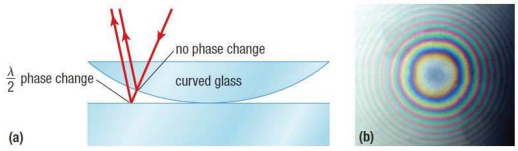
SPH4U UNIVERSITY PHYSICS

THE WAVE NATURE OF LIGHT

- Newton's Rings & Air Wedges (P.508-511)

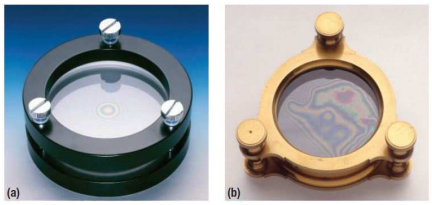
Newton's Rings

*When a curved glass surface is placed in contact with a flat glass surface, and it is illuminated by monochromatic light, a series of concentric rings is seen. Called **Newton's rings**, they result from the interference between the rays reflected by the top and bottom of the variable air gap created between the two pieces of glass.*



Newton's Rings

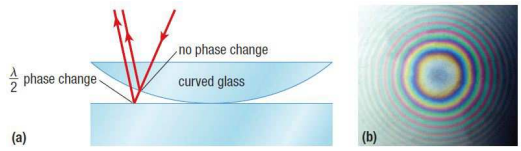
A practical application of Newton's rings is checking lenses for imperfections. Lenses are typically spherical in shape and, if shaped properly, will produce perfectly circular Newton's rings when illuminated with light (a). However, if the lens is imperfectly shaped, it will produce a pattern that clearly indicates a defective lens shape (b).



Newton's Rings

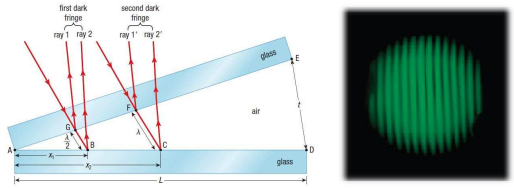
NEWTON'S RINGS

- interference pattern that consists of a series of concentric rings
- forms when light reflects from both the upper surface of the flat glass and the lower surface of the curved glass
- can be used to check lenses for imperfections



Air Wedge

*To create a measureable pattern of destructive and constructive interference researchers often use an **air wedge**, which is a wedge of air between two sheets of flat glass that have been angled to form a wedge. The upper glass is slightly raised by a very small distance, t, and illuminated with monochromatic light, as shown. The interference patterns produced can be used to measure very small distances.*



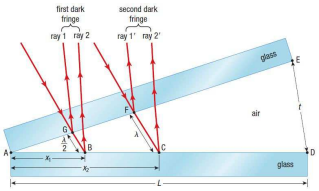
Air Wedge

Using similar triangles, we find:

$$\frac{x_1}{L} = \frac{\left(\frac{\lambda}{2}\right)}{t} \quad \text{or} \quad x_1 = \frac{L\lambda}{2t}$$

$$\frac{x_2}{L} = \frac{\lambda}{t} \quad \text{or} \quad x_2 = \frac{L\lambda}{t}$$

$$\Delta x = x_2 - x_1 \quad \text{or} \quad \Delta x = \frac{L\lambda}{2t}$$



Air Wedge

AIR WEDGE

- wedge of air between two sheets of flat glass
- light reflecting from each flat surface creates a measureable pattern of interference

$$\Delta x = \frac{L\lambda}{2t}$$

where Δx is the separation between adjacent fringes (m)
L is the length of the air wedge (m)
λ is the wavelength of the light (m)
t is the thickness of the air wedge (m)

Air Wedge

PRACTICE

1. A sheet of paper 0.12 mm thick separates two microscope slides 11 cm long. What is the spacing of the dark fringes in the interference pattern when the air wedge is illuminated with red light of wavelength 660 nm?

   $t = 3.0 \times 10^{-4}$ m

Air Wedge

PRACTICE

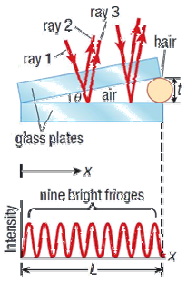
2. An air wedge 9.8 cm long is separated at one end by a piece of paper 0.019 mm thick. The distance between the centres of the first and eight successive dark bands is 1.23 cm. What is the wavelength of the light being used?

   $\lambda = 6.8 \times 10^{-7}$ m (8 dark bands = $7\Delta x$)

Air Wedge

PRACTICE

3. Two glass plates are separated on one side by a human hair. The light shining on the plates has a wavelength of 600 nm. The light intensity is zero at the point of contact of the two plates, followed by nine alternating bright and dark fringes. Estimate the thickness of the hair. (Hint: let L = 9Δx)



$t = 2.7 \times 10^{-6}$ m

✔ Check Your Learning

TEXTBOOK

P.510 Q.1,2