Competitive Exams: Reflection, Absorption, Interference of Light

Reflection of Light

If we draw a line perpendicular to a surface, this line is the normal of the surface. When a ray of light hits the surface of an object, part of the light is reflected. If the ray of light is in angle with the surface, then the angle between the incident ray and the normal will be the same angle between the normal and the reflected ray.

They are not completely flat surfaces. When millions of rays of light hit the rough surface of an object, they are reflected in all directions. This is how we can see illuminated objects.

Refraction of Light

When a ray of light passes from one medium to another, it bends. Depending of the new medium the light will travel faster or slower. If the light travels faster in the second medium, then this medium is called the rarer medium. On the other hand, the medium in which the light travels slower, in this case the first one, is called the denser medium.

When a ray of light enters a denser medium, it is bent towards the normal.

When a ray of light enters a rarer medium, it is bent away from the normal.

There is an index of refraction (n) between the two mediums. To get a value, we have to divide the sine of the angle in vacuum or air by the sine of the angle in the denser medium.

In the example above, the index of refraction would be $n = \sin a/\sin b$

Some of the light is always reflected. However, when a ray of light goes from a denser medium to a rarer medium, all the light will be reflected if the angle of incidence is greater than the critical angle. The critical angle is the angle of incidence for which the refracted ray is at 90 degrees with the normal.

Absorption

Light falling on an object may be absorbed, transmitted, or reflected. What happens to it depends on the color of the object: a red object reflects red light and absorbs much of the rest of the other colors that we see. The color of an object is that color which is reflected rather than absorbed. Absorption, in optics, is the process by which the energy of a photon is taken up by another entity, for example, by an atom whose valence electrons make a transition between two electronic energy levels. The photon is destroyed in the process. The absorbed energy can be lost by heat and radiation.

The absorbance of an object quantifies how much light is absorbed by it. This may be related to other properties of the object through the Beer-Lambert law. For most substances, the amount of absorption varies with the wavelength of the light, leading to the appearance of colour in pigments that absorb some wavelengths but not others. For example, an object that absorbs blue, green and yellow light will appear red when viewed under white light. More precise measurements at many wavelengths allow the indentification of a substance via absorption spectroscopy.

Interference

Interference is the superposition of two or more waves resulting in a new wave pattern. As most commonly used, the term usually refers to the interference of waves which are correlated or coherent with each other, either because they come from the same source or because they have the same or nearly the same frequency. Two non-monochromatic waves are only fully coherent with each other if they both have exactly the same range of wavelengths and the same phase differences at each of the constituent wavelengths.

The principle of superposition of waves states that the resultant displacement at a point is equal to the sum of the displacements of different waves at that point. If a crest of a wave meets a crest of another wave at the same point then the crests interfere constructively and the resultant wave amplitude is greater. If a crest of a wave meets a trough then they interfere destructively, and the overall amplitude is decreased. Interference is the net effect of the combination of two or more wave trains moving on intersecting or coincident paths. The effect is that of the addition of the amplitudes of the individual waves at each point affected by more than one wave.

If two of the components are of the same frequency and phase (i.e.. they vibrate at the same rate and are maximum at the same time), the wave amplitudes are reinforced, producing constructive interference; but, if the two waves are out of phase by ½ period (i.e.. one is minimum when the other is maximum), the result is destructive interference, producing complete annulment if they are of equal amplitude.

One of the best examples of interference is demonstrated by the light reflected from a film of oil floating on water or a soap bubble, which reflects a variety of beautiful colors when illuminated by natural or artificial light sources.

Polarisation

In electrodynamics, polarization (also spelled polarisation) is a property of waves, such as light and other electromagnetic radiation. Unlike more familiar wave phenomena such as waves on water or sound waves, electromagnetic waves are three-dimensional, and it is their vector nature that gives rise to the phenomenon of polarization.

Natural sunlight and most forms of artificial illumination transmit light waves whose electric field vectors vibrate in all perpendicular planes with respect to the direction of propagation. When the electric field vectors are restricted to a single plane by filtration then the light is said to be polarized with respect to the direction of propagation and all waves vibrate in the same plane.

Lenses

A lens is a device for either concentrating or diverging light, usually formed from a piece of shaped glass. Analogous devices used with other types of electromagnetic radiation are also called lenses: For instance, a microwave lens can be made from paraffin wax.

There are differently shaped lenses. A concave lens makes objects appear smaller, while a convex lens makes them appear bigger.