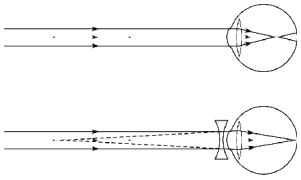
07. HUMAN EYE AND COLOURFUL WORLD

Questions and Answers

1. How do you correct the eye defect Myopia?

A. The eye lens can form clear image on the retina, when an object is placed between far point and point of least distance of distinct vision.

If we are able to bring the image of the object kept beyond far point , between the far point and the point of least distance of distinct vision using a lens, this image acts as an object for the eye lens.

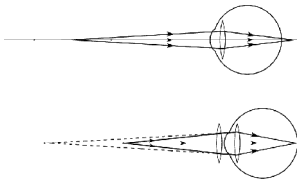


This can be made possible only when a concave lens is used.

2. Explain the correction of the eye defect Hypermetropia.

A. Eye lens can form a clear image on the retina when any object is placed beyond near point.

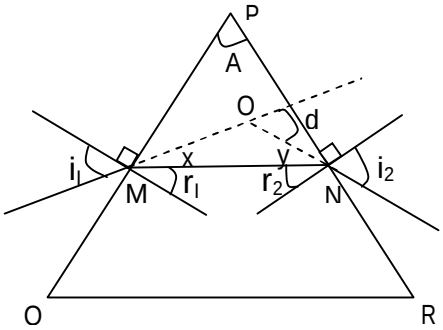
To correct the defect of hypermetropia, we need to use a lens which forms an image of an object beyond near point, when the object is between near point (H) and least distance of distinct vision (L).



This is possible only when a double convex lens is used.

3. How do you find experimentally the refractive index of material of a prism.

A.



Place a white paper on a drawing board and arrange clips at is four ends. Place a prism on the paper so that the triangular shape touches the paper. Draw the boundary line with pencil. Name the vertices as P, Q and R. Measure the angle of the prism at 'P' and note down it as 'A' .

Now fix two pin on the line which was drawn with an angle to the surface 'PQ'. Observe the images at 'PR' side and fix another two pins such that four pins lie along a straight line.

Remove the prism. Extend the incident ray and emergent ray such that they can intersect with each other. The angle between incident ray and emergent ray is called angle of deviation (d).

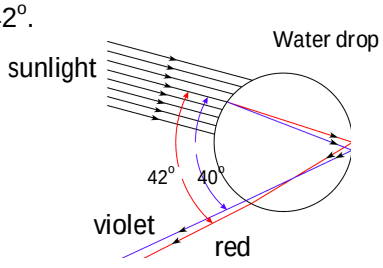
Find angle of deviations for different angles of incidence. The minimum value of 'd' is to be taken as angle of minimum deviation (D).

The refractive index of prism is calculated by using the formula $n = = \frac{Sin(\frac{A+D}{2})}{Sin(\frac{A}{2})}$

4. Explain the formation of rainbow.

A. The formation of rainbow is due to dispersion of sunlight by millions of tiny water droplets in atmosphere. The ray of sunlight enters the drop near its top surface. At this first refraction, the white light is dispersed into its spectrum of colours. The most deviated colour is violet and the least deviated colour is red.

Reaching the opposite side of the water drop, each colour is reflected back into the drop due to total internal reflection. We can see the colours of VIBGYOR in the range of 40^o and 42^o.



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5. Explain briefly the reason for the blue of the sky.

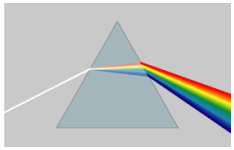
A. As light moves through the atmosphere, most of the longer wavelengths pass straight through. Little of the red, orange and yellow light is affected by the air.

The sky appears blue due to atmospheric refraction and scattering of light through different size molecules like N_2 and O_2. Because molecules act as scattering centres. The sizes of these molecules are comparable to the wave length of blue light. Due to this reason the sky appears in blue colour.

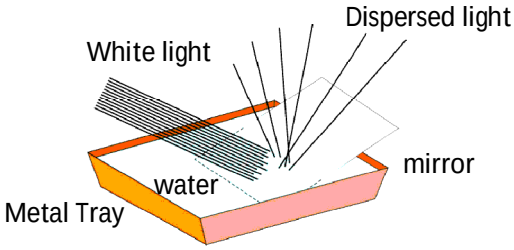
6. Explain two activities for the formation of artificial rainbow.

A. **:**Formation of artificial rainbow:

Activity-1: Take a prism before a white wall. Keep a light source such that the light rays fall on the prism through a narrow slit which was arranged. Adjust the prism such that the colours (VIBGYOR) fall on the wall.



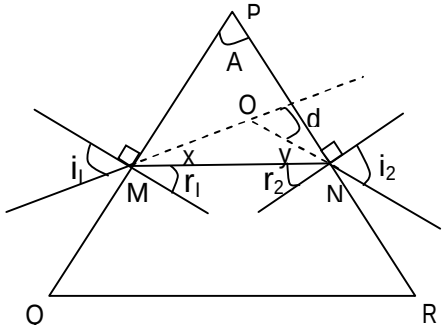
Activity-2: Take a metal tray and fill it with water. Place a mirror in water such that it makes an angle to the water surface. Keep a white card board screen/sheet above the water surface. Now focus white light on the mirror through water. Try to obtain the colours on the screen. We can see the seven colours (VIBGYOR) of rainbow on the screen.



We can place the water tray with mirror inside in sunlight to produce rainbow on the wall.

7. Derive an expression for the refractive index of the material of a prism.

A. Derivation for refractive index of the material of a prism:



From figure : $i_1 = x + r_1 \rightarrow x = i_1 - r_1$

$i_2 = y + r_2 \rightarrow y = i_2 - r_2$

From ΔOMN: $d = x + y$

$d = (i_1 - r_1) + (i_2 - r_2)$

$d = (i_1 + i_2) - (r_1 + r_2)$ ……..(1)

From ΔPMN: $A + x + y = 180^o$

$A + (90^o - r_1) + (90^o - r_2) = 180^o$

$A + 180^o - (r_1 + r_2) = 180^o$

$A = (r_1 + r_2)$ ….(2)

(1)+(2) then : $A + d = i_1 + i_2$ ……..(3)

From Snell's law : $n_1 \sin i = n_2 \sin r$

At point of incidence 'M'

$n_1 = 1$, $n_2 = n$; $i = i_1$, $r = r_1$;

therefore $\sin i_1 = n \sin r_1 \rightarrow n = \frac{\sin i_1}{\sin r_1}$ ….(4)

At point of emergence 'N'

$n_1 = n$, $n_2 = 1$; $i = r_2$, $r = i_2$;

therefore $n \sin r_2 = \sin i_2 \rightarrow n = \frac{\sin i_2}{\sin r_2}$ ….(5)

Angle of deviation (d) , becomes angle of minimum deviation (D) when $i_1 = i_2$.

From (3) : $A + D = 2 i_1 \rightarrow i_1 = \frac{A+D}{2}$ …..(6)

From (4) & (5) : $\frac{\sin i_1}{\sin r_1} = \frac{\sin i_2}{\sin r_2}$

If $i_1 = i_2$ then $\sin r_1 = \sin r_2 \rightarrow r_1 = r_2$

From (2) : $A = 2 r_1 \rightarrow r_1 = \frac{A}{2}$ ……..(7)

Refractive index of material of prism

$$n = : \frac{\sin i_1}{\sin r_1} = \frac{\sin(\frac{A+D}{2})}{\sin(\frac{A}{2})}$$

8. Light of wavelength λ_1 enters a medium with refractive index n_2 from a medium with refractive index n_1. What is the wavelength of light in second medium?

A.

	Wave lengths	Refractice index
Medium-1	λ_1	n_1
Medium-2	λ_2	n_2

$$(n_1) = \frac{c\ (velocity\ of\ light\ in\ vacuum)}{v_1\ (velocity\ of\ light\ in\ medium{-}1)}$$

$$(n_2) = \frac{c\ (velocity\ of\ light\ in\ vacuum)}{v_2\ (velocity\ of\ light\ in\ medium{-}2)}$$

We know that : $\frac{n_1}{n_2} = \frac{v_2}{v_1}$

$\Rightarrow \frac{n_1}{n_2} = \frac{\lambda_2}{\lambda_1}$ $[v = \vartheta\lambda]$

$\Rightarrow \lambda_2 = \lambda_1 . \frac{n_1}{n_2}$

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NOTE: For questions 9 and 10 the following options are given. Choose the correct option by making hypothesis based on given assertion and reason. Give an explanation.

a. Both A and R are true and R is the correct explanation of A.
b. Both A and R are true and R is not the correct explanation of A.
c. A is true but R is false.
d. Both A and R are false.
e. A is false but R is true.

9. Assertion (A): The refractive index of a prism depends only on the kind of glass of which it is made of and the colour of light.
Reason (R): The refractive index of a prism depends on the refracting angle of the prism and the angle of minimum deviation.

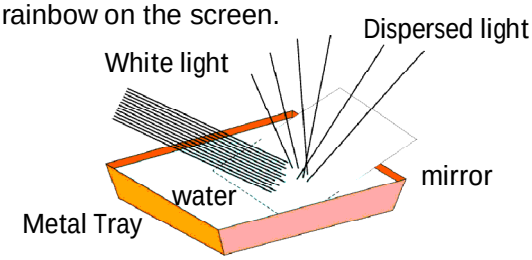
A. Ans : b
i.e. Both A and R are correct.
But R is not the correct explanation of A.
Reason: If angle of deviation decreases refractive index of the material decreases. Refractive index depends upon the material of the prism.

10. Assertion (A): Blue colour of sky appears due to scattering of light.
Reason (R): Blue colour has shortest wave length among all colours of white light.

A. Ans : c
i.e. A is true but R is false.
Reason: The sky is blue due scattering. And Violet is the colour which has shortest wave length all colours of white light.

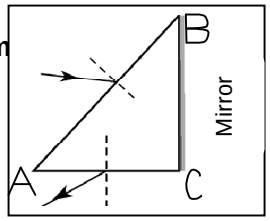
11. Suggest an experiment to produce a rainbow in your classroom and explain the procedure.

A. Take a metal tray and fill it with water. Place a mirror in water such that it makes an angle to the water surface. Keep a white card board screen/sheet above the water surface. Now focus white light on the mirror through water. Try to obtain the colours on the screen. We can see the seven colours (VIBGYOR) of rainbow on the screen.

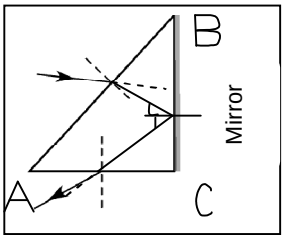


We can place the water tray with mirror inside in sunlight to produce rainbow on the wall.

13. Incident ray on one of the face (AB) of a prism and emergent ray from the face AC are given in figure.Complete the ray diagram.



A.



14. How do you appreciate the role of molecules in the atmosphere for the blue colour of the sky?

A. The sky appears blue due to atmospheric refraction and scattering of light through different size molecules like N_2 and O_2. Because molecules act as scattering centres. The sizes of these molecules are comparable to the wave length of blue light. Due to this reason we appreciate the role of molecules in atmosphere for the blue colour of sky.

15. Eye is the only organ to visualise the colourful world around us. This is possible due to accommodation of eye lens. Prepare a six line stanza expressing your wonderful feelings.

A.
Eyes are useful
Eyes are helpful
Eyes makes us beautiful
Eyes makes the world colourful
Eyes, if see plants green full
Eyes makes then, us peaceful.

16. How do you appreciate the working of Ciliary muscles in the eye?

A. Eye lens is attached to the ciliary muscle. The ciliary muscle helps to change the focal length of eye lens, by changing the radii of curvature of the eye lens.

When eye lens is focused on a distant object, the ciliary muscles are relaxed so that the focal length of eye lens has its maximum value. We can see the clear image then.

When eye lens is focused on a closer object, the ciliary muscles are strained and focal length of eye lens decreases. So we can see the image clearly.

This process of adjusting focal length is called accommodation. So we appreciate the working of ciliary muscles in the eye.

17. Why does the sky sometimes appear white?

A. On a hot day, due to rise in the temperature water vapour content is more in the atmosphere. These water molecules scatter the colours of other frequencies (other than blue). All such colours of other frequencies reach our eye and the sky appears white.

18. Glass is known to be a transparent material. But ground glass is opaque and white in colour. Why?

A. Ground glass is a glass whose surface is flat but rough. It scatters the light which falls on it. So it is not transparent (opaque) and appers in white colour.

19. If a white sheet of paper is stained with oil, the paper turns transparent. Why?

A. White paper has some refractive index. Oil has also some refractive index. The paper is made up of very tiny fibers. There are small gaps between fiber molecules. If we make the paper stained with oil, the oil occupies the gaps in the papers. If the refractive indices of both paper and oil are exactly equal, then it becomes transparent. Generally oil paper is translucent.

20. A light ray falls on one of the faces of a prism at an angle 40^o so that it suffers angle of minimum deviation of 30^o. Find the angle of prism and angle of refraction at the given surface.

A. Incident angle is (i) = 40^o

Angle of minimum deviation (D) = 30^o

Formula: $A + D = 2i$

$\rightarrow A = 2i - D$

$\rightarrow A = 2(40^o) - 30^o$

$\rightarrow A = 80^o - 30^o = 50^o$

Angle of prism (A) = 50^o

Angle of refraction (r) = $\frac{A}{2} = \frac{50}{2} = 25^o$

21. The focal length of a lens suggested to a person with Hypermetropia is 100cm. Find the distance of near point and power of the lens.

A. Focal length of lens (f) = 100 cm

Let 'd' is the distance of the near point.

Formula: $f = \frac{25d}{d-25}$

$\rightarrow 100 = \frac{25d}{d-25}$

$\rightarrow 100d - 2500 = 25d$

$\rightarrow 75d = 2500$

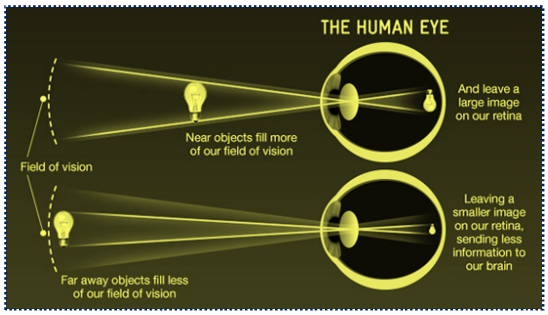
$\rightarrow d = \frac{2500}{75} = \frac{100}{3} = 33.33$ cm

Power of lens (P) = $\frac{100}{\text{focal length in cm}} = \frac{100}{100} = 1$ Diapter

22. A person is viewing an extended object. If a converging lens is placed in front of his eye, will he feel that the size of object has increased? Why?

A. Converging lens is normally a convex lens. It is used as magnifying lens. The extended object seem to be bigger as it can appear in the normal view.

A person is viewing an extended object. If a converging lens is placed in front of his eye, will he feel that the size of object has increased



*** ADDITONAL QUESTIONS ***

23. Write about presbyopia?

24. Doctor advised Ramu o use 2D lens. What is the focal length of the lens?

25. A prism with an angle A = 60^o produces an angle of minimum deviation of 30^o. Find the refractive index of material of the prism.

26. Define scattering?

27. Define Disperson?

28. Can you guess the reason for why sun does not appear red during noon hours?

29. Why the Sun appears red during sun rise and sun set?

30. What do you observe in a soap bubble? Do you observe the seven colours (VIBGYOR) of a rainbow? Explain.

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