

SUBJECT: PHYSICS

TOPIC: RAY OPTICS

Pre-Content/content Post-Content	Learning outcomes/Objectives	
	General	Specific
PRE-CONTENT: Q1What is the nature of light waves? Q2State the laws of reflection. Q3State the features of image formed by plane mirror Q4State the rules for drawing ray diagrams using spherical mirrors. Q5Draw ray diagrams using concave and convex mirror CONTENT <u>Behaviour of light at the interface of two media</u> Spherical mirrors Mirror formula linear magnification -related numericals Spherical aberration Uses of curved mirrors Refraction of light Laws of refraction Refractive index Cause of refraction n, principle of reversibility, practical applications of refraction	Students will be able to : • derive Mirror formula, • derive magnification • comprehend refraction • state Laws of refraction, Snell's law, • understand apparent and actual depth, • define Critical angle, • comprehend Total internal reflection	Students will be able to : •recall the laws of reflection of light •name the types of spherical mirrors and define the related terms •state the Cartesian sign convention •obtain the relation between the focal length and radius of curvature • comprehend the rules for drawing ray diagrams. •draw ray diagrams for image formation by a concave/convex spherical mirror for different positions of the object . •tabulate the basic features of the images formed, for different positions of objects for spherical mirrors •derive the mirror formula • explain spherical aberration •define the term linear magnification and obtain the mathematical expression for it • uses of spherical mirrors •solve problems on the mirror formula. •explain the term refraction of light and •state laws of refraction:Snell,'s law •comprehend the meaning of refractive index/ optical density and compare it with mass density •explain refraction of light taking place through glass slab and combination of media. •relate real depth and apparent depth and obtain the relation between the two. •explain natural phenomenon related to atmospheric refraction . •define the term total internal reflection •state the conditions to be fulfilled for total internal reflection

Teacher's Activity	Student's Activity	Teacher's observation and Remedial
Teacher will - enable students to recall their previous knowledge through an interactive session. Based on which the new concepts of light will be taught. - Conduct optics experiments and related activities also simultaneously in the lab while teaching various concepts of Ray Optics. To reinforce laws of reflection a simple activity will be performed in the class using plane mirror and LASER light(Annexure 9A)(attached at the end) - Introduce the terms related to spherical mirrors, Cartesian sign convention and derive mirror formula - enable students to understand the image formed by spherical mirrors by performing an activity in the lab- to study the nature of image formed by concave mirror using candle and screen method and - make students find out the focal length of concave mirror in the lab using optical bench after explaining the meaning of parallax, method for its removal and the need for removal of parallax(Annexure 9B,9C,9D)(attached at the end) - Explain laws of refraction, concept of refractive index, real depth and apparent depth and various natural phenomenon based on refraction - enable students to understand the laws of refraction by making them perform an activity in the lab- using glass slab and LASER light /two pin method	Students will - recall the basics learnt in class X and few concepts in class XII in chapter EMW. - perform various optics based experiments in the lab and comprehend concepts - derive mirror formula by applying Cartesian sign convention and study the nature of image formed by concave mirror by using candle and screen method and will also practice numerical problems based on mirror formula - find out the focal length of concave mirror in the lab using optical bench after understanding the meaning of parallax and methods used for its removal .In the process they will realize the need for removal of parallax - attempt application based questions on the concepts related to refraction - study the laws of refraction using glass slab and LASER light / two pin method 2/33	

Pre-Content/content Post-Content	Learning outcomes/Objectives	
	General	Specific
Total internal reflection and its applications-totally internally reflecting Prisms, optical fibres Refraction at a spherical surface -ray diagrams for image formation in different cases Thin Lenses -lens formula -lens maker's formula -magnification -power of a lens -combination of lenses -combination of Prism, Dispersion Refraction of light through a prism Deviation through a prism of small angles dispersion of white light Angular dispersion and dispersive power	Students will be able to : • draw spherical lenses and Ray diagrams • derive Lens Maker's Formula, • define Power of lens, • understand refraction in Prism, • explain Dispersion, • apply scattering,	Students would be able to : • explain applications of total internal reflection for explaining i) mirage ii) sparkling of diamonds and (iii) totally reflecting prisms(iv) optical fibres • name the types of spherical lenses define the related terms • state sign convention and rules for drawing ray diagrams • draw ray diagrams for image formation in a thin convex/concave lens for different positions of the object and list the features of the image • derive thin lens formula • define the term magnification and obtain the expression for it. • derive the basic equation for refraction at a spherical surface. • derive lens maker's formula and obtain the thin lens formula .. • define the term 'power' of a lens and state its SI unit. • comprehend the need for combining lenses and find the formula for equivalent focal length and total magnification produced in combination of thin- lenses in contact. • solve problems on combination of a lens and a mirror. • trace the path of light through a triangular glass prism. • derive expression for the angle of deviation in terms of angle of incidence, angle of emergence and angle of prism • plot the variation of the angle of deviation with angle of incidence for a prism and identify the angle of minimum deviation. • derive the expression for refractive index of the material of the prism in terms of angle of prism and angle of minimum deviation • derive the angle of deviation for small angled prism • comprehend the term dispersion of light and its cause-Cauchy's relation • define angular dispersion and dispersive power

Teacher's Activity	Student's Activity	Teacher's observation and Remedial
Teacher will • explain total internal reflection and it's applications by taking real life examples and will enable students to witness total internal reflection by making light incident on a beaker containing water with few drops of Dettol added to it. • enable students to understand the image formed by convex lens by making them perform an activity in the lab- to study the nature of image formed by convex lens using candle and screen method • first take up refraction at spherical surfaces and then guide students to derive lens maker's formula, thin lens formula, expression for magnification , power of lens, and combination of lenses • help students to find out the focal length of convex lens in the lab using optical bench • facilitate students to find out the focal length of convex mirror using convex lens and optical bench in the lab • derive the relationship between angle of minimum deviation, angle of Prism and refractive index and other related concepts • make students perform an experiment to understand refraction of light through a prism	Students will • perform an activity in the lab- making light incident on a beaker containing water with few drops of dettol added to it to observe TIR and after revising related concepts will attempt related questions given in the NCERT exercises • perform an activity in the lab- to study the nature of image formed by convex lens using candle and screen method and after covering lens Maker's formula and other related concepts in order to understand the behavior of lens(n_2) as per the surrounding medium(n_1) , (when $n_2 > n_1$, $n_2 < n_1$ and $n_2 = n_1$) they will perform a simple activity by using a hollow filament bulb and a beaker(<u>Annexure 9 E</u>) • find out the focal length of convex lens in the lab using optical bench • find out the focal length of convex mirror using convex lens and optical bench in the lab • perform the derivation and attempt related questions from NCERT exercises • perform an experiment to understand refraction of light through a prism	

Pre-Content/content Post-Content	Learning outcomes/Objectives	
scattering of light	General	Specific
	Students will be able to :	Students will be able to :
-related natural phenomenon Optical instruments -Microscopes -Simple Microscope -Compound microscope -Astronomical telescopes- - refracting and reflecting -Terrestrial telescope Post-content Light possesses wave nature as well as particle nature. It shows reflection, refraction, polarisation, Diffraction etc. When it goes from one medium to another its speed and wavelength changes but frequency remains unchanged.	derive Magnifying power of simple & compound microscope , Telescope (refraction & reflecting	explain the term scattering of light state Rayleigh scattering criteria and explain related different phenomenon-analyse the blue colour of sky and the reddishness at sunrise and sunset draw ray diagrams for image formation in a simple microscope and a compound microscope (i) in its normal adjustment and (ii) when the final image is formed at distance of distinct vision derive formulae for the magnifying power of a simple microscope and a compound microscope in the above mentioned cases draw ray diagrams for image formation in a refracting type astronomical telescope (i) in its normal adjustment and (ii) when the final image is formed at distance of distinct vision derive the formulae for the magnifying power of astronomical telescope in both the cases .. draw ray diagram for the formation of image in a reflecting type astronomical telescope. list the advantages of reflecting type telescope over refracting type telescope.

Teacher's Activity	Student's Activity	Teacher's observation and Remedial
Teacher will • make students familiar with the phenomenon of selective scattering teacher will perform an activity –making light incident on smoke box/conical flask containing water with few drops of milk added to it.(<u>Annexure 9F, 9G</u>)(attached at the end) • or making light pass through layers of sheets stacked one behind the other(<u>Annexure 9 H</u>)(attached at the end) • <u>facilitate students</u> to derive magnifying power of simple/compound microscope, telescope • list advantages of reflecting type telescope over refracting type telescopes • prepare assignment consisting of a variety of conceptual ,numerical and previous years' board problems and guide students to solve it (<u>Annexure 9I, 9J</u>)(attached at the end)	students will • understand the phenomenon of selective scattering by performing various activities –making light incident on smoke box/ conical flask containing water with few drops of milk added to it and hence will be able to justify red colour of rising/setting sun, blue colour of sky, blue being scattered more than red etc • draw ray diagrams and derive expression for magnifying power of various optical instruments • appreciate advantages of reflecting type telescope over refracting type telescopes • solve the NCERT in text questions and back exercise. They will also solve the assignment consisting of a variety of conceptual ,numerical and previous years board problems.	

TEACHING AIDS: Textbooks, Smartboard , ICR,,Equipments from the Physics Lab.

METHODOLOGY/ INNOVATIVE METHODS: Activity based teaching, discussion method, hands on experience

INTERDISCIPLINARY LINKS: Biology-light enables us to see and eye is a very important organ of our body comprising of a highly flexible lens, which enables us to see far off as well as nearby objects with equal ease

Subject	PHYSICS
Class	XII
Chapter/Unit	Ray optics
Topic	To Verify that the incident ray, the reflected ray and the normal, all lie in the same plane
Time	10min
Nature of Activity	Individual

What will I learn (Learning Outcome)?

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

Skills:

Observing, analyzing, Interpreting

What I have to do?

To verify law of reflection which states that the incident ray, the reflected ray and the normal lie in the same plane

What do I require?

Plane mirror , holder , white sheet, pencil, protractor, scale, source of light=Torch/laser

What do I need to know?

Phenomenon of Reflection of light , Laws of reflection

➤ **Teacher's Activity**

Teacher will

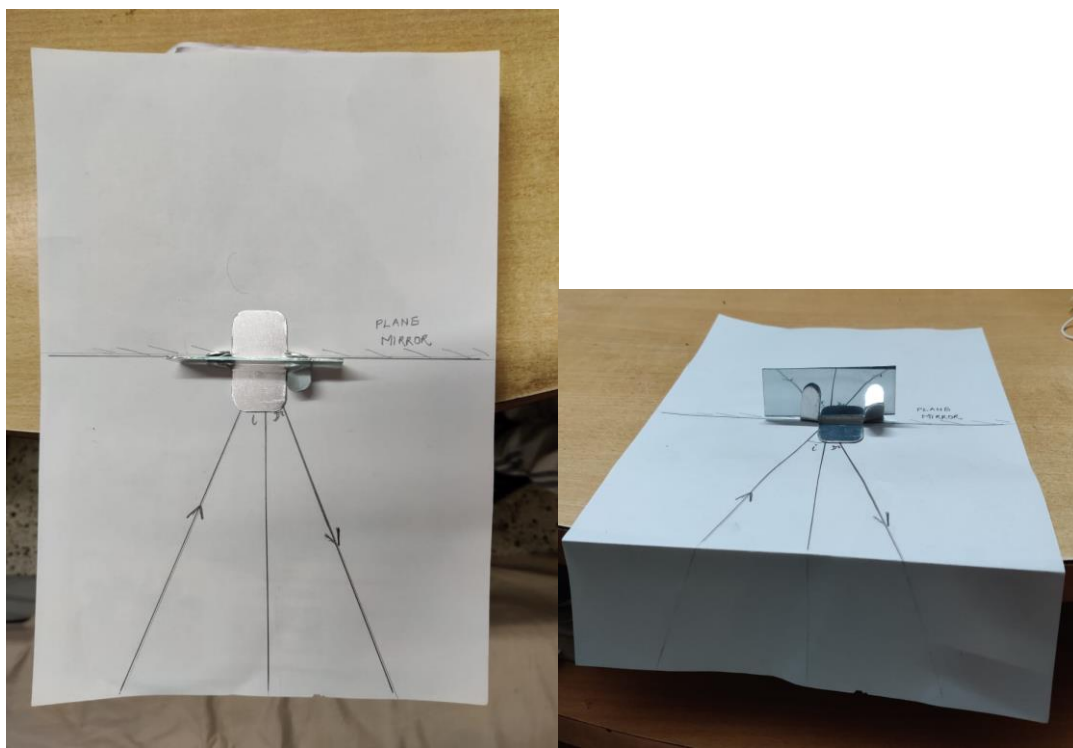
- be able to seek attention of students and generate their interest by carrying out simple activities based on reflection of light
- enable students to recall laws of reflection
- facilitate students to perform a simple activity to make them understand that the incident ray, reflected ray and the normal lie in the same plane as even students of class XII at times are unable to comprehend this concept

How will I proceed?➤ **Student's Activity**

Student will

- place a white blank paper on a table such that a portion of it extends beyond the edge of the table On the paper place a plane mirror in a holder such that the plane mirror is parallel to the edge of the table

- Make laser light/beam of light from a torch incident on the mirror obliquely along the paper and observe the reflected ray



- fold the portion of paper that extends beyond the edge of the table in downward direction along the edge of the table .
- observe the reflected ray on the portion of the paper which has been folded down.

What have I observed?

S. No.	Status of Paper paper that extends beyond the edge of the table	Reflected ray on the portion of the paper that extends beyond the edge of the table (Visible/Not visible)
1	Before bending in the downward direction	
2.	After bending in the downward direction	

Before bending the portion of paper that extends beyond the edge of the table in the downward direction the reflected ray is----- (Visible/Not visible) on it.

After bending the portion of paper that extends beyond the edge of the table in the downward direction the reflected ray is ----- (Visible/Not visible) on the bent portion

What have I learnt?

The incident ray, the reflected ray and the normal----- (lie/do not lie) in the same plane

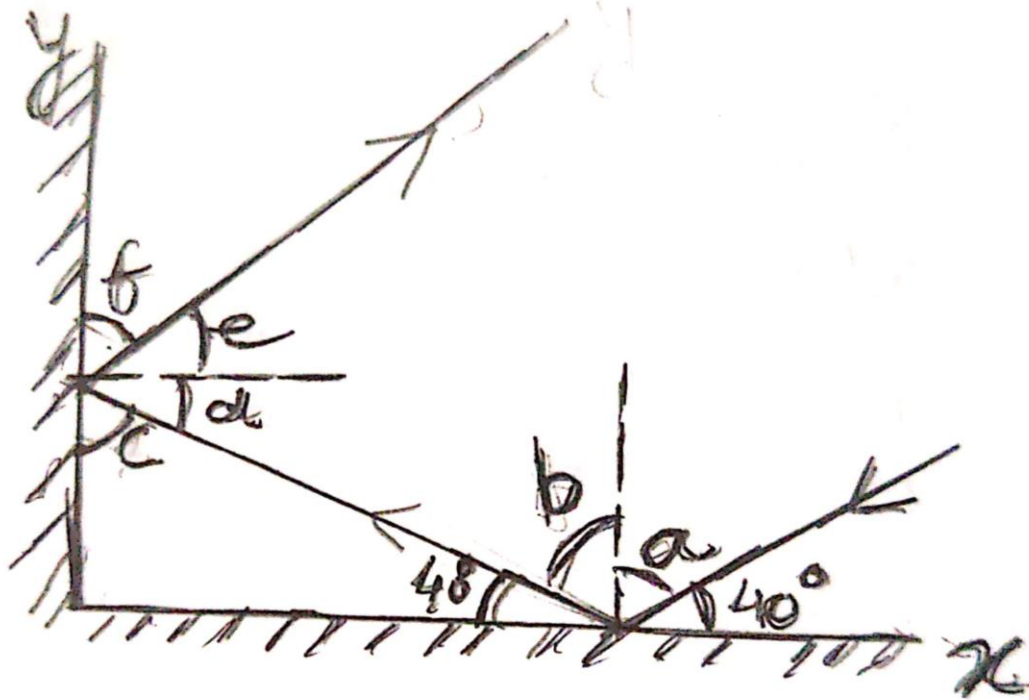
What am I curious to learn?

How do mirrors reflect photons? Can Mirrors reflect sound also just like light . What are such mirrors called?

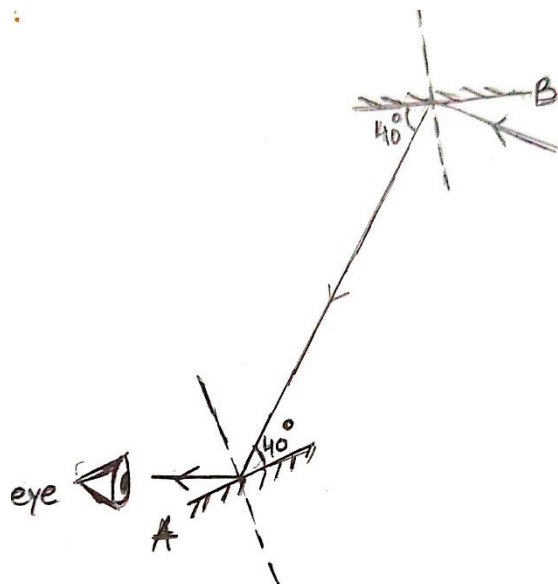
Let me evaluate myself

Q1) A ray of light falls normally on a mirror, what are the values of angle of incidence and angle of reflection

Q2) Two mirrors X and Y are lying mutually perpendicular to each other A ray of light is made incident at X as shown below in the diagram. Compute values of angles a, b, c, d, e



Q3) A ray of light is reflected by two parallel mirrors (A) and (B) . Calculate the angle of incidence and the corresponding angle of reflection for the two mirrors



Q4) A plane mirror which is a highly polished surface reflects the light falling on it. This is regular reflection. However, irregular surfaces also reflect light falling on them and it is called

irregular reflection. If it is so, then why does a plane mirror form an image but a rough surface doesn't? Support your answer by giving a suitable example

Q5) A plane mirror reflects a beam of light to form a real image. Then the pencil of light incident on the mirror is

- (i) Parallel
- (ii) Convergent
- (iii) Divergent

Justify your answer with the help of ray diagram

(Annexure 9B) ACTIVITY - (Reflection of light)

Subject	PHYSICS
Class	XII
Chapter/Unit	Ray optics
Topic	Reflection of light by plane mirror-This activity will help a student later in understanding the concept of parallax and it's removal
Time	10 min
Nature of Activity	Individual

What will I learn (Learning Outcome)?

Object distance is equal to image distance in case of plane mirror

Skills:

Observing, Analyzing and interpreting

What I have to do?

To verify that image distance is equal to object distance in case of plane mirror

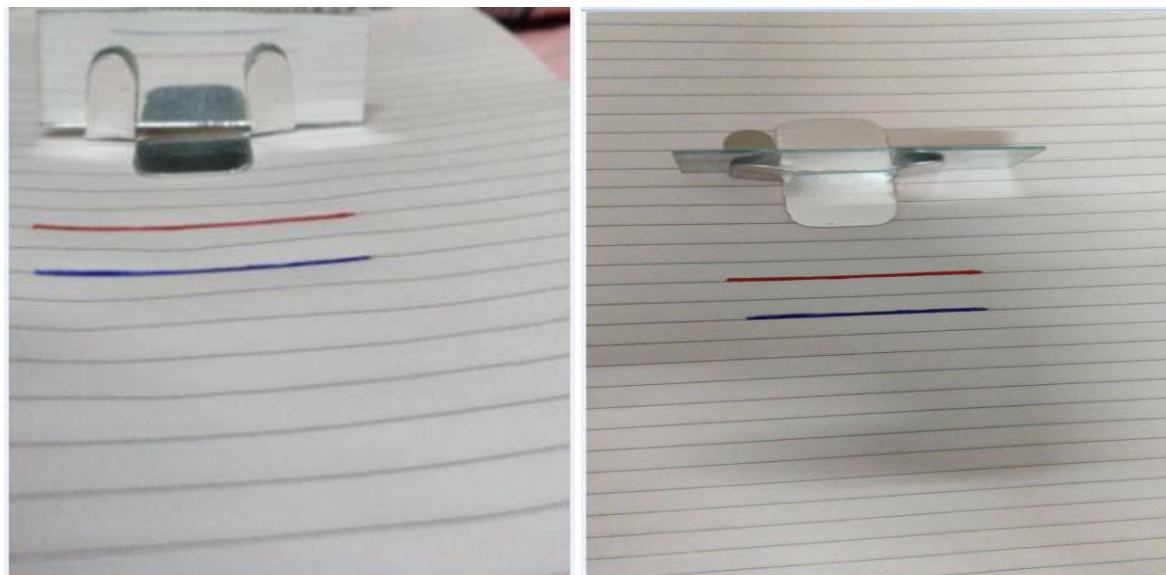
What do I require?

Plane mirror strip, mirror holder, wooden board, thumb pins, a ruled sheet, sketch pens-red and green

What do I need to know?

- **Teacher's Activity** Teacher will
 - be able to seek attention of students and generate their interest by carrying out simple activities based on reflection of light
 - enable students to recall laws of reflection and list features of image formed by plane mirror

- facilitate students to perform a simple activity to make them understand that the image distance is equal to object distance in case of plane mirror experimentally as **it will help student later in understanding the concept of parallax and its removal**



How will I proceed?

- **Student's Activity** Student will
 - place ruled sheet on the wooden board and fix it by using thumb pins
 - place plane mirror along any one line of ruled sheet preferably in the middle of the ruled sheet
 - draw a line parallel to the mirror on the ruled sheet coincident with some line on the ruled sheet at some distance from the mirror by using red sketch pen
 - observe the image of red line in the mirror and count the number of lines on the ruled sheet from the mirror at which it is formed
 - draw a line parallel to the mirror on the ruled sheet along a line on the ruled sheet from the mirror by using green sketch pen
 - observe the image of green line in the mirror and count the number of lines from the mirror at which it is formed

What have I observed?

S. No.	The distance from the mirror (by counting lines on ruled sheet) of			
	Red line	Image of red line	Green line	Image of Green line
1	Two lines away		Three lines away	
2	Five lines away		Six lines away	
3				

If a line is drawn on the ruled sheet at its n th line from the mirror the image is formed behind the mirror on -----(n th/ $(n-1)$ th) line of ruled sheet from the mirror

What have I learnt? Distance of image from the mirror is -----(equal /unequal)to the distance of the object from the mirror

What am I curious to learn?

How can image of an object formed by plane mirror can be located by parallax method?

Let me evaluate myself

Q1) A person moves with velocity v towards a plane mirror. With what velocity does his image move towards him?

Q2) A mirror is turned through 15° , by what angle does the reflected light turn?

Q3) What is the focal length and radius of curvature of a plane mirror?

Q4) What is the minimum size of a plane mirror which can enable a man to see his full image?

Q5) How many images of himself can a person see in a room whose ceiling and two adjacent walls are mirrors?

Q6) What should be the angle between two plane mirrors so that whatever be the angle of incidence, the incident and the reflected ray from the two mirrors be parallel to each other

(i) 60° (ii) 90° (iii) 120° (iv) 175°

(Annexure 9C) _ACTIVITY-(Defining Parallax)

Subject	PHYSICS
Class	XII
Chapter/Unit	Ray optics
Topic	Parallax- What is meant by Parallax
Time	10 min
Nature of Activity	Individual

What will I learn (Learning Outcome)?

Meaning of term parallax

Skills:

Observing and analysing

What I have to do?

Perform a simple activity to understand the meaning of term parallax

What do I require?

An A4 size sheet , pencil ,scale,

What do I need to know?

Definition of term parallax

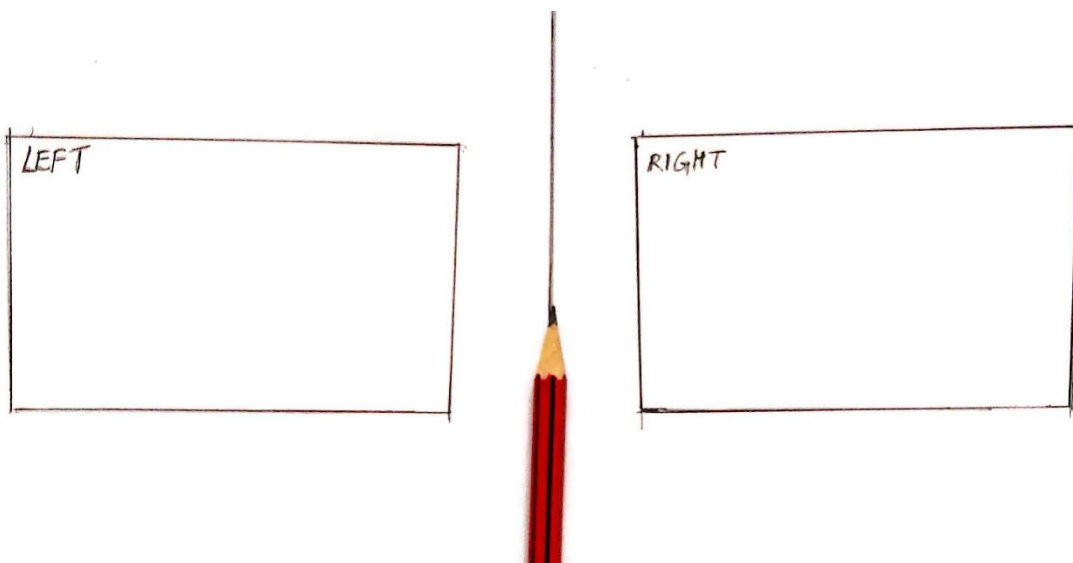
- **Teacher's Activity** Teacher will
 - enable students to recall the concepts learnt in the class while dealing with topics based on parallax
 - facilitate students to perform a simple activity to make them experience 'Parallax' and understand its meaning .

How will I proceed?

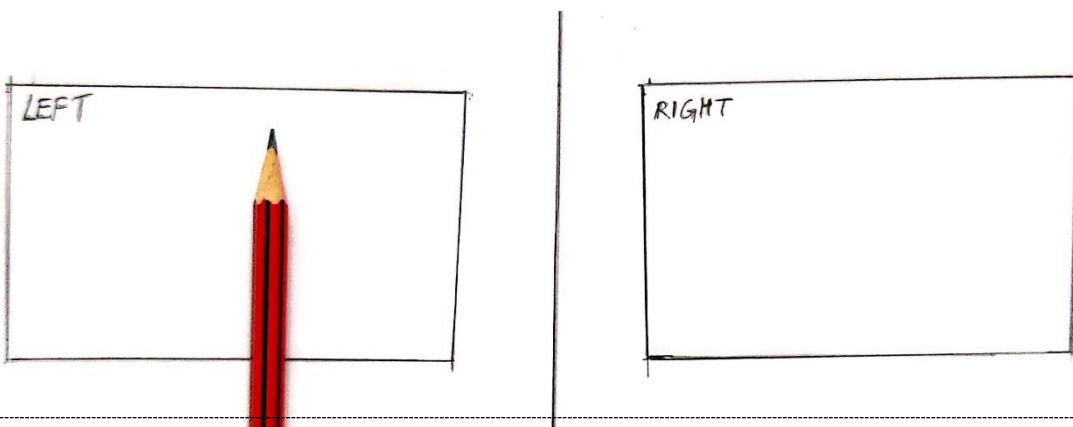
- **Student's Activity**

Student will

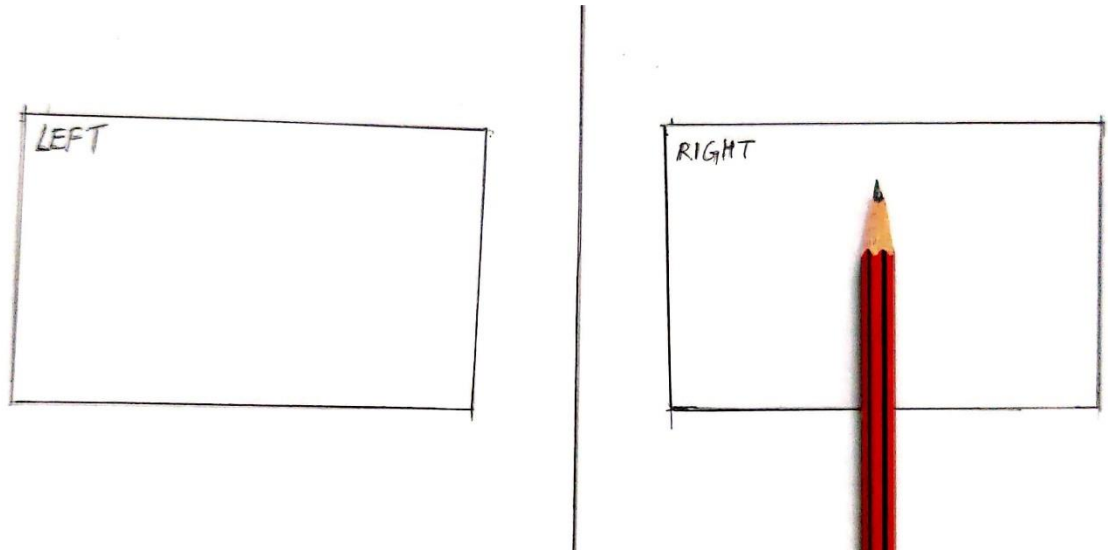
- draw a line at the centre of the A4 sheet such that it divides the sheet in two equal halves. In each half draw identical rectangles as given in the image given below. Label them as **LEFT** and **RIGHT**. Place the sheet vertically at some distance from the eyes.



- hold a pencil in vertical position very close to the nose such that it gets aligned with the line drawn at the center of the A4 sheet held at some distance from the eyes
- view this pencil in the background of white sheet, without changing its position, from right eye , by keeping left eye closed, Note the position of pencil w.r.t sheet in the table given below



- view this pencil in the background of white sheet, without changing its position, from left eye, by keeping right eye closed, Note the position of pencil w.r.t sheet in the table given below



What have I observed?

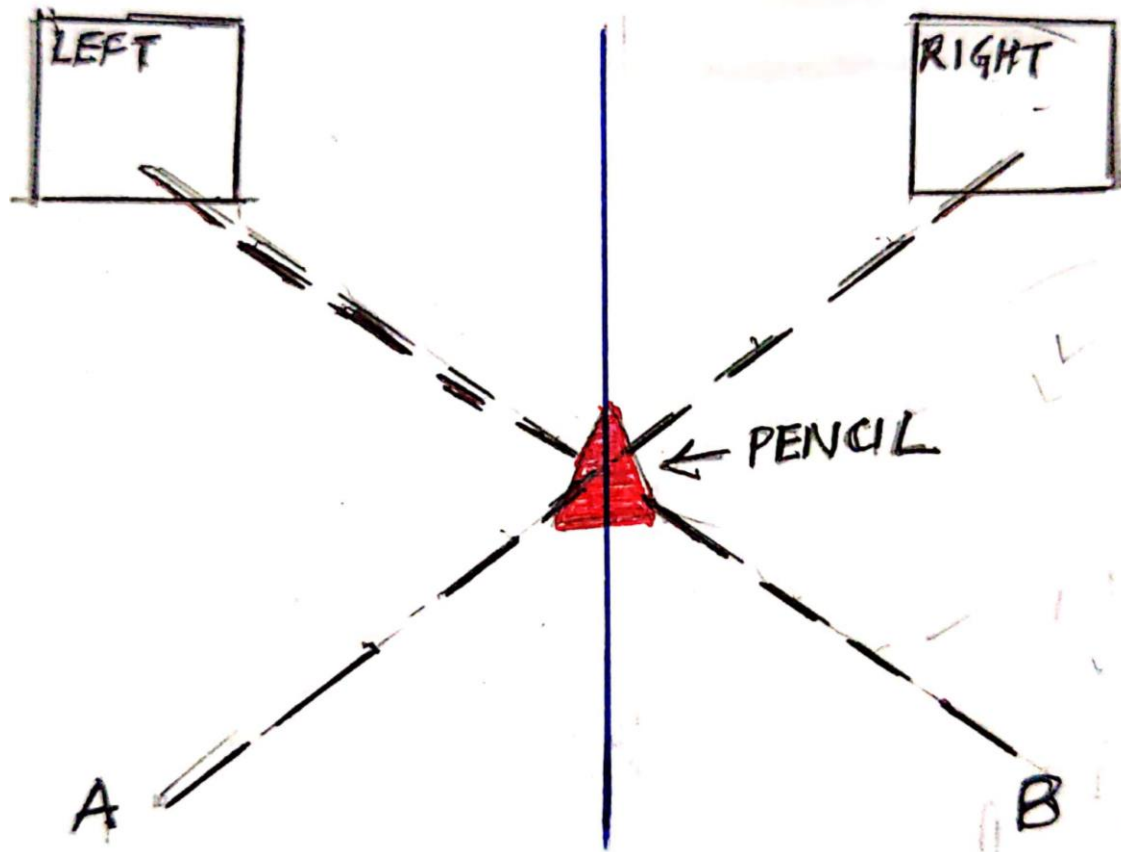
S. No.	Eye which is kept open for viewing the pencil in the background of sheet, by keeping the other eye closed	Position of pencil noted w.r.t the rectangles on the A4 sheet
1	Left eye kept open	------(left/right)rectangle
2	Right eye kept open	------(left/right)rectangle

When the pencil is observed through left eye by keeping the right eye closed in the background of A4 sheet, the pencil appears to be in the -----(left/right) rectangle. When the pencil is observed through right eye by keeping the left eye closed in the background of A4 sheet, the pencil appears to be in the -----(left/right) rectangle. The -----(shift in position of pencil/ pencil remaining in same position) when viewed in turn from left and right eye is due to-----

What have I learnt? .

The apparent shift in position of pencil when viewed against a fixed background, in turn from left eye followed by right eye is due to-----, which is defined as-----.

This can be diagrammatically shown as



A- Left eye B-Right eye

What am I curious to learn?

Why does Parallax occur? How does it get affected if object to be viewed from different positions against a fixed background is at a far off distance from the observer.

Let me evaluate myself

Q1) The apparent shift in the position of an object when viewed from different locations is called

- a) Parallelogram
- b) Blue shift
- c) Red Shift
- d) Parallax

Q2) Why can't scientists use parallax method to find distances of stars lying at a distance of more than 100LY from the earth?

- a) because parallax decreases at large distances
- b) because parallax increases at large distances
- c) because they can't get starlight from very far away
- d) that's not true, parallax is a great tool for finding far distances as well

Q3)With greater distance, the parallax angle

- a) increases
- b) decreases
- c) stays the same
- d) becomes zero

Q4) Which of these statements best explains parallax?

- a) a shift in position of a nearby object against a far-away object
- b) a shift in position of a far-away object seen from Earth
- c) the same position in the Earth's orbit around the Sun
- d) viewing an object from two different places on the Earth

Q5 Your two eyes can be part of an example of parallax. How does that relate to the Earth in stellar parallax?

- a) We can see a star from two different places on the Earth.
- b) We can look at two different stars from the Earth.
- c) Earth can be in two different places in its orbit around the Sun
- d) It does not relate.

(Annexure 9D) ACTIVITY – What,Why and How of Parallax-PARALLAX PARADOX

Subject	PHYSICS
Class	XII
Chapter/Unit	Ray Optics
Topic	Parallax-What is the need to remove Parallax/ what, why and How of Parallax.....
Time	15 min
Nature of Activity	Pair

What will I learn (Learning Outcome)?

What is Parallax? and why do we need to remove it?

Skills:

Observing , analyzing ,interpreting

What I have to do?

To locate the position of image formed by a plane mirror by using parallax method and hence conclude that why removing parallax is essential

What do I require?

Rectangular plane mirror and it's holder, Two long nails(such that their height is more than the width of the mirror), pencil, plane white A4 size sheet

What do I need to know?

What is Parallax?

- **Teacher's Activity**

Teacher will

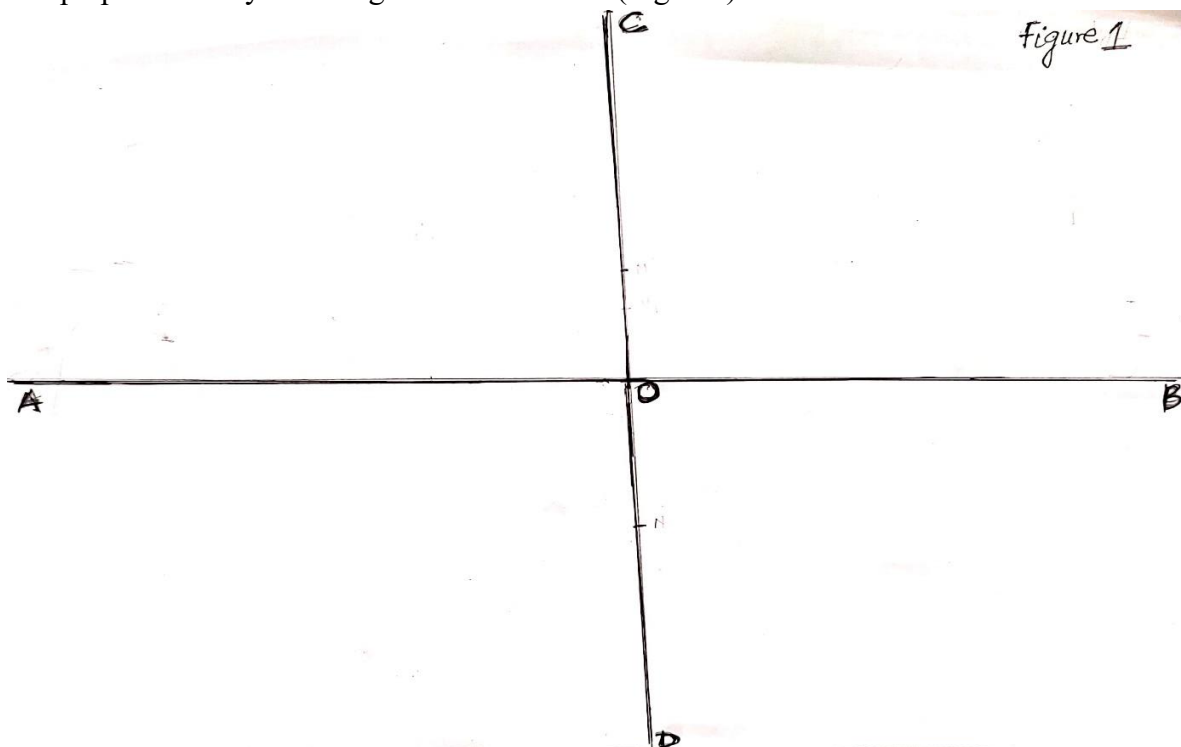
- make students recall the features of image formed by a plane mirror i.e. the image distance is always equal to the object distance and meaning of the term Parallax by reviewing the activities done earlier in this regard
- facilitate students to perform a simple activity to make them understand the need for removal of parallax in various experiments of optics by asking them to locate the image formed by a plane mirror by using hit and trial method

How will I proceed?

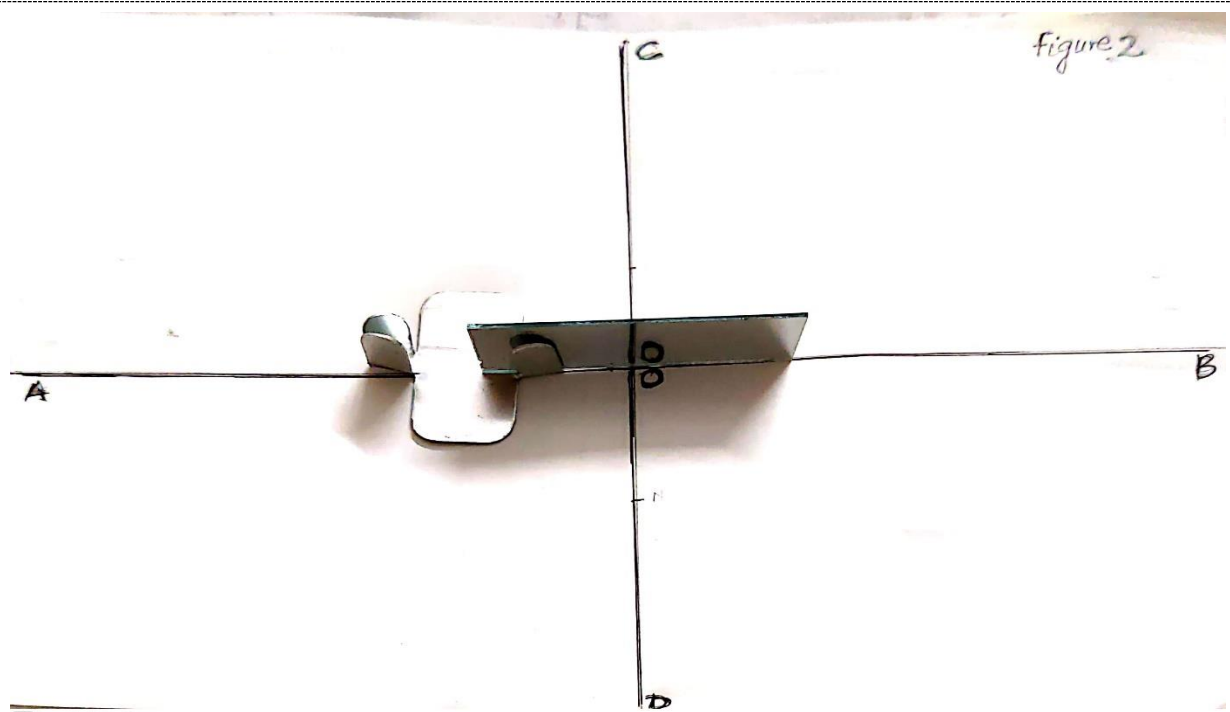
- **Student's Activity**

Student will

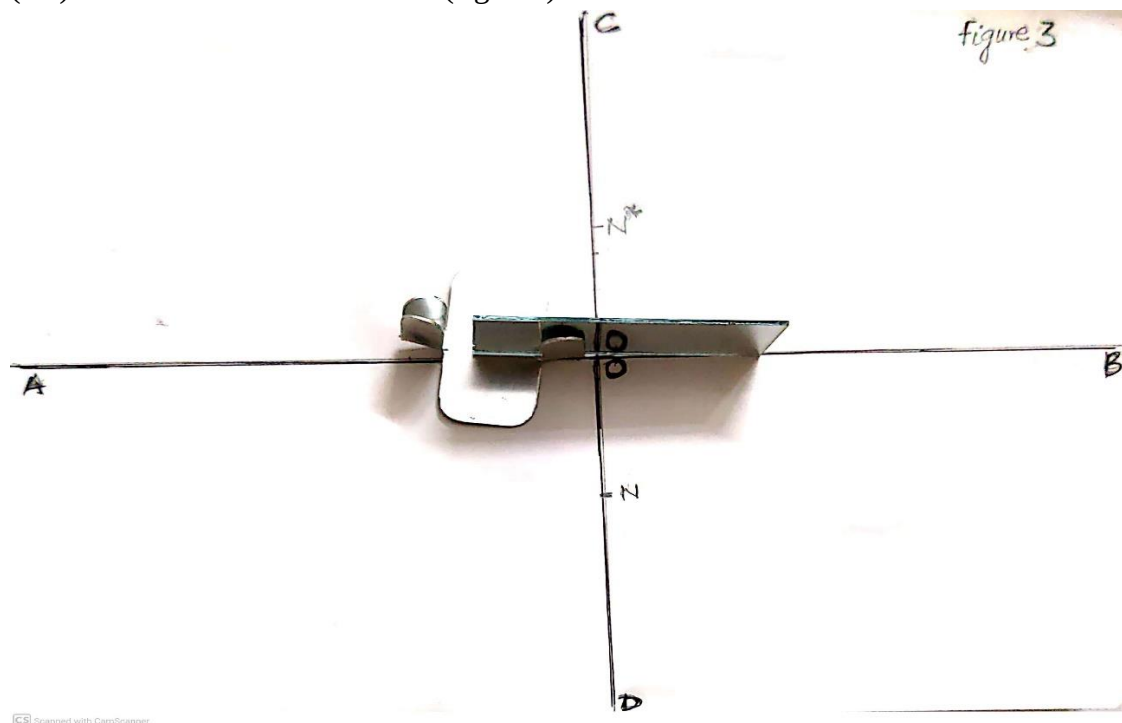
- Take a white A4 sheet and fix it on the wooden board with the help of thumb pins
- Draw a line (AB) parallel to the length of the sheet at its centre, such that the sheet gets divided into two equal parts and draw another line (CD) parallel to the breadth of the sheet at its centre, such that the sheet gets divided into four equal parts with AB and CD perpendicularly bisecting each other at 'O' (Figure 1)



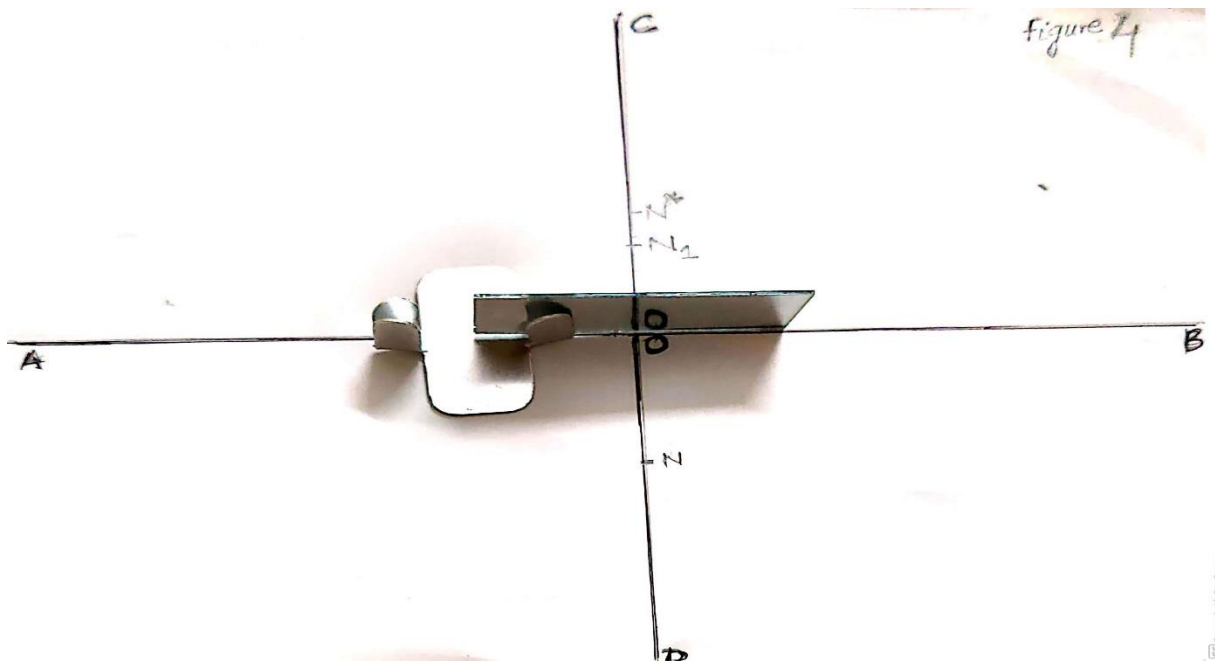
Place a plane mirror in its holder on AB in vertical position perpendicular to the plane of paper, such that the centre of the mirror coincides with 'O' (Figure 2)



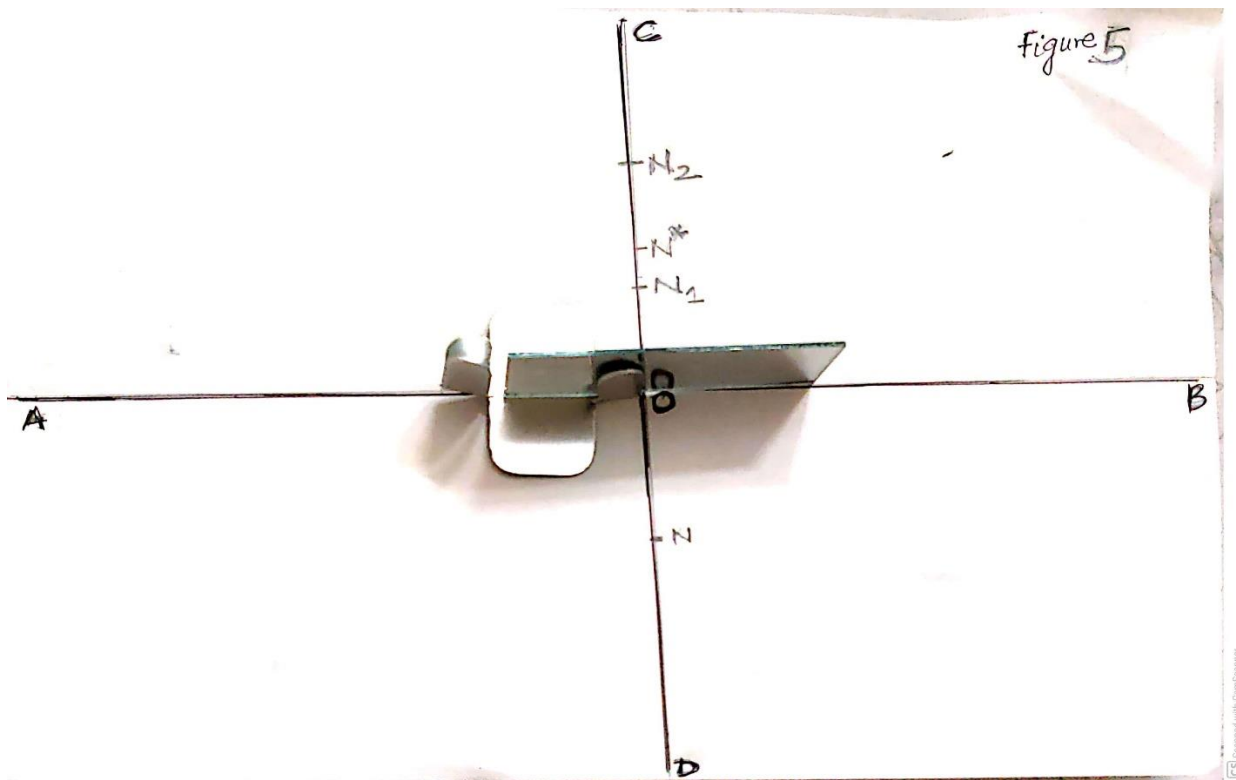
- On CD in front of mirror at point N (at a distance of 5cm from the mirror) place a nail on its head on the sheet. It will serve the purpose of object. As for a plane mirror image distance is equal to the object distance hence 5cm inside the mirror the erect image (N^*) will be seen as shown below (figure 3)



- Place another nail (on its head) behind the mirror on CD. It will be called as rear nail
- Place the rear nail at N_1 (at a distance closer than 5cm) from the mirror (Figure 4)



- Now by looking into the mirror while looking at the image of the nail (placed at N) and the upper portion of rear nail extending above the mirror, turn your neck to right and then to the left . Note if the rear nail and the image of N are aligned. and seem to move together.
- Place the rear nail at CD at N_2 (at distance more than 5cm) from the mirror behind the mirror(Figure5)



- Now by looking into the mirror while looking at the image of nail (placed at N) and the upper portion of rear nail extending above the mirror , turn your neck to right and then to the left . Note if the rear nail and the image are aligned and seem to move together..

- Now place the rear nail at N^* (at a distance equal to image distance) from the mirror i.e 5cm behind the mirror
- Now by looking into the mirror while looking at the image of nail (placed at N) and the rear nail turn your neck to right and then to the left . Note if the rear nail and the image are aligned and seem to move together..

What have I observed?

(The nail placed at N serves the purpose of object)

Object distance=5cm

Image distance=5cm

S. No.	Distance of the rear nail from the mirror(cm)	Do the image of nail (placed at N) and the upper portion of rear nail extending above the mirror remain aligned on moving the neck to right and then to left(yes/NO)
1	less than image distance (N_1)	
2	More than image distance(N_2)	
3	Equal image distance(N)	

When the neck is moved in turn from left to right and then from right to left while looking into the mirror in the cases when the distance of rear nail from the mirror is----- (not equal/equal to) image distance in that case the image and the upper portion of rear nail extending above the mirror remain aligned and when the distance of rear nail from the mirror is----- (not equal/equal to) image distance in that case the image and the upper portion of rear nail extending above the mirror were not aligned .

What have I learnt? The parallax is said to be removed when distance of rear nail from the mirror is----- (not equal/equal to) image distance and on moving the neck in turn from left to right and then from right to left while looking into the mirror the image and the rear nail----- (were/were not) aligned. When the parallax is removed, we can find out exactly the position of----- (image/object) from the mirror. Hence to be acquainted with the skill of removal of parallax is very important in order to do experiments of optics.

What am I curious to learn?

In an experiment for finding the focal length of convex lens by two pin method using optical bench how the distance of image needle gets changed when lenses of varying thicknesses are used and the object distance is kept constant.

Q1)What is meant by the term ‘Parallax error’ which we come across while performing various experiments of optics in the lab?

Q2) How can parallax error be avoided in measuring length while using a geometry box scale?

Q3) Why do we remove parallax

Q4) How can parallax error be avoided while noting the reading of the meniscus of liquid present in the measuring cylinder. Explain your answer with the help of an appropriate diagram

Q5) Why is a mirror present below the scale in some components i.e. voltmeter, ammeter etc

Q6) while removing the parallax in optics experiments using the optical bench how should the image pin be moved, if by moving the head sideways while removing the parallax between image pin and the image of the object pin the image of the object pin in the mirror/lens appears to be moving faster than the image pin?

(Annexure 9E) ACTIVITY - ACTIVITY - : (Be like Romans in Rome)

Subject	PHYSICS
Class	XII
Chapter/Unit	Ray Optics
Topic	Behavior of a lens depending on the medium surrounding it: <u>(Be like Romans in Rome)</u>
Time	10 min
Nature of Activity	Individual/Pair

What will I learn (Learning Outcome)?

A lens behaves according to the medium in which it is present

Skills:

observing, analyzing, reasoning, applying,

What I have to do?

To study the behavior of a lens as per the surrounding medium

What do I require?

An old filament bulb with filament removed, A big transparent glass jar which can hold the bulb inside it, water, A small cutout of any picture, adhesive

What do I need to know?

Lens maker's formula, Convex lens is also known as converging lens, concave lens is also known as diverging lens, concept of refractive index

- **Teacher's Activity** Teacher will teach the derivation of lens maker's formula and will also help students in solving numericals based on it. Specially the ones

in which the following cases get covered- $n_2 > n_1$ and $n_2 < n_1$ and also enable students to interpret the result. where n_2 is the refractive index of the material of the lens and n_1 is refractive index of the surrounding medium.

- Teacher will facilitate students to perform a simple activity to make them understand the dependence of behavior of a lens on it's surrounding medium

How will I proceed?

- Student's Activity**
- stick a picture on the exterior curved surface of the transparent glass jar such that the side of the paper with picture is facing the interior of the jar . observe the picture from the diametrically opposite end. Note the size of the picture
- Pour water in the beaker and observe the picture from the diametrically opposite end. Note the size of the picture
- Insert the empty bulb inside the jar containing water, such that water doesn't get inside it and observe the picture again from the diametrically opposite end with line of vision passing through the bulb. Note the size of the picture
- Fill water inside the bulb .place your finger on the bulb and observe it from the diametrically opposite end. Note the size of your finger
- Insert the bulb again inside the jar containing water but this time with water filled inside it and observe the picture again from the diametrically opposite end. Note the size of the picture

What have I observed?

S. No.	Condition	Observation	Name of the object behaving like lens	Medium of the lens(n_2)	Medium surrounding the lens(n_1)	Nature of lens formed as per the condition with reason
1	Jar is empty	Picture appears to be of original size	Jar	Air	Air	Neither concave nor convex as $n_1 = n_2$
2	Jar is filled with water	Picture appears to be enlarged	Jar	Water	Air	Convex lens as $n_2 > n_1$
3	Bulb is empty	Finger appears to be of original size	Bulb	Air	Air	Neither concave nor convex as $n_1 = n_2$
4.	Bulb is filled with water	Finger appears to be enlarged	Bulb	Water	Air	Convex lens as $n_2 > n_1$
5	Empty bulb is immersed	Picture appears to be	Bulb	Air	Water	Concave lens as

	in jar with water	diminished				$n_2 < n_1$
6	Bulb filled with water is immersed in jar with water	Picture appears to be of original size	Bulb	Water	Water	Neither concave nor convex as $n_1 = n_2$
7	Empty bulb placed in empty Jar	Picture appears to be of original size	Bulb	Air	Air	Neither concave nor convex as $n_1 = n_2$

What have I learnt? A convex lens (or concave lens) made up of material with refractive index n_2 behaves as a converging lens (or diverging lens) when placed in a medium of refractive index n_1 if $n_2 > n_1$ and vices versa.

What am I curious to learn?

To be able to find out experimentally the change in the focal length of a convex lens of focal length 10 cm when immersed in water

Let me evaluate myself

Q1 (a) Write the expression for lens maker's formula

(b) why is it named so?

(c) What is thin lens formula

Q2 What is the focal length of a double convex lens ($\mu = 3/2$) if radius of curvature of its surfaces is 15cm?

(a) 30cm

(b) 7.5cm

(c) 15cm

(d) 45cm

Q3. A glass lens is immersed in water. What will be the effect on the power of lens?

(a) increase

(b) decrease

(c) constant

(d) no change

Q4 A biconvex lens made of a transparent material of refractive index 1.5 is immersed in water of refractive index 1.33. Will it undergo any change ? Give reason, support your answer with necessary calculations

Q5 A hollow double concave lens is made of very thin transparent material. It can be filled with air or either of two liquids L1 and L2 having refractive indices μ_1 and μ_2 respectively ($\mu_2 > \mu_1 > 1$). In which of the following case/cases the lens will converge a parallel beam of light on being filled with

(a) air and placed in air

(b) air and immersed in L1

(c) L1 and immersed in L2

(d) L2 and immersed in L1

Q6 What happens to the shine of diamond if it is dipped in oil?

Q7 An empty test tube immersed in a beaker appears silvery, when viewed from a suitable direction Why?

Q8 why does a piece of clear ice disappear when placed in a glass of water?

Q9 How can the purity of emerald stone embedded in a ring be tested without taking it out of the ring

(Annexure 9F) ACTIVITY - : The Symphony of colors

Subject	PHYSICS
Class	XII
Chapter/Unit - Concept	Ray optics
Topic	Rayleigh's Criteria of selective scattering of light- The Symphony of colors
Time	15 min
Nature of Activity	Individual/pair

What will I learn (Learning Outcome)?

The concept of Rayleigh's Criteria of selective scattering of light

Skills:

observing, reasoning, analyzing, interpreting

What I have to do?

To understand the concept of Rayleigh's Criteria of selective scattering of light

What do I require?

A large conical flask, Source of white light(Torch), Water, soap solution, White chart paper to serve the purpose for screen

What do I need to know?

Light, Scattering

➤ **Teacher's Activity**

Teacher will

- explain Rayleigh's Criteria of selective scattering of light and the necessary conditions for it to happen. **24/33**

- facilitate students to perform a simple activity to make them understand the Rayleigh's Criteria of selective scattering of light

How will I proceed?

➤ Student's Activity

- White chart is fixed at some suitable place as it will serve the purpose of screen
- Conical flask filled with water to which few drops of soap solution are added is placed at a distance of few centimeters from the white chart
- From the side opposite to the side on which chart is put up, focus white light on the conical jar and observe the screen while moving the torch from top to bottom of the jar along its wall

What have I observed?

S. No.	Position of torch w.r.t conical flask	Colour of light falling on the screen
1	Neck of the conical flask	blue
2	While going down from neck to the middle of the conical flask	
3	Middle of the conical flask	
4	While moving down from the middle of the conical flask to the bottom of the conical flask	
5	bottom of the conical flask	Red

As the torch is moved along the wall of conical flask from its neck to its bottom the color of the light falling on the screen changes from----- (blue/red) to ----- (blue/red). The water molecules with few drops of soap solution added to it are able to scatter light selectively as per Rayleigh's criteria because the ----- (size/wavelength) of molecules is comparable to the ----- (size/wavelength) of light, which is also a prerequisite to be fulfilled for selective scattering to take place according to which scattering of light of a particular wavelength is ----- (directly/inversely) proportional to ----- (second/fourth) power of its wavelength. Blue colored light has ----- (lowest/highest) wavelength so it scatters the ----- (most/least) and on the contrary red being of ----- (lowest/highest) wavelength scatters the ----- (most/least) hence as we move the torch from top to bottom of the flask as the width of flask increases so most of the lower wavelength light gets scattered away hence the color of light falling on the screen changes from ----- (blue/red) to ----- (blue/red).

What have I learnt?

To demonstrate practically Rayleigh's criteria of selective scattering which states that-----

What am I curious to learn?

Why some clouds are of white color while some are of black color?

Let me evaluate myself

Q1 Why twilight is formed before sunrise and sunset?

Q2 Why the Space beyond earth's atmosphere appears dark

Q3 How do the following contribute to scattering of light

(a) Dust particles suspended in the atmosphere as their size is greater than the wavelength range of visible light

(b) The air molecules (Nitrogen and oxygen) in the atmosphere as their size is smaller than the wavelength range of visible light

Q4 Why can't we see through fog

Q5 Why is yellow sodium light used for illumination in foggy conditions

Q6 Eye is more sensitive to yellow color. Why do then we use traffic light stop signals of red colour?

(Annexure 9G ACTIVITY -: The Sunset

Subject	PHYSICS
Class	XII
Chapter/Unit -Concept	Ray optics
Topic	Rayleigh's Criteria of selective scattering of light-(The Sunset)
Time	10 min
Nature of Activity	Individual/pair

What will I learn (Learning Outcome)?

The concept of Rayleigh's Criteria of selective scattering of light

Skills:

Reasoning, logical ability, analyzing, observing

What I have to do? To experience the concept of Rayleigh's Criteria of selective scattering of light and understand the reason for the color of which rising/setting sun appears.

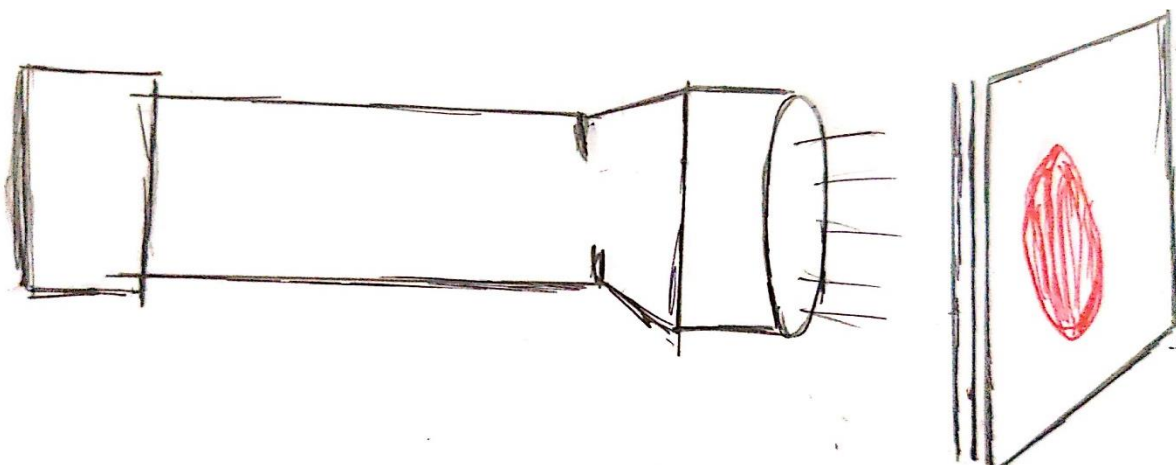
What do I require? A notebook preferably with blank plane sheets, Source of white light(Torch)

What do I need to know? Scattering of light

➤ **Teacher's Activity** Teacher will

- explain the phenomenon of Rayleigh's Criteria of selective scattering of light and the necessary conditions for it to happen.

- facilitate students to perform a simple activity to make them understand the Rayleigh's Criteria of selective scattering of light and hence various changes observed in its appearance during the course of day



How will I proceed?

➤ Student's Activity student will

- Open the notebook and hold last page in vertical position,
- Place lighted torch against the page from behind and observe the light coming through the page from the other side
 - Now in addition to the last page open the second last page as well both held vertical back to back
 - Place lighted torch against the last page from behind and observe the light coming through the second last page from the other side
 - Now in addition to last two pages open the third last page as well all the three held vertical back to back
 - Place lighted torch against the last page from behind and observe the light coming through the third last page from the other side
 - Repeat the last two steps by going on adding pages one by one and observe the light coming through the pages held vertical back to back from the opposite side and fill the observation table

• What have I observed?

S. No.	Number of pages of notebook held vertical back to back	Color of Light emerging out of the layers of pages
1	1	white
2	2	
3		

4		
5		
		yellow
		orange
		Red

As the layers of pages go on increasing the color of light emerging from the pages changes from -----(white/red) to -----(red/white) The layers of pages are able to scatter light selectively as per Rayleigh's criteria because the -----(thickness/wavelength) of layers of pages is comparable to the -----(thickness/wavelength) of light, which is also a prerequisite to be fulfilled for selective scattering to take place, according to which scattering of light of a particular wavelength is ----- (directly/inversely)proportional to -----(second/fourth) power of its wavelength . Blue colored light has -----(lowest /highest) wavelength so it scatters the----- (most/least) and on the contrary red being of -----(lowest /highest) wavelength scatters the -----(most/least) hence as we go on adding the number of pages one after the other the color of light emerging out of the layers gradually changes from----- (white/red) to -----(white/red).

The above experience can be compared with the phenomenon of rising or setting sun. The layers of papers act like----- (atmosphere/vacuum). The rising or setting sun is----- (farthest/closest) from the earth and -----(red/blue) part of the radiations having ----- least/highest wavelength while coming from the sun scatter the -----most/least by the particles of----- (atmosphere/vacuum) as per Rayleigh's criteria of selective scattering Finally the light reaching into the eye of an observer on the earth consists of----- (red/blue) light, as it scatters the----- (least/most). Hence the rising/setting sun appears----- (red/blue) and the sky appears -----(blue/red) as the -----(blue/red) color is scattered all over.

What have I learnt?

Rising/setting sun appears to be of-----color and the sky of -----color because of the Rayleigh's criteria of selective scattering which states that-----

What am I curious to learn?

Why twilight is formed before sunrise and sunset?

Let me evaluate myself

Q1 Sun appears red at sun rise and sunset. This is due to scattering of

- (a) longer wavelengths
- (b) Shorter wavelengths
- (c) lower frequencies

(d) all frequencies

Q2 The air is full of _____, which are among the greatest causes of selective scattering.

(a) Oxygen

(b) argon

(c) Sulphur

(d) dust

Q3 These are examples of phenomenon of scattering of light except

(a) Sky appears blue at midday

(b) Sun appears reddish in the evening

(c) Rainbow after rain

(d) Clouds appear white

Q4 what happens when a beam of sunlight enters in a dusty room?

Q5 why does the sky appears black to an astronaut instead of blue?

(Annexure 9H) ACTIVITY - Rayleigh's Criteria of selective scattering of light

Subject	PHYSICS
Class	XII
Chapter/Unit -Concept	Ray optics
Topic	Rayleigh's Criteria of selective scattering of light
Time	10 min
Nature of Activity	Individual/pair

What will I learn (Learning Outcome)?

The concept of Rayleigh's Criteria of selective scattering of light

Skills:

Reasoning, logical ability, analyzing, observing

What I have to do?

To understand the concept of Rayleigh's Criteria of selective scattering of light and hence the reason for different colours of light getting scattered differently

What do I require?

A transparent plastic rectangular box having length much longer than its breadth, (incense stick in a holder, match box / water, soap solution), torch

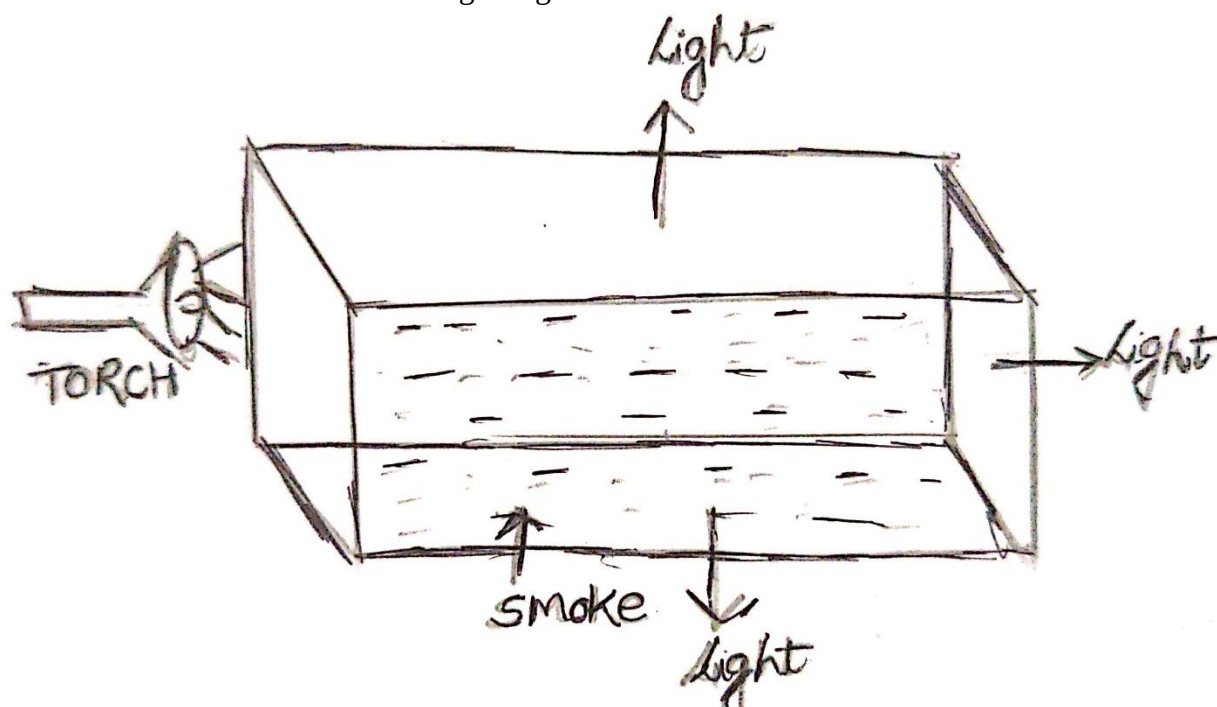
What do I need to know?

The phenomenon of scattering of light

- **Teacher's Activity** Teacher will

explain the phenomenon of Rayleigh's Criteria of selective scattering of light and the necessary conditions for it to happen

- facilitate students to perform a simple activity to make them understand the Rayleigh's Criteria of selective scattering of light



How will I proceed?

- **Student's Activity** student will
 - Under the supervision of teacher place a lighted incense stick fixed on its holder inside the plastic box for few minutes such that it doesn't touch any wall of the box with its lid closed so that smoke gets collected inside the box (or alternately pour water in it with few drops of soap solution added to it)
 - focus lighted torch on the box, such that a beam of light enters inside the box parallel to its length.
 - Observe the color of light emerging out of the box from the opposite wall of the box facing the torch and also from the adjacent walls.

- **What have I observed?**

Color of light emerging from	
The opposite face facing the torch	Adjacent faces
------(Red/blue)	------(Red/blue)

The light coming from the opposite face facing the torch is of------(red/blue) color and

from the adjacent face is of----- (red/blue) color as for the light to reach to the opposite face length wise it has to travel ----- (longer/shorter) distance and hence most of the----- (blue/red) color gets scattered away by the molecules of smoke/ soap solution selectively as per Rayleigh's criteria of selective scattering because their size is comparable to the wavelength of light, which is also a prerequisite to be fulfilled for selective scattering to take place. According to Rayleigh's criteria of selective scattering, the scattering of light of a particular wavelength is ----- (directly/inversely) proportional to ----- (second/fourth) power of its wavelength. Blue colored light has ----- (lowest /highest) wavelength so it scatters the----- (most/least) and on the contrary red being of ----- (lowest /highest) wavelength scatters the ----- (most/least) hence while travelling along the length most of the----- (blue/red) color gets scattered away and finally the light emerging out of the opposite face facing the torch is the one which remains unscattered i.e.-- (blue/red) color and from the adjacent walls is of----- (blue/red) color as it gets scattered the most and emerges from the adjacent walls

The above experience can be compared with the phenomenon of rising or setting sun. The medium in the box acts like----- (atmosphere/vacuum). The rising or setting sun is----- (farthest/closest) to the earth and hence ----- (red/blue) part of the radiations having ----- least/highest wavelength coming from the sun scatters the ----- most/least by the particles of----- (atmosphere/vacuum) as per Rayleigh's criteria of selective scattering. Finally the light reaching into the eyes of an observer on the earth consists of----- (red/blue) light, as it scatters the----- (least/most). Hence the rising/setting sun appears----- (red/blue) and the sky appears ----- (blue/red) as the ----- (blue/red) colour is scattered all over.

What have I learnt?

Rising/setting sun appears to be of----- color and the sky of ----- color because of the Rayleigh's criteria of selective scattering which states that-----

What am I curious to learn?

How do the following contribute to scattering of light

- (i) Dust particles suspended in the atmosphere as their size is greater than the wavelength range of visible light
- (ii) The air molecules (Nitrogen and oxygen) in the atmosphere as their size is smaller than the wavelength range of visible light

Let me evaluate myself

Q1 The sky appears blue instead of red because

- (a) atmospheric particles scatter blue light more than red light
- (b) atmospheric particles scatter all the colors equally
- (c) atmospheric particles scatter red light more than blue light
- (d) the sun is much hotter than the earth

Q2A red object appears dark in the yellow light

- (a) Red color is scattered less
- (b) Red color is scattered more
- (c) As the object absorbs yellow light
- (d) As the object transmits yellow light

Q3) Give reasons for the following in case of moon

- (i) Sunrise and sunset are abrupt
- (ii) Sky appears dark
- (iii) A rainbow is never formed

Q4) Out of blue and red which is scattered more and why?

Q5) Why the sun appears white when overhead?

(Annexure 9I) RAY OPTICS- Direct questions

1. Derive relationship between Radius of Curvature and focal length of a mirror
2. What is spherical aberration in spherical mirrors? and how can it be reduced?
3. Derive Relation between Image distance, object distance and focal length of a mirror or Mirror formula using concave mirror when the image formed is real
4. State laws of refraction
5. Draw ray diagram showing refraction through a Glass Slab and Prove that angle of incidence is equal to angle of emergence
6. Derive the relation between real and apparent depth
7. Explain the following with the underlying principle
 - (i) twinkling of stars
 - (ii) Stars appear higher than their actual position
 - (iii) advanced sunrise and delayed sunset
8. Explain the phenomenon of total Internal Reflection and define critical angle. Write its conditions. Derive the relation between refractive index and critical angle
9. Explain the following with the underlying principle
 - (i) sparkling of diamond
 - (ii) Totally internally reflecting prisms
 - (iii) Mirage
 - (iv) Construction and working of optical fibre
10. (a) What is totally internally reflecting Prism?
(b) Draw ray diagrams to show how a right angled isosceles prism can be used to deviate a ray through
 - (i) deviate a ray through 90°
 - (ii) deviate a ray through 180°
 - (iii) invert an image without the deviation of rays.
11. Mention the assumptions and derive the relationship between Image distance, Object distance and focal length for refraction at a convex refracting surface
12. Mention the assumptions and derive Lens Maker's Formula
13. Obtain an expression for the effective focal length of two thin lenses placed in contact coaxially with each other
14. (i) Explain refraction through a glass prism and plot the graph between angle of minimum deviation and the angle of incidence and derive the expression for its refractive index.
(ii) Derive the relationship between deviation and refractive index for a small angled prism
(iii) What is dispersion and explain its cause
(iv) Explain Cauchy's principle
(v) Explain the term- Dispersive Power
15. State and explain Rayleigh's Criteria of selective Scattering of Light and explain with reasons for the following phenomenon-
 - (i) Sky is of blue Color,
 - (ii) Clouds are of white Color
 - (iii) Danger signals are of red colour
 - (iv) Sun appears reddish at time of sunrise and sunset
20. Resolving power of Telescope
16. (a) Draw ray diagram of Simple Microscope when the image is at infinity (normal adjustment) and derive the expression for its Magnifying power

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- b) Draw ray Diagram of Simple Microscope when the image is at least distance of distinct vision and derive the expression for its Magnifying power
17. a) Draw ray diagram of Compound Microscope when the image is at infinity (normal adjustment) and derive the expression for its Magnifying power
- b). Draw ray Diagram of Compound Microscope when the image is at least distance of distinct vision and derive the expression for its Magnifying power
- 18.a) Draw ray Diagram of Refracting Telescope or Astronomical Telescope when the image is at least distance of distinct vision and derive the expression for its Magnifying power
- b) Draw ray Diagram of Refracting Telescope or Astronomical Telescope when the image is at infinity (normal adjustment) and derive the expression for its Magnifying power
19. Draw Ray diagram of Newtonian Telescope and explain its working
20. Draw Ray diagram of Cassegrain Telescope and explain its working
21. Mention the advantages of Reflecting type telescope over refracting type telescope
22. How does the focal length of concave mirror change when the incident violet light on it is replaced with red light
23. How does the focal length of convex lens change when the incident violet light on it is replaced with red light .

(Annexure 9J) Previous Years' board questions