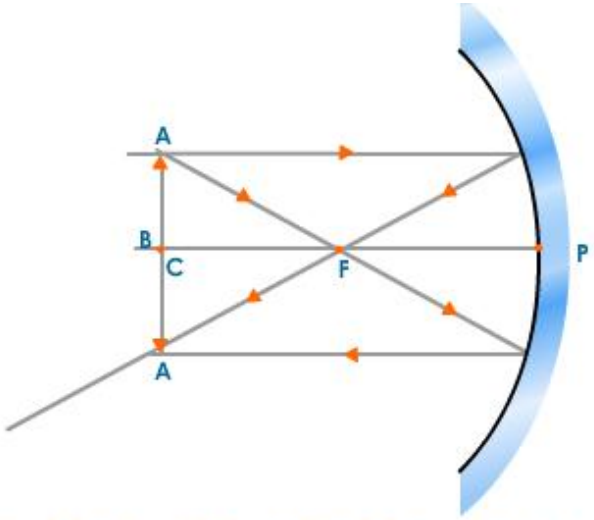
Name the mirror(s) that can give (i) an erect and enlarged image, (ii) same sized, inverted image?

Answer

(i) Concave mirror gives *an erect and enlarged image* of an object, when the object is between pole (P) and principal focus of mirror (F).



(ii) Concave mirror gives *same sized and inverted image when object is place on centre of curvature of the mirror.*



When the Object is Placed at the Centre of Curvature

5. Question

Name the spherical mirror(s) that has/have

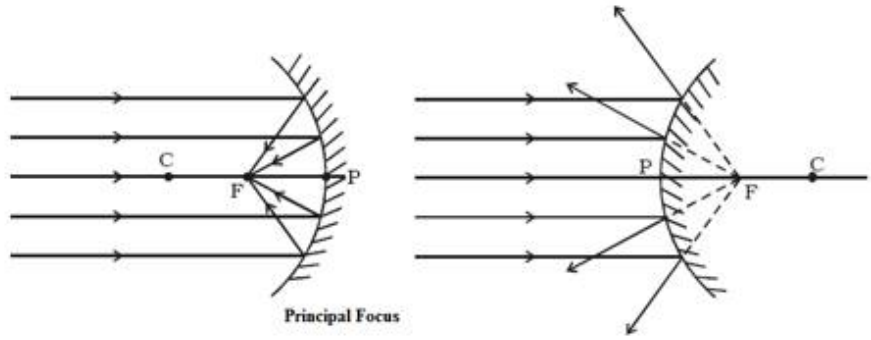
i) Virtual principal focus

ii) Real principal focus

Answer

1) convex mirror

2) Concave mirror



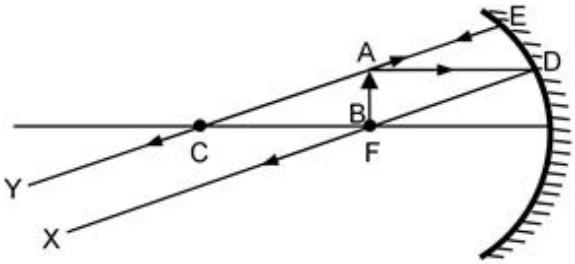
Real focus virtual focus

6. Question

If an object is placed at the focus of a concave mirror, where is the image formed?

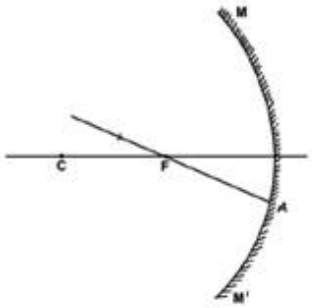
Answer

If an object is placed at the focus of a concave mirror,then a large image appears at infinity . after reflection the rays meet at infinity .



7. Question

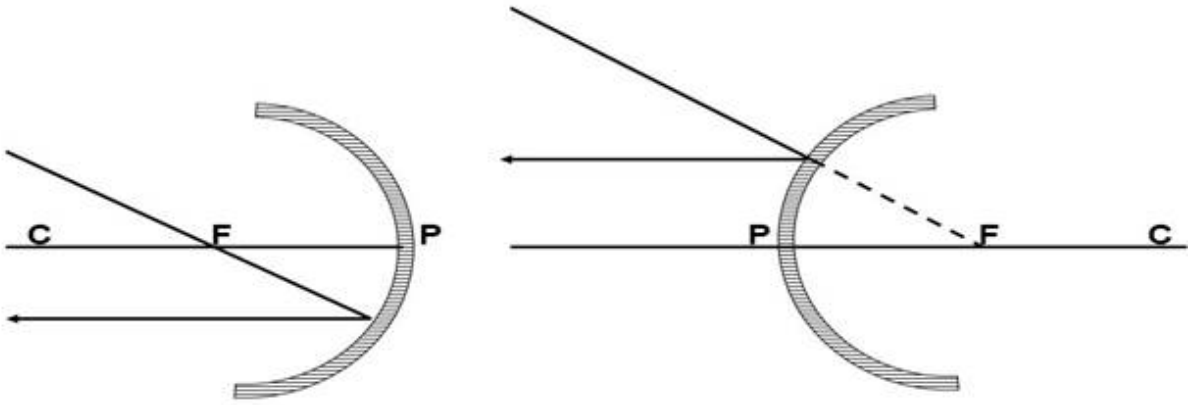
Copy this figure in your answer book and show the direction of the light ray after reflection



Answer

the ray will become pallarel to the principal axis.

) In a concave mirror a ray of light passing through the focus after reflection goes parallel to the principal axis.
In a convex mirror a ray of light directed towards the focus after reflection goes parallel to the principal axis.



8. Question

Why does a ray of light bend when it travels from one medium to another?

Answer

when a light ray travels from one medium to another, it shows some deviation from its path this phenomenon is called refraction of light.

9. Question

What is the speed of light in a vacuum? Who first measured the speed of light?

Answer

the speed of light in vaccum is 3×10^8 ms^{-1}

It was the Danish astronomer, Olaus Roemer, who, in 1676, first successfully measured the speed of light. His method was based on observations of the eclipses of the moons of Jupiter (by Jupiter)

10. Question

Concave mirrors are used by dentists to examine teeth. Why?

Answer

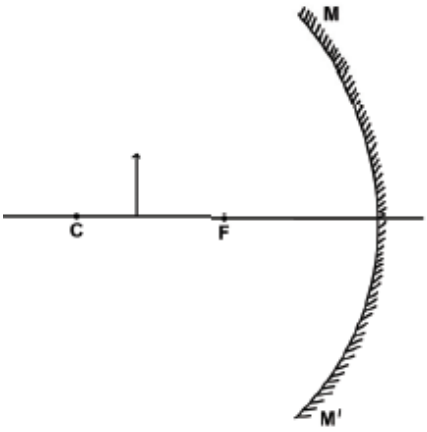
Concave mirror produces virtual, erect and magnified images when a object is placed in between focus and pole. That's the reason why dentists use concave mirror to examne teeth.

Short Answer Type

1. Question

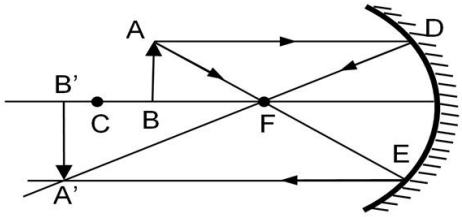
a) Complete the diagram to show how a concave mirror forms the image of the object.

b) What is the nature of the image?



Answer

(a)



(b) When the object AB is placed between the centre of curvature and principal focus, then the ray AD going parallel to the principal axis and another ray AE passing through the principal focus F intersect each other at point A' beyond the centre of curvature. Thus the image formed in this case is beyond C, enlarged, real and inverted.

2. Question

Pick out the concave and convex mirrors from the following and tabulate them

Rear-view mirror, Dentist's mirror, Torch-light mirror, Mirrors in shopping malls, Make-up mirror.

Answer

concave mirror - Dentist's mirror, Torch-light mirror , Make-up mirror.

Convex mirror - Rear-view mirror , Mirrors in shopping malls

3. Question

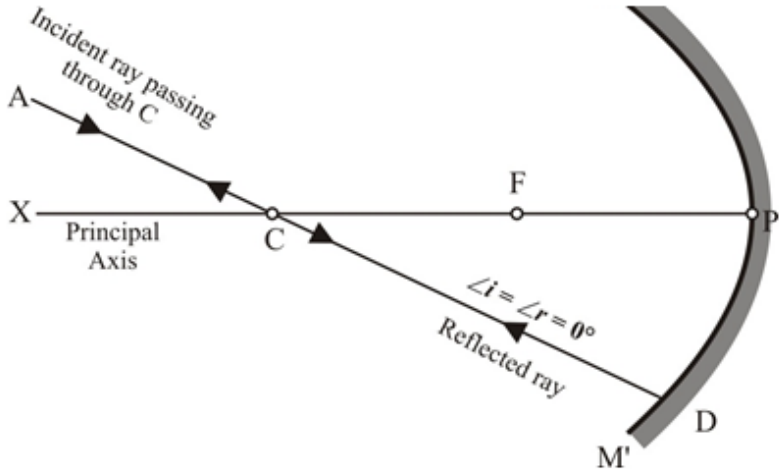
State the direction of incident ray which after reflection from a spherical mirror retraces its path. Give reason for your answer.

Answer

A ray of light passing through the centre of curvature of a concave mirror retraces its path (gets reflected along the same path), because as the ray of light passes through centre of curvature of a concave mirror it strikes the mirror

along the normal and it incidences on to the mirror at 90 degree. Hence the incident ray coincides with the normal.

Therefore angle of incidence = 0 .As we know according to law of reflection angle of reflection = 0, hence the angle of reflection too become zero degree, thus ray of light retraces its path.



4. Question

What is meant by magnification? Write its expression. What is its sign for the

a) real image

b) virtual image

Answer

Magnification – magnification is defined as how many times bigger or smaller the image of the object formed by the spherical mirror.

It is defined as the ratio of the height of the image to the height of the object.

Let , height of the object = h_o

Height of the image =h_i

Then the magnification

$$m = \frac{hi}{ho}$$

Magnification can also be defined as ratio of object distance(u) and the image distance (v)

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

The sign will be

- negative for real image

• positive for virtual image

5. Question

Write the spherical mirror formula and explain the meaning of each symbol used in it.

Answer

The spherical mirror formula is the relation among the image distance ,object distance and focal length of the mirror .

If The image distance is = v

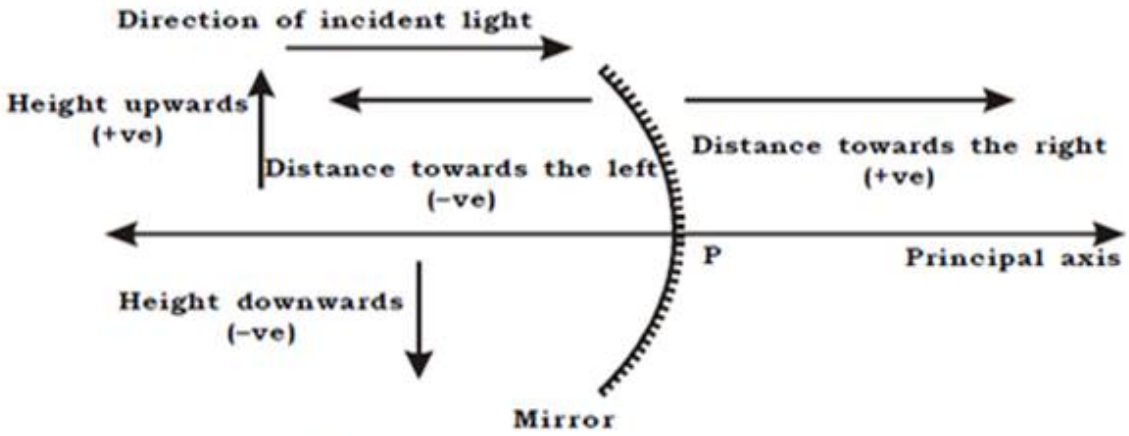
The object distance is = u

The focal length of mirror =f

Then the mirror formula will be –

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

The sign convention can be used as given in the figure –



Representation of sign conventions

We can see following things from the figure –

• Focal length (f) is positive for a convex lens and convex mirror.

• Focal length(f) is negative for concave lens and concave mirror.

• Image distance (v) can be both positive and negative for convex lens and concave mirror depending on the position of the object.

• Image distance(v) is always negative for a concave lens.

• Image distance(v) is always positive for a convex mirror.

• Object distance (u) is negative for convex as well as the concave mirror.

Long Answer Type

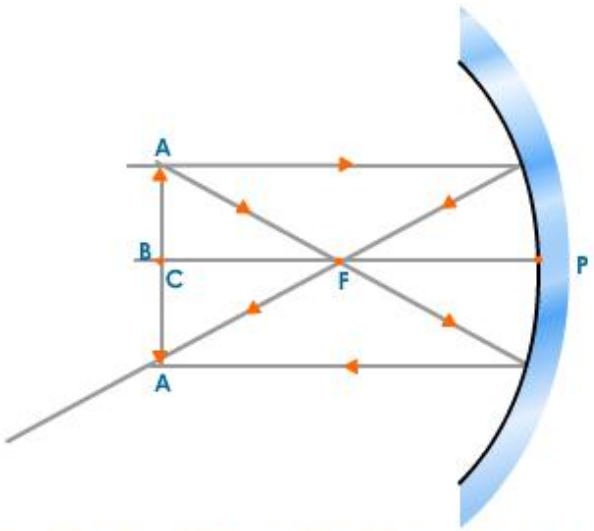
1. Question

a) Draw ray diagrams to show how the image is formed, using a concave mirror when the position of object is i) at C ii) between C and F iii) between F and P of the mirror.

b) Mention in the diagram the position and nature of image in each case.

Answer

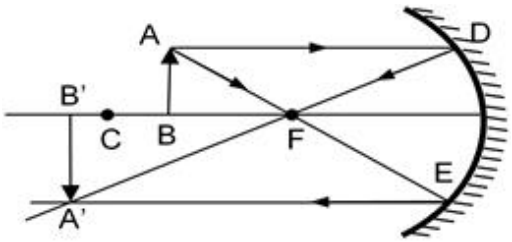
(a)



When the Object is Placed at the Centre of Curvature

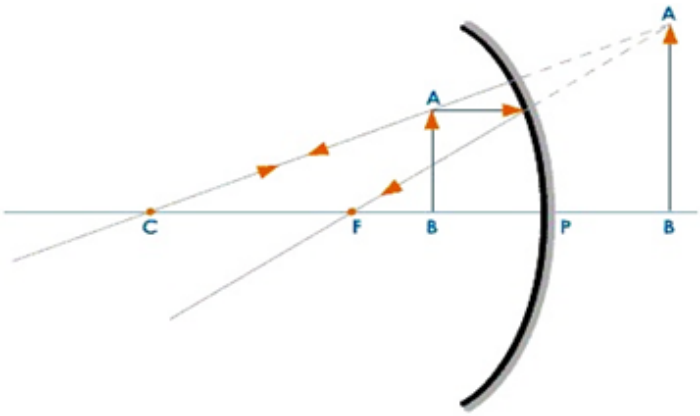
• Image is inverted and same size

(b)



• Image is inverted , real and large in size

(c)



• Image will be Virtual and large in size

2. Question

Explain with diagrams how refraction of incident light takes place from

a) rarer to denser medium

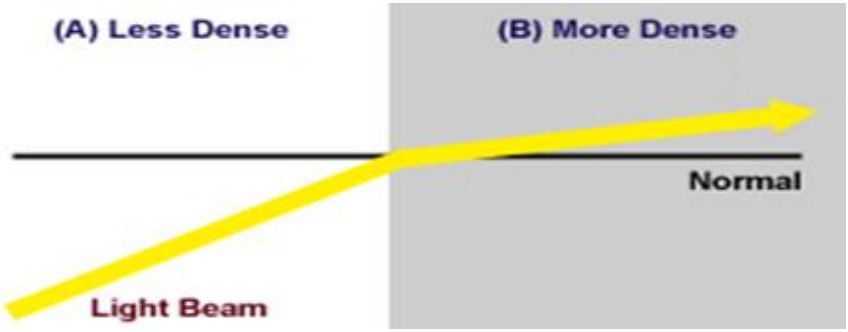
b) denser to rarer medium

c) normal to the surface separating the two media

Answer

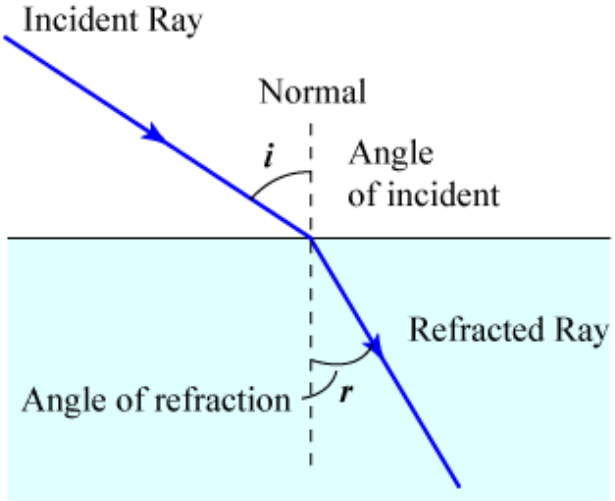
Refraction of light take place when light travels between two medium. As the speed of light is different in different medium that is the major factor for refraction of light .

(a)



As you can see in this figure the light is travelling from less dense medium to more dense medium ,its path is deviated ,this is because of refraction taking place between these two medium.

Whenever the light travels from less dense medium to more dense medium it will bend towards the normal to the surface.

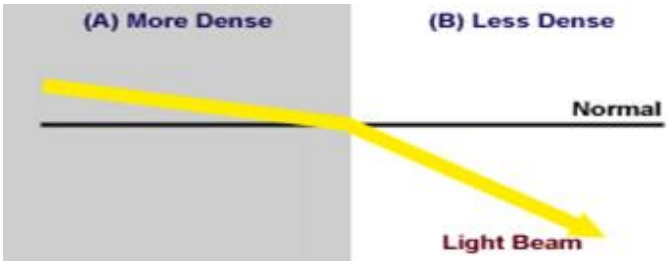


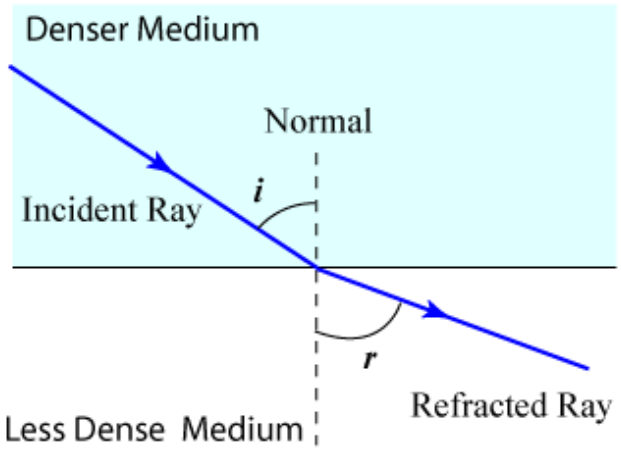
As you can see in the diagram incident ray bends towards the normal axis .

In this case always incident angle I > r (angle of refraction)

(b)

when the ray of light travels from more dense medium to less dense medium it move away from the normal axis. As you can see in the following figure



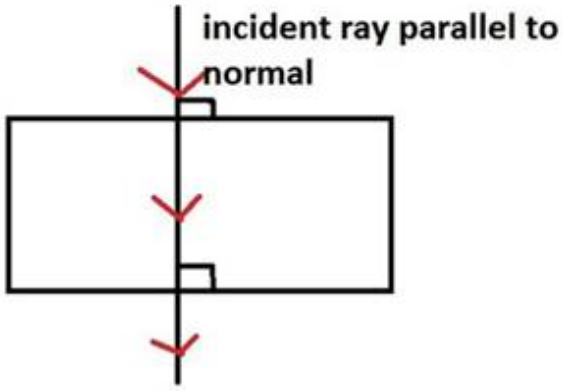


Consider the figure above when light ray passes through the interface of two medium it will deviated from its path . in this case always

Angle of incident I < r (angle of refraction)

(c) when the light ray incident normally to the interface of two medium then it travels in same path , no deviation will be there. Because the angle of incident will be 0.

You can see this in following figure –



3. Question

State and verify laws of refraction using a glass slab.

Answer

There are two Laws of Refraction these are –

• The incident ray, the refracted ray and the normal to the surface at the point of incidence all lie in one plane.

• For any two given pair of media, the ratio of the sine of the angle of incidence to the sine of the angle of refraction is a constant.

• The second law is called Snells Law after the scientist Willebrod Van Roijen Snell who first formulated it.Thus, Sin i by Sin r (where the i is the angle of incident and r is the angle of refraction) is equal to a constant that is equal to μ where, mew is the refractive index of the second medium (R2) with respect to the first medium (R1).

Hence

$$\frac{\sin i}{\sin r} = \frac{R2}{R1} = \mu$$

There are the procedure how we can verify the laws of refraction-

• Place a rectangular glass slab on a white sheet of paper fixed to a drawing board.

• Trace the boundary A1B1C1D1 of the glass slab.

• Remove the glass slab.

• Draw IO to represent the incident ray.

• Draw the normal MN at the point of incidence O.

• Fix two pins P1 and Q1 on the incident ray IO.

• Place the glass slab within its boundary A1B1C1D1.

• Look in from the other side of the glass slab, fix two pins R1 and S1 such that the feet of all the pins are in one straight line.

• Remove the glass slab and the pins.

• Mark the pin points P1, Q1, R1 and S1.

• Join R1 S1 to represent the emergent ray O2 E.

• Join O1O2 . O1O2 dash is the refracted ray.

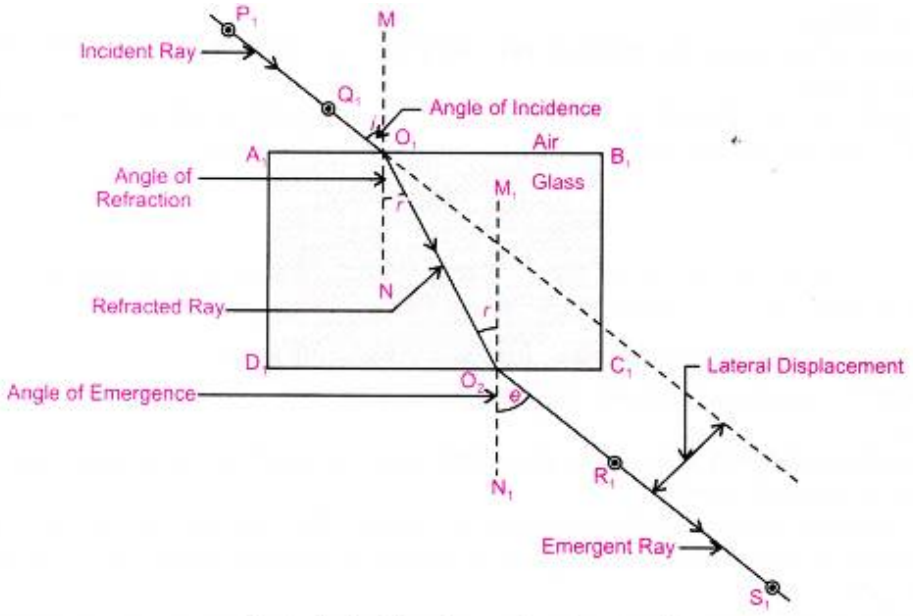


Fig. Refraction through a rectangular glass slab

The incident ray, the refracted ray and the normal are all lying in the same plane. This proves the first law of refraction.

Measure and record the angle of incidence(i) and angle of refraction(r).Repeat the experiment by varying the angle of incidence and Measure the corresponding angle of refraction.Now find the ratio of the sine of the angle of incidence(i) to the sine of the angle of refraction(r).

The ratio of the sine of the angle of incidence to the sine of the angle of refraction is found to be the same in all the three cases.

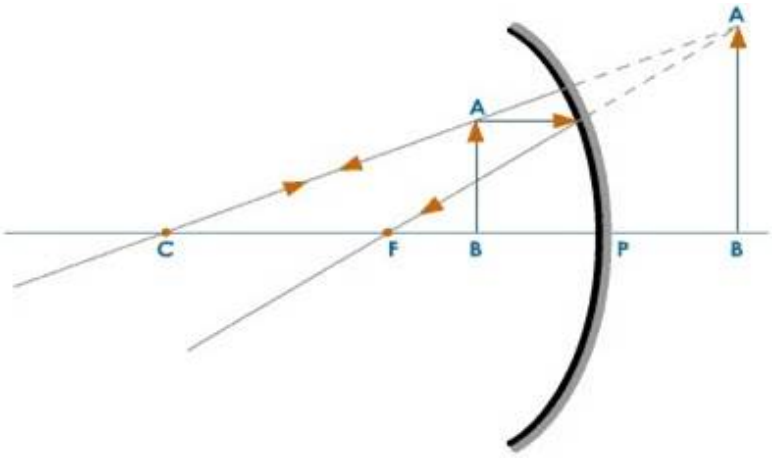
$$\frac{\sin i}{\sin r} = \frac{R2}{R1} = \mu$$

This verifies the second law of refraction or Snells law that is sin i by sin r is equal to μ , a constant for a given pair of media.

4. Question

Draw a ray diagram to show the formation of image by a concave mirror for an object placed between its pole and Principal focus and state three characteristics of the image.

Answer



When an object is placed between the principal focus (F) of the mirror and the pole of the mirror (P) then the image of the object is become on the back side of the mirror ,

YOU can see the image formation in above figure ,where the object AB is placed between focus and pole of the mirror and the image of the object AB is formed other side of the mirror .

This image will be –

- Virtual
- Large then the image
- And erect.

Numerical Problem

1. Question

The radius of curvature of a convex mirror is 40 cm. Find its focal length

Answer

as we know focal length f = R/2

Given that radius of curvature R = 40cm

Then the focal length will be

f = R/2 =40/2 = 20cm.

2. Question

An object of height 2 cm is placed at a distance 20 cm in front of a concave mirror of focal length 12 cm. Find the position, size and nature of the image.

Answer

given that

Object height h_o = 2 cm

Object distance u = -20cm (left side of mirror)

Focal length f = -12cm (concave mirror)

As we know mirror equation -

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

$$\frac{1}{-12} = \frac{1}{-20} + \frac{1}{v}$$

$$\frac{1}{v} = \frac{1}{20} + \frac{1}{-12}$$

V= -30

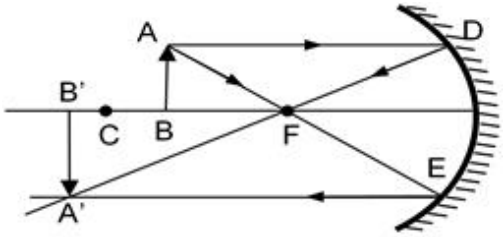
As we know magnification is

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

Putting values in formula we get -

$$\frac{hi}{2cm} = -\frac{-30}{-20}$$

h_i=3cm



Thus the image is 30cm from pole of mirror , its height will be 3 cm ,its real, inverted and magnified

3. Question

A concave mirror produces three times magnified real image of an object placed at 7 cm in front of it. Where is the image located?

Answer

Given that-

Object distance u = -7cm (left side of mirror)

Magnification m = 3

Image is real then the magnification formula become –

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

Putting values in formula we get -

$$3 = -\frac{v}{-7}$$

V = 21cm

The image is located at 21 cm in front of mirror

4. Question

Light enters from air into a glass plate having refractive index 1.5. What is the speed of light in glass? (Speed of light in vacuum is 3×10^8 ms^{-1})

Answer

Given that –

Refractive index of glass =1.5

Speed of light in vacuum = 3×10^8 ms^{-1}

As we know

$$\text{The refractive index of glass } = \frac{\text{speed of light in vacuum}}{\text{speed of light in glass}}$$

$$\text{So } 1.5 = \frac{3 \times 108\ ms-}{\text{speed of light in glass}}$$

Speed of light in glass =2×10^8m/s

5. Question

The speed of light in water is 2.25×10^8 ms^{-1}. If the speed of light in vacuum is 3×10^8 ms^{-1}, calculate the refractive index of water.

Answer

Given that –

Speed of light in water is = 2.25×10^8 ms^{-1}

Speed of light in vacuum = 3×10^8 ms^{-1}

As we know

$$\text{The refractive index of water } = \frac{\text{speed of light in vacuum}}{\text{speed of light in water}}$$

So

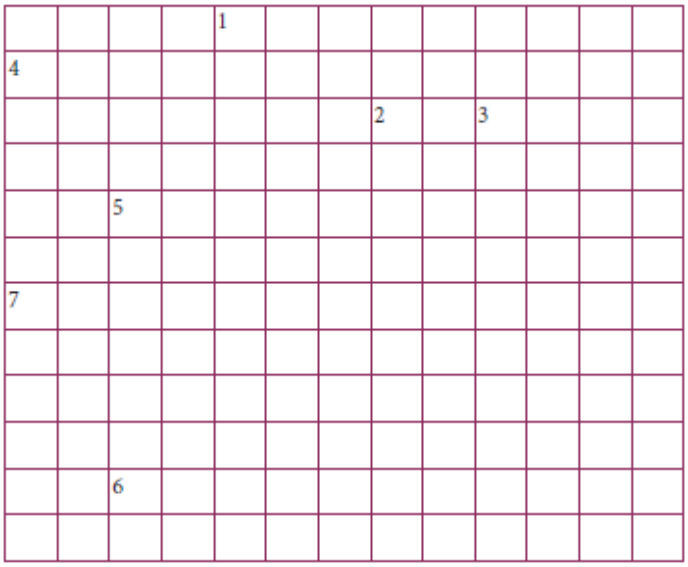
$$\text{The refractive index of water} = \frac{3 \times 10^8 \text{ m/s}}{2.25 \times 10^8 \text{ m/s}}$$

The refractive index of water =1.33

Cross word Puzzle

1. Question

Cross word puzzle



Across

2. Optical illusion due to refraction

4. A type of mirror that diverge the light rays

6. The nature of image formed when object is near the pole of concave mirror

7. Electromagnetic radiation visible to us

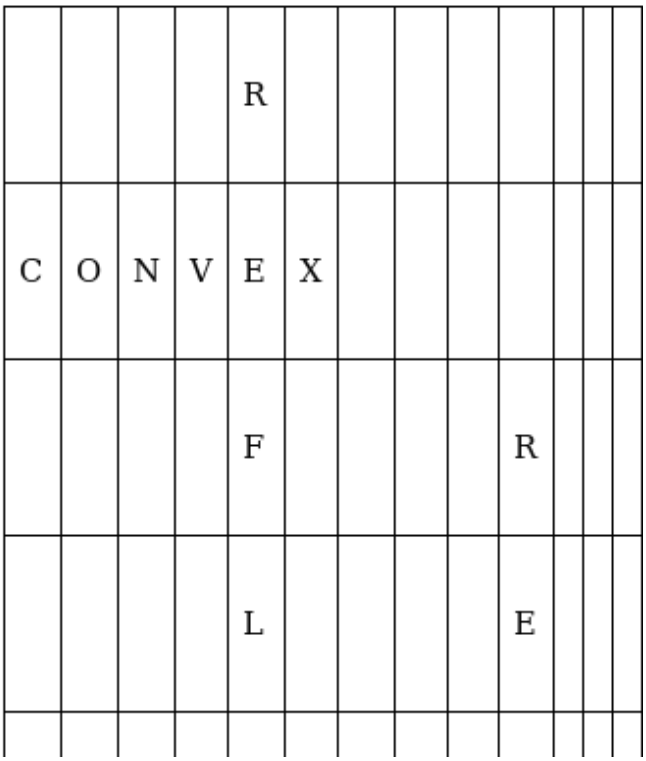
Down

1. The light ray sent back from a surface into the same medium

3. When magnification is negative, the nature of the image is _____

5. For concave mirror u and f are always _____

Answer



		N		E					A			
		E		C					L			
N	E	G	A	T	I	V						
		A		I								
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		V	I	R	T	U	A	L				
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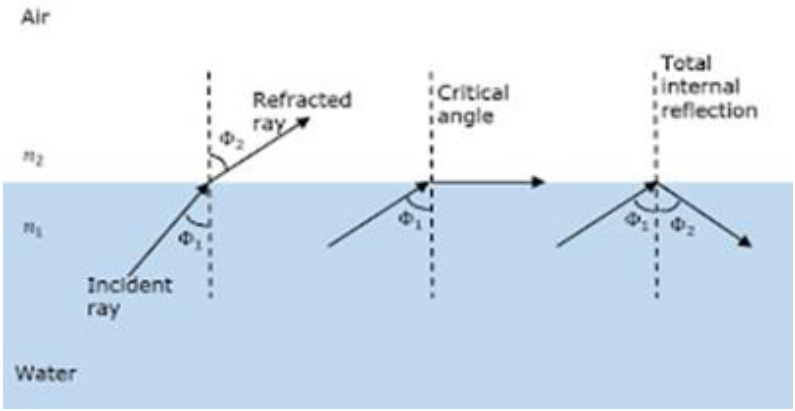
Hots

1. Question

Light ray emerges from water into air. Draw a ray diagram indicating the change in its path in water.

Answer



There are three cases for a ray going from water to air ,these are

Clearly shown in the figure -

1) Normal refraction

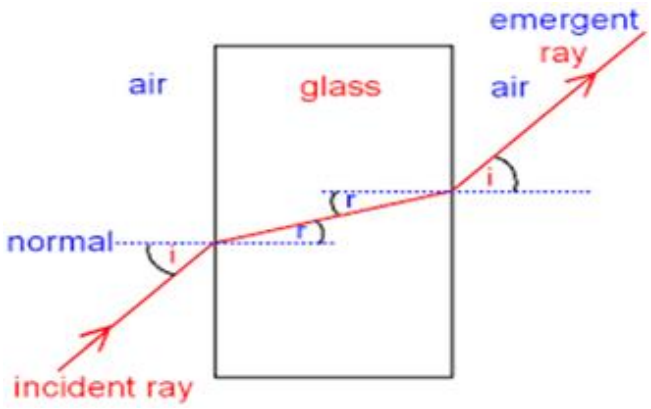
2) Critical angle

3) Total internal reflection

2. Question

When a ray of light passes from air into glass, is the angle of refraction greater than or less than the angle of incidence?

Answer



As clearly shown in the above when the ray of light from air is going into glass it will deviated from its path .as we known glass is denser then air, so according to the laws of refraction when light is travels from less dense medium to more dense medium it will bend towards the normal , that is the reason the angle of refraction become less then the angle of incident .

So , angle of refraction (r) < angle of incident(i)

3. Question

What do you conclude about the speed of light in a diamond if you are told that the refractive index of diamond is 2.41?

Answer

As we all know that

$$\text{The refractive index of diamond } = \frac{\text{speed of light in vacuum}}{\text{speed of light in diamond}}$$

We also know that

Speed of light in a vacuum is = 3×10^8 ms^{-1}

So,

$$2.41 = \frac{3 \times 10^8 \text{ m/s}}{\text{speed of light in diamond}}$$

Speed of light in diamond =1.244×10^8m/s