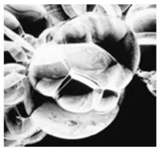
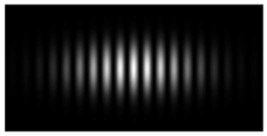
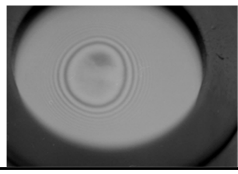
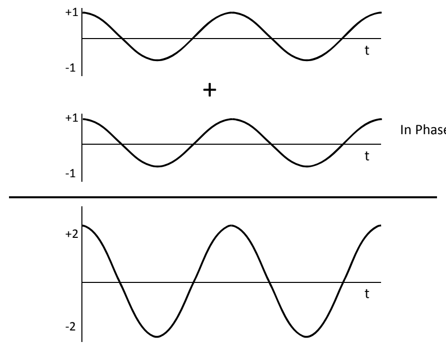
Physics 1161: Lecture 20
Interference

- **textbook sections 28-1 -- 28-3**

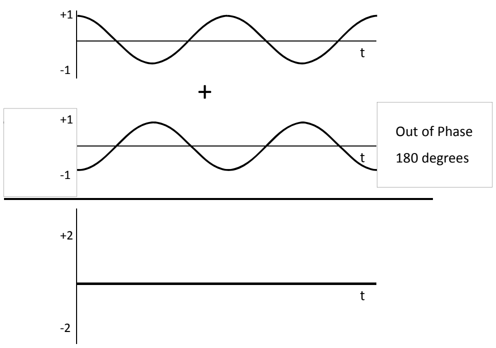

Superposition

Constructive Interference

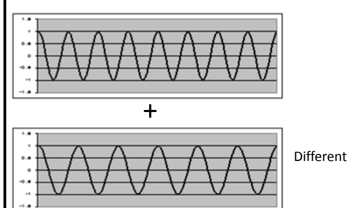


Superposition

Destructive Interference



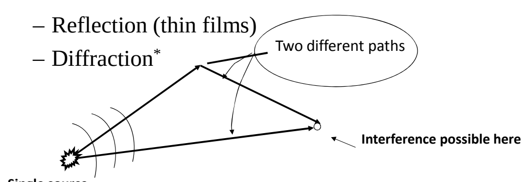
Which type of interference results from the superposition of the two waveforms shown?



1. Constructive
2. Destructive
3. Neither

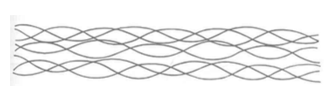
Interference for Light …

- Can't produce coherent light from separate sources. (f ≈ 10^{14} Hz)
- Need two waves from single source taking two different paths
  - Two slits
  - Reflection (thin films)
  - Diffraction*



Coherent & Incoherent Light

◄ **Figure 31.25** Incoherent white light contains waves of many frequencies and wavelengths that are out of phase with one another.



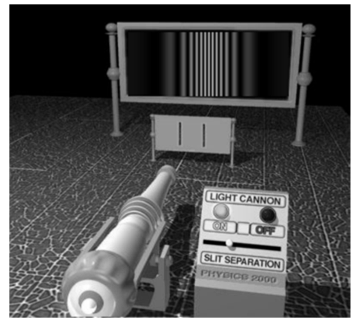
◄ **Figure 31.26** Light of a single frequency and wavelength can still be out of phase.

Figure 31.27 ▲ Coherent light. All the waves are identical and in phase.

Double Slit Interference Applets

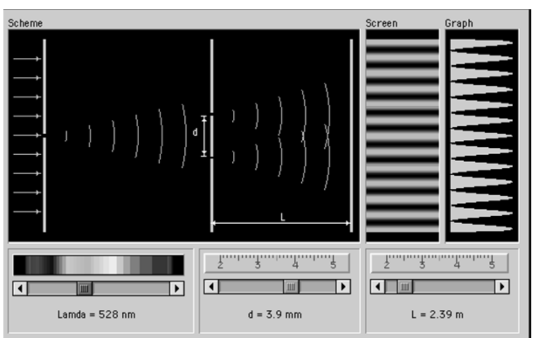
- http://www.walter-fendt.de/ph14e/doubleslit.htm
- http://vsg.quasihome.com/interfer.htm

Young's Double Slit Applet



http://www.colorado.edu/UCB/AcademicAffairs/ArtsSciences/physics/PhysicsInitiative/Physics2000/applets/twoslitsa.html

Young's Double Slit Layout



Interference - Wavelength

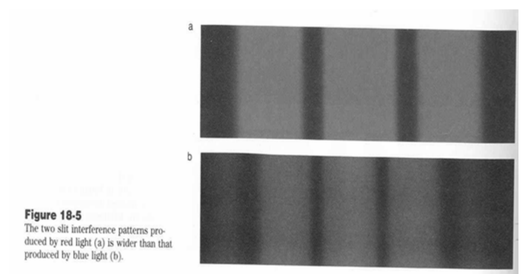
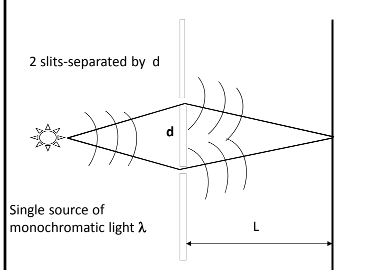


Figure 18-5
The two slit interference patterns produced by red light (a) is wider than that produced by blue light (b).

Light waves from a single source travel through 2 slits before meeting at the point shown on the screen. The interference will be:

1. Constructive
2. Destructive
3. It depends on L

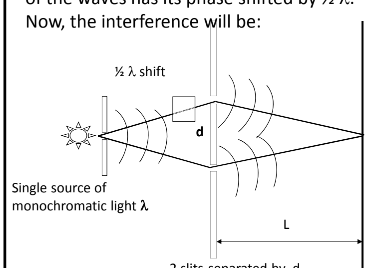


Screen a distance L from slits

Young's Double Slit Phase Checkpoint

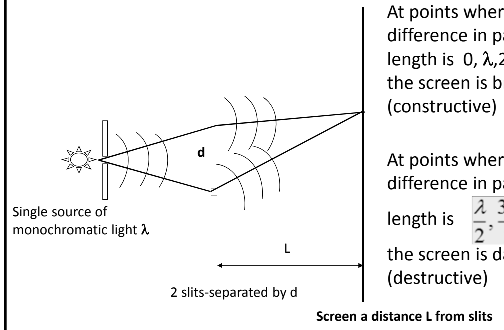
The experiment is modified so that one of the waves has its phase shifted by ½ λ. Now, the interference will be:

1) Constructive
2) Destructive
3) Depends on L



Screen a distance L from slits

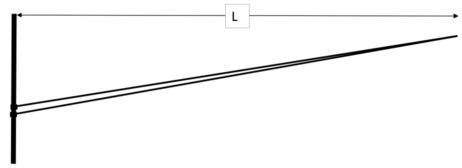
Young’s Double Slit Concept



At points where the difference in path length is 0, λ,2λ, …, the screen is bright. (constructive)

At points where the difference in path length is $\frac{\lambda}{2}, \frac{3\lambda}{2}, \frac{5\lambda}{2} \cdots$ the screen is dark. (destructive)

Young’s Double Slit Key Idea

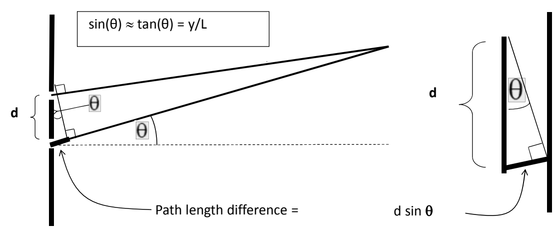


Two rays travel almost exactly the same distance. (screen must be *very* far away: L >> d)

Bottom ray travels a little further.

Key for interference is this small extra distance.

Young’s Double Slit Quantitative

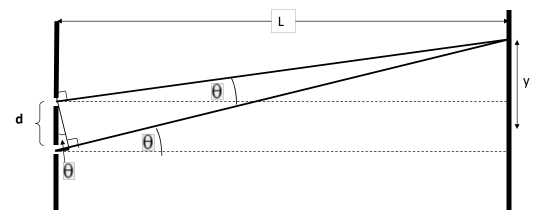


Constructive interference

Destructive interference

(Where m = 0, 1, 2, …)

Young’s Double Slit Under Water Checkpoint



When this Young’s double slit experiment is placed under water. The separation y between minima and maxima

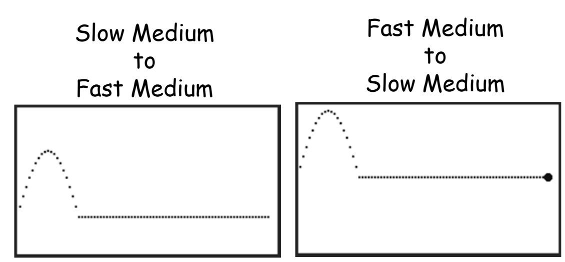
1) increases 2) same 3) decreases

Young’s Double Slit Checkpoint

In the Young’s double slit experiment, is it possible to see interference maxima when the distance between slits is smaller than the wavelength of light?

1) Yes 2) No

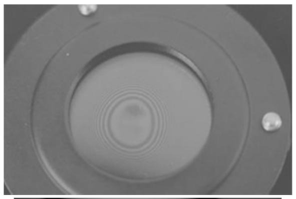
Reflections at Boundaries

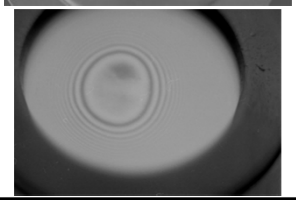


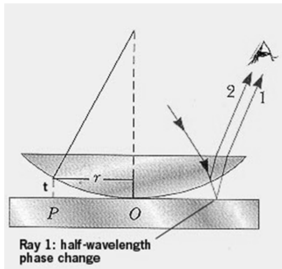
Free End Reflection
No phase change

Fixed End Reflection
180^o phase change

Newton's Rings

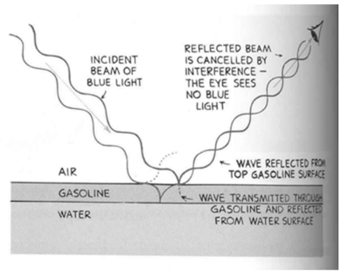






Iridescence

Figure 31.24 ▶
The thin film of gasoline is just the right thickness so that monochromatic blue light reflected from the top surface of the gasoline is canceled by light of the same wavelength reflected from the water.



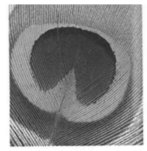
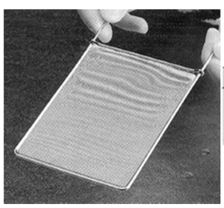
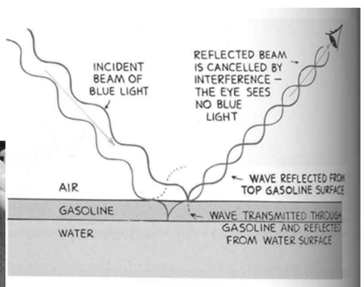


Figure 31.19 ▲
Diffraction from ridges in a peacock's feathers produce beautiful iridescent colors.

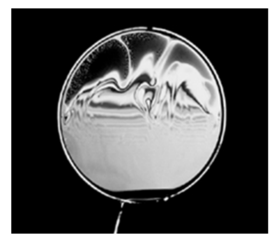
Iridescence

Figure 31.24 ▶
The thin film of gasoline is just the right thickness so that monochromatic blue light reflected from the top surface of the gasoline is canceled by light of the same wavelength reflected from the water.

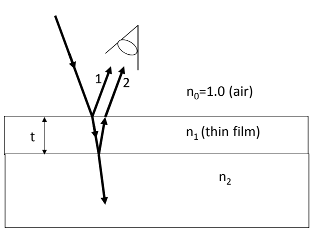




Soap Film Interference

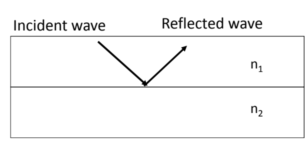


Thin Film Interference



Get two waves by reflection off of two different interfaces.

Reflection + Phase Shifts

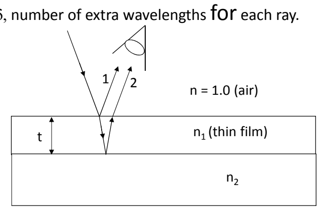


Upon reflection from a boundary between two transparent materials, the phase of the reflected light *may* change.

- If $n_1 > n_2$
- If $n_1 < n_2$

Thin Film Summary

Determine δ, number of extra wavelengths for each ray.



This is important!

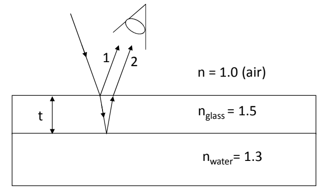
Reflection Distance

Ray 1: δ_1 = 0 or ½

Ray 2: δ_2 = 0 or ½ + 2 t/ λ_{film}

Thin Film Practice

Example



Blue light (λ_o = 500 nm) incident on a glass (n_{glass} = 1.5) cover slip (t = 167 nm) floating on top of water (n_{water} = 1.3).

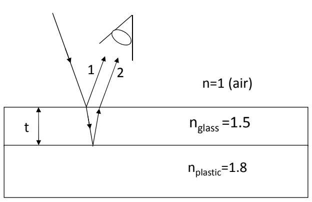
Is the interference constructive or destructive or neither?

δ_1 =

δ_2 =

Phase shift = $\delta_2 - \delta_1$ =

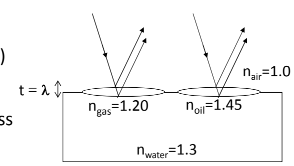
Blue light λ = 500 nm incident on a thin film (t = 167 nm) of glass on top of plastic. The interference is:



1. Constructive
2. Destructive
3. Neither

Thin Films Checkpoint

A thin film of gasoline (n_{gas}=1.20) and a thin film of oil (n_{oil}=1.45) are floating on water (n_{water}=1.33). When the thickness of the two films is exactly one wavelength…



The gas looks:
- bright
- dark

The oil looks:
- bright
- dark