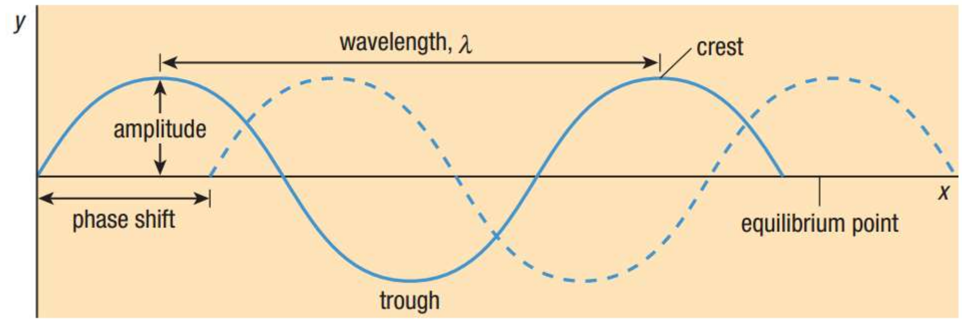
SPH4U 9.1 Properties of Waves and Light

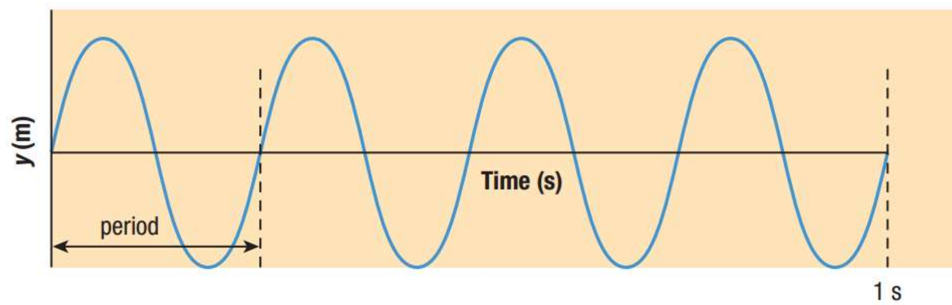
1. Geometric wave characteristics

Periodic wave:	
Wave front:	



Amplitude:	
Wavelength:	
Phase:	

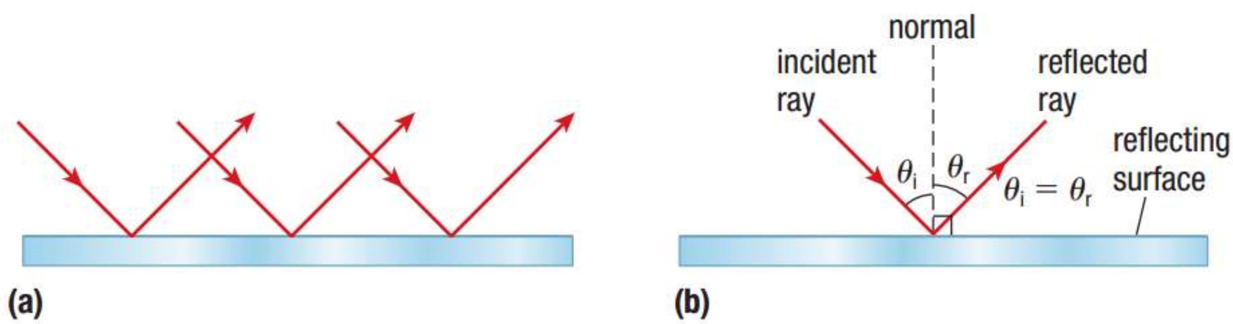
2. Time-based wave characteristics



Period:		
Frequency:		
equation		
Wave speed:		
equation		

3. Reflection

Ray approximation:	
Reflection:	
normal	
angle of incidence	
angle of reflection	
Law of reflection:	



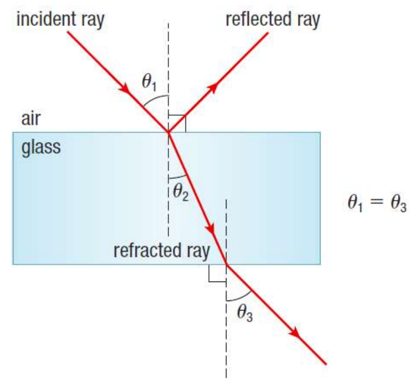
Homework: pg. 443 #6-10, 12, 14, 20

SPH4U 9.2 Refraction and Total Internal Reflection

1. Refraction

Refraction:	
Principle of reversibility:	
Optical density:	
Index of refraction:	
affected by	

Medium	Index of refraction	Speed of light (m/s)	Medium	Index of refraction	Speed of light (m/s)
vacuum	1.00	2.9979×10^8	lens of human eye	1.41	2.1262×10^8
air	1.0003	2.9970×10^8	quartz crystal	1.46	2.0534×10^8
ice	1.30	2.3061×10^8	Pyrex glass	1.47	2.0394×10^8
liquid water	1.33	2.2541×10^8	Plexiglas (plastic)	1.51	1.9854×10^8
aqueous humour (liquid between the lens and cornea)	1.33	2.2541×10^8	benzene	1.50	1.9986×10^8
cornea of human eye	1.38	2.1724×10^8	zircon	1.92	1.5601×10^8
vitreous humour (liquid between the lens and retina)	1.38	2.1724×10^8	diamond	2.42	1.2388×10^8



Angle of refraction:	
Snell's Law:	
wavelengths	

Light moves from a vacuum into a plate of glass with index of refraction 1.47. The angle of incidence is 40.0°.

a. Calculate the angle of refraction.

b. The light continues through the glass and emerges back into a vacuum. Calculate the angle of refraction when the light exits the glass.

c. Suppose the light exits into water instead of a vacuum. Calculate the angle of refraction for the light moving from glass into water (n_{water} = 1.33).

Light travels at 3.0×10^8 m/s. Laser light with a wavelength of 520 nm enters a sheet of plastic. The index of refraction for the plastic is 1.49.

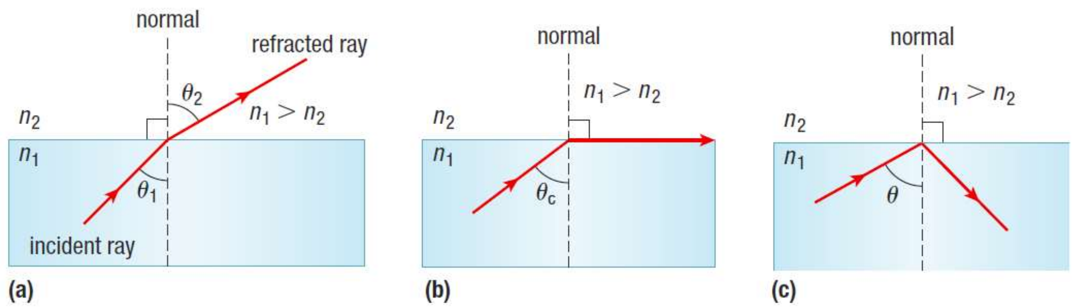
a. Calculate the speed of the laser light in the plastic.

b. Calculate the wavelength of the laser light in the plastic.

c. Calculate the frequency of the laser light in the plastic.

2. Total internal reflection

Total internal reflection:	
Critical angle:	
equation	



Light passes through water (n = 1.33) into air (n = 1.0003).

a. Calculate the critical angle.

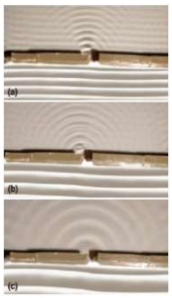
b. What does an underwater swimmer see if she looks toward the surface at angles 40°, θ_c, and 60° relative to the normal?

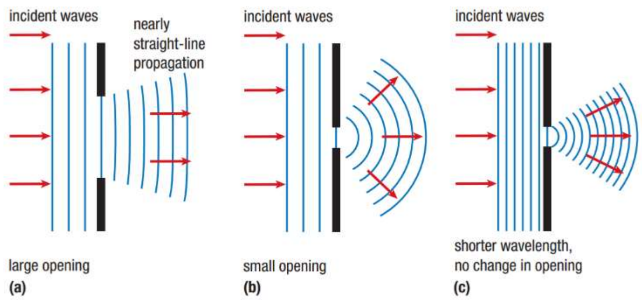
Homework: pg. 458 #3-5, 7-10

SPH4U 9.3 Diffraction and Interference of Water Waves

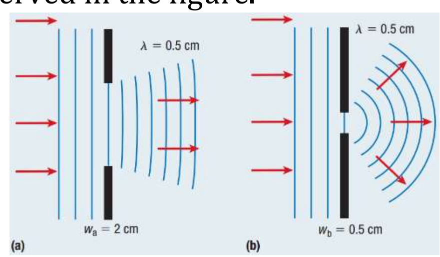
3. Diffraction

Diffraction:	
depends on	



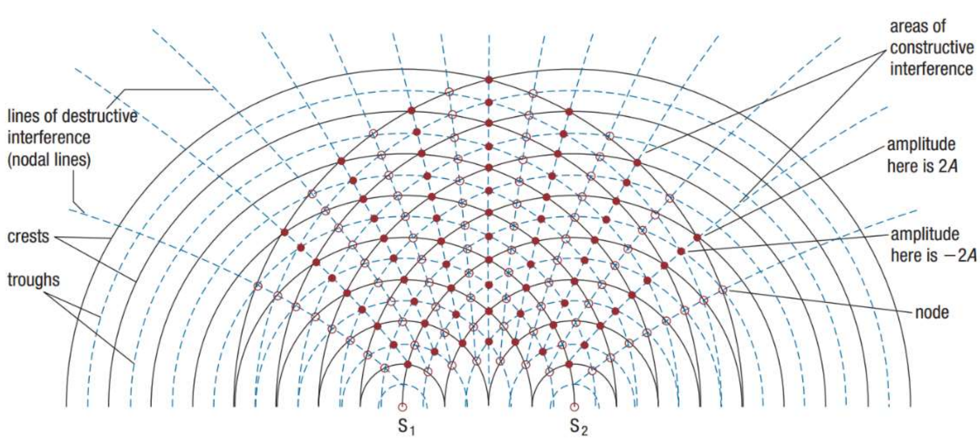


Determine and explain the difference between the diffractions observed in the figure.



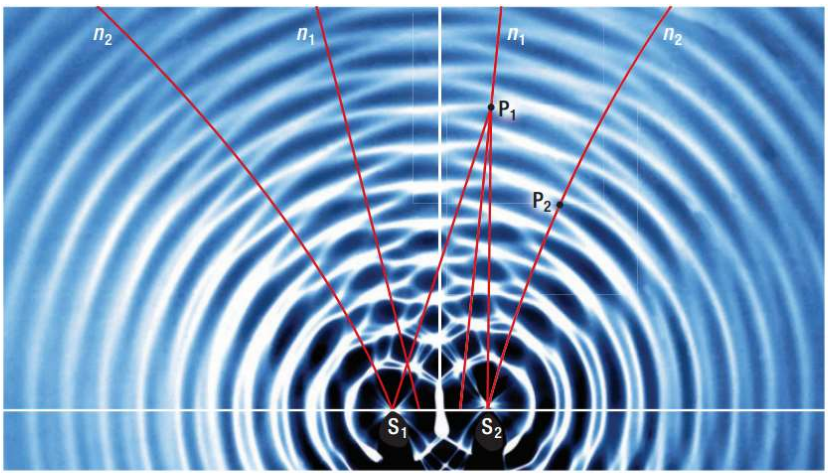
4. Interference

Interference:	
constructive interference	
destructive interference	
Node:	
nodal line	



5. Interference in two dimensions

nth nodal line:	
Finding λ:	
equation	

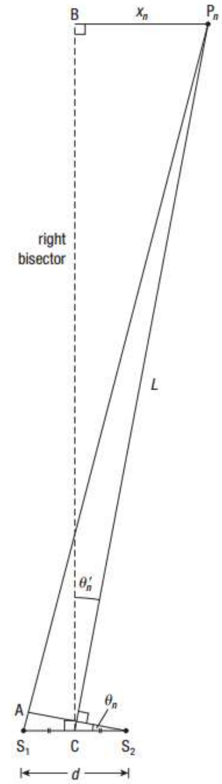


Two identical point sources are 5.0 cm apart, in phase, and vibrating at a frequency of 12 Hz. They produce an interference pattern. A point on the first nodal line is 5 cm from one source and 5.5 cm from the other.

a. Determine the wavelength.

b. Determine the speed of the waves.

When P is far away:	
θ_n	
λ	



The distance from the right bisector to a point P on the second nodal line in a two-point interference pattern is 4.0 cm. The distance from the midpoint between the two sources, which are 0.5 cm apart, to point P is 14 cm.

a. Calculate the angle θ_2 for the second nodal line.

b. Calculate the wavelength.

Homework: pg. 469 #1, 3-4, 6

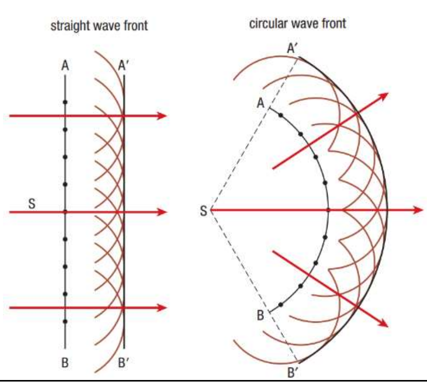
SPH4U 9.4 Light: Wave or Particle?

6. Theories of light

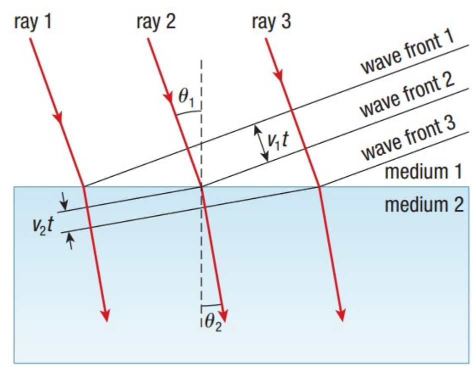
Early theories of light:	
Wave theory of light:	
Huygens' principle	
drawbacks	
Particle theory of light:	
rectilinear propagation	

7. Huygens' principle

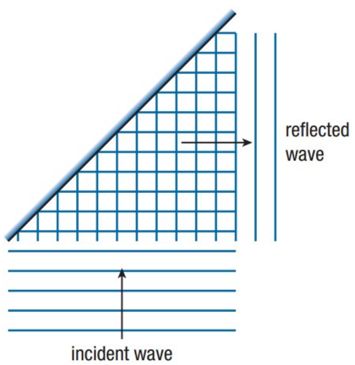
Wave fronts:



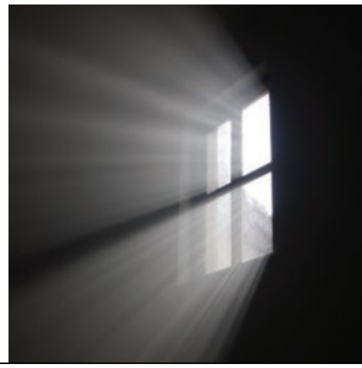
Refraction:



Reflection:



Diffraction:



8. Comparing theories

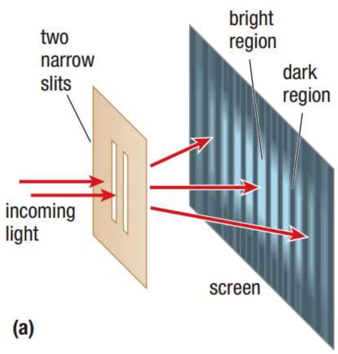
Property	Newton	Huygens
rectilinear propagation		
diffraction		
reflection		
refraction		

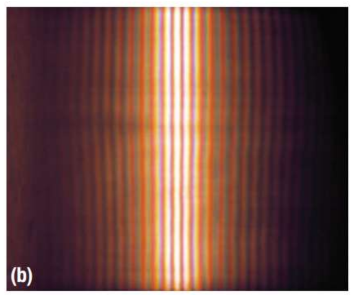
Homework: pg. 476 #1-3, 5, 9

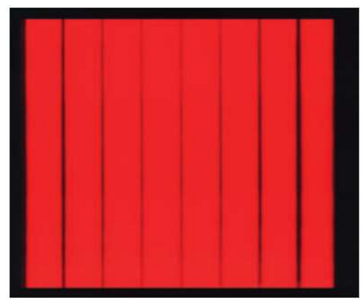
SPH4U 9.5 Interference of Light Waves

9. Young's double-slit experiment

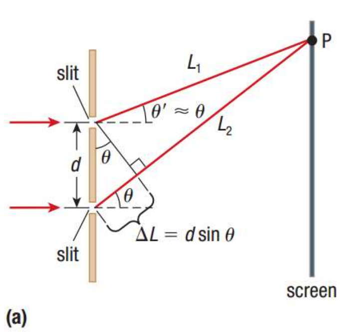
Continued debate:	
problems	
Young's experiment:	

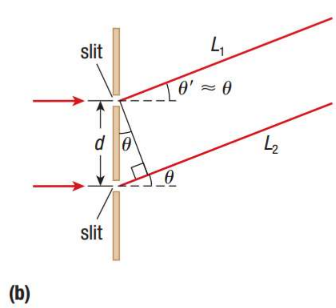


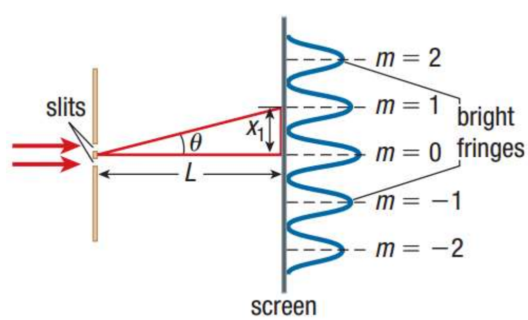




Maxima:	
equation	
Minima:	
equation	







Distance from centre to a max:	
Distance from centre to a min:	

A double-slit experiment is carried out with slit spacing d = 0.41 mm. The screen is at a distance of 1.5 m. The bright fringes at the centre of the screen are separated by a distance of Δx = 1.5 mm. Calculate the wavelength of the light.

The third-order dark fringe of 660 nm light is observed at an angle of 20.0° when the light falls on two narrow slits. Determine the slit distance.

Homework: pg. 484 #2, 4-6, 8