Wave Interactions

IB Physics Content Guide

Big Ideas

- Light waves can be transformed through reflection, refraction, and diffraction
- Light travels at different speeds through different material

1 – Light and the EM Spectrum

I can convert using metric prefixes			
I can identify and use the speed of light to solve wave problems with the wave equations			
I can estimate the wavelength magnitude for the different EM waves			
I can provide real world examples for each of the electromagnetic waves			

2 – Reflection and Refraction

I can identify the angle of incidence and angle of reflection for a reflected wave ray			
I can use the law of reflection to predict the way light bounces off a plane mirror			
I can relate the index of refraction of a material to the speed of light as it travels through			
I can qualitatively describe how light bends when transitioning between boundaries			
I can predict the direction that light will bend at a medium transition			

3 – Snell's Law

I can mathematically relate the angles of refraction to the indices of refraction for the materials			
I can describe the phenomenon of total internal reflection			
I can calculate the critical angle of incidence so that the light cannot escape the medium			

4 – Superposition and Interference

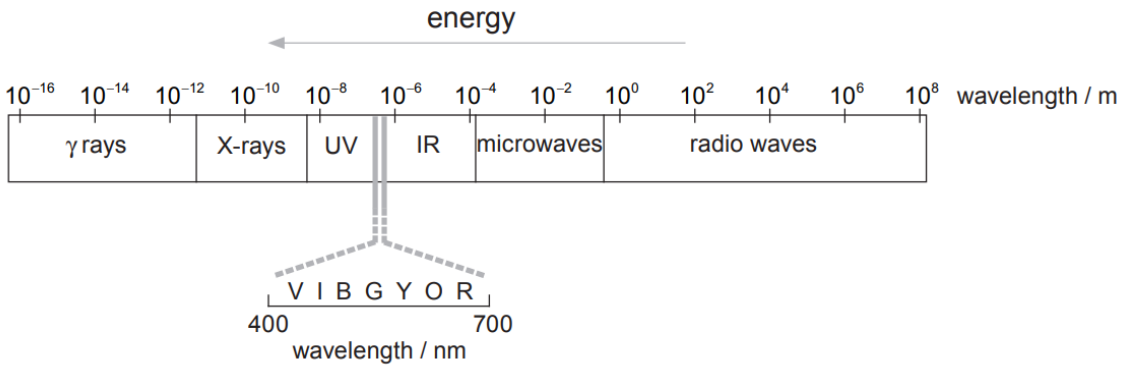
I can qualitatively and quantitatively interpret cases of constructive and destructive interference			
I can add up two waves with superposition to create a new waveform			
I can describe applications and real-world examples for wave interference			
I can use wavelength and source distance to identify maxima and minima for interference			

5 – Diffraction

I can describe how light bends around a boundary			
I can predict the resulting image from a double slit experiment			
I can calculate the spacing between bright spots for the double slit experiment			
I can conceptually relate band spacing with wavelength and gap distance			

6 – The Doppler Effect

I can conceptually describe how a moving wave source impacts the observed frequency			



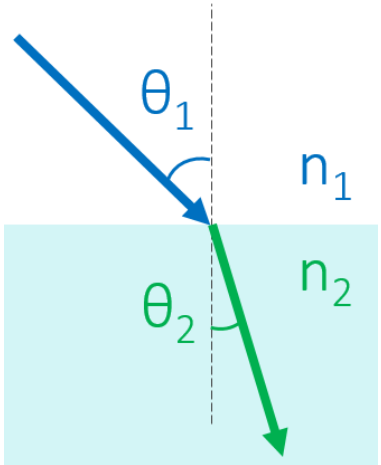
Index of Refraction

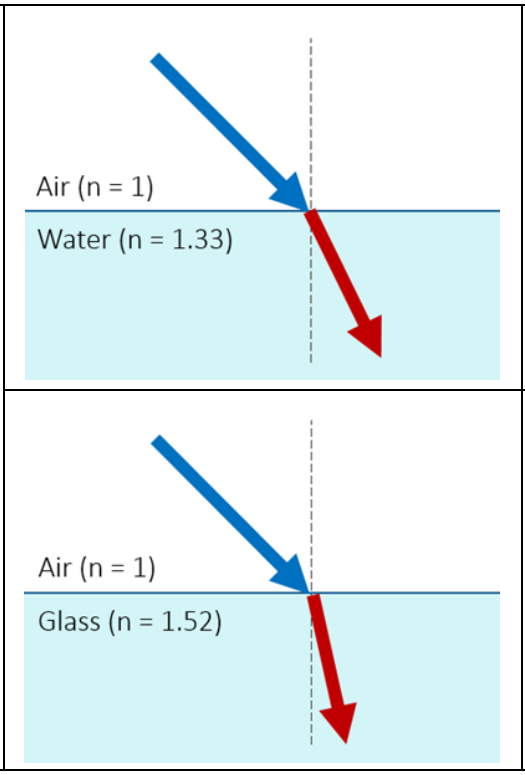
Medium	Wave Speed (v)	Index of Refraction (n)
Vacuum	3.00×10^8 m s^{-1}	1.0000
Air	2.999×10^8 m s^{-1}	1.0003
Water	2.256×10^8 m s^{-1}	1.33
Glass	1.974×10^8 m s^{-1}	1.52

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

Refraction

$$\frac{n_1}{n_2} = \frac{sin\theta_2}{sin\theta_1}$$



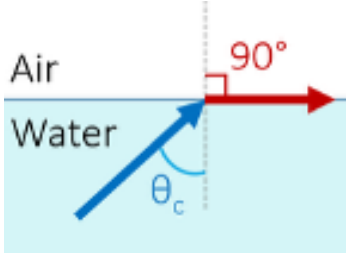


Critical Angle

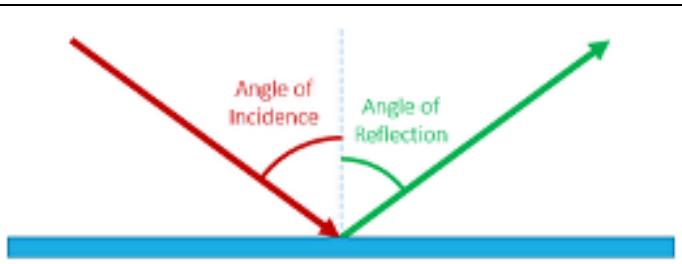
When $\theta_1 = \theta_c$

$\theta_2 = 90°$

$$\theta_c = sin^{-1}\left(\frac{n_2}{n_1}\right)$$



Reflection

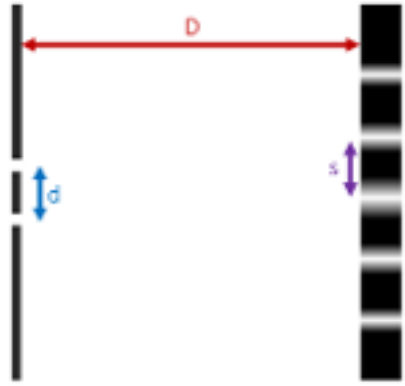
Law of Reflection	
Angle of Incidence = Angle of Reflection	

Double Slit Experiment

$$s = \frac{\lambda D}{d}$$

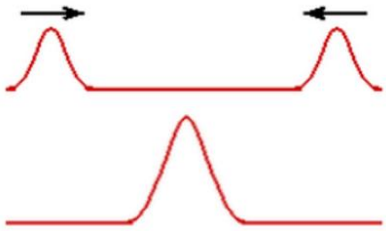
s	Distance between fringes
λ	Wavelength
D	Distance to Screen
d	Distance between slits

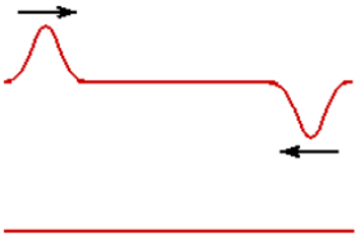
Label this diagram:

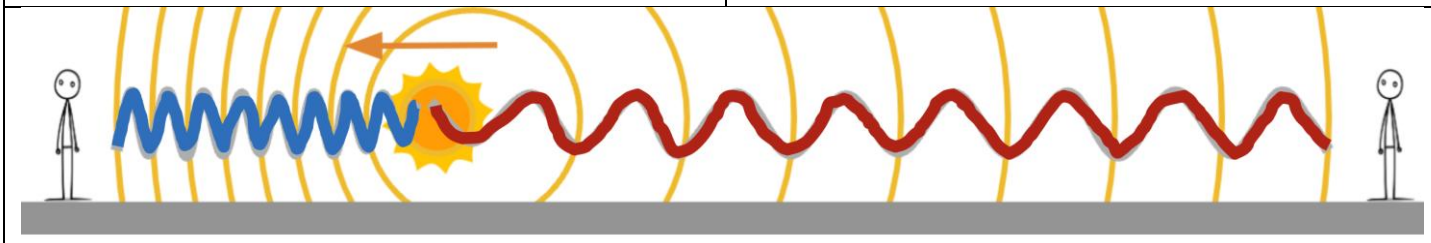


Interference

Constructive	Path Difference = $n\,\lambda$	Destructive	Path Difference = $(n + ½)\,\lambda$





Doppler Effect

Wave source **moving toward** the observer	Wave source **moving away from** the observer
Wavelength **decreases** Frequency **increases**	Wavelength **increases** Frequency **decreases**