In general the well defined and objectively measured quantities of geometrical radiometry are used in quantitative studies of optical oceanography, remote sensing, and radiative transfer. However, there are times when, either unavoidably or by choice, the human eye becomes one of our instruments. Such is the case when we enjoy the beautiful colors of nature or when someone observes the appearance of a distant object as a semi-quantitative measure of the clarity or "visible range" of the atmosphere or ocean. In other instances, the eye-brain system may be the preferred instrument, as in visual searches for underwater objects. We therefore must understand how the human visual system responds to radiant energy. This takes us into the domain of photometry, which, for our present purpose, is defined as the study of the human visual response to the quantities of geometrical radiometry.

Level 1 of this chapter presents the basic ideas of human visual response and visibility, beginning with an overview of how the eye senses light and color. The next topic discussed is the photopic luminosity function, which describes the spectral response of the average human eye, and luminance, which corresponds to the visual sensation of brightness. Luminance is an inherently broad-band (all visible wavelengths) correspondent of monochromatic radiance. An equation for luminance transfer is then developed from the monochromatic radiative transfer equation. This requires the development of photopic (broad-band) replacements for wavelength-dependent inherent optical properties. The quantitative specification of color via CIE chromaticity coordinates is then developed. The Level 1 material closes with a discussion of the relation between CIE chromaticity coordinates and the red-green-blue RGB values used by computer monitors.

The Level 2 material presents the mathematical formulation of the concepts of visibility. A luminance transfer equation, corresponding the the radiative transfer equation for monochromatic light, is first developed. Whether or not an object can be seen depends on the visual contrast between the object and its background. This is quantified by the inherent and apparent contrast, and a law of contrast reduction is developed. These tools give us what is needed to understand the classic theory of the Secchi disk and the prediction of the Secchi depth.