

# Newton's Ring Apparatus

P2-1300



## BACKGROUND:

Newton's Rings are the interference pattern seen when light passes through two glass pieces, one convex and the other flat, pressed together.

The colorful rings that result from this simple arrangement, even in normal room light, are quite amazing and will prompt discussions of light interference, refraction, and the visible spectrum. Apparatus consists of two 1.6in (40mm) glass plates in a frame, adjusted with three screws.

The phenomenon of Newton's Rings was first described by Robert Hooke in his 1664 book, *Micrographia*, although its name derives from the physicist Isaac Newton, who was the first to analyze it. It is caused by the reflection, refraction and interference of light between two surfaces - a spherical surface and an adjacent flat surface. When viewed with a monochromatic light source (one color), it appears as a series of concentric, alternating light and dark rings centered where the two surfaces touch. When viewed with white light, it forms a concentric ring pattern of rainbow colors because the different wavelengths of light interfere at different thicknesses of the air layer between the surfaces. The bright rings are caused by Constructive Interference (whole  $\lambda$ 's) between the light rays reflected from both surfaces, while the dark rings are caused by Destructive Interference ( $\lambda/2$ ). Moving outward from the center (from one dark ring to the next dark ring), increases the difference in the light's path through the glass and the increase of thickness of the air layer, yet still interfere at a multiple of  $\lambda/2$ . Since the curved lens surface has an increased slope as you move outwards, the outer rings are formed more closely than the inner ones.

Newton's Rings successively appear as the air gap between the glass plate and the lens surface increases by half a wavelength. If incident light of different wavelengths is utilized, corresponding to red and green, for example, then the interval between successive rings will be wider for red light than for green.

## EXPLANATION:

For Middle School students, the phenomenon known as Newton's Rings can be explained in terms of wavelengths of light interfering with each other as the air gap between the two surfaces increases.

When a light ray is incident on the upper surface of the lens, it is reflected as well as refracted. The two rays interfere with each other and bright rings will form if the light rays are in step with each other (In Phase). When the two rays interfere causing dark rings to form, the light rays are out of step with each other (Out of Phase).

Similar interference patterns can be observed in gasoline spills in water puddles or driveways, soap bubbles or oily secretions on birds and seashells.

For Physics students, the phenomenon can be quantified in addition to simple observations. Newton's Rings are to be explained using the concept of the wave theory of light. For example, after passing through the top curved glass, the refracted ray is incident upon the lower glass from air and undergoes a phase change of 180°; light from a less dense medium traveling into a more dense medium will always become inverted. Constructive Interference will always occur between any two waves when the path difference between them is  $(m+1/2)\lambda$  and destructively if the path difference between them is  $m\lambda$  producing alternate bright and dark rings. The equation for determining the radius of the Nth Newton's bright ring is given by...

$$R_n = [(N - 1/2) \lambda R]^{1/2}$$

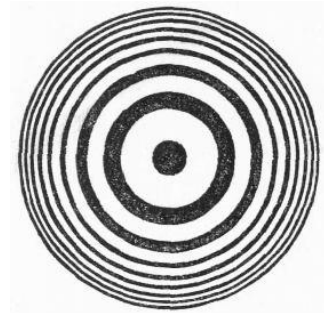
Where...

$r_n$  = radius of N<sup>th</sup> bright ring

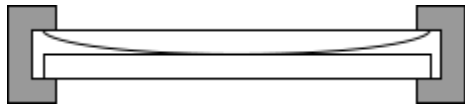
N = bright ring number

R = radius of curvature of lens the light is passing through

$\lambda$  = Wave length of light passing through the glass



Newton's Rings (Concentric Circles)



Newton's Rings Apparatus

## USING THE NEWTON'S RING APPARATUS:

The Newton's Ring Apparatus is a convex lens under the tension of screws, into contact with a flat glass plate. Tightening the screws will change the ring pattern that is produced.

