

# [History and formation of newton's rings](https://assignbuster.com/history-and-formation-of-newtons-rings/)

In this experiment the physical property of interference of light will be used to determine the wavelength,, of a light source. The interference fringe system here is a pattern of concentric circles, the diameter of which you will measure with a travelling microscope (which has a Vernier scale). If a clean convex lens is placed on a clean glass slide (optically flat) and viewed in monochromatic light, a series of rings may be seen around the point of contact between the lens and the slide. These rings are known as Newton’s rings and they arise from the interference of light reflected from the glass surfaces at the air film between the lens and the slide. The experimental set-up is shown in figure 1.

History of history of Newton’s ring

The phenomenon of Newton’s rings, named after sir Isaac Newton who first studied them in 1717, Newton’s rings is a pattern of interference caused by two surfaces after reflection of light – a sphere surface and an adjacent flat surface. When view with monochromatic light its appears as a series of concentric, alternating bright and dark rings centered at the point of contact between the two surfaces. When we see with white light, it forms like a rainbow colours concentric ring pattern because the different wavelengths of light interfere at different thickness of the layer between the surfaces. The light reflected from both surfaces caused by constructive interference, while the dark rings are caused by destructive. Perhaps, the outer rings are more closely spaced than the inner.

So the above phenomenon was first described by Robert Hooke in his 1664 book Micrographia although its name derives from the physicist sir Isaac Newton, who was the first to analyze it.

## Newton’s rings

The term “ Newton’s rings” is a ring formed by the glass of curved, typically a convex lens, is put in contact with a glass of a plan surface. The curved glass kept on the plan glass, forming a film of air between them is increasingly larger along the length of the curve. When light is directed into the curved glass, a many of concentric circles appears. That is why the rings are referred to as Newton’s rings. Which was the first to observe the phenomenon by Sir Isaac Newton?

The Newton’s rings formed will be phenomenon typically is dark alternating with bright, with the dark beginning in the center. It is formed as a result of interference between the light reflected by the two surfaces. Towards the application, Newton’s rings can be used by lens makers to find out the quality of a lens. In a well-made lens, the rings should be uniform.

When a convex surface with its Plano-convex lens is placed on a glass sheet, an air film of gradually increasing thickness outward is formed between the lens and the sheet. The thickness of film at the point of contact is zero. If light is allowed to fall on the lens, and the film is viewed in reflected light, alternate bright and dark concentric rings are seen around the point of contact.

(Source google. com)

Newton’s Rings, it is visible a pattern of light and dark circles when a convex lens is placed, curved side down, on top of a flat piece of glass. The pattern was first observed by Sir Isaac Newton. The rings are caused by interference of light waves.

When a light is falls downward onto the two pieces of glass, two overlapping beams of light are formed-one from light reflected by the lower surface of the curved glass and the other from light reflected by the upper surface of the flat glass. The light reflected from the plane glass moves farther than the light reflected from the curved glass. It depends on the distance between the two surfaces, light waves in the two beams may be in phase, and reinforcing each other or they may be out of phase, canceling each other out. Since the distances between the two reflecting surfaces increases with distance from the point where the lens and flat glass make contact, the areas where the waves are in phase and out of phase occur in concentric bands around the center of the lens.

If the beam of light falls at the two pieces of glass is of a single wavelength i. e. monochromatic, the rings are thin circles of a single color. The rings are fewer in number, but highly colored when white light is used

## Formation of Newton’s Rings

Newton’s rings are formed as a result of interference between the light waves reflected from the top and bottom surfaces of the air film formed between the lens and glass sheet.

The phenomenon of the formation of Newton’s ring can be explained on the basis of wave theory of light i. e.:

An air film of varying thickness is formed between lens and the glass sheet.

When a ray is incident on the surface of the lens, it is reflected as well as refracted.

When the refracted ray strikes the glass sheet, it undergoes a phase change of 180 on the reflection.

Interference occurs between two waves which interfere constructively if path differences between them is (m+1/2) 1 and destructively if path difference between them is ml producing alternate bright and dark rings.

## Radius of Newton’s Ring

Let the radius of curvature of the convex lens is R and the radius of ring is ‘ r’. Consider light of wave length ‘ l’ falls on the lens. After refraction and reflection two rays 1 and 2 are obtained. These rays interfere each other producing alternate bright and dark rings. At the point of contact the thickness of air film is zero and the path difference is also zero and as a 180O path difference occurs, so they cancel each other and a dark ring is obtained at the centre.

As we move away from the central point, path difference is also changed and alternate dark and bright rings are obtained. Let us suppose that the thickness of air film is’t’.

By using the theorem of geometry,

x = x

r x r = t (2R – t)

= (2Rt -)

Since’t’ is very small as compare to ‘ r’, therefore neglecting ‘

= 2Rt

## r2 = 2Rt………….. (1)

In thin films, path difference for constructive interference is:

## 2nt = (m+1/2) l

Where n= refractive index

for air n = 1

Therefore,

## 2t = (m+1/2)l ………….. (2)

For first bright ring m = 0

for second bright ring m = 1

For third bright ring m = 2

Similarly

For Nth bright ring m = N-1 Putting the value of m in equation (2)

## 2t = (N-1+1/2)l

## 2t = (N-1/2)l

## t = 1/2 (N-1/2) l ………….. (3)

Putting the value of’t’ in equation (1)

## r2 = 2Rt

## r2 = 2R. 1/2 (N-1/2) l

## r2 = R (N-1/2) l

## =

Where N is the bright ring number, R is the radius of curvature of the lens the light is passing through, and Î» is the wavelength of the light passing through the glass.

## Working of Newton’s Ring

When convex surface of a long focal length lens is placed in contact with a plane glass disk and clamped together, as shown in cross section below. Adjustment screws are tightened to secure intimate contact at the center.

Between the two surfaces of glass a thin film of air is formed and when this band is viewed under reflected light from an extensive light source. We ignore reflections from the top (Plano-convex lens) and bottom (plane glass disk) as these reflections just contribute to the overall glare. Since the wave is going from a higher to lower refractive index medium, there is no phase change at the glass air surface of convex lens. Whereas at the air-glass surface of the plane disk suffers a half-cycle phase shift due to reflection.

Let R be the radius of curvature of the convex lens, r distance from center and the t air film thickness.

Then, = 2Rt

And the radius of the bright ring is given by:

## = [(N + ½) Î» R] ½

Here the two glass surfaces are in close contact and there is no reflection because it is as if there were no surfaces. The reflected light is almost white in colour for first maximum, this is because the distance between the two glass surfaces is such that it’s almost () Î» for the entire spectrum. Similarly succeeding rings exhibit more and more colour. Where the thickness is odd number N of (1/4) Î» for green, and where blue is about (N+1) (1/4) Î» and red is (N-1) (1/4) Î» will be most monochromatic ring. Therefore blue and red at reflection minima while green is at a reflection maximum.

The experimental procedure to find the radius of Newton’s bright ring is as follows.

The convex surface of large radius of curvature is placed in contact with a plane glass disk and clamped together

Adjustment screws are tightened to secure intimate contact at the center

A thin film of air is formed between the 2 surfaces of glass

The thin film of air is viewed under reflected light from an extensive light source

Reflections from the top ( Plano-convex lens) and the bottom ( plane glass disk) are ignored, since these reflections just contribute to the overall glare

The reflections of interest involves where the surfaces in contact

Since the wave is going from higher to a lower refractive index medium, there is no phase change at the glass-air surface of the convex lens

Whereas at the air-glass surface of the plane disk suffers a half-cycle phase shift due to reflection.

Taking R as the radius of curvature of the convex lens, the relation between the radius of the ring “ r” and the “ air-film” thickness “ t” is given by r2 = 2Rt .

Then radius of the nth bright ring will be given by =

The Newton’s ring is used to;

· Illustrate the interference fringes formed in the air film between optical surfaces.

· Newton’s rings are used to determine the radius of curvature of the bi convex or Plano-convex lens

· Measure the refractive index of a substance placed beneath the same lens.

· Determine the wavelength of sodium light