Phys102 Lecture 30

The Wave Nature of Light; Interference

Key Points

- Huygens' Principle
- Interference – Young's Double-Slit Experiment
- Intensity in the Double-Slit Interference Pattern

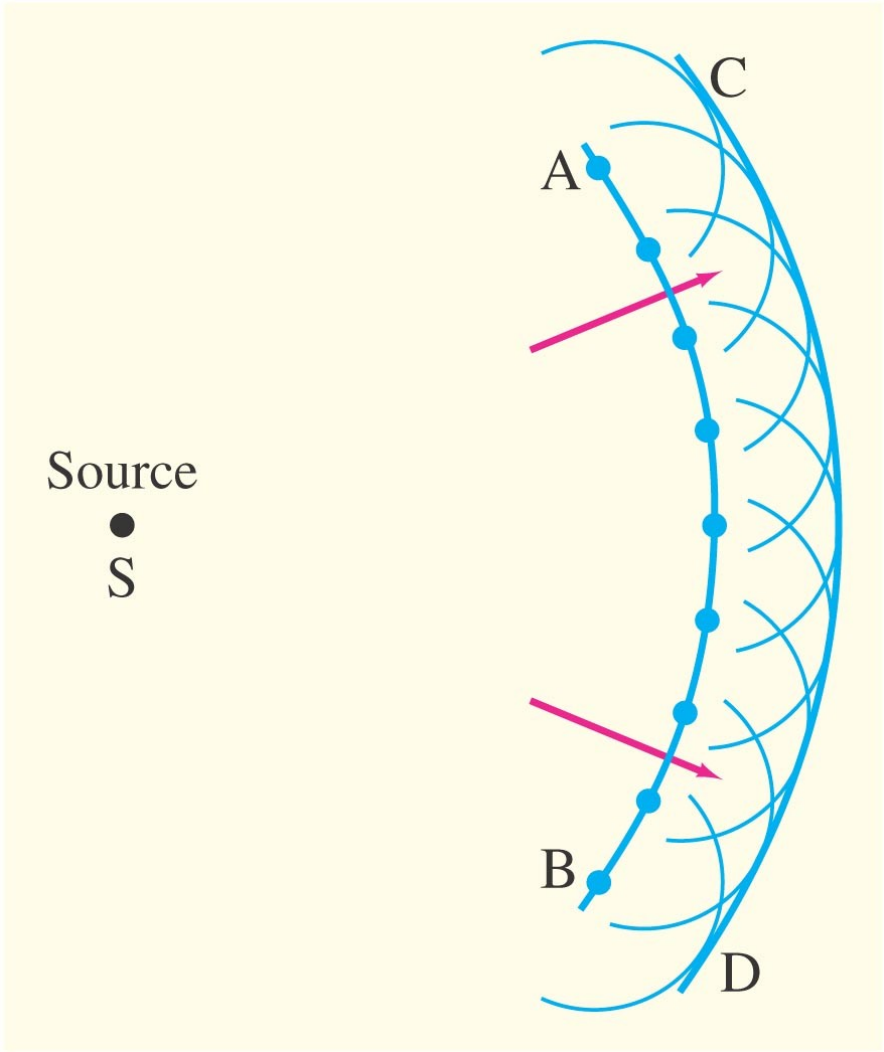
References

SFU Ed: 34-1,2,3,5*.

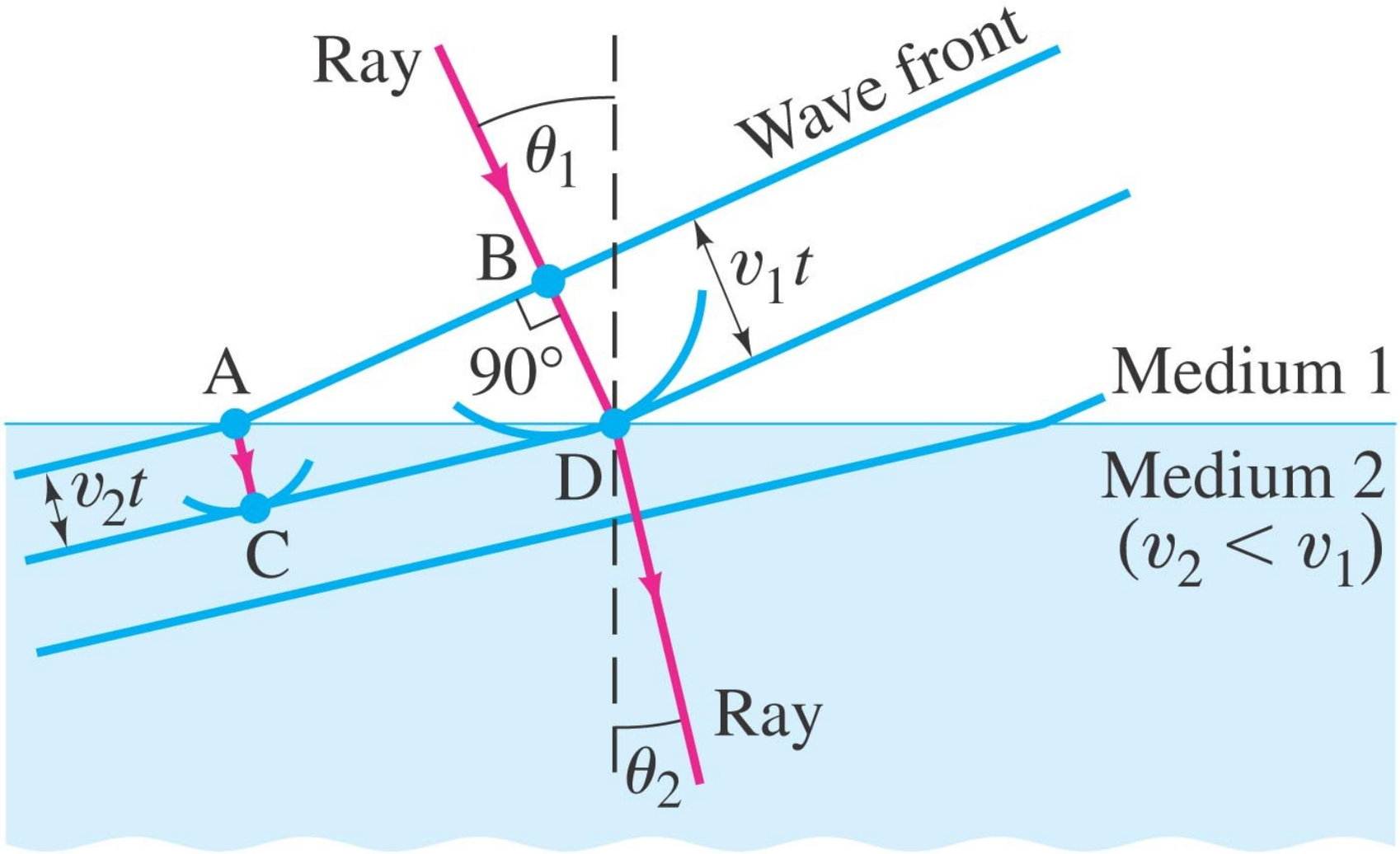
6th Ed: 24-1,2,3,8*.

Huygens' Principle

Huygens' principle: every point on a wave front acts as a point source; the wave front as it develops is tangent to all the wavelets.



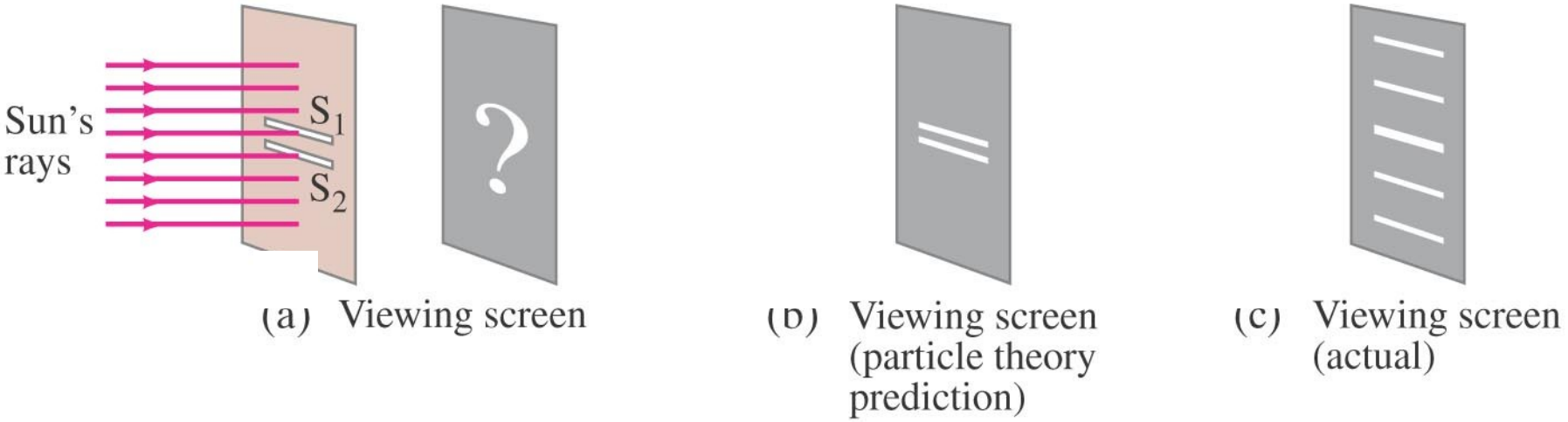
Huygens' Principle and the Law of Refraction



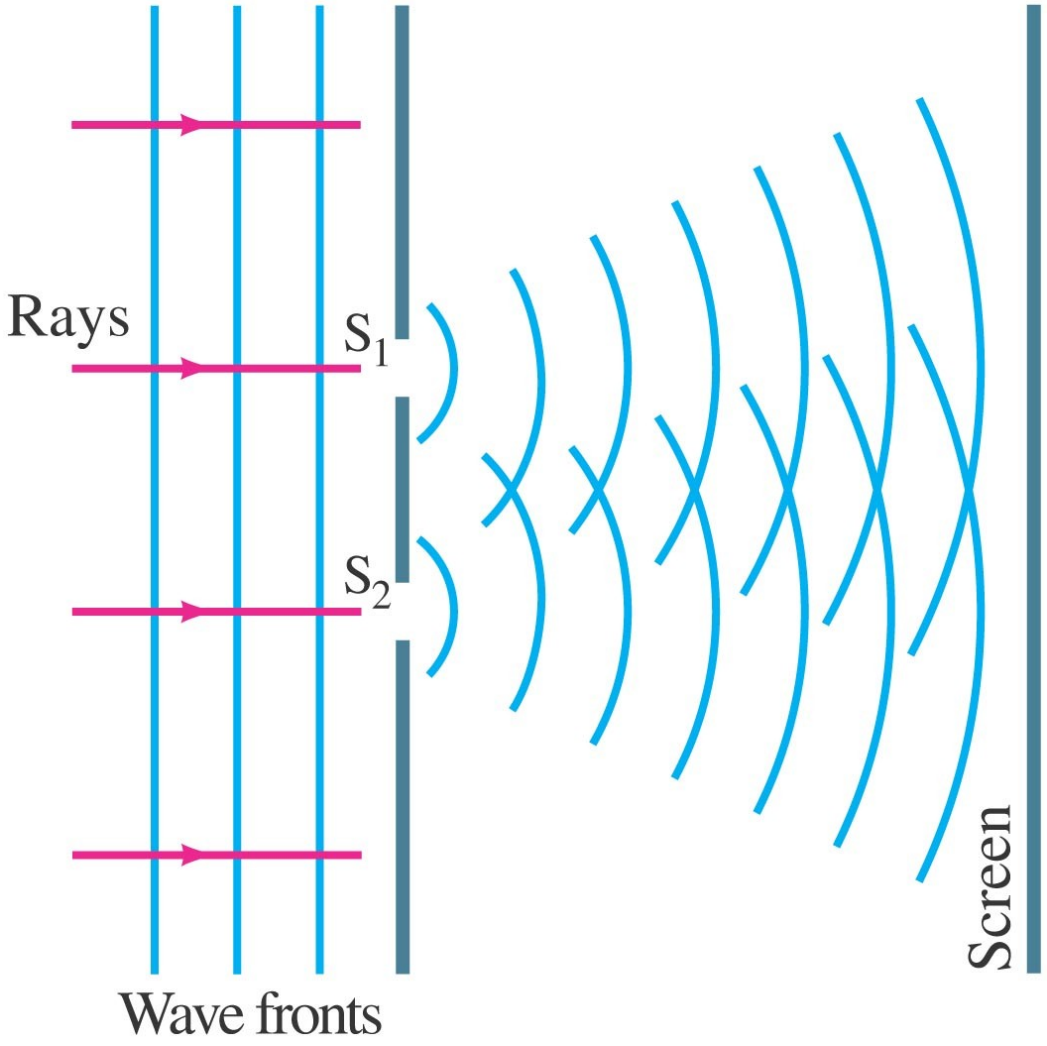
Interference – Young's Double-Slit Experiment

If light is a wave, interference effects will be seen, where one part of a wave front can interact with another part.

One way to study this is to do a double-slit experiment:



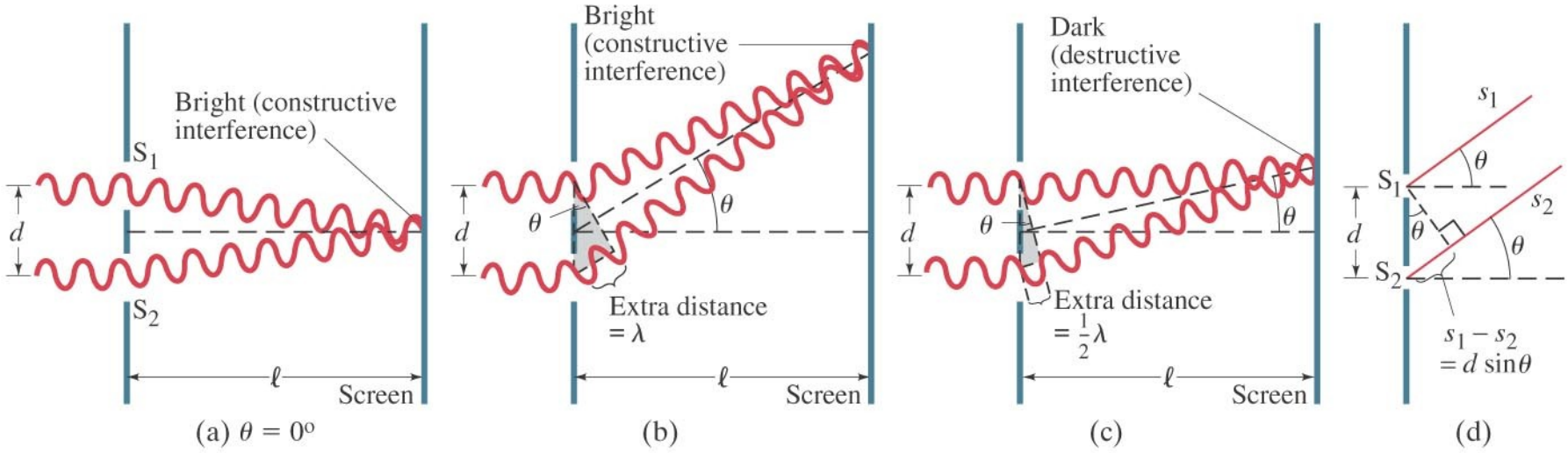
Interference – Young's Double-Slit Experiment



If light is a wave, there should be an interference pattern.

Young's Double-Slit Experiment

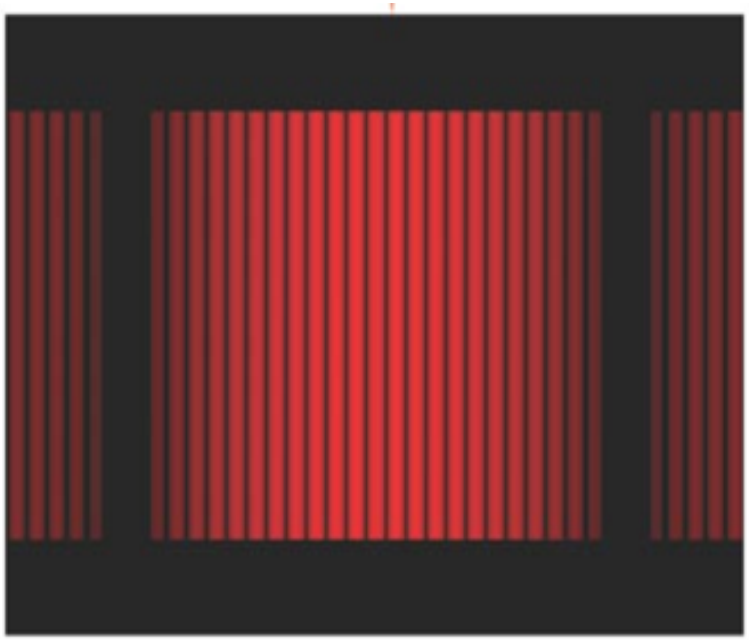
The interference occurs because each point on the screen is not the same distance from both slits. Depending on the path length difference, the wave can interfere constructively (bright spot) or destructively (dark spot).



Constructive interference: $d \sin\theta = m\lambda, \quad m = 0,1,2,.....$

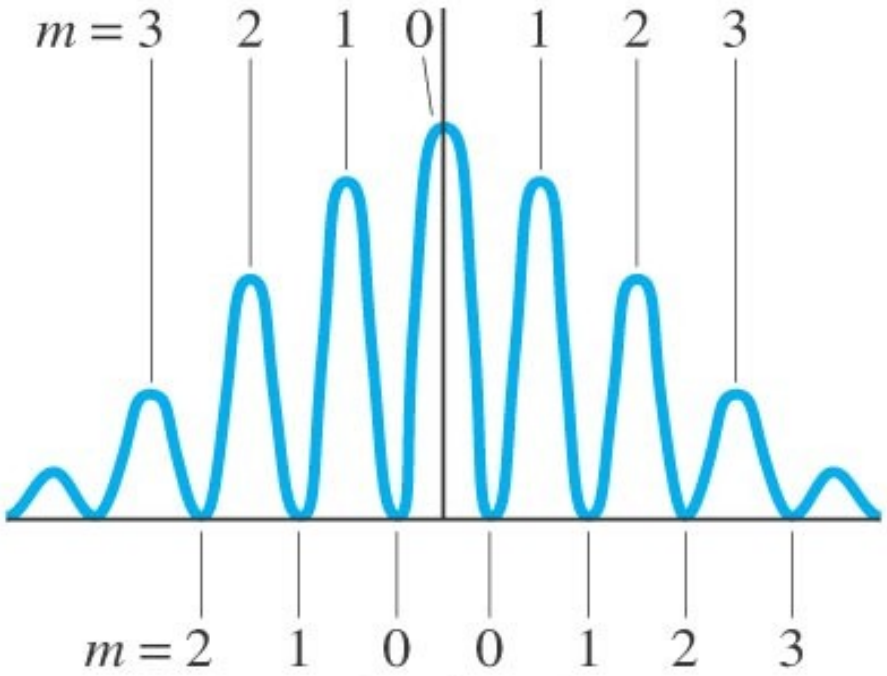
Destructive interference: $d \sin\theta = \left(m + \frac{1}{2}\right)\lambda, \quad m = 0,1,2,.....$

Between the maxima and the minima, the interference varies smoothly.



$d \sin\theta = m\lambda$

Constructive interference



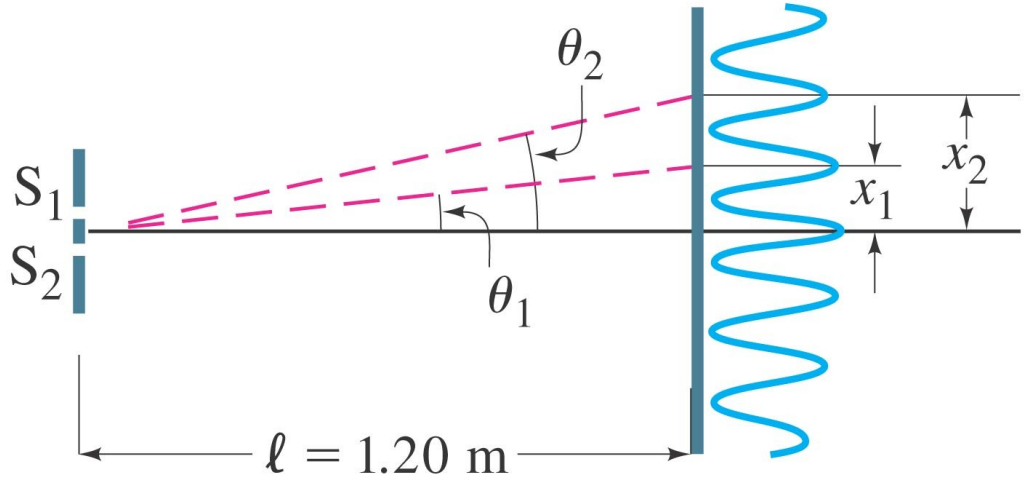
Destructive interference

$d \sin\theta = \left(m + \frac{1}{2}\right)\lambda$

Young's Double-Slit Experiment

Example 34-2: Line spacing for double-slit interference.

A screen containing two slits 0.100 mm apart is 1.20 m from the viewing screen. Light of wavelength λ = 500 nm falls on the slits from a distant source. Approximately how far apart will adjacent bright interference fringes be on the screen?

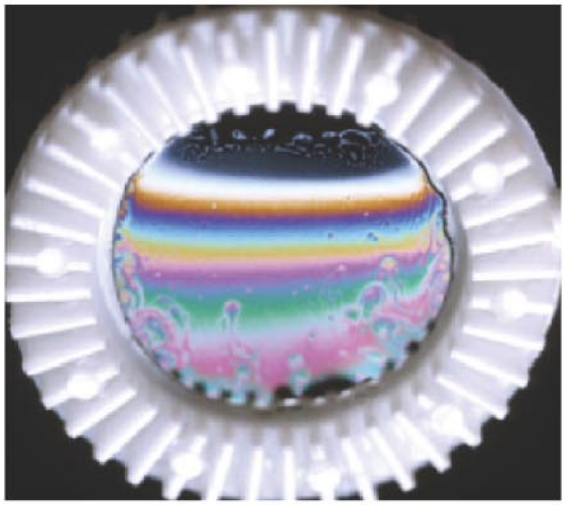


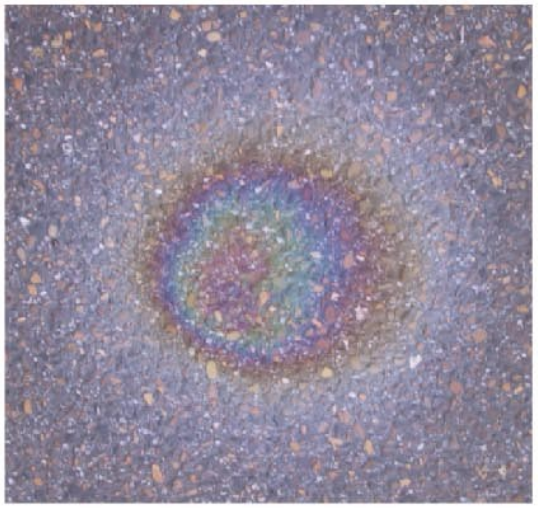
Conceptual Example 34-3: Changing the wavelength.

(a) What happens to the interference pattern in the previous example if the incident light (500 nm) is replaced by light of wavelength 700 nm? (b) What happens instead if the wavelength stays at 500 nm but the slits are moved farther apart?

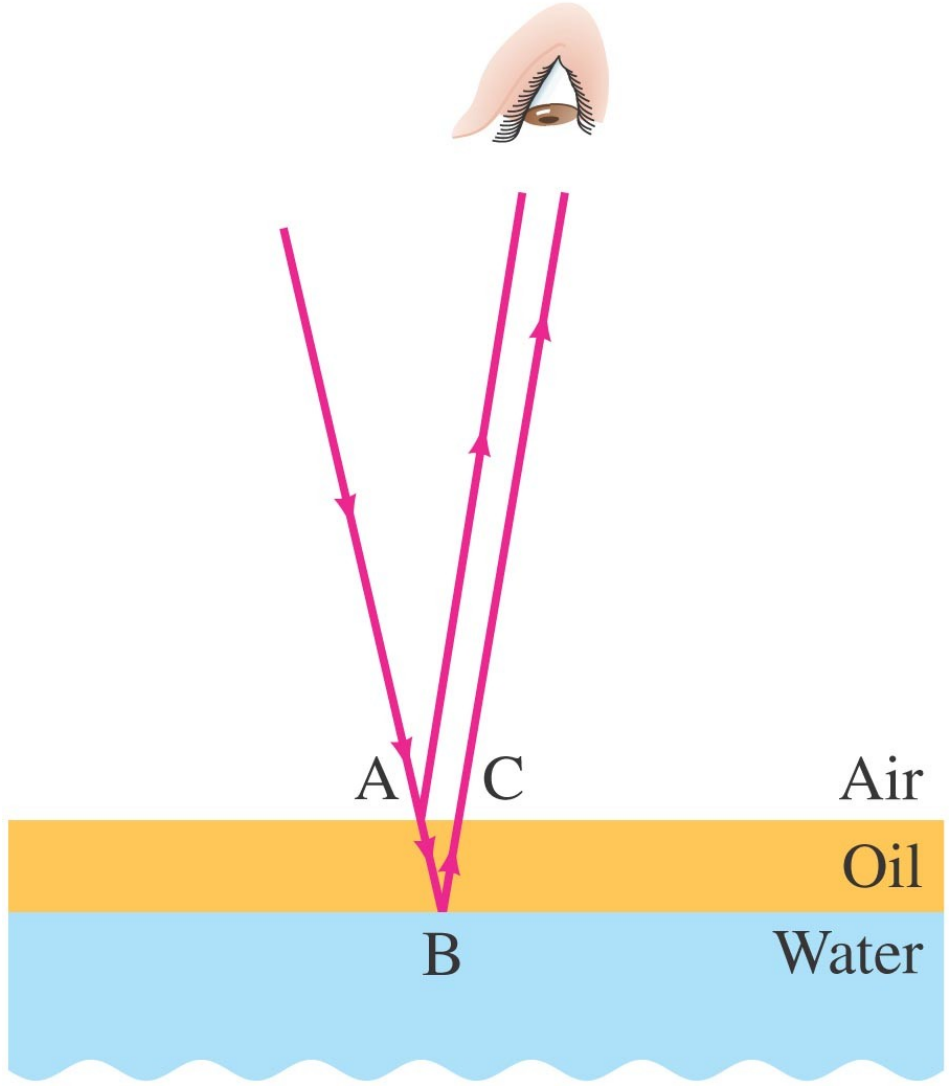
Interference in Thin Films

Another way path lengths can differ, and waves interfere, is if they travel through different media. If there is a very thin film of material – a few wavelengths thick – light will reflect from both the bottom and the top of the layer, causing interference. This can be seen in soap bubbles and oil slicks.





Interference in Thin Films



Interference in Thin Films

A similar effect takes place when a shallowly curved piece of glass is placed on a flat one. When viewed from above, concentric circles appear that are called Newton's rings.