SAMPLE CONTENT

SCIENCE AND TECHNOLOGY PART- 1

BASED ON NEW SYLLABUS

Mirage

The phenomenon of mirage occurs when light rays suffer total internal reflection while passing through layers of air at different temperature.

STD. X

(ENG. MED.)

Target Publications Pvt. Ltd.

Written as per the latest syllabus prescribed by the Maharashtra State Bureau of Textbook Production and Curriculum Research, Pune.

STD. X

Science and Technology

Part - 1

Salient Features

- Written as per the new textbook
- Exhaustive coverage of entire syllabus
- Ample numericals for thorough revision
- Memory maps provided for revision at a glance
- 'Reading between the lines' provided for concept elaboration
- Chapter-wise assessment with every chapter for knowledge testing
- Model Question Paper in accordance with the latest paper pattern
- Activity demonstration/concept explanation videos included wherever required

This book comprises of **QR Codes** at strategic touch points. You can simply scan this Code through your Smartphone camera and get a plethora of subject knowledge at your disposal. The QR Codes included herein would take you to videos that shall provide you a better understanding of 'Activities', 'Experiments', 'Projects' and 'Try This' section of the book. We hope students would maximize the use of this book with the aid of these videos.

Printed at: **Repro India Ltd.,** Navi Mumbai

Balbharati Registration No.: 2018MH0022 **TEID: 13125** P.O. No. 147657

PREFACE

While designing the book, our main intention was to create a book that would act as a single point of reference for students. We wanted this book to provide students, the much needed answers for their textual questions as well as build up their knowledge quotient in the process.

Science and Technology: Std. X Part - 1 has been prepared as per the new syllabus and paper pattern which is more child-centric and focuses on active learning along-with making the process of education more enjoyable and interesting.

We have infused the book with a liberal sprinkling of real life examples, pictorial explanations and additional questions. A series of 'Intext Questions' along with questions titled under 'Use your brain power', 'Can you tell' and various similar titles pave the way for a robust concept building.

Every chapter begins with covering all the textual content in the format of Objectives, Question - Answers, Give Reasons, Numericals, Diagram-based questions, paragraph based questions and a host of other Objective and Subjective type of questions. For the students to grasp a better understanding of the concept lying behind the answer, 'Reading between the lines' (not a part of the answer) has been provided wherever necessary. To enhance audio-visual learning, videos showing demonstration of activities / concept explanation are included wherever required.

Wherever possible questions are allotted with marks in accordance with new marking scheme. The question without marks can be modified as per the new marking scheme and asked in examination. Memory maps have been included wherever needed which provides a quick revision of the important topics of a chapter. The chapter eventually ends with a Chapter wise Assessment that stands as a testimony to the fact that the child has understood the chapter thoroughly. Model question paper, designed as per the latest paper pattern, is a unique tool to enable self-assessment for the students.

With absolute trust in our work, we hope, our holistic efforts towards making this book an ideal knowledge hub for students pays off.

The journey to create a complete book is strewn with triumphs, failures and near misses. If you think we've nearly missed something or want to applaud us for our triumphs, we'd love to hear from you.

Please write to us at: mail@targetpublications.org

A book affects eternity; one can never tell where its influence stops.

Best of luck to all the aspirants!

From,
Publisher

Edition : Second

PAPER PATTERN

- There will be separate question papers for Part 1 and Part 2 of 40 marks each.
- Duration of each paper will be 2 hours.

Question No.	Type of Questions	Total Marks
1.	(A) 5 Questions of 1 mark each (Objectives)	05
	(B) 5 Questions of 1 mark each (Practicals / Projects based MCQs)	05
2.	7 Questions of 2 marks each (solve any 5)	10
3.	7 Questions of 3 marks each (solve any 5)	15
4.	2 Questions of 5 marks each (solve any 1)	05

Distribution of marks according to question type and aims

Sr. No.	Question type	Marks	Marks with option	% Marks
1.	Objective	10	10	25
2.	Very short answer	10	14	25
3.	Short answer	15	21	37.5
4.	Long answer	5	10	12.5
	Total	**40**	**55**	**100**

Sr. No.	Aims	Marks	Marks with option	% Marks
1.	Knowledge	10	10	25
2.	Understanding	10	15	25
3.	Application	16	25	40
4.	Skill	4	5	10
	Total	**40**	**55**	**100**

[**Reference**: महाराष्ट्र राज्य पाठ्यपुस्तक निर्मिती व अभ्यासक्रम संशोधन मंडळ, पुणे निर्मित मूल्यमापन आराखडा]

[**P.S.** Scan this **Q.R. Code** to get a better understanding of the New Syllabus as well as Paper Pattern.]

Contents

Note: Textual exercise questions are represented by * mark.
Textual solved examples are represented by + mark.

Exam Pointers

Students are expected to write the answers in their Examination as illustrated below.

Fill in the blanks - Write the complete statement and underline the answer.

1. In Dobereiner's triads, atomic mass of the middle element was approximately equal to the mean of the _____ of the other two elements.

Ans: In Dobereiner's triads, atomic mass of the middle element was approximately equal to the mean of the <u>atomic masses</u> of the other two elements.

Find out the correlation – Determine the correlation between two components and write it in one sentence.

2. In Fleming's right hand rule-Thumb: Motion of conductor :: In Fleming's right hand rule-Index finger: _____

Ans: In Fleming's right hand rule-Thumb: Motion of conductor :: In Fleming's right hand rule-Index finger: **Magnetic field**

MCQ - Write the answer of each MCQ with option number.

3. When _____ is passed through fresh lime water, it turns milky.

(A) H_2 (B) CO_2

(C) CO (D) SO_2

Ans: 3. (B) CO_2

Numericals - Write the valid final answer along with the correct unit.

4. Calculate the escape velocity on the surface of the moon given the mass and radius of the moon to be 7.34×10^{22} kg and 1.74×10^{6} m respectively.

Ans: $v_{esc} = 2.372$ km/s

Reading between the lines

The explanation provided under 'Reading between the lines' is not expected to be a part of the answer. Its sole purpose is to provide a sound understanding of the concept behind the answer.

1. What is the expected trend in the variation of nonmetallic character of elements from left to right in a period?

Ans: The nonmetallic character increases from left to right in a period. } **Answer**

Reading between the lines

While going from left to right within a period, electrons get added in the same shell. At the same time, protons get added in the nucleus increasing the nuclear charge. This increases the effective nuclear charge experienced by valence electrons. As a result, the tendency to gain electrons increases. Thus, the nonmetallic character increases from left to right in a period. } **Not part of the answer**

6 Refraction of light

Fill in the blanks

1. Complete the following statements. ***[1 Mark each]***

i. Light travels along a _____ path in a transparent medium.

ii. Shadows change due to the change in relative _____ of source of light and object.

iii. For a given pair of media, the ratio of the sine of the angle of incidence to the sine of the angle of refraction is _____.

iv. The refractive index of hot air is _____ than cool air.

v. The band of coloured components of a light beam is called its _____.

Answers:

i. straight ii. positions
iii. constant. iv. less
v. spectrum.

2. Select the appropriate options and complete the following paragraph. ***[3 Marks]***

(spectrum, dispersion, grey, green, maximum, minimum, electromagnetic, refraction, optical, intense)

Light is an _____ radiation. The process of separation of light into its component colours while passing through a medium is called as _____ of light. The band of coloured components of a sunlight beam is called its _____. Various colours appearing in the spectrum are of the order as violet, indigo, blue, _____, yellow, orange and red. Different colours have different wavelengths which are visible to our eyes i.e., between 400 nm and 700 nm. Red light has _____ wavelength whereas violet light has _____ wavelength.

Answer:

Light is an **electromagnetic** radiation. The process of separation of light into its component colours while passing through a medium is called as **dispersion** of light. The band of coloured components of a sunlight beam is called its **spectrum**. Various colours appearing in the spectrum are of the order as violet, indigo, blue, **green**, yellow, orange and red. Different colours have different wavelengths which are visible to our eyes i.e., between 400 nm and 700 nm. Red light has **maximum** wavelength whereas violet light has **minimum** wavelength.

Choose the correct alternative *[1 Mark each]*

1. The velocity of light is _____in different media.
   (A) 3×10^8 m/s
   (B) same
   (C) different
   (D) infinite

2. When a ray of light passes through glass slab, refraction of light occurs _____.
   (A) once
   (B) twice
   (C) thrice
   (D) many times

3. Choose the correct statement regarding the incident ray, refracted ray and normal drawn at the point of incidence.
   (A) They all lie in the same plane.
   (B) Refracted ray lies in one plane, while incident ray and normal lie in another plane.
   (C) Refracted ray and normal lie in one plane, incident ray in another plane.
   (D) Incident ray and refracted ray are always perpendicular to each other.

4. When rays of light are incident on a glass slab, then the incident ray and emergent ray are _____ to each other.
   (A) perpendicular
   (B) parallel
   (C) opposite
   (D) concurrent

5. Amol performed an experiment on tracing the path of a ray of light passing through a rectangular glass slab. When ray of light enters from air to glass slab, he observed $\angle i = 45°$. The angle of refraction must be
   (A) $\angle r = 45°$
   (B) $\angle r$ = more than 45°
   (C) $\angle r$ = less than 45°
   (D) $\angle r = 60°$

*6. If the refractive index of glass with respect to air is $\frac{3}{2}$, what is the refractive index of air with respect to glass?

(A) $\frac{1}{2}$ (B) 3

(C) $\frac{1}{3}$ (D) $\frac{2}{3}$

7. A ray of light strikes the glass slab at an angle of 50°. What is the angle of incidence?

(A) 50° (B) 25°

(C) 40° (D) 100°

8. In an experiment, the path of a ray of light passing through a rectangular glass slab was traced by a student. Which of the following diagram shows correct measurement of angle of incidence (i), refraction (r), and emergence (e)?

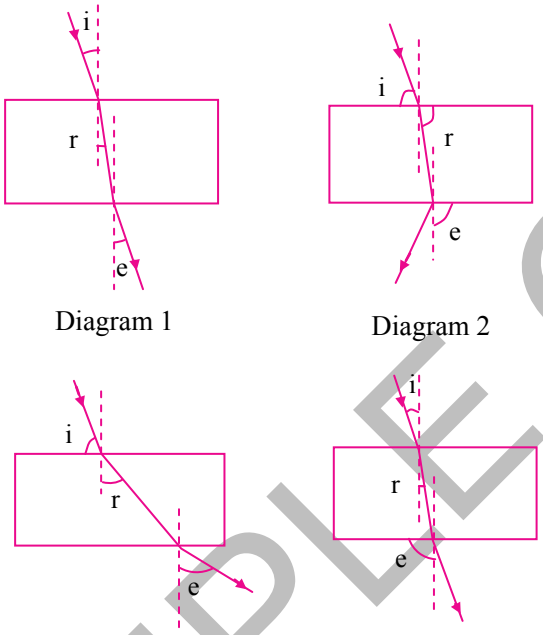


Diagram 1 Diagram 2

Diagram 3 Diagram 4

(A) Diagram 1 (B) Diagram 2

(C) Diagram 3 (D) Diagram 4

9. Mirage is the effect of atmospheric _____on a small scale.

(A) scattering (B) reflection

(C) dispersion (D) refraction

10. The actual position of star is slightly _____ than apparent position of star.

(A) lower (B) higher

(C) nearer (D) farther

*11. What is the reason for the twinkling of stars?

(A) Explosions occurring in stars from time to time.

(B) Absorption of light in the earth's atmosphere.

(C) Motion of stars.

(D) Changing refractive index of the atmospheric gases.

*12. We can see the sun even when it is little below the horizon because of _____.

(A) reflection of light

(B) refraction of light

(C) dispersion of light

(D) absorption of light

Answers:

1.	(C)	2.	(B)	3.	(A)
4.	(B)	5.	(C)	6.	(D)
7.	(C)	8.	(A)	9.	(D)
10.	(A)	11.	(D)	12.	(B)

Name the following *[1 Mark each]*

1. A phenomenon of light which generally occurs in desert due to atmospheric refraction.

2. The device used by Sir Issac Newton to produce spectrum of seven colours.

3. Colour of spectrum which deviates most during dispersion.

Answers:

1. Mirage 2. Glass prism

3. Violet

Right or Wrong. If wrong, write the correct sentence *[1 Mark each]*

1. The refractive index of first medium with respect to second medium is given by

$${}_1n_2 = \frac{v_1}{v_2}$$

2. The angle of refraction is always greater than the angle of incidence for a ray of light travelling from optically denser medium to a rarer medium.

3. Twinkling of stars is due to dispersion of light.

4. The rainbow can be enjoyed in front of fountain in the morning, on a sunny day, facing the west.

Answers:

1. Wrong.
The refractive index of first medium with respect to second medium is given by ${}_1n_2 = \frac{v_2}{v_1}$

2. Right.

3. Wrong.
Twinkling of stars is due to change in refractive index of atmosphere.

4. Right.

Complete the analogy *[1 Mark each]*

1. Reflection: Velocity remains same :: _____ : Velocity changes
2. Reflection of light: Mirror :: _____ : Prism
3. A ray travels from optically rarer to optically denser medium: i > r :: A ray travels from optically denser to optically rarer medium: _____

Answers:

1. Refraction
   In reflection, light travels in same medium hence velocity remains same. In refraction, light travels in different medium hence velocity changes.
2. Dispersion of light
   Mirror is used to study the reflection of light and prism is used to study the dispersion of light.
3. i < r
   When ray of light travels from optically rarer medium to optically denser medium, the ray of light bends towards the normal hence i > r. When ray of light travels from optically denser medium to optically rarer medium, the ray of light bends away from the normal hence i < r.

Match the following *[½ Mark each]*

1. Match the colour given in column I with corresponding wavelength in column II.

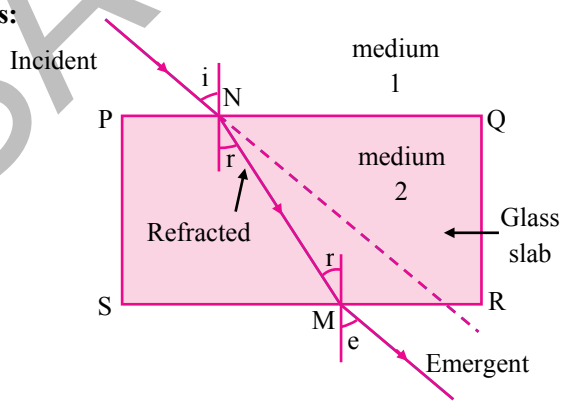
	Column I		Column II
i.	Red	a.	4×10^{-7} m
ii.	Violet	b.	7×10^{-7} m
		c.	5.5×10^{-7} m

Answer:
(i – b), (ii – a)

Answer the following

***1. If the angle of incidence and angle of emergence of a light ray falling on a glass slab are i and e respectively, prove that, i = e.** *[3 Marks]*

Ans:



i. In the above figure,
   i = angle of incidence,
   r = angle of refraction,
   e = angle of emergence.
   At point N, using Snell's law,

$$_{glass}n_{air} = \frac{\sin i}{\sin r} \quad ....(1)$$

   At point M, using Snell's law

$$_{air}n_{glass} = \frac{\sin r}{\sin e} \quad ....(2)$$

   But $_{glass}n_{air} = \frac{1}{_{air}n_{glass}}$

$$\therefore \frac{\sin i}{\sin r} = \frac{1}{\left(\frac{\sin r}{\sin e}\right)} \quad ....[\text{From (1) and (2)}]$$

$$\therefore \frac{\sin i}{\sin r} = \frac{\sin e}{\sin r}$$

$$\therefore \sin i = \sin e$$

$$\therefore \angle i = \angle e$$

ii. Hence, for the refraction of light through a glass slab angle of incidence is equal to angle of emergence, i.e., i = e.

Reading between the lines

In the figure given above, refraction of light takes place twice in the glass slab. The first refraction takes place at point N on side PQ when the ray of light enters from air medium to glass medium. The second refraction takes place at M on side SR when the ray of light enters from glass medium to air medium.

2. Use your brain power!
(Textbook page no. 74)

i. Will light travel through a glass slab with the same velocity as it travels in air?

ii. Will the velocity of light be same in all media? *[2 Marks]*

Ans: i. No. The speed of light is different in glass than in air.
ii. No. The velocity of light varies in different media.

3. State and explain laws of refraction of light. *[3 Marks]*

Ans: i. The incident ray and the refracted ray are on the opposite side of the normal at the point of incidence, and all three lie in same plane.
ii. a. For a given pair of media, the ratio of the sine of the angle of incidence to the sine of the angle of refraction is constant.
b. The second law is also called as Snell's law.

c. If 'i' is the angle of incidence and 'r' is angle of refraction, then

$$\frac{\sin i}{\sin r} = \text{constant}$$

d. This constant is called the refractive index of second medium with respect to first medium. It is denoted by n.

$$\therefore \quad \frac{\sin i}{\sin r} = n$$

4. What is meant by absolute refractive index? ***[1 Mark]***

Ans: The refractive index of a medium with respect to vacuum is called its absolute refractive index.

5. What is refraction of light? How is refractive index of material related to velocity of light? ***[3 Marks]***

Ans: Refraction of light:

Light changes its direction when passing from one transparent medium to another transparent medium. This is called the refraction of light.

Relationship between refractive index and velocity of light:

i. The extent of change in the direction of light ray is different for different media and depends upon the refractive index of medium.

ii. The value of refractive index is different for different media and it depends on the velocity of the light in the medium.

iii. The refractive index ($_2n_1$) of second medium with respect to the first is given by the ratio of the magnitude of velocity of light in first medium (v_1) to that in second medium (v_2),

i.e.,

$$_2n_1 = \frac{\text{velocity of light in first medium } (v_1)}{\text{velocity of light in second medium } (v_2)}$$

iv. Refractive index of medium 1 with respect to medium 2 is $_1n_2 = \frac{v_2}{v_1}$

Thus, the refraction of light depends upon refractive index of the material which in turn depends on velocity of light in medium.

6. Fill in the blanks and explain the completed sentences.** ***[5 Marks]

i. The change in _____ of light rays while going from one medium to another is called refraction.

ii. Refractive index depends on the _____ of light.

Ans: i. The change in **direction** of light rays while going from one medium to another is called refraction.

ii. Refractive index depends on the **velocity** of light.

Explanation: *Refer Answer the following Q.5*

7. Can you tell? *(Textbook page no. 75)*

If the refractive index of second medium with respect to first medium is $_2n_1$ and that of third medium with respect to second medium is $_3n_2$, what and how much is $_3n_1$? ***[2 Marks]***

Ans: i. $_3n_1$ denotes refractive index of third medium with respect to first medium.

ii. Refractive index of third medium with respect to first medium is given by,

$$_3n_1 = \frac{v_1}{v_3}$$

Multiplying and dividing R.H.S. of above equation by v_2,

$$_3n_1 = \frac{v_1}{v_2} \times \frac{v_2}{v_3}$$

Since, $_2n_1 = \frac{v_1}{v_2}$ and $_3n_2 = \frac{v_2}{v_3}$

$$\therefore \quad _3n_1 = {}_2n_1 \times {}_3n_2$$

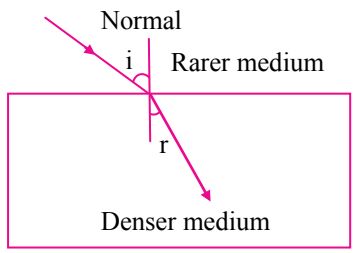
8. State using a neat diagram, what happens to the path of light

i. when light ray passes from rarer to denser medium.

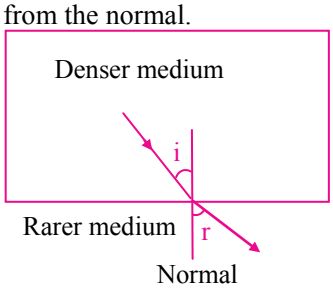
ii. when light ray passes from denser to rarer medium.

iii. when light ray is incident normally at the boundary between two media. ***[3 Marks]***

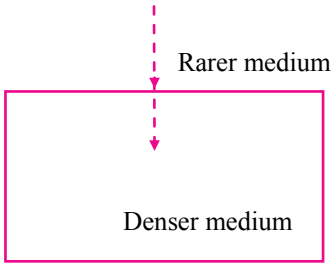
Ans: i. When a light ray passes from a rarer medium to a denser medium, it bends towards the normal.



ii. When a light ray passes from a denser medium to a rarer medium, it bends away from the normal.



iii. When a light ray is incident normally at the boundary between two media i.e., i = 0, it does not change its direction and hence does not get refracted. i.e., r = 0



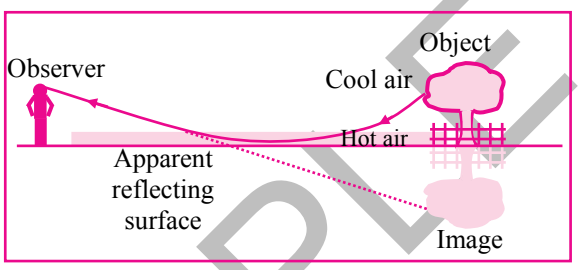
9. Explain the formation of mirage. ***[3 Marks]***

Ans: i. In summer, the air near the hot road or desert surface has very high temperature and hence it becomes lighter than the cool air above it.

ii. As, the density of air goes on decreasing with increase in height above the surface, the refractive index of air increases.

iii. Hence, the direction of light rays coming from a distant object keeps changing according to laws of refraction.

iv. This makes the light rays coming from distant object appear to come from an image of the object inside the ground as shown in the figure. This is called mirage.



v. Thus, formation of mirage is the effect of changing refractive index in the atmosphere.

vi. An illusion of the appearance of water on a hot road or in a desert is an example of mirage.

10. Explain with an example the effect of atmospheric refraction on a small scale. ***[2 Marks]***

Ans: The effect of atmospheric refraction on a small scale:

i. At the time of holi, objects beyond and above the holi fire appear to be shaking.

ii. The air just above the fire becomes hotter than the air further up. The hot air is lighter (rarer) than the cool air (denser) above it.

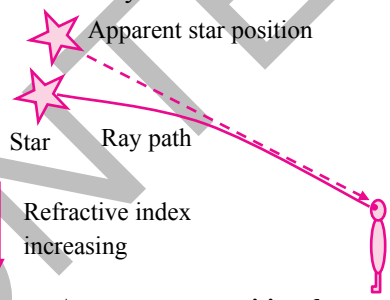
iii. Hence, the refractive index of hot air is less than that of cool air.

iv. As the physical conditions of air are not stationary, the apparent position of object changes due to atmospheric refraction of light.

11. Explain how twinkling of stars is an effect of atmospheric conditions on refraction of light. ***[3 Marks]***

Ans: i. Stars are point sources of light as they are very far away from us.

ii. The apparent position of star is slightly higher than its actual position due to refraction of starlight from the atmosphere. The starlight travels from rarer medium to denser medium and continuously bends towards the normal.



Apparent star position due to atmospheric refraction

iii. Due to the motion of atmospheric air and change in density and temperature, the atmosphere is not steady. As a result refractive index of air in given region changes continuously and randomly.

iv. Hence, the apparent position of star and its brightness is not stationary but changes slightly.

v. In this way, due to change in refractive index of atmosphere, the stars appear twinkling at night.

12. Explain the occurrence of advanced sunrise and delayed sunset on the basis of atmospheric refraction. ***[2 Marks]***

Ans: i. In the morning, the Sun should be seen by the observer when it reaches the horizon, but it is seen two minutes before that.

ii. As ray of light from the Sun enters the earth's atmosphere, it follows a curved path due to refraction, before reaching the observer.

iii This makes the apparent position of the Sun slightly higher than actual position for the observer. Hence, the Sun is seen earlier before the Sun reaches the horizon.

iv. Atmospheric refraction of sunlight also occurs at the sunset. In this case, the observer on the earth continues to see the setting Sun for two minutes after the Sun has dipped below the horizon, thus delaying the sunset.

13. Explain partial reflection, critical angle and total internal reflection with the help of a neat labelled diagram. ***[5 Marks]***

Ans: i. When a ray of light enters a rarer medium from a denser medium, it gets partially reflected i.e., part of the light gets reflected and comes back into the denser medium obeying the laws of reflection. This is called partial reflection.

ii. The rest of the light gets refracted and goes into the rarer medium. As light is going from denser to rarer medium, it bends away from the normal i.e., the angle of incidence (i) is smaller than the angle of refraction (r).

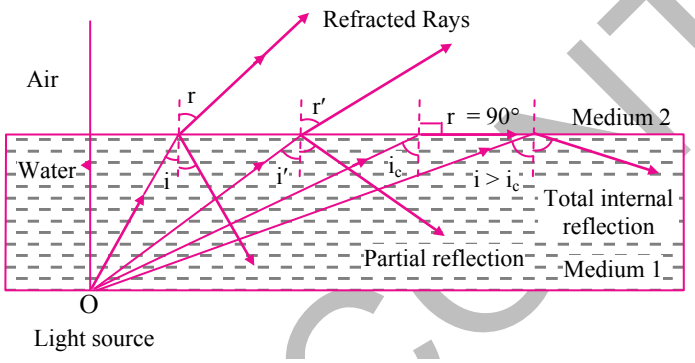
iii. According to Snell's law, the refractive index of the material is constant. Hence, on increasing the angle of incidence the angle of refraction (r) increases.

iv. For a particular value of i for which, the value of r becomes equal to 90°, is called the critical angle.

For i = critical angle = i_c, r = 90°

$$_2n_1 = \frac{\sin i_c}{\sin 90°} = \sin i_c \qquad ....(\because \sin 90° = 1)$$

v. For angles of incidence larger than the critical angle, the angle of refraction is larger than 90°. Such rays return to the denser medium as shown in the figure. Thus, all the incident light gets reflected back into the denser medium. This is called total internal reflection.



Partial reflection, Critical angle and total internal reflection

14. Prove that a rainbow is the combined effect of the refraction, dispersion, and total internal reflection.** ***[3 Marks]

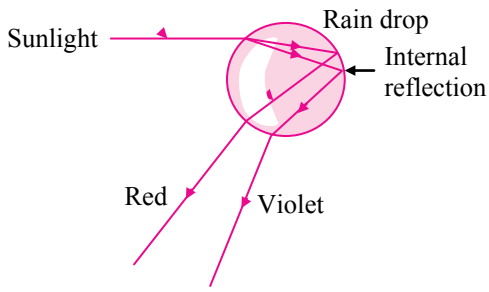
Ans: i. The rainbow appears in the sky after a rainfall.

ii. Water droplets present in the atmosphere act as small prism.

iii. When sunlight enters these water droplets it gets refracted and dispersed.

iv. This dispersed light gets totally reflected inside the droplet and again is refracted while coming out of the droplet.

v. As a combined effect of all these phenomena, the seven coloured rainbow is observed.



Formation of rainbow

Give reasons *[2 Marks each]*

1. Planets do not twinkle.

Ans: i. The rays of light from a planet pass through the atmosphere of the earth.

ii. As compared to stars, planets are nearer to earth.

iii. So a planet can be considered as a collection of large number of point sources of light.

iv. If the intensity of light from one point source decreases, it increases from the other source. Thus, the average intensity remains the same.

Hence, planets do not twinkle.

2. Violet light is deviated most and red light is deviated the least on passing through the prism.

Ans: i. Different colours travel with different speed in prism.

ii. Hence, refractive index of prism is different for different colours. It is maximum for violet light and minimum for red light.

iii. The angle of deviation of ray of light on passing through a prism depends on the refractive index of the material of the prism.

Hence, violet light is deviated the most and red light is deviated the least on passing through a prism.

Questions based on diagram *[3 Marks each]*

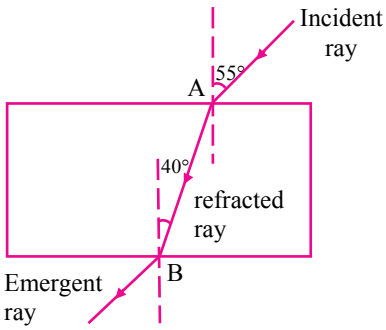
1. In an experiment with a rectangular glass slab, a student observed that a ray of light incident at an angle of 55° with the normal on one face of the slab, after refraction striked the opposite face of the slab before emerging out into air making an angle of 40° with the normal.

i. Draw a labelled diagram to show the path of this ray.

ii What value would you assign to the angle of refraction?

iii. What value would you assign to the angle of emergence?

Ans: i.



ii. Angle of refraction at point A is 40°.

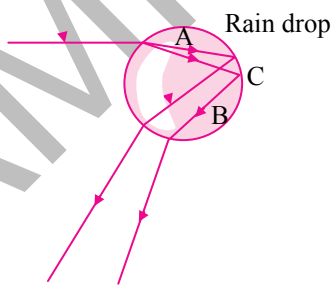
iii. Angle of emergence at point B is 55°.

2. Given figure represents formation of rainbow in the sky.

i. Label A and B of the given diagram.

ii. Which colour deviates most through water drop?

iii. Which phenomena is shown with label C?



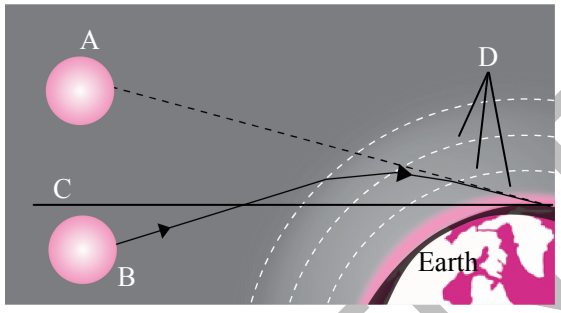
Formation of rainbow

Ans: i. Label A: Red colour light
Label B: Violet colour light

ii. Violet colour, i.e., B deviates most through water drop.

iii. Label C represents total internal reflection.

3. Based on the below diagram, answer the following question.



i. What do labels A and B denote?

ii. What do labels C and D denote?

iii. What does the above diagram represent?

Ans: i. Label A : Apparent position of star.
Label B : Real position of star.

ii. Label C : Horizon
Label D : Atmospheric layers

iii. The above diagram represents effect of atmospheric refraction

Questions based on paragraph *[5 Marks]*

1. Ekta and Vaibhav performed an experiment and found refractive indices of various media as mentioned in the following table. Observe the table and answer the questions based on it.

Substance	Refractive Index	Substance	Refractive Index
Air	1.0003	Crown glass	1.52
Water	1.33	Rock salt	1.54
Alcohol	1.36	Dense flint glass	1.66
Kerosin	1.39	Ruby	1.76
Turpentine oil	1.47	Sapphire	1.76
Benzene	1.50	Diamond	2.42

i. Arrange the following substances from denser to rarer medium.
Benzene, Alcohol, Water, Turpentine oil, Rock salt

ii. From the above table, mention the most rare and most dense media.

iii. What will happen to the path of light, when light travels from crown glass to dense flint glass?

iv. What will happen to the path of light, when light travels from sapphire to ruby?

v. What is the value of refractive index of rock salt with respect to water?

Answers:

i. Rock salt, Benzene, Turpentine oil, Alcohol, Water.

ii. Most rare medium: Air
Most dense medium: Diamond

iii. Light ray will bend towards the normal.
iv. Light ray will go undeviated as both the media have same refractive index.
v. Refractive index of rock salt with respect to water $= \frac{1.54}{1.33} = 1.16$

Numerical Section

Formulae

1. Refractive index:

i. ${}_1n_2 = \frac{v_2}{v_1}$ ii. ${}_2n_1 = \frac{v_1}{v_2}$

iii. ${}_1n_2 = \frac{1}{{}_2n_1}$

Where, ${}_1n_2$ = refractive index of first medium with respect to second medium,
${}_2n_1$ = refractive index of second medium with respect to first medium,
v_1 = velocity of light in first medium,
v_2 = velocity of light in second medium.

2. Absolute refractive index: $n = \frac{v_1}{v_2}$

Where, v_1 = velocity of light in vacuum,
v_2 = velocity of light in medium.

3. Second law of refraction / Snell's law:

${}_2n_1 = \frac{\sin i}{\sin r}$

Where, ${}_2n_1$ = refractive index of second medium with respect to first medium,
i = angle of incidence,
r = angle of refraction.

Solve the following problems

+1. The absolute refractive index of water is 1.36. What is the velocity of light in water? (Velocity of light in vacuum = 3×10^8 m/s) *[2 Marks]*

Solution:

Given: Absolute refractive index of water (n) = 1.36,
Velocity of light in vacuum (v_1) = 3×10^8 m/s

To find: Velocity of light in water (v_2)

Formula: $n = \frac{v_1}{v_2}$

Calculation: From formula,

$$v_2 = \frac{v_1}{n} = \frac{3 \times 10^8}{1.36} = \mathbf{2.21 \times 10^8\ m/s}$$

Ans: The velocity of light in water is **2.21×10^8 m/s**.

***2. If the speed of light in a medium is 1.5×10^8 m/s, what is the absolute refractive index of the medium?** *[2 Marks]*

Solution:

Given: Speed of light in medium (v_2) = 1.5×10^8 m/s

To find: Absolute refractive index (n)

Formula: $n = \frac{v_1}{v_2}$

Calculation: From formula,

$$n = \frac{3 \times 10^8}{1.5 \times 10^8} \quad (\because \text{velocity of light in vacuum} = 3 \times 10^8 \text{ m/s})$$

$$= \mathbf{2}$$

Ans: The absolute refractive index of the medium is **2**.

3. Calculate the refractive index of water with respect to glass and refractive index of glass with respect to water if speed of light in water and glass is 2.2×10^8 m/s and 2×10^8 m/s respectively. *[3 Marks]*

Solution:

Given: Speed of light in water (v_w) = 2.2×10^8 m/s, speed of light in glass (v_g) = 2×10^8 m/s

To find: i. Refractive index of glass w.r.t. water (${}_gn_w$)
ii. Refractive index of water w.r.t glass (${}_wn_g$)

Formulae: i. ${}_2n_1 = \frac{v_1}{v_2}$ ii. ${}_1n_2 = \frac{1}{{}_2n_1}$

Calculation: From formula (i),

$${}_gn_w = \frac{v_w}{v_g} = \frac{2.2 \times 10^8}{2 \times 10^8} = \mathbf{1.1}$$

From formula (ii),

$${}_wn_g = \frac{1}{{}_gn_w} = \frac{1}{1.1} = \mathbf{0.909}$$

Ans: i. Refractive index of glass w.r.t. water is **1.1**.
ii. Refractive index of water w.r.t glass is **0.909**.

+4. Light travels with a velocity 1.5×10^8 m/s in a medium. On entering second medium its velocity becomes 0.75×10^8 m/s. What is the refractive index of the second medium with respect to the first medium? *[2 Marks]*

Solution:

Given: Velocity of light in first medium (v_1) = 1.5×10^8 m/s,
Velocity of light in second medium (v_2) = 0.75×10^8 m/s

To find: Refractive index of second medium with respect to first medium (${}_2n_1$)

Formula: $_2n_1 = \frac{v_1}{v_2}$

Calculation: From formula,

$$_2n_1 = \frac{1.5 \times 10^8}{0.75 \times 10^8} = \mathbf{2}$$

Ans: Refractive index of second medium with respect to first medium is **2**.

5. Refractive index of water with respect to air is $\frac{4}{3}$ and speed of light in air is 3×10^8 m/s. Find speed of light in water. ***[2 Marks]***

Solution:

Given: Refractive index of water $(_2n_1) = \frac{4}{3}$,

Speed of light in air $(v_1) = 3 \times 10^8$ m/s

To find: Speed of light in water (v_2)

Formula: $_2n_1 = \frac{v_1}{v_2}$

Calculation: From formula,

$$_2n_1 = \frac{v_1}{v_2}$$

$$\therefore \quad v_2 = 3 \times 10^8 \times \frac{3}{4} = \frac{9}{4} \times 10^8 = \mathbf{2.25 \times 10^8\ m/s}$$

Ans: The speed of light in water is **2.25×10^8 m/s**.

6. If the absolute refractive indices of glass and water are 3/2 and 4/3 respectively, what is the refractive index of glass with respect to water?** ***[3 Marks]

Solution:

If v_1 is the velocity of light in vacuum, v_2 is the velocity of light in glass and v_3 is the velocity of light in water then,

absolute refractive index of glass

i.e., refractive index of glass with respect to vacuum, $n_g = \frac{v_1}{v_2} = \frac{3}{2}$ ....(i)

Absolute refractive index of water

i.e., refractive index of water with respect to vacuum, $n_w = \frac{v_1}{v_3} = \frac{4}{3}$ ....(ii)

$\therefore$ Refractive index of glass with respect to water

$$_gn_w = \frac{v_3}{v_2}$$

$$= \frac{v_1}{v_2} \times \frac{v_3}{v_1}$$ ....(Multiplying and dividing R.H.S. of equation by v_1)

$$= \frac{3}{2} \times \frac{3}{4}$$ ....[From equations (i) and (ii)]

$$= \mathbf{\frac{9}{8}}$$

Ans: The refractive index of glass with respect to water is $\mathbf{\frac{9}{8}}$.

7. A ray of light falls on a material body at an incident angle 60° and refracted at angle 30°.

i. What is the refractive index of the material?

ii. What is the measure of the angle of emergence 'e'? ***[2 Marks]***

Ans: i. Refractive index of material

$$= \frac{\sin i}{\sin r} = \frac{\sin 60°}{\sin 30°} = \frac{\sqrt{3}/2}{1/2} = \sqrt{3}$$

ii. Angle of emergence is numerically equal to angle of incidence.

$\therefore$ e = i = 60°

Practice problems

1. The speed of light in transparent medium is 2.6×10^8 m/s. Calculate absolute refractive index of the medium. **[2 M]**

2. The speed of light in water and diamond is 2.2×10^8 m/s and 1.25×10^8 m/s respectively. What is the refractive index of:
   i. water w.r.t. diamond?
   ii. diamond w.r.t. water? **[3 M]**

3. The refractive index of ruby is 1.71 and speed of light in air is 3×10^8 m/s. Find speed of light in ruby. **[2 M]**

4. A ray of light travelling from first medium is incident at an angle of 30° on the second medium and refracted at an angle of 45°. Find refractive index of the second medium with respect to first medium and angle of emergence. **[3 M]**

Answers:

1. 1.15
2. i. 0.57 ii. 1.76
3. 1.75×10^8 m/s
4. 0.707, 30°

Apply your Knowledge

1. Can you recall? *(Textbook page no. 73)*

i. What is meant by reflection of light?

Ans: When rays of light fall on any opaque surface, they turn back. This is called as reflection of light.

ii. What are the laws of reflection?

Ans: Laws of reflection of light:

a. The angle of reflection is equal to the angle of incidence.

b. The incident ray, the reflected ray and the normal, all lie in the same plane.

c. The incident ray and the reflected ray are always on opposite sides of the normal.

2. Try this. *(Textbook page no. 73)*

Material: Glass, 5 rupee coin, Pencil, metallic vessel etc.

Answer the following questions based on the activities given on page 73 of your textbook.

i. In activity 1, why does the portion of the pencil inside the water appears to be thicker and broken near the surface of water?

Ans: When we look at the portion of the pencil that is inside the water, light travels from water to air via glass. This light ray changes the medium and undergoes refraction. As a result, the pencil inside the water appears to be thicker and broken near the surface of water.

[Note:** Students are expected to refer the accompanying QR code to understand this phenomenon.**]

ii. In activity 2, why does the coin become visible once the level of water reaches a certain height?

Ans: Light rays coming from the coin emerge out of water and change their direction due to refraction of light. Thus, the coin becomes visible once the level of water reaches a certain height.

[Note:** Students are expected to refer the accompanying QR code to understand this phenomenon.**]

iii. Observe the incident ray AN and emergent ray MD from activity 3.

[Students are expected to refer the accompanying QR code for demonstration of above activity and observe the incident ray and emergent ray on their own.]

3. Can you tell? *(Textbook page no. 76)*

i. Have you seen a mirage which is an illusion of the appearance of water on a hot road or in a desert?

ii. Have you seen that objects beyond and above a holi fire appear to be shaking? Why does this happen?

Ans: i. Yes, I have seen a mirage which is an illusion of the appearance of water on a hot road or in a desert.

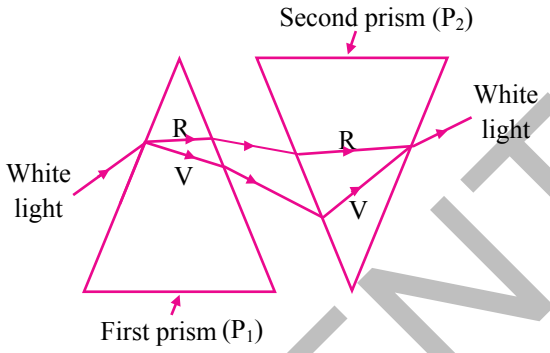
ii. Yes, I have seen that objects beyond and above a holi fire appear to be shaking.

For reason Refer Answer the following Q.9 and Q.10.

4. Use your brain power! *(Textbook page no. 77)*

i. From incident white light how will you obtain white emergent light by making use of two prisms?

Ans: To obtain white emergent light from two prisms, the second prism should be placed parallel to the first prism but in an inverted position as shown in the figure below.



ii. You must have seen chandeliers having glass prisms. The light from a tungsten bulb gets dispersed while passing through these prisms and we see coloured spectrum. If we use an LED light instead of a tungsten bulb, will we be able to see the same effect?

Ans: If LED is not white then the LED will not produce dispersion of light. Assuming the LED bulb to be white, the LED bulb will produce dispersion of light but the dispersion pattern is not as effective as the one with an incandescent bulb i.e., tungsten wire bulb.

5. Books are my friends. *(Textbook page no. 78)*

i. Why the sky is blue – Dr. C.V. Raman talks about science: C.V. Raman and Chandralekha

ii. Optics: Principles and Applications: K.K. Sharma

iii. Theoretical concepts in Physics: M. S. Longair.

[Students are expected to read the above mentioned books for better understanding of concepts.]

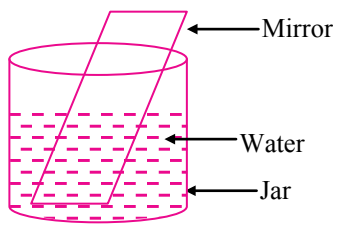
6. Some fun. *(Textbook page no. 78)*

Try to see if you can see dispersion of light using plastic jar, mirror and water.

Ans: Fill a plastic jar with water. Place mirror into water inside the jar at an angle.

Position the jar such that sunlight shines directly at the mirror. Also, adjust the angle of mirror until rainbow is observed on wall.

(It would be easier to spot the rainbow if room is dark.)



[Note:** Students are expected to refer the accompanying QR code for demonstration of the above activity.**]

7. Can you tell?
Why dispersion of light is not observed in glass slab but it is observed in prism?

Ans: i. When a light passes from one medium to another, it changes its speed.
ii. The glass slab and prism both have two glass-air interfaces. Hence, the light undergoes refraction twice in both the cases.
iii. When the two interfaces are parallel to each other, although the colours are separated at first interface, they all travel the same path after refracting from second interface.
iv. However, in prism, the two interfaces are not parallel. Therefore, the colours separated at first interface do not travel the same path after second refraction.
Thus, dispersion of light is not observed in glass slab but it is observed in prism.

***8. Project:**
Using a laser and soap water, study the refraction of light under the guidance of your teacher.
[Students are expected to refer the accompanying QR code to study refraction of light using a laser and soap water.]

Memory Map

Some natural phenomena of light

Refraction
- Change in the direction of light when it passes from one transparent medium to another.
- Twinkling of stars, advanced sunrise, etc. are examples or effect of atmospheric refraction.

Total internal reflection
- When light enters a rarer medium from a denser medium at an angle greater than critical angle then the light gets reflected back into the denser medium.

Dispersion
- Splitting of light into its component colours.
- The band of coloured components of a light beam is called its spectrum.

Combined effect → **Rainbow**

Related to → **Refractive index**
- $_2n_1 = \frac{\sin i}{\sin r}$
- $_2n_1 = \frac{\text{Velocity of light in first medium } (v_1)}{\text{Velocity of light in second medium } (v_2)}$

- When light ray travels obliquely from an optically rarer medium to denser medium, it bends towards normal after refraction.
- $n_1 < n_2$
- $\angle i > \angle r$

- When light ray travels obliquely from an optically denser medium to rarer medium, it bends away from normal after refraction.
- $n_1 > n_2$
- $\angle i < \angle r$

- When a ray of light is incident normal to the interface between any two media, the ray propagates undeviated from one medium to another.
- $\angle i = \angle r = 0$

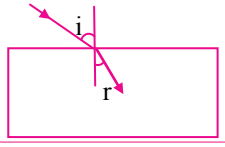
Chapter Assessment

[Total Marks: 25]

Q.1. (A) Answer the following: **[5]**

i. Find the odd one out.
Red colour, Yellow colour, Violet colour, White colour

ii. Complete the given analogy.



: Light passes from rarer medium to denser medium :: _____ : Light passes from denser medium to rarer medium

iii. Match the columns.

	Column I		Column II
a.	Reflection	1.	Change in the direction of light
b.	Refraction	2.	Turning back of light ray
		3.	Split up the light ray into number of colours

iv. Fill in the blank.
When a ray of light enters a rarer medium from a denser medium then an incident angle for which angle of refraction is 90° is called as _____.

v. Name the following.
The colour of spectrum which deviate least during dispersion.

(B) Choose the correct alternative. **[3]**

i. If a ray of light travels through two prisms such that second prism is parallel to first prism but placed in an inverted position then, the light coming out of second prism will be
(A) only red and violet. (B) consisting of bands of seven colours.
(C) white. (D) only blue.

ii. When a ray of light travels from air to glass slab and strikes the surface of separation at 90°, then it
(A) bends towards normal. (B) bends away from normal.
(C) passes undeviated. (D) passes in zigzag way.

iii. If a ray of light propagating in air strikes a glass slab at an angle of 30° with the surface of the slab, the angle of refraction is
(A) 90° (B) less than 60°
(C) 60° (D) more than 60°

Q.2. Answer the following (any three): **[6]**

i. State laws of refraction of light.
ii. The speed of light in transparent medium is 2.4×10^8 m/s. Calculate absolute refractive index of the medium.
iii. A teacher was explaining the phenomena of advanced sunrise and delayed sunset, what reason should the teacher give for the phenomena?
iv. Give two examples based on phenomenon of refraction of light observed in nature and explain their occurrence in brief.

Q.3. Answer the following (any two): **[6]**

i. Velocity of light ray in two media A and B are v_1 and v_2 respectively.
a. If $v_B = 1.5v_A$, then which medium is denser?
b. What is the refractive index of A with respect to B?
c. What is the refractive index of B with respect to A?
ii. Explain how spectrum is formed by a prism with the help of a diagram.
iii. Define refraction of light and explain the relation between refractive index of material and velocity of light.

Q.4. Answer the following. (Any one) **[5]**

i. Complete the table.

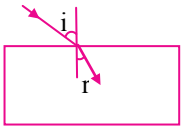
	Velocity in first medium (v_1)	Velocity in second medium (v_2)	Refractive index $_2n_1$	Refractive index $_1n_2$
a.	3×10^8 m/s	1.2×10^8 m/s	----------	----------
b.	----------	2.25×10^8 m/s	----------	4/3
c.	2×10^8 m/s	----------	1.5	0.67

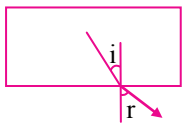
ii. With the help of a neat labelled diagram, explain partial reflection, critical angle and total internal reflection.

Answers:

Q.1. (A)

i. White colour
Others are colours of spectrum.

ii. 

: Light passes from rarer medium to denser medium :: 

: Light passes from denser medium to rarer medium

iii.

	Column I		Column II
a.	Reflection	2.	Turning back of light ray
b.	Refraction	1.	Change in the direction of light

iv. When a ray of light enters a rarer medium from a denser medium then an incident angle for which angle of refraction is 90° is called as **critical angle**.

v. Red

(B)

i. (C): white. ii. (C): passes undeviated. iii. (B): less than 60°

Q.2. i. a. The incident ray and the refracted ray are on the opposite sides of the normal at the point of incidence, and all three lie in same plane.

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

ii. ***Solution:***

Given: Speed of light in a medium (v_2) = 2.4×10^8 m/s

To find: Absolute refractive index (n)

Formula: $n = \frac{v_1}{v_2}$

Calculation: From formula,

$$n = \frac{v_1}{v_2}$$

$$= \frac{3 \times 10^8}{2.4 \times 10^8} \quad \text{....}(\because \text{ velocity of light in vacuum} = 3 \times 10^8 \text{ m/s})$$

$$= \mathbf{1.25}$$

Ans: The absolute refractive index of the medium is **1.25**.

iii. *Refer Answer the following: Q.12*

iv. a. Mirage: The light rays coming from a distant object appear to be coming from the image of the object inside the ground. This is called a mirage.

b. Twinkling of stars: Due to the motion of atmospheric air and change in density and temperature, the atmosphere is not steady. As a result, refractive index of air in given region changes continuously and randomly. Hence, the apparent position of star and its brightness is not always same but changes slightly which leads to twinkling of stars.

Q.3. i. a. Medium A is denser.

b. Refractive index of A with respect to B is given by

$${}_A n_B = \frac{v_B}{v_A} = \frac{1.5 v_A}{v_A} = 1.5 = \frac{3}{2}$$

c. Refractive index of B with respect to A is given by

$${}_B n_A = \frac{1}{{}_A n_B} = \frac{2}{3}$$

ii. Formation of spectrum of different colours by a prism:

a. As the sunlight enters the prism, each colour gets refracted through different angles.

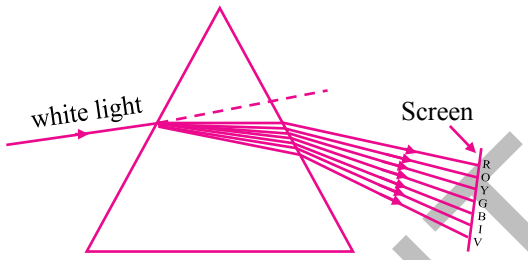
b. Hence, white light disperses into seven colours showing different colours of light.

c. Out of these seven colours, red colour bends the least and hence, it is at the top of the spectrum.

d. Violet colour bends the most and hence, it is at the bottom of the spectrum.

e. Each colour emerges out along different paths and becomes distinct.

f. Hence, a spectrum of seven different colours is obtained.



Dispersion of light

iii. *Refer Answer the following: Q.5*

Q.4. i. ***Solution:***

a. *Given:* Velocity in first medium (v_1) = 3×10^8 m/s,
Velocity in second medium (v_2) = 1.2×10^8 m/s

To find: Refractive index ($_1n_2$), Refractive index ($_2n_1$)

Formulae: i. $_1n_2 = \frac{v_2}{v_1}$ ii. $_2n_1 = \frac{1}{_1n_2}$

Calculation: From formula (i),

$$_1n_2 = \frac{v_2}{v_1} = \frac{1.2\times10^8}{3\times10^8} = \mathbf{0.4}$$

From formula (ii),

$$_2n_1 = \frac{1}{0.4} = \mathbf{2.5}$$

b. *Given:* Velocity in second medium (v_2) = 2.25×10^8 m/s, Refractive index ($_1n_2$) = 4/3

To find: Velocity in first medium (v_1), Refractive index ($_2n_1$)

Formulae: i. $_1n_2 = \frac{v_2}{v_1}$ ii. $_2n_1 = \frac{1}{_1n_2}$

Calculation: From formula (i),

$$v_1 = \frac{v_2}{_1n_2} = \frac{2.25\times10^8\times3}{4} = \mathbf{1.69\times10^8\ m/s}$$

From formula (ii),

$$_2n_1 = \frac{1}{4/3} = \frac{3}{4} = \mathbf{0.75}$$

c. *Given:* Velocity in first medium (v_1) = 2×10^8 m/s, Refractive index ($_2n_1$) = 1.5, Refractive index ($_1n_2$) = 0.67

To find: Velocity in second medium (v_2)

Formula: $_1n_2 = \frac{v_2}{v_1}$

Calculation: From formula,

$$v_2 = {}_1n_2 \times v_1 = 0.67\times2\times10^8 = \mathbf{1.34\times10^8\ m/s}$$

Ans:

	Velocity in first medium (v_1)	Velocity in second medium (v_2)	Refractive index $_2n_1$	Refractive index $_1n_2$
a.	3×10^8 m/s	1.2×10^8 m/s	**2.5**	**0.4**
b.	**1.69×10^8 m/s**	2.25×10^8 m/s	**0.75**	4/3
c.	2×10^8 m/s	**1.34×10^8 m/s**	1.5	0.67

ii. *Refer Answer the following Q.13*

Std.X

AVAILABLE SUBJECTS:

- English Kumarbharati
- हिंदी लोकभारती
- हिंदी लोकवाणी
- मराठी अक्षरभारती
- आमोदः (सम्पूर्ण संस्कृतम्)
- आनन्दः (संयुक्त संस्कृतम्)
- Mathematics - I
- Mathematics - II
- Science and Technology - 1
- Science and Technology - 2
- History and Political Science
- Geography

BUY NOW

SALIENT FEATURES:

- Detailed description of the SSC Paper Pattern & Marking Scheme
- Exhaustive coverage of textual questions in all subjects
- Thorough explanation of all concepts in all subjects
- Two Model Question Papers for self-evaluation
- QR Codes in every book provide access to videos and a plethora of subject knowledge for students

Target Publications Pvt. Ltd.

88799 39712 / 13 / 14 / 15

mail@targetpublications.org

www.targetpublications.org