POLARIZATION:-

1 a)***define polarizarion of light***

Polarization refers to the restriction of the vibrations of light. It involves the alignment of the electric field vector of light waves in a specific direction. Light can be polarized in different ways, such as plane polarization, circular polarization, elliptical polarization, and partially polarized light. Polarization is possible only for transverse waves, as longitudinal waves cannot be polarized. Various devices, such as Nicol prisms, Polaroids, quarter-wave plates, and half-wave plates, work based on the principle of polarization. Polarization has several applications, including polarizing sunglasses, LCD and LED displays, 3D movies, and photoelasticity.

b)
sound waves cannot be polarized"explain

Sound waves are longitudinal waves, which means that the vibrations occur parallel to the direction of propagation. Unlike transverse waves, such as light waves, which have vibrations perpendicular to the direction of propagation, sound waves do not have a specific orientation that can be restricted or aligned. Therefore, it is not possible to polarize sound waves like we can with light waves.

c) **Polarized Goggles: Their Usefulness**

Polarized goggles are more useful in situations where there is a significant amount of glare from light sources such as white sand on a sea beach, water surfaces, and window glasses from cars. These goggles are effective in cutting the glare of light, reducing eye strain, and improving image clarity. They are particularly beneficial for activities like driving, water sports, and outdoor activities where glare can be a problem.

D) **Types of Polarization**
Assignment

e) **what is E and O ray?(e=extraordinary and o =ordinary)**

E and O rays refer to the two types of polarized light waves that are produced when light passes through a doubly refracting crystal.

- The **E ray** (extraordinary ray) is the ray of light that does not obey Snell's law and has a refractive index that varies with direction. It vibrates in a plane that is perpendicular to the plane of the paper.
- The **O ray** (ordinary ray) is the ray of light that obeys Snell's law and has a constant refractive index in all directions. It vibrates in a plane that is parallel to the plane of the paper.

2) state and explain

a)Malus law

It states that the intensity of light passing through a second polarizer is a cosine square function of the angle between the two polarizers. Mathematically, it can be represented as $I\ 2 = I\ 1\ cos$^2 θ, where I 2 is the intensity of light passing through the second polarizer, I 1 is the maximum intensity of light, and θ is the angle between the optic axes of the polarizers.

Explanation of Malus Law

When light passes through two polarizers, the intensity of the transmitted light depends on the angle between their optic axes. If the angle is 0 degrees or 180 degrees, the transmitted intensity is maximum, equal to I 1. As the angle increases, the transmitted intensity decreases, following a cosine square function. At an angle of 90 degrees, the transmitted intensity becomes zero.

b) Brewestear law

Brewster's Law, discovered by Sir David Brewster, states that when unpolarized light is incident on a nonmetallic medium, such as glass, at a specific angle called the polarizing angle, the reflected light becomes completely polarized. This means that the reflected light contains only vibrations perpendicular to the plane of incidence, while vibrations in the plane of incidence are completely absent

3. what is polarization of light ? what are different types of polarization .

Polarization of Light

Polarization refers to the restriction of the vibrations of light. It involves the alignment of the electric field vector of light waves in a specific direction. Light can be polarized in different ways, resulting in different types of polarized light.

Types of Polarized Light

There are several types of polarized light:

1. **Unpolarized Light (UPL):** Unpolarized light consists of vibrations that are randomly and uncoordinated in all possible directions perpendicular to the direction of propagation.
2. **Plane Polarized Light (PPL):** Plane polarized light occurs when the vibrations of light are restricted to a single plane. This can be achieved by passing unpolarized light through a polarizer.
3. **Circularly Polarized Light (CPL):** Circularly polarized light is produced when two plane polarized waves with a path difference of $\lambda/4$ are superimposed. The resulting wave has a circular motion.
4. **Elliptically Polarized Light (EPL):** Elliptically polarized light is also produced by superimposing two plane polarized waves, but with unequal amplitudes. The resulting wave has an elliptical motion.
5. **Partially Polarized Light (PRPL):** Partially polarized light is a combination of polarized and unpolarized light. It has some degree of polarization, but the vibrations are not restricted to a single plane.

4.i)Discuss the two applications of Polarization of light.

1. **Polarizing Sunglasses**: Polarization is used in the production of sunglasses to reduce glare from surfaces such as water, snow, and glass. The polarized lenses block horizontally polarized light, which is responsible for glare, while

allowing vertically polarized light to pass through. This helps to enhance visual clarity and reduce eye strain in bright outdoor conditions.

2. **LCD and LED Displays**: Liquid Crystal Displays (LCD) and Light Emitting Diode (LED) displays utilize polarization to control the transmission of light.LCD screens consist of liquid crystals that can be aligned to block or allow the passage of light based on their polarization.

ii)Give the name of crystals used to Polarize light. (any four)

1. Calcite: Calcite is a birefringent crystal that can be used to polarize light. It exhibits double refraction, where an incident beam is refracted into two rays, the ordinary (O) ray and the extraordinary (E) ray. These rays are plane polarized, with their planes of polarization perpendicular to each other.
2. Quartz: Quartz is another birefringent crystal commonly used for polarizing light. Like calcite, it exhibits double refraction and can create a path difference between the O and E rays. This path difference allows for the production of circularly polarized light (CPL) or elliptically polarized light (EPL) when the rays are superimposed.
3. Nicol Prism: Nicol prism is a specific type of crystal used for polarizing light. It is made from calcite and eliminates the O ray through total internal reflection. Nicol prisms are commonly used in polarizing microscopes and other optical instruments.
4. Polaroids: Polaroids are polarizing filters made from a special type of plastic film that contains aligned polymer chains. These filters selectively absorb one of the polarizations of light, allowing only the desired polarization to pass through. Polaroids are widely used in various applications, including sunglasses and LCD screens.

5 .Explain the concept of double refraction. State min. 3 properties exhibited by the Ordinary and extraordinary rays

Double Refraction

Double refraction refers to the phenomenon where a single incident beam of light splits into two refracted beams when passing through certain materials, such as calcite, quartz, tourmaline, and ice. These materials are known as birefringent materials.

Properties of Ordinary (O) Ray

1. The vibrations of the Ordinary (O) ray are perpendicular to the plane of the paper.
2. The refractive index of the birefringent crystal for the O ray remains the same in all directions.
3. The O ray obeys Snell's law.

Properties of Extraordinary (E) Ray

1. The vibrations of the Extraordinary (E) ray are in the plane of the paper.
2. The refractive index of the birefringent crystal for the E ray varies with direction.
3. The E ray does not obey Snell's law.

QUESTIONS ON QUANTUM

1.Postulates of the Planck's Quantum Theory

1. **Quantization of Energy**: The energy of a system can only take on certain discrete values, rather than any value. This is due to the quantized nature of energy levels in quantum mechanics.
2. **Wave-Particle Duality**: Particles, such as electrons, can exhibit both wave-like and particle-like behavior. This means that they can have characteristics of both waves and particles, depending on the experimental setup.
3. **Uncertainty Principle**: There is a fundamental limit to the precision with which certain pairs of physical properties, such as position and momentum, can be simultaneously known. This principle introduces inherent uncertainties in the measurements of these properties.
4. **Wavefunction and Probability**: The behavior of particles is described by a mathematical function called the wavefunction. The square of the wavefunction, known as the probability density, gives the probability of finding the particle in a particular state.
5. **Superposition and Interference**: Quantum systems can exist in a superposition of multiple states simultaneously. When these states interfere, they can produce patterns of constructive and destructive interference, leading to observable effects.
6. **Measurement and Collapse**: When a measurement is made on a quantum system, the wavefunction collapses to a specific state corresponding to the measurement outcome. This collapse is probabilistic and governed by the probabilities determined by the wavefunction.

These postulates form the foundation of Planck's quantum theory and provide a framework for understanding the behavior of particles and energy at the atomic and subatomic levels.

II) Planck's radiation law

Planck's radiation law is a fundamental principle in physics that explains the spectrum of radiation emitted by a black body. It was developed by Max Planck in the early 20th century. The law states that the energy of the radiation emitted by a black body is quantized, meaning it can only take on certain discrete values. This quantization is described by the equation E = nhv, where E is the energy, n is an integer, h is Planck's constant, and v is the frequency of the radiation. Planck's radiation law was a significant breakthrough in understanding the behavior of electromagnetic waves and laid the foundation for the development of quantum mechanics.

2.What is de Broglie hypothesis?

De Broglie hypothesis suggests that particles such as electrons and photons exhibits both wave like and particle like behaviour .
It states that every particle or object with mass exhibits wave like properties .
This wave particle duality is fundamental concept in quantum mechanics implying that particles can be described not only in terms of particles but laso in terms of waves.

ii)formulate the De Broglie wavelength equation for the electron of charge q moving in the presence of accelerating electric potential V.

De Broglie Wavelength Equation for Electron in the Presence of Accelerating Electric Potential V

The De Broglie wavelength equation for an electron of charge q moving in the presence of an accelerating electric potential V can be formulated as follows:

$\lambda = h / \sqrt{(2mqV)}$

Where:

- λ is the De Broglie wavelength of the electron
- h is Planck's constant
- m is the mass of the electron
- q is the charge of the electron
- V is the accelerating electric potential

This equation relates the De Broglie wavelength of the electron to its mass, charge, and the accelerating electric potential it experiences.

5.Write down any three properties of matter waves

Properties of Matter Waves

1. **Wave Nature**: Matter waves, also known as De Broglie waves, exhibit wave-like properties. They have characteristics such as wavelength, frequency, amplitude, and displacement. Unlike particles, matter waves are delocalized and spread in space.
2. **Quantization**: The energy of matter waves is quantized, meaning it is restricted to discrete values. This quantization is similar to the quantization observed in the energy levels of atoms and molecules. The energy levels of matter waves are not continuous but exist in specific, discrete amounts.
3. **Dual Nature**: Matter waves possess a dual nature, just like electromagnetic waves. They can exhibit both wave-like and particle-like properties depending on the experimental situation. This duality suggests that material particles, such as electrons or atoms, can also exhibit wave properties under certain conditions.

Diffraction and Interference

1.a when a light beam can be considered coherent?

A light beam can be considered coherent if the phase difference between any two points on the wave remains constant with respect to time

examples of coherent and non-cohernet sources of light

Coherent Sources of Light

Coherent sources of light are those that emit waves with a constant phase difference between them. Here are some examples of coherent sources of light:

1. **Laser**: Laser light is highly coherent and is often considered the best coherent source of light. It is produced through the process of stimulated emission and

amplification of light. Laser light is monochromatic, directional, and can generate a well-defined interference pattern.

2. **Division of Wavefront**: In the technique of division of wavefront, a point monochromatic source of light emits primary wavefronts, which are then divided into two secondary wavefronts. These wavefronts are coherent as they are derived from the same source.
3. **Division of Amplitude**: In the technique of division of amplitude, a semi-silvered glass plate is used to divide a ray of light into two parts. These two parts can interfere with each other and create an interference pattern. This technique also produces coherent light.

Non coherent not found

1.c 'Only coherent light waves can interfere'- Explain what is wrong with this statement?

The statement "only coherent light waves can interfere" is incorrect .

Interference occurs when two or more waves overlaps and combine to form a new wave . coherence refers to the phase relationship between waves.

Coherent light waves have a constant phase relationship ,making interference pattern more stable and defined ,but interference can still occur between non coherent light waves, although thev resulting pattern may be less distinct. So both, coherent and non coherent light waves can interfere under appropriate conditions.

2.a. In an interference pattern, where does the energy of the light at the dark fringe go to?

In an interference pattern, the energy of the light at the dark fringe is not destroyed. Instead, it is redistributed within the pattern. At the dark fringe, the intensity of the light is decreased, but this does not mean that the energy is lost. The energy that was supposed to be at the dark fringe is transferred to the bright fringes, resulting in an enhancement of intensity at those points. Therefore, in interference, there is a redistribution of energy rather than creation or destruction.

2.b.

Diffraction and interference are two phenomenon exhibited by light, what are the scenarios in which diffraction happens and when does interference occur, or is it like always both are happening as light propagates?

Diffraction occurs when light encounters an obstacle or a slit that is comparable in size to its wavelength. This results in the bending or spreading out of the wavefront, creating a pattern of maxima and minima. Diffraction can be observed when light passes through a single slit or encounters an obstacle with finite width.

Interference, on the other hand, occurs when two or more waves superpose or overlap with each other. This can happen when light waves from different sources or from different parts of the same source combine. Interference results in the formation of alternate maxima and minima in the pattern of light intensity.

In the case of light propagation, both diffraction and interference can occur simultaneously.

2.c.Assume two light beams are incident at the same region of a screen, one beam is horizontally polarized and the other is vertically polarized. Would we see interference pattern on the screen?

No, we would not see an interference pattern on the screen when two light beams, one horizontally polarized and the other vertically polarized, are incident at the same region. Interference patterns are produced when two coherent light waves superpose, and in this case, the two light beams have perpendicular polarizations and are not coherent. Therefore, no interference pattern would be observed on the screen.

3.Describe how polarization is used in each of the following cases a. LCD display b. Sunglasses

a. LCD display

Polarization is used in LCD displays to control the intensity and color of light. A system of two polarizers with liquid crystals placed in between them can produce red, green, and blue light with different intensities. By adjusting the orientation of the liquid crystals, the polarized light can be manipulated to create different colors and shades, allowing for the display of images and videos on LCD screens.

b. Sunglasses

Polarization is used in sunglasses to reduce glare and improve visibility. When light reflects off surfaces such as water, sand, or glass, it becomes polarized and vibrates in a specific direction. Polarized sunglasses have a special filter that blocks this horizontally polarized light, reducing glare and improving clarity. This helps to enhance visual comfort and reduce eye strain, making polarized sunglasses ideal for outdoor activities such as driving, fishing, and skiing.

2.a. Give two examples of randomly polarized light

Examples of Randomly Polarized Light

1. **Unpolarized Light (UPL):** Ordinary light emitted by spontaneous excitations of atoms is an example of randomly polarized light. The vibrations of the electric and magnetic fields in UPL are random and uncoordinated, vibrating in all possible directions perpendicular to the direction of propagation.
2. **Natural Sunlight:** Sunlight is another example of randomly polarized light. The vibrations of the electric and magnetic fields in sunlight are also random and uncoordinated, vibrating in all possible directions perpendicular to the direction of propagation.

2.b.How can you generate linearly polarized light from a source which is randomly polarized?

Generating Linearly Polarized Light from Randomly Polarized Source

To generate linearly polarized light from a randomly polarized source, we can use a polarizer. A polarizer is a device that allows only vibrations in a specific direction to pass through. By placing a polarizer in front of the randomly polarized source, it will selectively transmit light vibrations that are parallel to its optic axis, while blocking vibrations in other directions.

Suppose you have a source emitting vertically polarized light, and you have 3 polarizers at your disposal, how can you generate horizontally polarized light?

2.c.Suppose you have a source emitting vertically polarized light, and you have 3 polarizers at your disposal, how can you generate horizontally polarized light?

To generate horizontally polarized light from a source emitting vertically polarized light, you can use a combination of polarizers.

1. Start with the vertically polarized light emitted by the source.
2. Place the first polarizer in the path of the light and align it vertically, parallel to the polarization of the source.
3. Rotate the second polarizer by 90 degrees, so that it is aligned horizontally.
4. Finally, place the third polarizer in the path of the light and align it horizontally as well.

By passing the vertically polarized light through the first polarizer, it will only allow vertically polarized light to pass through. Then, by rotating the second polarizer to be aligned horizontally, it will block the vertically polarized light and only allow horizontally polarized light to pass through. The third polarizer, aligned horizontally, will further enhance the horizontal polarization of the light.

As a result, the combination of these three polarizers will generate horizontally polarized light from the initially vertically polarized light source

QUANTUM

a Mention an experiment, where we can see the particle-like nature of waves.

One experiment that demonstrates the particle-like nature of waves is the photoelectric effect. In this experiment, when light is shone on a metal surface, electrons are emitted. The intensity of the light determines the number of electrons emitted, while the frequency of the light determines their kinetic energy. This phenomenon cannot be explained by wave theory alone and requires the concept of photons, which are particles of light. The photoelectric effect provides evidence that light behaves as both a wave and a particle

b. Mention an experiment, where we can see the wave-like nature of particles.

Experiment: Electron Diffraction

One experiment where we can observe the wave-like nature of particles is electron diffraction. In this experiment, electrons are passed through a material, such as a thin metal foil, and they exhibit well-defined diffraction patterns. This phenomenon was observed by Davisson, Germer, and G.P. Thomson, who were awarded the Nobel Prize in physics in 1937 for their work. The diffraction patterns observed in this experiment provide evidence for the wave-like behavior of electrons.

c. If particles have wave-like properties, explain if we all have wave like properties and what are its consequences? Not found

d. What are the requirements for a average human being to have a matter wave of 1x10^-6 m. Can these requirements be achieved?

To have a matter wave with a wavelength of 1x10^-6 m, an average human being would need to possess a momentum that corresponds to this wavelength. According to the De Broglie wavelength equation, $\lambda = h/p$, where λ is the wavelength, h is Planck's constant, and p is the momentum.

To achieve a matter wave with a wavelength of 1x10^-6 m, the momentum of the human being would need to be such that $p = h/\lambda$. However, the given document does not provide any information about the momentum of an average human being or how it can be altered to achieve a specific matter wave wavelength.

Therefore, based on the given document data, we cannot determine the specific requirements for an average human being to have a matter wave of 1x10^-6 m, nor can we determine if these requirements can be achieved.