Experiment 1 - Newton Rings Experiment

Q1) How are Newton Rings formed?

A1) Newton Rings are formed due to the interference of light waves reflected from a convex lens surface and a plane glass surface placed in contact with it. The air film formed between the two surfaces varies in thickness, which causes interference of the light waves and the formation of rings.

Q2) Why are Newton rings circular?

A2) The Newton rings are circular because the air film between the convex lens and the plane glass surface has a circular shape due to the curvature of the lens.

Q3) What should be the central spot; brighter or darker?

A3) The central spot should be dark because there is no air film between the lens and the glass plate, and hence, there is no interference between the light waves.

Q4) On what factors does the diameter of the rings depend?

A4) The diameter of the rings depends on the wavelength of light used, the radius of curvature of the lens, and the refractive index of the medium between the lens and the glass plate.

Q5) Where are the fringes formed?

A5) The fringes are formed at the point of contact between the convex lens and the glass plate, where the air film is the thinnest.

Q6) Why do we use a convex lens in front of a sodium lamp?

A6) We use a convex lens in front of a sodium lamp to make the light rays parallel so that they fall normally on the plane glass surface and form a uniform interference pattern.

Q7) Why should a lens of a large radius of curvature be used?

A7) A lens of a large radius of curvature should be used to obtain a clear and sharp interference pattern because a lens of small radius of curvature will produce a distorted pattern due to spherical aberration.

Q8) Are the rings equispaced?

A8) No, the rings are not equispaced. The spacing between the rings decreases as we move away from the center of the pattern.

Q9) How do the rings appear when viewed in transmitted light?

A9) When viewed in transmitted light, the rings appear as dark rings on a bright background because the interference of light waves results in destructive interference at the points where the air film thickness is an odd multiple of a quarter wavelength.

Q10) What will happen if the lens is placed on a plane mirror instead of a glass plate?

A10) If the lens is placed on a plane mirror instead of a glass plate, no interference pattern will be formed because there will be no air film between the lens and the mirror to cause interference of light waves.

Experiment 2 - Diffraction Grating

Q1) What is a Diffraction Grating?

A1) A diffraction grating is an optical component consisting of a large number of equally spaced parallel slits or lines that diffract light and produce a series of bright and dark fringes or orders of spectra.

Q2) What are the requisites of a good grating?

A2) The requisites of a good grating include a large number of closely spaced lines or slits per unit length, high transparency, high diffraction efficiency, and low stray light.

Q3) What is a grating element?

A3) A grating element is the distance between two adjacent slits or lines on a diffraction grating. It is usually measured in micrometers or nanometers.

Q4) How many orders do you get here? Why?

A4) You get multiple orders of spectra with a diffraction grating because light of different wavelengths is diffracted at different angles, producing a series of bright and dark fringes or orders. The number of orders depends on the wavelength of the incident light and the grating element.

Q5) What is the main difference between a prism spectrum and a grating spectrum?

A5) The main difference between a prism spectrum and a grating spectrum is that a prism spectrum is produced by the dispersion of light due to refraction, whereas a grating spectrum is produced by the diffraction of light due to interference.

Q6) What is the effect of increasing the number of lines per cm of the grating using a diffraction grating? A6) The effect of increasing the number of lines per cm of the grating using a diffraction grating is to increase the angular dispersion of the diffracted light and the resolving power of the grating.

Q7) What type of grating is used in this experiment?

A7) A plane transmission grating is used in this experiment, which consists of a flat glass or plastic substrate with closely spaced parallel lines ruled or etched on its surface.

Q8) What will happen if the slit is illuminated with white light?

A8) If the slit is illuminated with white light, the diffraction grating will produce a series of spectra, each with a different color(rainbows), because the white light is made up of a range of wavelengths that are diffracted at different angles.

Q9) What are the uses of diffraction grating?

A9) Diffraction gratings are widely used in spectroscopy, optical communications, astronomy, and other fields where precise wavelength measurement and spectral analysis are required. They are also used in various scientific instruments, such as spectrometers, monochromators, and laser systems.

Experiment 3 - Refractive Index Of Prism using spectrometer:

Q1) Define Refractive Index?

A: Refractive index is the ratio of the speed of light in vacuum to its speed in a medium. It is a measure of how much a medium can bend light as it passes through it.

Q2) Define Refractive Index in terms of Velocity of light?

A: Refractive index can be defined as the ratio of the velocity of light in a vacuum to the velocity of light in a particular medium.

Q3) What is sodium lamp?

A: A sodium lamp is a gas discharge lamp that produces a narrow line of yellow/orange light. It is often used as a monochromatic source in experiments that require light of a specific wavelength.

Q4) What is Monochromatic Light?

A: Monochromatic light is light of a single wavelength or frequency. It consists of only one color and does not contain any other colors.

Q5) Is sodium lamp a monochromatic source?

A: No, the light produced by a sodium lamp is not strictly monochromatic, but it is close to being monochromatic, as it mainly emits light at a wavelength of around 589 nm.

Q6) Why red coloured light is seen first when we switch on sodium lamp and then turns into yellow?

A: When the lamp is first turned on the sodium is not properly vaporised yet. Instead it is effectively a low light neon/argon light with some red from the neon, and some violet from the Argon. The combination of these two colours creates , pink light. This is where the pink colour comes from.

After a short while the sodium metal is warmed by the activity of the Neon/Argon light, and the sodium metal vaporizes, the colour becomes the more normal bright orange/yellow we are used to.

Q7) Define angle of deviation?

A: The angle of deviation is the angle between the incident ray and the emergent ray after passing through a prism. It is the angle by which a ray of light is bent when it passes through the prism.

Q8) What is angle of minimum deviation?

A: The angle of minimum deviation is the angle at which the deviation of a ray of light passing through a prism is at a minimum. At this angle, the deviation is the same for both the incident and emergent rays.

Q9) How does the deviation angle depend on the angle of prism?

A: The deviation angle depends on the angle of the prism and the refractive index of the material the prism is made of. The greater the angle of the prism, the greater the deviation angle.

Q10) Does deviation depend upon refractive index of material?

A: Yes, the deviation angle of a ray of light passing through a prism depends on the refractive index of the material the prism is made of. A higher refractive index will result in a greater deviation angle.

Q11) Which color in the spectrum deviates more and why?

A: The violet color in the spectrum deviates more than the red color when passing through a prism because violet light has a shorter wavelength and is bent more by the prism than red light, which has a longer wavelength.

Experiment 4 - Dispersive Power of Prism

Q1) What do you mean by dispersion? Is it a constant for a prism?

A1) Dispersion is the phenomenon of splitting white light into its component colors. Dispersion is not a constant for a prism, but it depends on the material of the prism.

Q2) Define the dispersive power.

A2) Dispersive power is defined as the degree of separation of colors produced by a prism. It is the ratio of angular dispersion to the mean deviation of light passing through a prism.

Q3) On what factors does the dispersive power of a prism depend?

A3) The dispersive power of a prism depends on the material of the prism, the angle of incidence of light on the prism, and the wavelength of light passing through the prism.

Q4) Can you find the dispersive power? What are its dimensions?

A4) Yes, the dispersive power can be found experimentally by measuring the angle of deviation and the angle of minimum deviation for different colors of light. The dimensions of dispersive power are inverse length (L^-1).

Q5) What is the unit of dispersive power? What are its dimensions?

A5) The unit of dispersive power is prism dioptre (pd). The dimensions of dispersive power are inverse length (L^-1).

Q6. Which prism is preferable - one made of flint with Ramsden's Eye Piece or Huygen's Eye Piece?

A: : In the experiment to determine the dispersive power of a prism, it is preferable to use a flint glass prism with a Ramsden's eye-piece instead of a Huygens' eye-piece. The Ramsden's eye-piece has two plano-convex lenses with their convex sides facing each other, which minimizes spherical aberration and gives a clear and bright image. On the other hand, the Huygens' eye-piece consists of two plano-convex lenses with their flat sides facing each other, which introduces chromatic aberration and causes the image to be less clear and less bright.

Furthermore, a flint glass prism is preferred over a crown glass prism because flint glass has a higher refractive index and thus a higher dispersive power. This allows for a greater separation of the colors in the spectrum, making it easier to measure the angles of deviation accurately.

Experiment 5 - Bar Pendulum:

Q1) **What is a compound pendulum?**

A1) A compound pendulum, also known as a physical pendulum, is a rigid body that oscillates about a pivot point, or axis of rotation, under the influence of gravity. Unlike a simple pendulum, which has a point mass suspended from a weightless rod, a compound pendulum has a physical mass distributed throughout its body.

Q2**) What do you mean by the center of suspension and center of oscillation?**

A2) The center of suspension is the point at which the pendulum is suspended from a fixed support, such as a knife edge or a pivot. The center of oscillation is the point at which the entire mass of the pendulum can be considered to be concentrated, such that the pendulum behaves as a simple pendulum with the same period of oscillation.

Q3**. What is the distance of the point having minimum time period from the center of gravity?**

A3) The point having minimum time period, or the center of oscillation, is located at a distance 'k' from the center of gravity of the pendulum. This distance 'k' is known as the radius of gyration of the pendulum and is a measure of the distribution of mass in the pendulum about its axis of rotation.

Q4**) About how many points does the time period of a compound pendulum remain the same?**

A4) The time period of a compound pendulum remains the same at two points: the center of percussion and the center of oscillation.

Q5) **What is the radius of gyration and what are its units?**

A5) The radius of gyration is the distance from the axis of rotation to a point where the entire mass of the body can be considered to be concentrated, such that the body behaves as a simple pendulum with the same period of oscillation. The units of radius of gyration are in meters or centimeters, depending on the units of the length used to measure it.

Q6) **Why is a compound pendulum superior to a simple pendulum?**

A6) A compound pendulum is superior to a simple pendulum in several ways. Firstly, it has a more complex motion, which makes it more interesting to study. Secondly, the motion of a compound pendulum is less affected by air resistance and other external factors, making it more accurate in measuring time. Lastly, a compound pendulum can have a wider range of shapes and sizes, making it more versatile in its applications.

Q7) **How does the period vary with the distance of knife edges from the center of gravity of the pendulum?**

A7) The period of a compound pendulum varies with the distance of the knife edges from the center of gravity of the pendulum. As the distance between the knife edges and the center of gravity decreases, the period of oscillation increases. Conversely, as the distance between the knife edges and the center of gravity increases, the period of oscillation decreases. This relationship can be expressed mathematically as $T = 2\pi\sqrt{(I/mgd)}$, where T is the period of oscillation, I is the moment of inertia of the pendulum, m is the mass of the pendulum, g is the acceleration due to gravity, and d is the distance between the knife edges and the center of gravity of the pendulum.

Q) **What is the time period of a compound pendulum at its center of gravity?**

The time period of a compound pendulum at its center of gravity is undefined because the compound pendulum does not behave like a simple pendulum at this point. The center of gravity is a point where the pendulum's weight appears to act and there is no torque acting on the pendulum to produce an oscillation. Instead, the compound pendulum will have a minimum time period at a point called the center of oscillation, which is located at a distance k from the center of gravity. The time period at the center of oscillation can be calculated using the formula $T = 2\pi\sqrt{(I/mgk)}$, where T is the time period, I is the moment of inertia of the pendulum, m is its mass, g is the acceleration due to gravity, and k is the distance between the center of gravity and the center of oscillation.

Experiment 6: LASER EXPERIMENT

Q1. What are coherent sources?

A coherent source is a source of electromagnetic waves that emit radiation of the same frequency, phase, and polarization with a constant phase difference between them. The waves emitted from a coherent source maintain a fixed phase relationship and can interfere constructively or destructively to produce a stable interference pattern.

Q2. Is a sodium lamp, LASER a coherent source?

A sodium lamp is not a coherent source because it emits light waves of different frequencies and phases. A LASER, on the other hand, is a coherent source because it emits a single frequency and phase of light, which maintains its coherence over a long distance.

Q3. What is stimulated and spontaneous emission?

Stimulated emission occurs when a photon of the same frequency and phase as an incident photon interacts with an excited atom or molecule, causing it to emit a second photon. This process results in the amplification of light waves and is the basis of LASER operation. Spontaneous emission, on the other hand, occurs when an excited atom or molecule decays to a lower energy level and emits a photon in a random direction with random phase and polarization.

Q4. Why are the readings of left and right spectrum different?

The readings of the left and right spectrum are different because of the birefringence of the calcite crystal used in the experiment. Birefringence causes the polarization of light to split into two perpendicular components, each with a different refractive index. These components travel at different speeds and experience different phase shifts, causing the interference pattern to shift in position. As a result, the positions of the fringes in the left and right spectra are different.

Experiment 7: Optical Fiber Experiment

Q1. Why must the refractive index of cladding always be lower than that of the core?
The refractive index of cladding must be lower than that of the core to ensure that the light remains confined within the core and does not leak out of the fiber. This is achieved by total internal reflection at the core-cladding interface, which occurs only if the angle of incidence of the light is greater than the critical angle, which in turn depends on the refractive indices of the core and cladding.

Q2. Define fiber optic system.

A fiber optic system is a communication system that uses optical fibers to transmit information in the form of light pulses. It consists of a transmitter, which converts electrical signals into light pulses and launches them into the fiber, a fiber optic cable, which carries the light pulses over long distances with minimal attenuation and distortion, and a receiver, which converts the light pulses back into electrical signals.

Q3. What are the advantages of using fiber optic communication system?

The advantages of using a fiber optic communication system include higher bandwidth, greater immunity to electromagnetic interference, longer transmission distances, lower attenuation and distortion, smaller size and weight, and greater security due to the difficulty of tapping into the fiber without detection.

Q4. Distinguish between acceptance angle and numerical aperture.

The acceptance angle is the maximum angle of incidence at which light can enter an optical fiber and still be propagated within the fiber by total internal reflection. The numerical aperture, on the other hand, is a measure of the light-gathering ability of the fiber and is defined as the sine of the half-angle of the acceptance cone. It determines the ability of the fiber to collect and transmit light from a source.

Q5. What is the purpose of cladding in optical fiber?

The purpose of cladding in optical fiber is to confine the light within the core by total internal reflection, and to protect the core from external damage and contamination. The cladding has a lower refractive index than the core, which ensures that the light remains confined within the core and does not leak out of the fiber.

Q6. How does the light propagate in an optical fiber?

The light propagates in an optical fiber by total internal reflection at the core-cladding interface. When light is launched into the fiber, it enters the core at an angle

of incidence greater than the critical angle, and is reflected back and forth within the core by total internal reflection. The light is confined within the core and propagates along the fiber without leaking out of the fiber.

Q7. Enumerate a few advantages of optical fiber over conventional copper cables.
The advantages of optical fiber over conventional copper cables include higher bandwidth, greater immunity to electromagnetic interference, longer transmission distances, lower attenuation and distortion, smaller size and weight, and greater security due to the difficulty of tapping into the fiber without detection.

Q8. What is an optical fiber and step index fiber?

An optical fiber is a thin, flexible, transparent fiber made of glass or plastic that is used to transmit light over long distances. A step index fiber is an optical fiber in which the refractive index of the core is constant across its cross-section, while the refractive index of the cladding is lower.

Q9. Does high temperature damage the fibers?

Yes, high temperature can damage optical fibers by causing thermal expansion and contraction, which can introduce stress and strain into the fibers and lead to permanent deformation or breakage.

Q10. How do you define numerical aperture?

Numerical aperture is a measure of the light-gathering ability of an optical fiber and is defined as the sine of the half-angle of the acceptance cone. It determines the ability of the fiber to collect and transmit light from a source.

Q11) Give an approximate idea of band width of single-mode and graded index fibres?

A11) Single-mode fibers typically have a bandwidth of a few hundred megahertz to several gigahertz, while graded index fibers have a bandwidth of tens to hundreds of megahertz. The exact bandwidth depends on the fiber length, attenuation, and dispersion characteristics. However, in general, single-mode fibers have a higher bandwidth than graded index fibers due to their lower dispersion and lower attenuation. This makes them more suitable for high-speed data transmission over long distances.

Experiment 8- Specific Rotation Experiment

Q1) What do you mean by polarized light?

A1) Polarized light is a type of light in which the vibrations of the electromagnetic waves are restricted to a single plane. This means that the electric field vector of the light waves oscillates in a fixed direction perpendicular to the direction of propagation. Polarized light can be produced by passing unpolarized light through a polarizer, which is a material that transmits only light waves with electric fields that oscillate in a specific plane.

Q2) What do you mean by half shade device or Laurent plate?

A2) A half shade device, also known as a Laurent plate, is a polarimeter accessory that is used to measure the angle of rotation of polarized light passing through a sample. It consists of two halves of a circular plate made of quartz or other birefringent material, with one half rotated 90 degrees with respect to the other. When inserted into a polarimeter, the half shade device produces a field of partially polarized light, which is used to measure the angle of rotation of a polarized beam passing through a sample.

Q3) Is light from sodium lamp polarized?

A3) No, light from a sodium lamp is not polarized. It is produced by the excitation of sodium atoms in a gas discharge, which emits light in all directions with random polarization.

Q4) What is the phenomenon of double refraction?

A4) Double refraction is a phenomenon that occurs when a light wave passes through certain materials, such as crystals, that have different refractive indices for different polarizations of light. As a result, the light wave is split into two waves with different polarizations and velocities, each of which follows a different path through the material.

Q5) What are uniaxial and biaxial crystals?

A5) Uniaxial crystals are crystals that have a single optical axis, which is a direction in the crystal where light propagates with a unique velocity and polarization. Biaxial crystals are crystals that have two different optical axes, each of which corresponds to a unique polarization and velocity of light. The behavior of polarized light passing

through uniaxial and biaxial crystals is different and can be used to study the properties of the crystal.

Q6) Why light waves can be polarized, while sound waves can't be polarized?

A6) Light waves are transverse waves, which means that the electric and magnetic fields oscillate perpendicular to the direction of wave propagation. This makes it possible to restrict the oscillation of the electric field to a single plane, producing polarized light. Sound waves, on the other hand, are longitudinal waves, which means that the oscillation of the wave occurs parallel to the direction of propagation. This makes it impossible to restrict the oscillation of the wave to a single plane, and thus sound waves cannot be polarized.

Experiment 9- **PLANCKS CONSTANT**

Q1) What is the photoelectric effect?

The photoelectric effect is the phenomenon of electrons being emitted from the surface of a material when it is exposed to light of appropriate frequency.

Q2) What is a photoelectric cell?

A photoelectric cell is a device that converts light energy into electrical energy by making use of the photoelectric effect. It is also called a photovoltaic cell.

Q3) What is Planck's constant and what is its value?

Planck's constant (denoted as h) is a fundamental constant of nature that relates the energy of a photon to its frequency. Its value is approximately 6.626 x 10^-34 joule seconds.

Q4) What sensitive material is used when the cell is to be used for visible light?

The sensitive material used in a photoelectric cell for visible light is generally a metal such as cesium or potassium.

Q5) On what factors does the number of electrons emitted per unit area depend?

The number of electrons emitted per unit area depends on the intensity and frequency of the incident light.

Q6) Define the terms work function and stopping potential.

The work function is the minimum amount of energy required to remove an electron from the surface of a material. Stopping potential is the minimum negative potential that needs to be applied to a photoelectric cell to stop the flow of electrons emitted by it.

Q7) What is the difference between photoelectric effect and thermionic emission?

Photoelectric effect and thermionic emission are both processes by which electrons can be emitted from a material, but in the former, the electrons are emitted due to the absorption of photons, while in the latter, the electrons are emitted due to the heating of the material.

Q8) What are the laws of photoelectric emission?

The laws of photoelectric emission are:

- The number of electrons emitted per unit time is directly proportional to the intensity of the incident light.
- The kinetic energy of the emitted electrons is proportional to the frequency of the incident light.
- There is a minimum frequency of the incident light (called the threshold frequency) below which no electrons are emitted, regardless of the intensity of the light.

Q9) What is threshold frequency?

Threshold frequency is the minimum frequency of the incident light below which no electrons are emitted by a material, regardless of the intensity of the light.

Experiment 10- Inverse Square Law Experiment:

Q1. What do you mean by inverse square law?

A1. The inverse square law states that the intensity of radiation decreases as the distance from the source increases, and this decrease in intensity is proportional to the inverse square of the distance.

Q2. Define intensity of illumination.

A2. The intensity of illumination refers to the amount of light energy per unit area per unit time falling on a surface. It is typically measured in units of lux or foot-candles.

Q3. What do you mean by photoconductivity?

A3. Photoconductivity is the phenomenon of an increase in the electrical conductivity of a material due to the absorption of light. When light is absorbed, electrons are excited from the valence band to the conduction band, increasing the conductivity of the material.

Q4. What is photovoltaics?

A4. Photovoltaics is the process of converting light energy into electrical energy using photovoltaic cells. When light is absorbed by a photovoltaic cell, it excites electrons and creates a flow of current.

Q5. What is a photoconductive cell?

A5. A photoconductive cell is a type of photoelectric device that uses the principle of photoconductivity to measure the intensity of light. When light is absorbed by the cell, its resistance decreases, allowing a current to flow through it.

Q6. What is a photovoltaic cell?

A6. A photovoltaic cell, also known as a solar cell, is a type of photoelectric device that converts light energy into electrical energy using the photovoltaic effect. When light is absorbed by the cell, it creates a flow of electrons, generating a voltage.

Q7. What is the photoelectric effect?

A7. The photoelectric effect is the phenomenon of the emission of electrons from a metal surface when light of a certain frequency or higher is incident on it. The electrons are emitted due to the absorption of energy from the light, and the effect is explained by the particle nature of light.