Competitive Exams: Optical Instruments and Luminous Flux

Prisms

When a beam of white light passes through a raindrop, or a glass prism, it is split into the colours of the rainbow. In optics, a prism is a device used to refract light, reflect it or break it up (to disperse it) into its constituent spectral colours (colours of the rainbow). The traditional geometrical shape is that of a triangular prism, with a triangular base and rectangular sides. Some types of optical prisms are not in fact in the shape of geometric prisms.

As light moves from one medium (e. g. Air) to another denser medium (the glass of the prism), it is slowed down and as a result either bent (refracted) or reflected. The angle that the beam of light makes with the interface as well as the refractive indices of the two media determine whether it is reflected or refracted, and by how much (see refraction, total internal reflection).

Reflective prisms are used to reflect light, for instance in binoculars, since they are easier to manufacture than mirrors. Dispersive prisms are used to break up light into its constituent spectral colours because the refractive index depends on frequency (see dispersion); the white light entering the prism is a mixture of different frequencies, each of which gets bent slightly differently. Blue light is slowed down more than red light and will therefore be bent more than red light. There are also polarizing prisms (also known as birefringent prisms) which can split a beam of light into components of varying polarization.

Isaac Newton first thought that prisms split colours out of colourless light. Newton placed a second prism such that a separated colour would pass through it and found the colour unchanged. He concluded that prisms separate colours. He also used a lens and a second prism to recompose the rainbow into white light.

Eye

Your eye projects an upside-down image of what you are looking at on to the retina. Special cells in the retina transmit information about the light that hits them to the brain, which then builds up a picture we can see. The lens in the eye ensures that we see a sharp and well-focussed image.

Short Sight

Short sight. The eyes, in people who suffer from short sight, focus light from a distant object in front of the retina. A concave lens will correct this.

Long sight. The eyes, in people who suffer from long sight, focus light from a near object behind the retina. A convex lens will correct this.

Cameras

A camera is a device used to take pictures (usually photographs), either singly or in sequence, with or without sound recording, such as with video cameras. A camera that takes pictures singly is sometimes called a photo camera to distinguish it from a video camera. The name is derived from camera obscura, Latin for “dark chamber” an early mechanism for projecting images in which an entire room functioned much as the internal workings of a modern photographic camera, except there was no way at this time to record the image short of manually tracing it. Cameras may work with the visual spectrum or other portions of the electromagnetic spectrum.

A lens is used in a camera to allow both a large hole (aperture) and a sharp image. The lens bends the light rays from a single point on the object back to a single focussed point on the film.

SLR Camera

- Single-lens reflex camera. A modern camera directs the light from the lens to the viewfinder, via a mirror. When the button is pressed, the mirror flips up, the shutter opens and the focussed light falls on the film.
- Pinhole camera. A pinhole camera can take a very sharp photograph. This is because the pinhole is very small and only lets through a tiny amount of sharply-focussed light. It can take several minutes before enough light has reached the film for a picture to form.
- Pinhole image-focussed. Like the eye, a pinhole camera projects an upside-down image. The pinhole is very small and only lets through a tiny amount of sharply-focussed light.
- Pinhole image-unfocussed. When the pinhole is large, the light from a single point on the object gives a blurred image on the film.

Microscopes & Magnifiers

This common microscope can be found in many school laboratories. A mirror is used to direct light through the specimen.

A microscope (Greek: Micron = small and scopos = aim) is an instrument for viewing objects that are too small to be seen by the naked or unaided eye. The science of investigating small objects using such an instrument is called microscopy, and the term microscopic means minute or very small, not easily visible with the unaided eye. In other words, requiring a microscope to examine.

The most common type of microscope and the first to be invented is the optical microscope. This is an optical instrument containing one or more lenses that produce an enlarged image of an object placed in the focal plane of the lens (es).

Diode

Diode rectifies or converts alternating current (AC) to direct current (DC).

Diode is made of two different parts. One part is called p-type and other part is called n-type. In between, we call it the p-n junction. P-type is silicon mixed with boron, and n-type is silicon mixed with phosphorous. In order to explain how it works, we must know about the octet rule and valence electrons.

The octet rule is that bonded nonmetialic atoms has eight electron outermost shell or energy level. It means that when two chemicals react each other and produce a product, its outer shell has eight electrons. The valence electrons are the electrons moving aroung the most outer shell of an individual atom and they are often involved into chemical reaction bonding.

LED (Light Emitting Diode)

LED is Light Emitting Diode and there are many types of LED. It is made of semiconductors which is related with Gallium and Arsenic. Some can emit light, and some can detect light, and some can even detect radiation. LED is used as light indicators which can be seen in almost every electronic product (such as TV remote controller, sign of computer screen, Num Lock light in keyboard, score board, etc). It works exactly the same as diode, but when electrons jump from n-type to p-type, they lose some energy which is converted to light. Because all the energy is converted to light, LEDs do not consume much energy and can operate at low voltages. They should not be operated at more than 40 mA (miliampere) or 0.04 A (ampere) or 2.2 V (volts). Otherwise, they will blow up:

LED emission is visible in the spectrum wavelengths from 0.4 to 0.7m or in the near infrared, which we cannot see, that of wavelengths between 2.0 and 0.7 m. More than 20 billion LEDs are produced each year.

Luminous and Illuminated Bodies

Light is produced by a luminous body. A light bulb is a luminous body that emits light in almost every direction. Light travels in straight lines at 299, 792, 458 m per sec in vacuum. When light hits an object, it is reflected. An illuminated body reflects light.

When a ray of light reaches our eyes, the receptors in our eyes will produce a different color sensation depending on the wavelength of the light wave.

Luminous Flux and Illuminance

The amount of light produced per unit of time is called the luminous flux, P. The unit for this is the lumen, lm.

If we only want to know the amount of light produced by a source on a specific object (table, chair), we have to use the formula for illuminance, E. This formula tells us the amount of light per meter square at a certain distance. $E = P/4 (\pi) d^2$

Thus, the illuminance is just the luminous flux divided by the area of a sphere. Why a sphere? For example, lets put two objects in different places, both of them two meters away from a source of light.

As you can see the illuminance on these objects is the same. This is because almost every source of light emits light in all directions and two objects within the same radius receive the same amount of light. However, objects that are placed at different distances have different illuminations.

The closer an object is to a source of light, the more illuminated it will be.

Colors

Red, green and blue are known as primary colors, because when they are added together white light is formed.

By mixing primary colors in pairs we obtain secondary colors. Red and green produce yellow. Blue and red produce magenta, and blue and green produce cyan.