

PHYSICS • CLASS 12

CHAPTER 10

Wave Optics

NCERT SOLUTIONS



LIGHT AT A WATER SURFACE – EXERCISE 10.1

Q. Monochromatic light of wavelength 589 nm is incident from air on water. Find wavelength, frequency and speed of (a) reflected and (b) refracted light. Refractive index of water $n = 1.33$.

Given and common frequency:

$$c = 3.00 \times 10^8 \text{ m s}^{-1}$$
$$\lambda_{\text{air}} = 589 \text{ nm} = 589 \times 10^{-9} \text{ m}$$
$$n = 1.33$$

Frequency of incident light (and hence of reflected and refracted light) is

$$f = \frac{c}{\lambda_{\text{air}}} = \frac{3.00 \times 10^8}{589 \times 10^{-9}} = 5.09 \times 10^{14} \text{ Hz}$$

(a) Reflected light (in air):

In air, reflection does not change the speed, frequency or wavelength.

$$v_r = 3.00 \times 10^8 \text{ m s}^{-1}$$

$$f_r = 5.09 \times 10^{14} \text{ Hz}$$

$$\lambda_r = 589 \text{ nm}$$

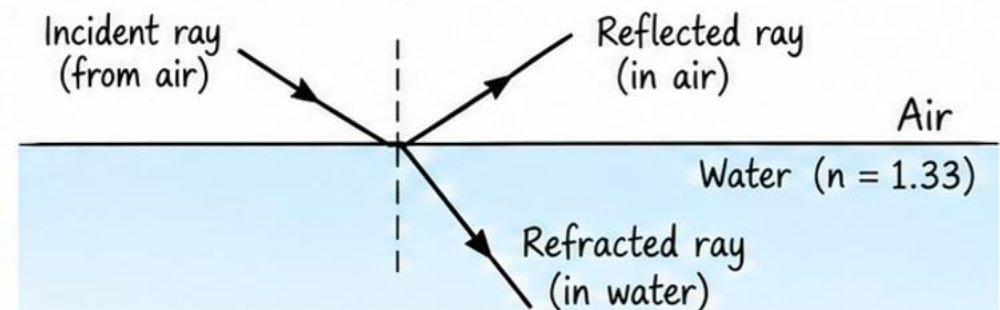
(b) Refracted light (in water):

In water, speed and wavelength fall by factor n , while frequency remains the same.

$$v_w = \frac{c}{n} = \frac{3.00 \times 10^8}{1.33} = 2.26 \times 10^8 \text{ m s}^{-1}$$

$$f_w = f_r = 5.09 \times 10^{14} \text{ Hz}$$

$$\lambda_w = \frac{\lambda_{\text{air}}}{n} = \frac{589}{1.33} = 443 \text{ nm}$$

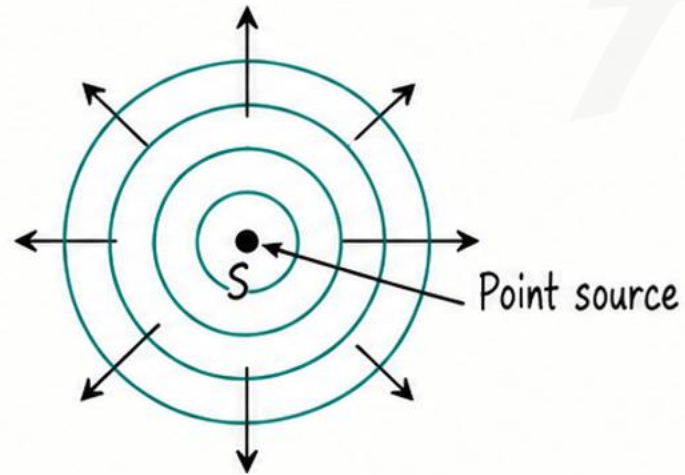


SHAPES OF WAVEFRONTS — EXERCISE 10.2

Q. Give the shape of the wavefront for (a) light diverging from a point source, (b) light emerging from a convex lens when a point source is at its focus, and (c) the portion of a distant star's wavefront intercepted by Earth.

(a) Light diverging from a point source.

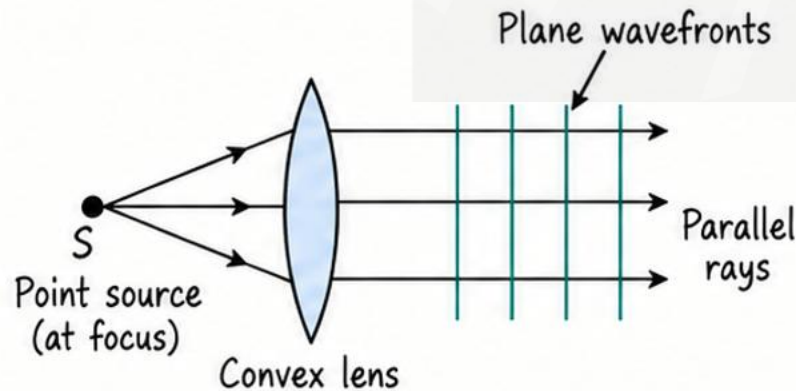
The light from a point source spreads equally in all directions. Hence, the wavefronts are expanding concentric spheres centred on the point source.



Answer: (a) Spherical wavefronts.

(b) Light emerging from a convex lens when a point source is at its focus.

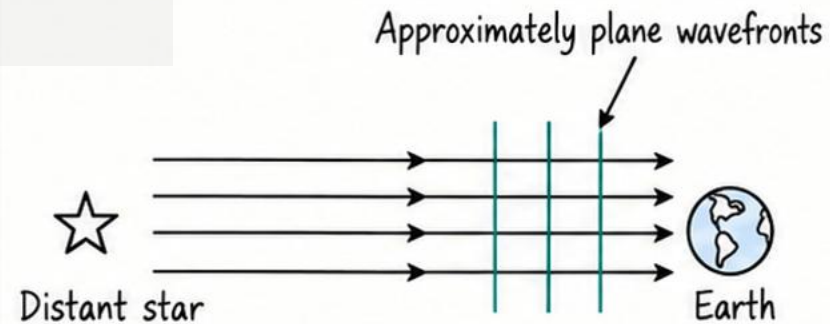
A point source placed at the focus of a convex lens emerges as a parallel beam of light. Hence, the wavefronts are plane and perpendicular to the direction of propagation.



Answer: (b) Plane wavefronts.

(c) The portion of a distant star's wavefront intercepted by Earth.

A star is so far away that the curvature of its spherical wavefront is negligible over the size of the Earth. Hence, the portion of the wavefront reaching Earth is approximately plane.



Answer: (c) Approximately plane wavefronts.

LIGHT SPEED IN GLASS – EXERCISE 10.3

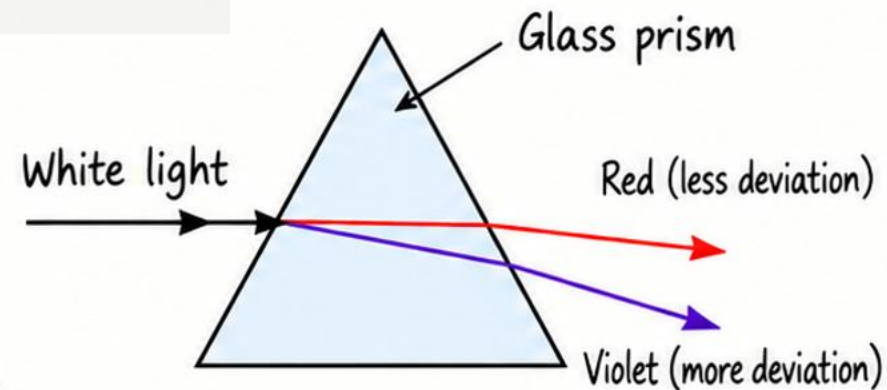
- Q. (a) Refractive index of glass is 1.5. Find the speed of light in glass if $c = 3.0 \times 10^8 \text{ m s}^{-1}$.
- (b) Is speed in glass independent of colour? Which travels slower through a glass prism: red or violet?

Answer:

$$(a) \quad n = \frac{c}{v}, \text{ so } v = \frac{c}{n} = \frac{3.0 \times 10^8 \text{ m s}^{-1}}{1.5} = 2.0 \times 10^8 \text{ m s}^{-1}.$$

- (b) No. Glass shows dispersion: its refractive index depends on wavelength. Ordinary glass bends violet more strongly than red, so $n_{\text{violet}} > n_{\text{red}}$.

Hence, $v_{\text{violet}} = \frac{c}{n_{\text{violet}}} < \frac{c}{n_{\text{red}}} = v_{\text{red}}$. VIOLET travels slower.





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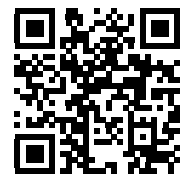


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