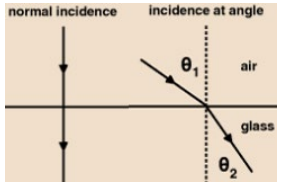
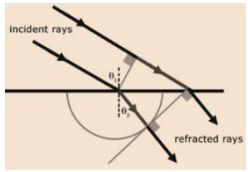
Wave Refraction: Waves

Definitions

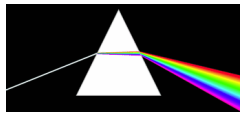


Refraction (Snell's law)
When light travelling in one substance enters another substance at an angle **other than perpendicular** (90°) to the surface, the light changes direction. This is called **refraction**. This is due to the light changing speed as it enters the second medium.
When light travels into a medium of **greater** density it refracts **towards** the normal. When light travels into a medium of **less** density it refracts **away** from the normal.



Since the wave fronts must remain parallel, a wave changes direction as it changes speed entering or leaving a medium.

Dispersion
Dispersion is splitting up white light into its different colours.
Because different wavelengths (colors) of light travel through a medium at different speeds, the amount of bending is different for different wavelengths. Violet is bent the most and red the least because violet light has a shorter wavelength, and short wavelengths travel more slowly through a medium than longer ones do.

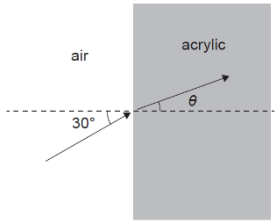


Equations

$n_1 \sin\theta_1 = n_2 \sin\theta_2$	Refractive index of medium 1	n_1	-
	Angle of ray in medium 1	Θ_1	°
	Refractive index of medium 2	n_2	m s^{-1}
	Angle of ray in medium 2	Θ_2	°
$\frac{n_1}{n_2} = \frac{v_2}{v_1} = \frac{\lambda_2}{\lambda_1}$	Refractive index of medium 1	n_1	-
	Refractive index of medium 1	n_2	-
	Velocity in medium 1	v_1	m s^{-1}
	Velocity in medium 2	v_2	m s^{-1}
	Wavelength in medium 2	λ_2	m
	Wavelength in medium 1	λ_1	m

Questions

THE LIGHTHOUSE (2021;2)



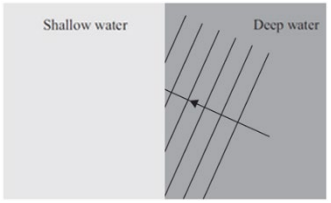
Fred shines a ray of light at an angle of incidence of 30° into an acrylic block. The refractive index of air is 1.0. The speed of light in air is 3.0 x 10^8 m s^{-1}, and the speed of light in acrylic is 2.0 x 10^8 m s^{-1}.

(a) Show that the refractive index of acrylic is 1.5.

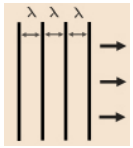
(b) Calculate Θ, the angle of the refracted ray in the acrylic.

WATCHING THE WAVES (2014;3)

(c) Moana watches waves travel from deep to shallow water. In shallow water, the waves travel more slowly, compared to in deep water. Complete the diagram showing the wave fronts and the wave direction in the shallow water.

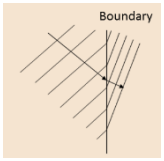


Terms



Wave fronts represent the leading edge of one complete wave.
Rays are simply the direction of travel of a wave front.
Wave fronts and rays are always at right angles to each other

Refraction of wave fronts:
In water waves, when water goes from deep to shallow, wave length (λ) decrease, velocity (v) decrease, frequency (f) of the wave ALWAYS stays the same.



Tips

- Snell's law calculation only works when your calculator is set in **degrees mode.**

Answers

(a)

$$\frac{n_2}{n_1} = \frac{v_1}{v_2}$$

$$n_2 = n_1 \frac{v_1}{v_2} = \frac{1 \times 3 \times 10^8}{2 \times 10^8} = 1.5$$

(b)

$$n_2 \sin\theta_2 = n_1 \sin\theta_1$$

$$1.5 \sin\theta_2 = 1 \sin\theta_1$$

$$\theta_2 = 19.5° = 20° \text{ (or } 19°)$$

(c)