

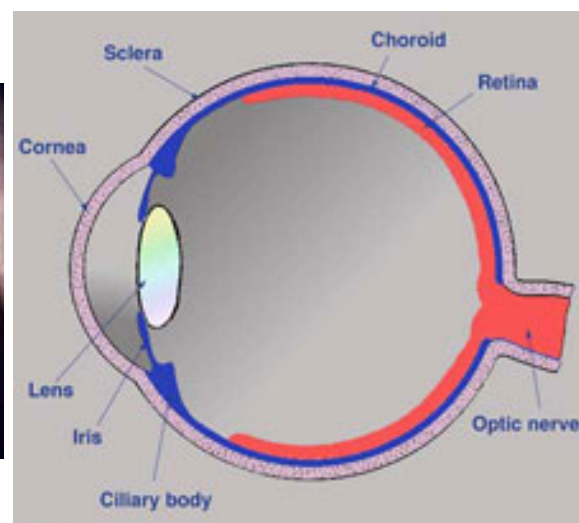
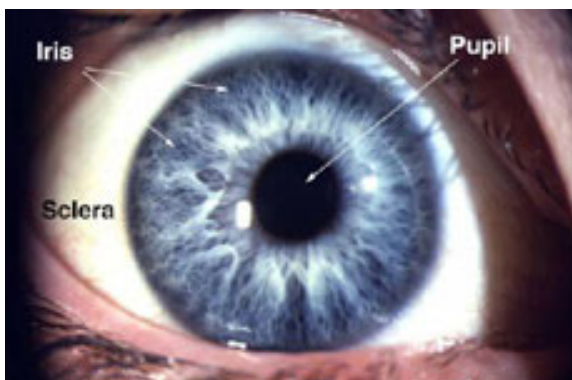
Visual Acuity of the Human Eye

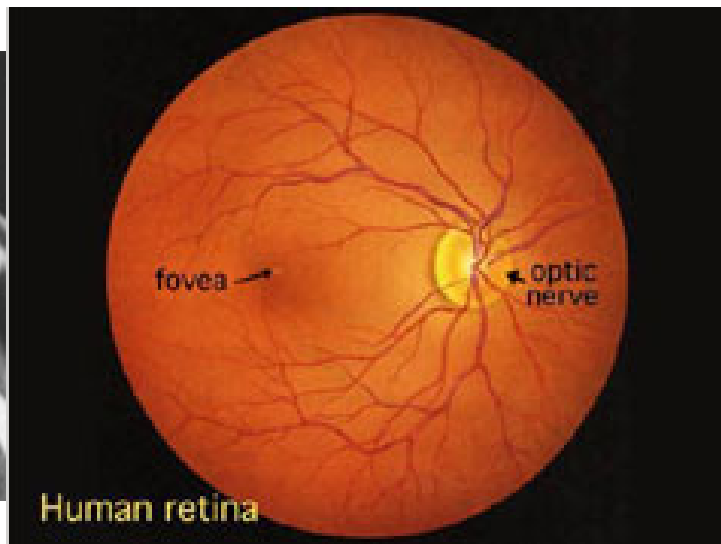
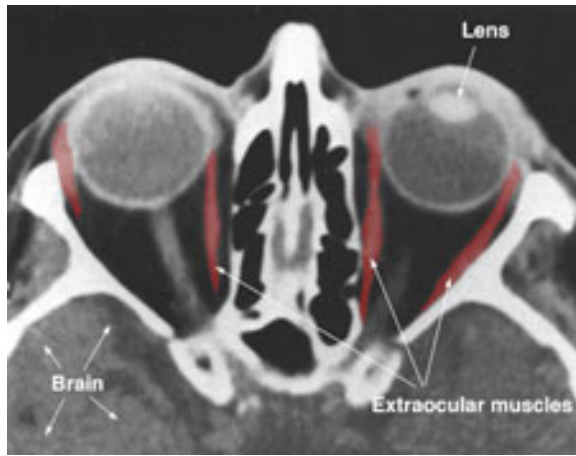
The eye has a visual acuity

Visual Acuity - The space visible to an eye in a given position of gaze.
threshold

Threshold - In reference to current or magnetic fields, the minimum strength necessary to create a looked-for effect is called the threshold value. For example, the minimum current necessary to produce a readable indication of a given defect is the threshold value of current for the purpose. below which an object will go undetected. This threshold

Threshold - In reference to current or magnetic fields, the minimum strength necessary to create a looked-for effect is called the threshold value. For example, the minimum current necessary to produce a readable indication of a given defect is the threshold value of current for the purpose. varies from person to person, but as an example, the case of a person with normal 20/20 vision can be considered. As light enters the eye through the pupil, it passes through the lens and is projected on the retina at the back of the eye. Muscles called extraocular muscles, move the eyeball in the orbits and allow the image to be focused on the central retinal or fovea.





The retina is a mosaic of two basic types of photoreceptors: rods, and cones. Rods are sensitive to blue-green light with peak sensitivity

Sensitivity - A measure of the ability to detect small signals. Limited by the signal-to-noise ratio. at a wavelength

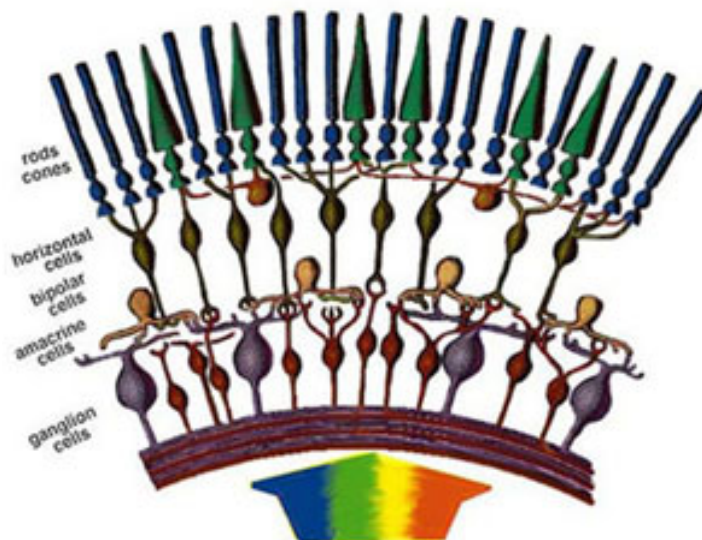
Wavelength - The distance needed in the propagation direction for a wave to go through a complete cycle.

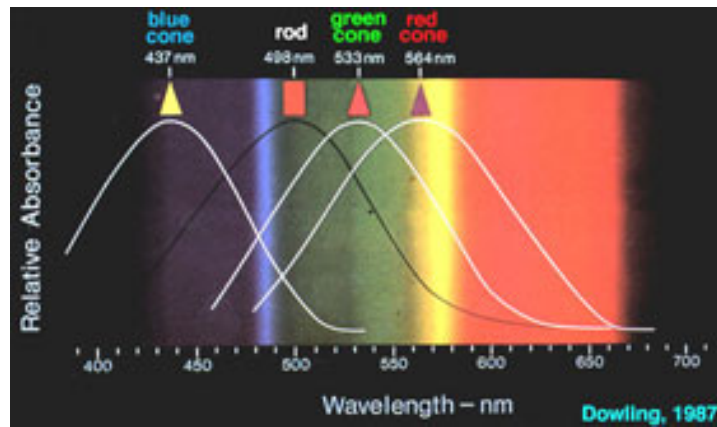
of 498 nm, and are used for vision under dark or dim conditions. There are three types of cones that give us our basic color vision: L-cones (red) with a peak sensitivity

Sensitivity - A measure of the ability to detect small signals. Limited by the signal-to-noise ratio. of 564 nm, M-cones (green) with a peak sensitivity

Sensitivity - A measure of the ability to detect small signals. Limited by the signal-to-noise ratio. of 533 nm, and S-cones (blue) with a peak sensitivity

Sensitivity - A measure of the ability to detect small signals. Limited by the signal-to-noise ratio. of 437 nm.

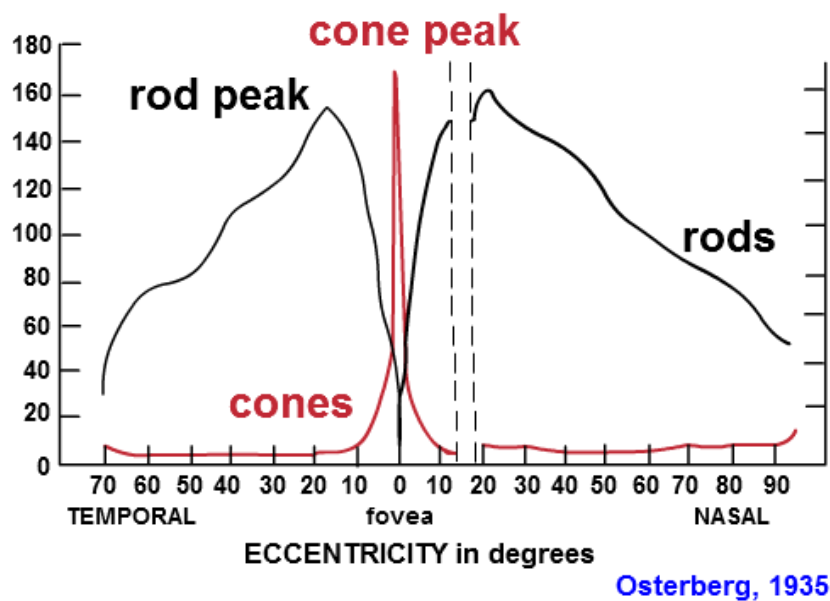




Cones are highly concentrated in a region near the center of the retina called the fovea region. The maximum concentration of cones is roughly 180,000 per square mm in the fovea region and this density

Density - The mass of a substance per unit volume.

decreases rapidly outside of the fovea to a value of less than 5,000 per square mm. Note the blind spot caused by the optic nerve which is void of any photoreceptors.



The standard

standard - A reference object used as a basis for comparison or calibration. - A concept established by authority, custom or agreement to serve as a model or rule in the measurement of quantity or the establishment of a practice or procedure.

definition

Definition - The sharpness of features on a radiograph that correspond to boundaries from thickness or material density changes in the radiographed component.

of normal visual acuity

Visual Acuity - The space visible to an eye in a given position of gaze.

(20/20 vision) is the ability to resolve a spatial pattern separated by a visual angle of one minute of arc. Since one degree contains sixty minutes, a visual angle of one minute of arc is 1/60 of a degree.

The spatial resolution

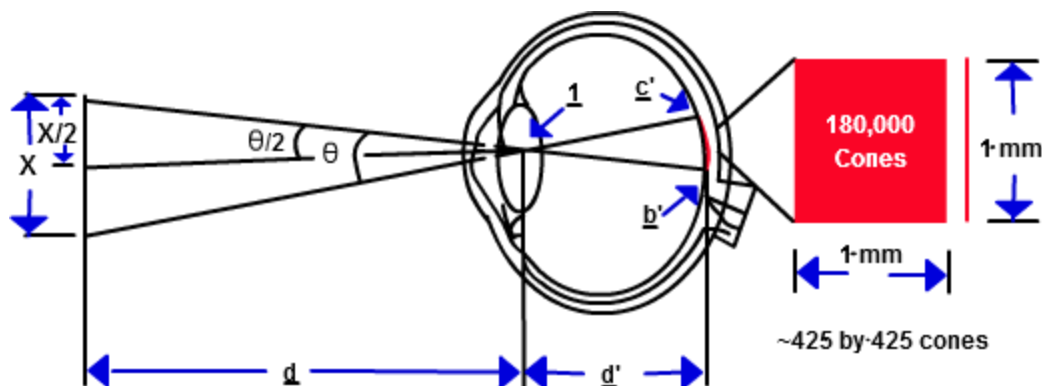
Resolution - The ability to clearly distinguish signals obtained from two reflective surfaces with a minimum difference in depth. Near surface resolution is the ability to clearly distinguish a signal from a reflector at a minimum distance under the near surface without interference from the initial pulse signal. Far surface resolution is the ability to clearly distinguish signals from the back surface when the sound beam is normal to that back surface.

limit is derived from the fact that one degree of a scene is projected across 288 μm of the retina by the eye's lens.

In this 288 μm , there are 120 color sensing cone cells packed. Thus, if more than 120 alternating white and black lines are crowded side-by-side in a single degree of viewing space, they will appear as a single gray mass to the human eye. With a little trigonometry, it is possible to calculate the resolution

Resolution - The ability to clearly distinguish signals obtained from two reflective surfaces with a minimum difference in depth. Near surface resolution is the ability to clearly distinguish a signal from a reflector at a minimum distance under the near surface without interference from the initial pulse signal. Far surface resolution is the ability to clearly distinguish signals from the back surface when the sound beam is normal to that back surface.

of the eye at a specific distance away from the lens of the eye.



For the case of normal visual acuity

Visual Acuity - The space visible to an eye in a given position of gaze.

the angle Theta is 1/60 of a degree. By bisecting this angle we have a right triangle with angle Theta/2 that is 1/120 of a degree. Using this right triangle it is easy to calculate the distance $X/2$ for a given distance d .

$$\frac{X}{2} = d \frac{\tan \theta}{2}$$

When visually inspecting an object for a defect

Defect - A discontinuity or other imperfection causing a reduction in the quality of a material or component.

such as a crack

Crack - A long narrow discontinuity

, the distance (d) might be around 12 inches. This would be a comfortable viewing distance. At 12

inches, the normal visual acuity

Visual Acuity - The space visible to an eye in a given position of gaze.

of the human eye is 0.00349 inch. What this means is that if you had alternating black and white lines that were all 0.00349 inch wide, it would appear to most people as a mass of solid gray.

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Contrast Sensitivity

When conducting a visible dye penetrant

Visible dye penetrant - An intensely colored (usually red) highly penetrating liquid which will provide maximum contrast with the white developer when used for detection of surface discontinuities.

inspection, the contrast sensitivity

Contrast Sensitivity - Being able to differentiate between an object and its background of the eye is important. Contrast sensitivity

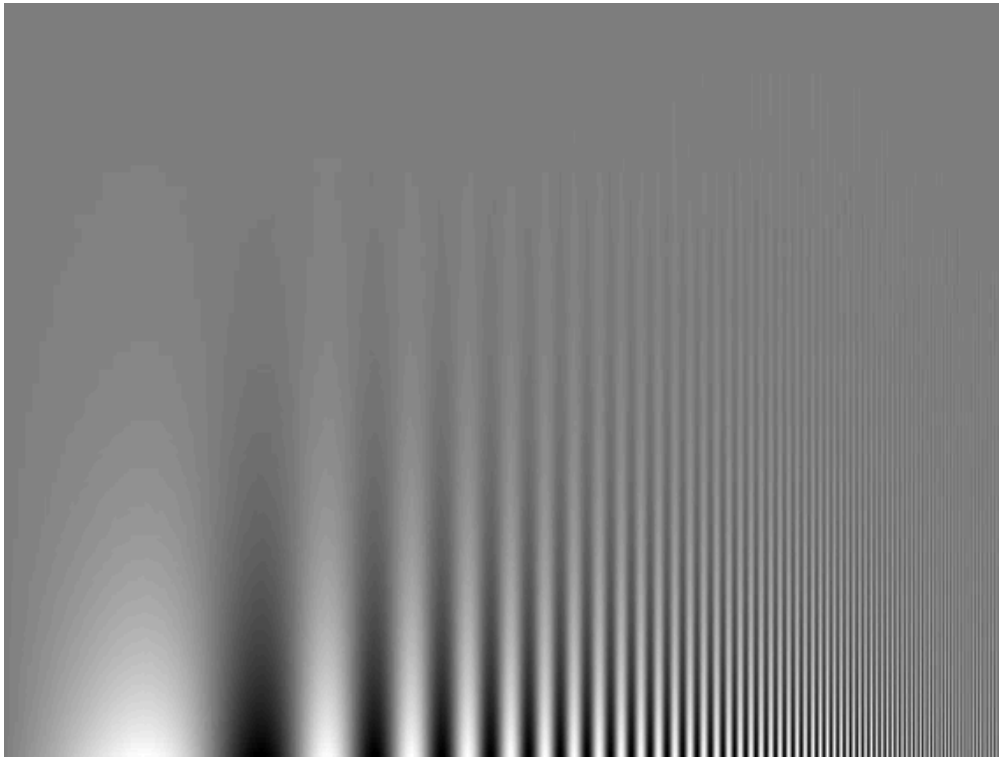
Contrast Sensitivity - Being able to differentiate between an object and its background is a measure of how faded or washed out an image can be before it becomes indistinguishable from a uniform field. It has been experimentally determined that the minimum discernible difference in gray scale level that the eye can detect is about 2% of full brightness. Contrast sensitivity

Contrast Sensitivity - Being able to differentiate between an object and its background is a function of the size or spatial frequency

Frequency - The number of waves that pass a given point in a specified unit of time. of the features in the image. However, this is not a direct relationship as larger objects are not always easier to see than smaller objects (as demonstrated by the image below).

In the image below, the luminance of pixels is varied sinusoidally in the horizontal direction. The spatial frequency

equency - The number of waves that pass a given point in a specified unit of time. increases exponentially from left to right. The contrast also varies logarithmically from 100% at the bottom to about 0.5% at the top. The luminance of peaks and troughs remains constant along a given horizontal path through the image. If the detection of contrast was dictated solely by image contrast, the alternating bright and dark bars should appear to have equal height everywhere in the image. However, the bars seem to be taller in the middle of the image.

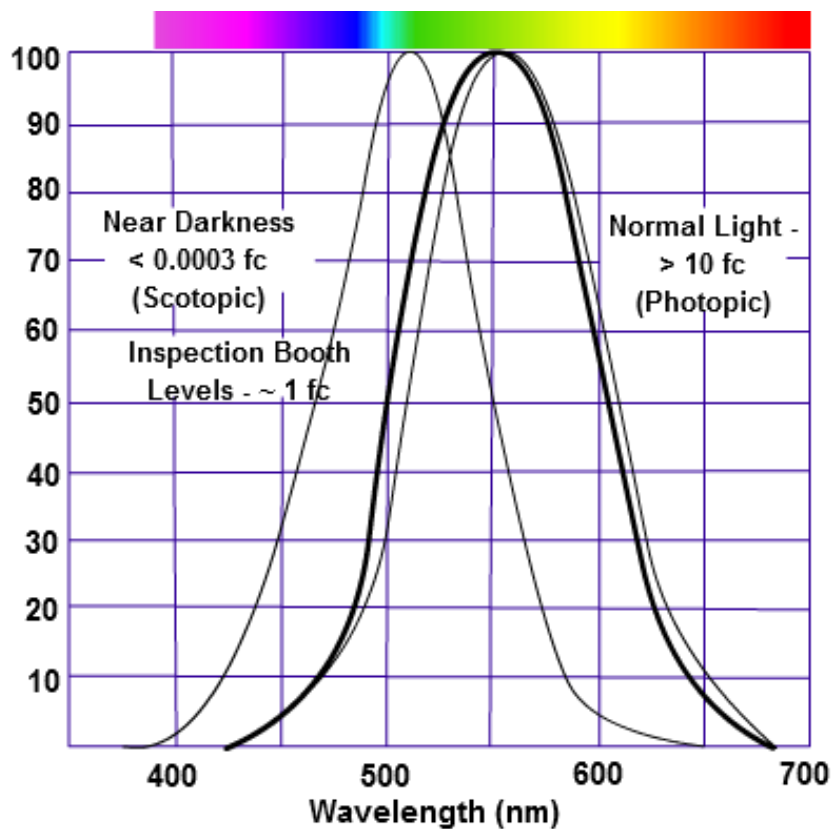


Campbell, F. W. and Robson, J. G. (1968) Application of Fourier Analysis to the Visibility of Gratings. Journal of Physiology (London) Image Courtesy of Izumi Ohzawa, Ph.D. University of California School of Optometry

Ref: The Internet site of the John Moran Eye Center, Department of Ophthalmology at the University of Utah. <http://webvision.med.utah.edu/>

[Nondestructive Evaluation Techniques](#) > [Penetrant Testing](#) > [The Human Eye's Response to Light](#)

The Human Eye's Response to Light



The three curves in the figure above shows the normalized response of an average human eye to various amounts of ambient

- Surrounding or background level. Usually used in relation to temperature, light or sound. light. The shift in sensitivity

Sensitivity - A measure of the ability to detect small signals. Limited by the signal-to-noise ratio. occurs because two types of photoreceptors called cones and rods are responsible for the eye's response to light. The curve on the right shows the eye's response under normal lighting conditions and this is called the photopic response. The cones respond to light under these conditions.

As mentioned previously, cones are composed of three different photo pigments that enable color perception. This curve peaks at 555 nanometers, which means that under normal lighting conditions, the eye is most sensitive to a yellowish-green color. When the light levels drop to near total darkness, the response of the eye changes significantly as shown by the scotopic response curve on the left. At this level of light, the rods are most active and the human eye is more sensitive to the light present, and less sensitive to the range of color. Rods are highly sensitive to light but are comprised of a single photo pigment, which accounts for the loss in ability to discriminate color. At this very low light level, sensitivity

Sensitivity - A measure of the ability to detect small signals. Limited by the signal-to-noise ratio. to blue, violet, and ultraviolet is increased, but sensitivity

ensitivity - A measure of the ability to detect small signals. Limited by the signal-to-noise ratio. to yellow and red is reduced. The heavier curve in the middle represents the eye's response at the ambient

Ambient - Surrounding or background level. Usually used in relation to temperature, light or sou

light level found in a typical inspection booth. This curve peaks at 550 nanometers, which means the eye is most sensitive to yellowish-green color at this light level. Fluorescent

Fluorescent - A bright vivid color that glows under a black light.

penetrant

Penetrant - A fluid (usually a liquid but can be a gas) which possesses unique properties that render it highly capable of entering small openings, a characteristic which makes this fluid especially suitable for use in the detection of surface discontinuities which may be present.

inspection materials are designed to fluoresce at around 550 nanometers to produce optimal sensitivity

Sensitivity - A measure of the ability to detect small signals. Limited by the signal-to-noise ratio. under dim lighting conditions.

References: Robinson, S. J. and Schmidt, J. T., Fluorescent

Fluorescent - A bright vivid color that glows under a black light.

Penetrant

Penetrant - A fluid (usually a liquid but can be a gas) which possesses unique properties that render it highly capable of entering small openings, a characteristic which makes this fluid especially suitable for use in the detection of surface discontinuities which may be present.

Sensitivity

Sensitivity - A measure of the ability to detect small signals. Limited by the signal-to-noise ratio.

and Removability - What the Eye Can See, a Fluorometer Can Measure, Materials Evaluation

Evaluation - The process of deciding the severity of a condition after an indication has been interpreted. Evaluation determines if the test object should be rejected, repaired or accepted. See indication and interpretation.

, Vol. 42, No. 8, July 1984, pp. 1029-1034