Chapter 3

Refraction of Light at Plane Surfaces

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Textual Questions

1. Why is it difficult to shoot a fish swimming in water? (AS1)

Ans: Due to refraction, the actual position of the fish is change. Fish and Observer are in two different mediums.The light ray travel from denser medium to rarer medium

2. The speed of the light in a diamond is 1,24,000 km/s. Find the refractive index of diamond if the speed of light in air is 3,00,000 km/s. (AS1)

Ans: Given V =1,24,000 m/s C=3,00,000 m/s n=?

$n=C/V = \frac{3,00,000}{1,24,000} = 2.42$

3. Refractive index of glass relative to water is 9/8. What is the refractive index of water relative to glass? (AS1)

Ans: Given $n_{gw} = 9/8$

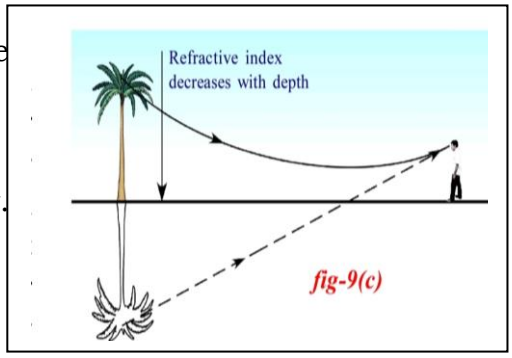
$n_{wg} = 1/\ n_{gw} = 8/9$

4. Determine the refractive index of benzene if the critical angle is 42^0.(AS1)

Ans: $c=42^0$ n=?

We know that $n= 1/\sin c = 1/\sin 42^0 = 1/0.6691 = 1.49$

5. Explain the formation of mirage? (AS1)



Ans: i) During a hot summer day, air just above the road surface is very hot and the air at higher altitudes is cool.

ii) It means that the temperature decreases with height.

iii) As a result density of air increases with height.

iv) We know that refractive index of air increases with density.

v) Thus the refractive index of air increases with height. So, the cooler air at the top has greater refractive index than hotter air just above the road. Light travels faster through the thinner hot air than through the denser cool air

vi)When the light from a tall object such as tree or from the sky passes through a medium just above the road, whose refractive index decreases towards ground, it suffers, refraction and takes a curved path because of total internal reflection.

vii) This refracted light reaches the observer in a direction shown in Figure.

viii) Hence we feel the illusion of water being present on road which is the virtual image of the sky (mirage) and an inverted image of tree on the road

6. How do you verify experimentally that sin i /sin r is a constant? (AS1)

Ans:

Aim: Obtaining a relation between angle of incidence and angle of refraction (or) experimentally prove that the angle of incidence is more than angle of refraction when light rays travel from rarer medium to denser medium (or) prove that Sin i/Sin r is constant

Materials required: Pro circle, scale, small black printed plank, a semi circular glass disc of thickness nearly 2 cm, pencil and laser light

Preparation of Pro Circle: 1)Take a wooden plank which is covered with white chart

2) Draw two perpendicular lines, passing through the middle of the paper as shown in the figure

3) Let the intersecting point be O.

4) Mark one line as NN which is normal to the another line marked as MM

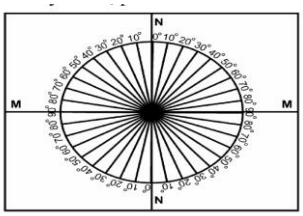
5) Here MM represents the line drawn along the interface of two media and NN represents the normal drawn to this line at O

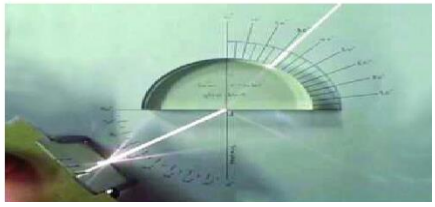
6) Take a protractor and place it along NN in such a way that its centre coincides with O as shown in fig.

7) Then mark the angles from 0^0 to 90^0 on both sides of the line NN

8) Repeat the same on the other side of the line NN

9) The angles should be represented on circular line.





Procedure: 10) Now place a semi-circular glass disc so that its diameter coincides with the interface line (MM) and its center coincides with the point O

11)Take the laser light and send it along NN in such a way that the laser propagates from air to glass through the interface at point O and observe the way of laser light coming from other side of disc

12) There is no deviation

13) Send laser light along a line which makes 15 with NN and see that it must pass through point O

14) Measure its corresponding angle of refraction

15) Repeat this experiment with angles of 20^0,30^0 ,40^0,50^0 and 60^0, note the corresponding angles of refraction

i	r	sin i	sin r	sin i/sin r

From the above table we observe that sin i/sin r is constant

From the above table, we observe that i > r

7. Explain the phenomenon of total internal reflection with one or two activities. (AS1)

Ans: i) Place the semi circular glass disc in such a way that its diameter coincides with interface line MM and its centre coincides with point 'O'.

ii) Now send light from the curved side of the semicircular glass disc.This means that we are making the light travel from denser medium to rarer medium.

iii) Start with angle of incidence (i) equal to 0^0 i.e., along the normal and look for the refracted ray on the other side of the disc.

iv) Send laser light along angles of incidence 5^0, 10^0, 15^0 etc.., and measure the angle of refraction.

v)Tabulate the results in table as shown below and note the values 'i' and 'r' in the table.

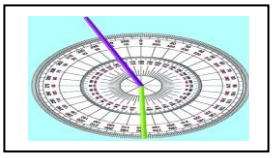
i	r

vi) At paricle angle of incidence, the refracted ray grazes the interface of the media. This angle is called criticle angle.

vii) When angle of incidence is greater than criticle angle, the light ray gets reflected into denser medium at the interface. This phenomenon is called total internal reflection.

(**Note:** You can also wrie the formation of mirage)

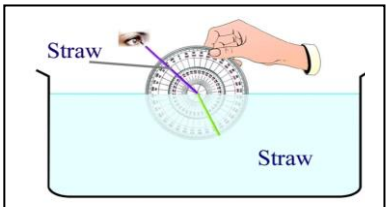
8. How do you verify experimentally that the angle of refraction is more than angle of incidence when light rays travel from denser to rarer medium. (AS1)



Ans: i) Take a Plastic Pro circle arrange two straws at the centre of the pro circle in such a way that they can be rotated freely about the centre of the pro circle as shown in the fig.

ii) Adjust one of the straws to make an angle 10^0.

iii) Immerse half of the pro circle vertically into the water, filled in a transparent vessel.



vi) While dipping, verify that the straw at 10^0 is inside the water.

vi) From the top of the vessel try to view the straw which is inside the water as shown in fig.

vii) Then adjust the other straw which is outside the water until both straws appear to be in a single straight line.

viii) Then take the pro circle out of the water and observe the two straws on it. You will find that they are not in a single straight line.

ix) Measure the angle between the normal and second straw. Note the value in the able.

i	r	sin i	Sin r	Sin i/sin r

x) Do the same for various angles. Find the corresponding angles of refraction and note them in the table.

xi) You will observe that in the above activity, 'r' is greater than 'i' in all cases when light ray travels from denser medium to rarer medium.

9. Take a bright metal ball and make it black with soot in a candle flame. Immerse it in water. How does it appear and why? (Make hypothesis and do the above experiment). (AS2)

Ans: Silvery or shiny, because total internal reflection takes place

Hypothesis: Speed of light changes when it travels from one medium to another medium.

10. Do activity-7 again. How can you find critical angle of water? Explain your steps briefly.(AS3)

Ans: i) Take a cylindrical transparent vessel.

ii) Place a coin at the bottom of the vessel.

iii) Now pour water until you get the image of the coin on the water surface

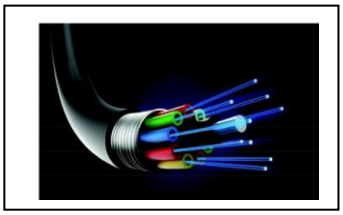
iv) This is due to total internal reflection

v) Refractive index of water =1.33

$$\sin c = 1/n = 1/1.33 = 0.7518$$

Critical angle of water = 48.7^0

11. Collect information on working of optical fibres. Prepare a report about various uses of optical fibres in our daily life. (AS4)



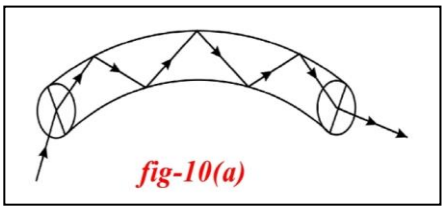
Ans: Optical fibres: i)Total internal reflection is the basic principle behind working of optical fibre.

ii) An optical fibre is very thin fibre made of glass (or) plastic having radius about a micrometer (10^{-6} m).

iii) A bunch of such thin fibres form a light pipe.

Working of optical fibre:

i) The principle of light transmission by an optical fibre. Sketches a optical fibre cable.



ii) Because of the small radius of the fibre, light going into it makes a nearly glancing incidence on the wall.

iii) The angle of incidence is greater than the critical angle and hence total internal reflection takes place.

iv) The light is thus transmitted along the fibre.

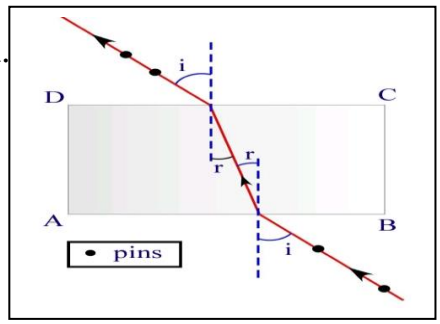
Uses:

i) Optical fibres are used in endoscopy

ii) Optical fibres are used in communication system

12. Explain the refraction of light through a glass slab with a neat ray diagram. (AS5)

Ans: i) Place a piece of chart on a drawing board. Clamp it. Place a glass slab in the middle of the paper.



ii) Draw border line along the edges of the slab by using a pencil. Remove it.

iii) Name the vertices of the rectangle as A, B, C and D.

iv) Draw a perpendicular at a point on the longer side (AB) of the rectangle.

v) Again keep the slab on paper such that it coincides with the sides of the rectangle ABCD.

vi) Take two pins. Stick them on the perpendicular line to AB. Take two more pins and stick them on the other side of the slab in such a way that all pins come to view along a straight line.

vii) Remove the slab from its place. Take out the pins. Draw a straight line by using the dots formed by the pins such that it reaches first edge (AB) of the rectangle. You will get a long straight line.

viii) The light ray that falls perpendicular to one side of the slab surface comes out without any deviation.

ix) We observed that angles of incidence and emergence are equal, incident ray and emergent ray are parallel.

13. What is the reason behind the shining of diamonds and how do you appreciate it? (AS6)

Ans: Total internal reflection is the main reason for brilliance of diamonds. The critical angle of a diamond is very low(24.4^0).So if a light ray enters a diamond it is very likely to undergo total internal reflection which makes the diamond shine

14. How do you appreciate the role of Fermat principle in drawing ray diagrams. (AS6)

Ans: I appreciate the Fermat principle in

i) To verify laws of reflection and refraction

ii) To derive refractive index of medium and glass slab

iii) To verify Snell's law

15. When we sit at a camp fire, objects beyond the fire are seen swaying. Give the reason for it. (AS6)

Ans: i) This happens due to refraction of light when it passes through hot to cold air.

ii) So, we observe the objects behind the fire seen swaying.

16. Why do stars appear twinkling? (AS6)

Ans: Stars appear twinkling due to multiple refractions of light through different atmospheric layers with different refractive indices.

17. Why does a diamond shine more than a glass piece cut to the same shape? (AS6)

Ans: The critical angle of a diamond is very low and high refractive index. So if a light ray enters a diamond it is very likely to undergo total internal reflection which makes the diamond shine. Whereas it is not possible with glass due to high critical angle and low refractive index.

Fill in the blanks

1. At critical angle of incidence, the angle of refraction is .....

Ans: 90^0

2. $n_1 \sin i = n_2 \sin r$, is called.....

Ans: Snell's law

3. Speed of light in vaccumis .....

Ans: $3x10^8$ m/s

4. Total internal reflection takes place when a light ray propagates from ..... to ..... medium.

Ans: denser, rarer

5. The refractive index of a transparent material is 3/2. The speed of the light in that medium is .....

Ans: $2x10^8$ m/s

6. Mirage is an example of .....

Ans: Total internal reflection

Multiple Choice Questions

1. Which of the following is Shell's law. [ ]

a) $n_1 \sin i = \sin r/n_2$ b) $n_1/n_2 = \sin r/\sin i$ c) $n_2/n_1 = \sin r/\sin i$ d) $n_2 \sin i$ = constant

Ans: b

2. The refractive index of glass with respect to air is 2. Then the critical angle of glass-air interface is ..... [ ]

a) 0^0 b) 45^0 c) 30^0 d) 60^0

Ans: c

3. Total internal reflection takes place when the light ray travels from..... [ ]

a) rarer to denser medium b) rarer to rarer medium

c) denser to rarer medium d) denser to denser medium

Ans: c

4. The angle of deviation produced by the glass slab is ..... [ ]

a) 0^0 b) 20^0

c) 90^0 d) depends on the angle formed by the light ray and normal to the slab

Ans: d

Try these

1. The absolute refractive index of water is 4/3. What is the critical angle? (AS1)

Ans: Given n=4/3=1.33 c=?

We know that sin c = 1/n =1/1.33=0.7518

c = 48.7^0

2. Take a glass vessel and pour some glycerine into it and then pour water up to the brim. Take a quartz glass rod. Keep it in the vessel.Observe the glass rod from the sides of the glass vessel. A) What changes do you notice? B) What could be the reasons for these changes?(AS2)

Ans: A) We cannot see the glass rod in glycerine but we can see the glass rod in water

B) The refractive indices of glass rod and glycerine are nearly same. The light ray not refracted, so we cannot see the glass rod in glycerine.

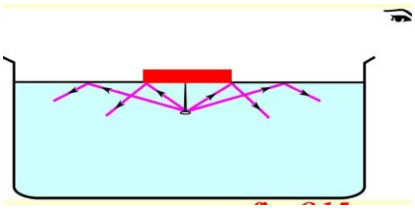
The refractive indices of glass rod and water are not same. The light ray refracted, so we can see the glass rod in water

3. Collect the values of refractive index of the following media. (AS4)
Water, coconut oil, flint glass, crown glass, diamond, benzene and hydrogen gas.

Ans:

Medium	Water	coconut oil	flint glass	crown glass	diamond	benzene	hydrogen gas
Refractive index	1.33	1.44	1.65	1.52	2.42	1.50	1.000132

4. Take a thin thermocol sheet. Cut it in circular discs of different radii like 2cm, 3cm, 4cm, 4.5cm, 5cm etc and mark centers with sketch pen. Now take needles of length nearly 6cm. Pin a needle to each disc at its centre vertically. Take water in a large opaque tray and place the disc with 2cm radius in such a way that the needle is inside the water as shown in fig-Q15. Now try to view the free end (head) of the needle from surface of the water.



a) Are you able to see the head of the needle? Now do the same with other discs of different radii. Try to see the head of the needle, each time. Note: the position of your eye and the position of the disc on water surface should not be changed while repeating the activity with other discs.

b) At what maximum radius of disc, were you not able to see the free end of the needle?

c) Why were you not able to view the head of the nail for certain radii of the discs?

d) Does this activity help you to find the critical angle of the medium (water)?

e) Draw a diagram to show the passage of light ray from the head of the nail in different situations. (AS4)

Ans: a) Yes, we can see head of the needle.

b) Height of the pin = 6 cm

Radius of the disc = x cm

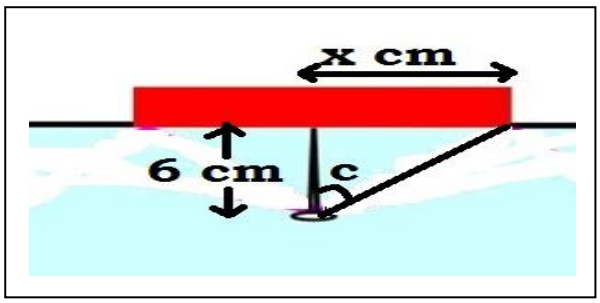
Critical angle of water = 48.7^0

Tan c = r/H

Tan 48.7^0 = x/6

1.138 = x/6

x = 6.828 cm



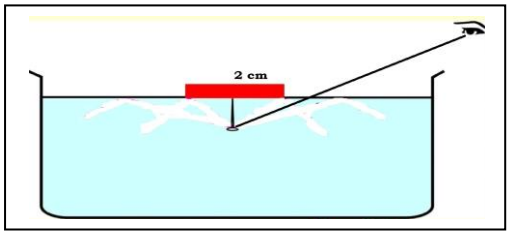
c) The light rays coming from head of the needle undergoes total internal reflection

d) Yes, we can find critical angle

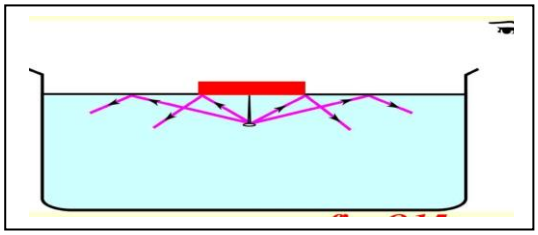
sin c = R.I of air/R.I of water =1.0003/1.33= 0.7518

Critical angle of water (c) = 48.7^0

e)



Free end of needle is visible

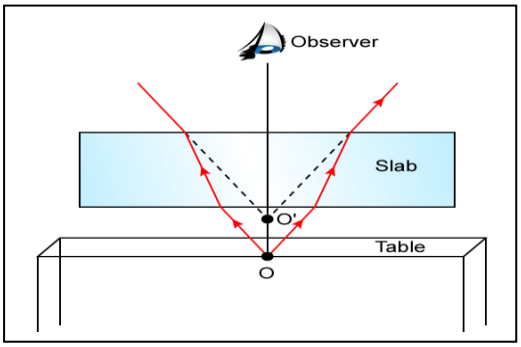


Free end of needle is not visible

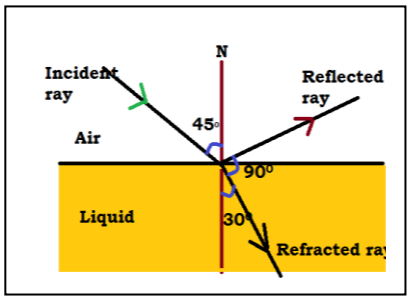
5. Place an object on the table. Look at the object through the transparent glass slab. You will

observe that it will appear closer to you. Draw a ray diagram to show the passage of light ray in this situation. (AS5)

Ans:



6. A light ray is incident on air-liquid interface at 45⁰ and is refracted at 30⁰ . What is the refractive index of the liquid? For what angle of incidence will the angle between reflected ray and refracted ray be 90⁰ ? (AS6)



Ans: i) Given $i = 45^0$ and $r = 30^0$

Refractive index of the liquid (n) = $\sin i / \sin r = \sin 45^0 / \sin 30^0$

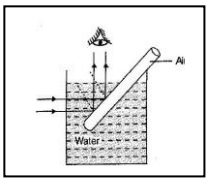
$$= \frac{\frac{1}{\sqrt{2}}}{\frac{1}{2}} = \frac{2}{\sqrt{2}} = \sqrt{2} = 1.414$$

ii) $\tan i = n$

$\tan i = 1.414$

$i = 54.7^0$

7. Explain why a test tube immersed at a certain angle in a tumbler of water appears to have a mirror surface for a certain viewing position? (AS6)



Ans: Because total internal reflection

Explanation: i) The critical angle for glass is 42^0

ii) The glass and test tube act as denser and rarer mediums

iii) A light ray while travelling through water strikes glass-air interface of test tube at an angle of more than 42^0, they get total internal reflection

iv) Now test tube appears like silvery

8. In what cases does a light ray not deviate at the interface of two media?(AS6)

Ans: In two cases, light ray will not deviate at the interface of two media.

1) When light ray is incident normally.

2) When two media having same refractive indices.

Additional Questions

½ Mark Questions

½ Mark Questions

1.Can a virtual image can be be photographed by a camera?

Ans: Yes

2. A Light ray passes from denser medium to rarer medium. If the angle of incidence is equal to critical angle, then what is the angle of refraction ?

Ans: 90^0

3.What phenomena of light is responsible for disappearance of coin placed bottom of transparent glass filled with water?

Ans: Refraction

4.What phenomena of light takes place in optical fibres? (or) Name the phenomenon involved in the function of optical fibre (or) Optical Fibre Cable (OFC) are Oftenly used in tele-communications. What is the working principle behind OFC (or) What is the basic principle of endoscope ?

Ans: Total internal reflection

5. A teacher asked questions to a student he/she said c/v a constant. Guess the question asked by the teacher ?

Ans: What is the formula of Refractive index?

What is the constant?

(Write any relevant question)

6. What is value of angle of refraction at critical angle of incidence?

Ans: 90^0

7. The correct order of the speed of light in the given substance ?

a) Air <kerosene<benzene b)benzene<kerosene<air c)kerosene>air>benzene d)air>benzene>kerosene

Ans: b

8. ASSERTION : It is difficult to shoot a fish swimming in water .

REASON : Due to refraction fish in water change its original position.

A) A –TRUE,R-FALSE B) A –FALSE,R-TRUE C) A –FALSE,R-FALSE D) A –TRUE,R-TRUE

Ans: D

9. Which phenomenon is involved in twinkling of stars?

Ans: Multiple refraction

10. Choose the suitable answers of Section B with Section A

Section A	Section B
1. Formula for Snell's Law	P) n2/n1 = Sin r / Sin i
2. At critical angle, the angle of refraction	Q) n1/n2 = Sin r/ Sin i
	R) 90^0
	S) 60^0

Ans: 1-Q, 2-R

11. Write Snell's law?

Ans: $n_1 \sin i = n_2 \sin r$ (or) $\sin i / \sin r = constant$

12.What do we call the phenomenon of the light occur when the angle of incidence is more than the critical angle C?

Ans: Total internal reflection

13.Mirage is an example of which phenomenon?

Ans: Total internal reflection

14.Choose the suitable answers of section-B with section-A

Section-A	Section-B
1. Formula for refractive index	P) V/C
2. Possible values of refractive index	Q) C/V
	R) >1
	S) <1

Ans: 1-Q, 2-R

15.When a light ray travel from denser to rarer medium along with the normal

a) It bends towards the normal b) It moves away from the normal c) It is an undeviated

Ans: c

16. What is the SI unit of refractive index?

A) m/s B) m/s^2 C)kg-m/s D) No unit

Ans: D

17. What process involved, when the image of the coin visible on the surface of the water in transaction vessel, placing the coin at the bottom of the vessel

Ans: Refraction

18.You are given kerosene, ice and water. In which of these does the light travel faster?

Ans: Ice

19.Choose the suitable answer of section-B with section-A

Section-A	Section-B
i) Water	a)2.42
ii)Diamond	b)1.50
	c)1.33

Ans: i-c, 2-a

20.The refractive index of glass respect to air is 2. Then the critical angle of glass air interface is

A)0^0 B)45^0 C)30^0 D)60^0

Ans: C

21. Saketh is doing an experiment with glass slab. He focused a laser light towards the glass slab at an angle 45^0. What would be the angle of emergence?

Ans: 45^0.

22. The most and least values pair of refractive index having substances among the following is

A) Vacuum, Water B) Water, Vacuum C) Vacuum, Diamond D) Diamond, Vacuum

Ans: D

23. Write the value of the speed of light in vacuum

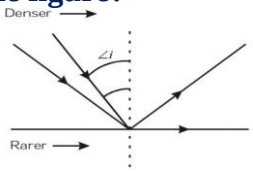
Ans: $3x10^8$ m/s

24. Assertion(A): The speed of light in water is greater than that of benzene.
Reason(R):The speed of light in a medium is high when refractive index of the medium is low.
Which of the following is correct ?

A) A and R are true and R supports A **B) A and R are true but R does not support A**
C) A is true but R is false **D) A is false but R is true**

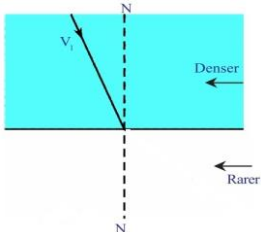
Ans: A

25. Which phenomenon do you observe from the figure?

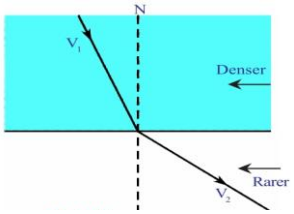


Ans: Total internal reflection

26.Complete the ray–diagram if a light ray passes from Denser to rarer medium



Ans:



1 Mark Questions

1. Refractive index of a material is 3/2. What is the speed of light in that material ? (or)The refractive index of glass is 1.5 then when is the speed of light in glass

Ans: : Given n=3/2 c=3x10^8 m/s

$v = \frac{c}{n}$ = 3x10^8x2/3=2x10^8 m/s

2. What is the formula of refractive index of glass slab,if its vertical shift is known?

Ans: : $Refractive\ index\ of\ glass\ slab = \frac{Thickness\ of\ the\ slab}{thickness\ of\ slab - vertical\ shift}$

3. Define Total Internal Reflection ?

Ans: When the angle of incidence is greater than critical angle, the light ray reflected into denser medium at interface. This phenomenon is called total internal reflection.

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

Ans: The speed of light is low in diamond

5. On what factors does the refractive index of medium depend? (or) What are the factors that influence the refractive index

Ans: The speed of light is low in diamond

6. Which has a higher refractive index, glass or water? Why?

Ans: Glass. Speed of light is low in glass

7.Define refraction?

Ans: The process of changing speed at an interface when light travels from one medium to another is called refraction

8. A small empty borosel test tube is immersed in big borosel test tube having water. Gauss your answer when we see them from outerview?

Ans: Small empty borosel test tube appeared as shiny

9. In refraction of light, write the purpose of using the following apparatus.
Metal disk, protractor, straws, transparent vessel tube with water

Ans: The light ray travels from denser to rarer, it bends away from the normal and r > i

10. Define "Refractive index"

Ans: The ratio of speed of light in vacuum to the speed of light in that medium is defined as refractive index

11. What are the conditions required for total internal reflection

Ans: 1) Light must travel from denser medium to rarer medium
2) The angle of incidence in the denser medium must be greater than the critical angle for the two media

12.Why does ray of light bent when it travels from one medium to another

Ans: Changing speed of the light at an interface

13. Refractive index of glass relative to water is 9/8. What is the refractive index of water relative to glass?

Ans: Given n_{gw} =9/8

n_{wg}= 1/ n_{gw}=$\frac{1}{\frac{9}{8}} = \frac{8}{9}$

14. Define Critical angle

Ans: The angle of incidence at which the light ray propagates from denser to rarer graze along interface is called

critical angle

15. Among objects made of glass and diamond, which one shines more. Why?

Ans: Diamond shines more because of lower critical angle of 24.4^0

2 Marks Questions

1. Frame some questions to know about the formation of mirage.

Ans: : 1) What is mirage?
2) Can you take a photo of a mirage?
3) Why should you see a mirage as a flowing water?
4) Which phenomenon is involved in formation of mirages?
5) What is condition to form mirage?
(Write any two relevant questions)

2. Prepare a report about various uses of optical fibres in our daily life.

Ans: a) Optical fibres are used in endoscopy
b) Optical fibres are used in transmit communication signals

3. Observe the table. Answer the following qusstions

Material medium	Water	Benzene	Turpentine oil	Kerosene
Refractive index	1.33	1.50	1.47	1.44

i. Which of the above material media, speed of light is less?
ii. Among water and kerosene, which is optically denser?

Ans: i) Benzene ii) Kerosene

4. During a hot summer day your school student of lower class, observed that water has collected on road at a distant place, but when he get there he don't find any water. Then some doubts rises in his mind. Predict those doubts and frame two questions regarding this phenomenon.(or) Ravi observed water at a distance on the road in a summer mid day. He went there and found no water is there. He got many doubts in his mind. What would be those doubts?

Ans: i) Do you know the reason why it appears so?
ii) Which phenomenon is involved ?
iii) Why, we observed water on the road in summer days?
iv) Can you take a photo of this phenomenon?
(Write any two relevant questions)

5. Give any two daily life examples for refraction of light?

Ans: i) A coin placed in a glass of vessel filled with water appears to be raised
ii) A lemon kept in a glass of water appears to be bigger than size
iii) A pencil or stick appear to be bent when placed in a glass of water
iv) When a thick glass slab is placed over some printed letters, the letters appear raised when viewed through glass slab
(Write any two relevant examples)

6. Write the applications of total internal reflection

Ans: Brilliance of diamond, optical fibres, formation of mirages etc

7. Abhi conduct an experiment of vertical shift of glass slab, his find the values of thickness and vertical shift of glass slab are 3cm and 1cm respectively. What is the refractive index of glass slab

Ans: Given thickness = 3 cm, vertical shift = 1 cm

$$Refractive\ index\ of\ glass\ slab = \frac{Thickness\ of\ the\ slab}{thickness\ of\ slab - vertical\ shift}$$

$$= \frac{3}{3-1} = \frac{3}{2} = 1.5$$

8. Write the laws of refraction?

Ans: 1) The incident ray,the refracted ray and the normal to interface of two transparent media at the point of incidence all lie in the same plane.
2)During refraction light follows Snell's law
$n_1 \sin i = n_2 \sin r$

4 Marks Questions

1. Write the procedure of an activity to find the refractive index of glass slab with vertical shift (or) Suggest an activity to find the refractive index of glass slab using vertical shift? (AS3)

Ans: i) Measure the thickness of the slab. Note it in your notebook.
ii) Take a white chart and fix it on the table.
iii) Take the slab and place it in the middle of the chart. Draw its boundary.
iv) Remove the slab from its place. The lines form a rectangle.
Name the vertices as A,B,C and D.
v) Draw a perpendicular to the longer line AB of the rectangle as shown in figure.

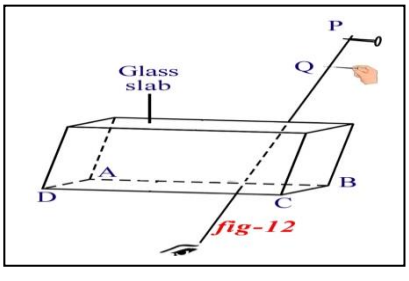


fig-12

vi) Place slab again in the rectangle ABCD. Take a pin. Place at a point P in such a way that its length is parallel to the AB on the perpendicular line at a distance of 15cm from the slab.

vii) Now take another pin and by looking at the first pin from the other side of the slab try to place the pin so that it forms a straight line with the first pin.

viii) Draw a perpendicular line from the second pin to the line on which first pin is placed. Call the intersection point Q.

ix) Find the distance between P and Q. We may call it vertical shift

x) $Refractive\ index\ of\ glass\ slab = \frac{Thickness\ of\ the\ slab}{thickness\ of\ slab - vertical\ shift}$

2. Observe the following table and answer the questions (AS4)

Material medium	Refractive index	Material medium	Refractive index
Air	1.0003	Canada balsam	1.53
Ice	1.31	Rock salt	1.54
Water	1.33	Carbon Diasulphide	1.63
Kerosene	1.44	Dense flint glass	1.65
Fused quartz	1.46	Ruby	1.71
Turpentine oil	1.47	Sapphire	1.77
Crown glass	1.52	Diamond	2.42
Benzene	1.50		

a) Write the SI unit of Refractive index

Ans: No units

b)What happens to the speed of light when light is passing from Water to Rock salt

Ans: Decrease

c) Write the relation between speed of light(v) and refractive index of the material medium(n)

Ans: n α 1/v (OR) Inversely proportional to each other

d) What is the speed of light in Benzene?

Ans: $2x10^3$ m/s

e) What is reason, R.I of kerosene is more than the R.I of water?

Ans: Kerosene with high refractive is optically denser than water

f) Among Ice, Fused quartz, Ruby and Diamond, Which is rarer medium? Why?

Ans: Ice. Ice has lowest refractive index

g) In the table, In which material medium speed of light is less? Why?

Ans: Diamond. It has high refractive index

h) Define refractive index

Ans: The ratio of speed of light in vacuum to the speed of light in that medium

i) Arrange the following materials medium based on the speed of the light
Diamond, Tarpentine oil, Flint glass, Air and Ice

Ans: Air, Ice, Turpentine oil, Flint glass and diamond

j) Whether the refracted ray bends towards normal or away from the normal when light ray travelled from Water to Kerosene

Ans: Bends towards normal