LUMINOUS REFLECTANCE and TRANSMITTANCE

DEFINITION OF LUMINOUS REFLECTANCE

Some of the luminous flux incident on a reflective surface is absorbed. The degree of absorption is quantified by luminous reflectance, ρ. By definition,

$$\rho = F_R / F_I$$

where F_I and F_R are the flux incident on and reflected from an area, respectively. Dividing numerator and denominator by that area gives

$$\rho = M / E \tag{1}$$

where E is the illuminance of the surface and M its luminous emittance. For most indoor surfaces, about half the incident light is re-radiated so $\rho \cong 0.5 = 50\%$. The reflectance varies with wavelength and we could define the reflectance at wavelength λ by

$$\rho_\lambda = M_\lambda / E_\lambda$$

where $E_\lambda d\lambda$ and $M_\lambda d\lambda$ are the illuminance and luminous emittance in an interval $d\lambda$.

MEASURING REFLECTANCE

If a surface is a Lambert radiator its reflectance may be measured with a luminance or illuminance meter. Using the relation between luminous emittance and luminance for a Lambert radiator,

$$\rho=\pi L(\text{cd/area})/E=L(\text{Lambert units})/E. \tag{2}$$

Reflectance, then, is the ratio of luminance in Lambert units to illuminance. If an illuminance meter is held near enough and parallel to a surface, $E=\pi L(\text{cd/area})=L(\text{Lambert units})$ and combining this with (2),

$$\rho=E_{meter}/E \tag{3}$$

where E_{meter} is the meter reading. Reflectance may be measured with an illuminance meter, then, by taking the ratio of the meter reading of reflected light to incident light (figure 1).

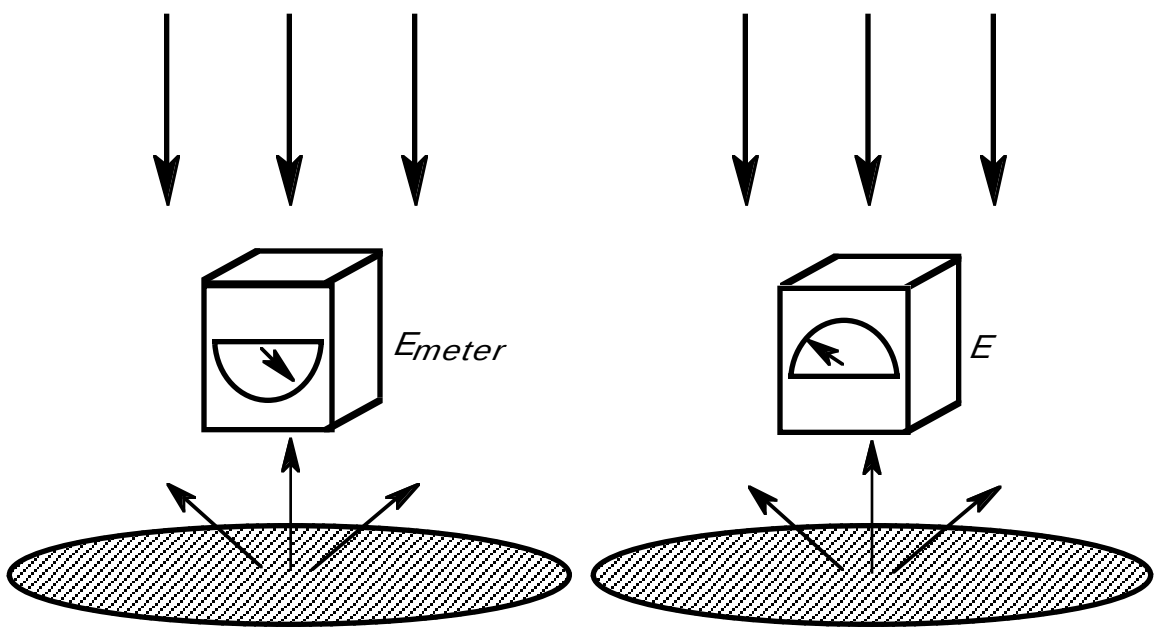

Figure 1. Measurement of reflectance of a Lambert radiator with an illuminance meter. (The scale is much exaggerated.)

DEFINITION OF LUMINOUS TRANSMITTANCE

Some of the luminous flux incident on a filter is absorbed and the degree of absorption is defined by luminous transmittance, τ. By definition

$$\tau = F_T / F_I.$$

Where F_I is the flux incident on the surface and F_T is the transmitted flux. By reasoning similar to that used in the previous section, this may be rewritten

$$\tau = M/E$$

where E is the illuminance of the filter and M the luminous emittance of the other side of the filter. A wavelength dependent transmittance, τ_λ, may be defined in analogy with ρ_λ.

Spectral transmission may be plotted as a function of wavelength, as in figure 2 below.

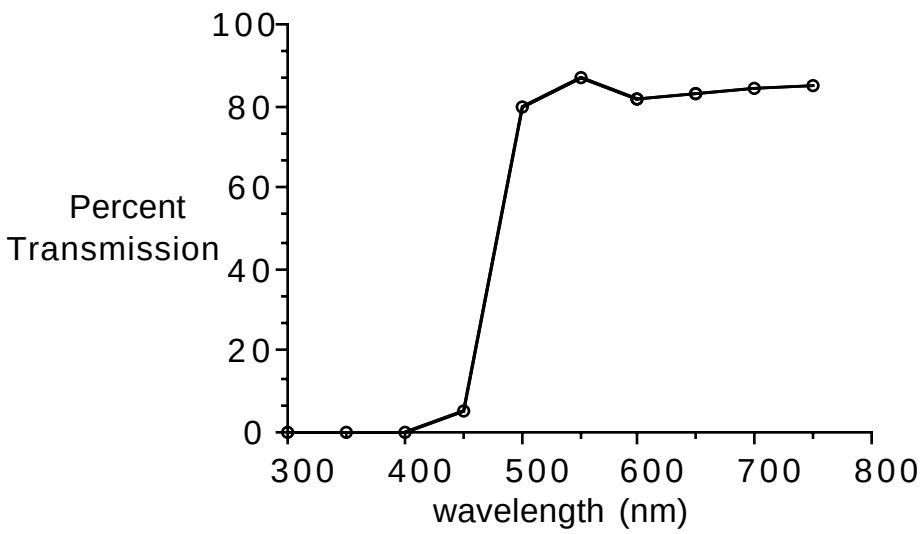

Figure 2. The spectral transmission curve of Kalichrome, a yellow tint used in sunglasses.

MEASURING TRANSMITTANCE

Luminous transmittance may readily be measured with an illuminance meter placed first upon and then behind the filter. The transmittance is the ratio of these two readings (figure 3).

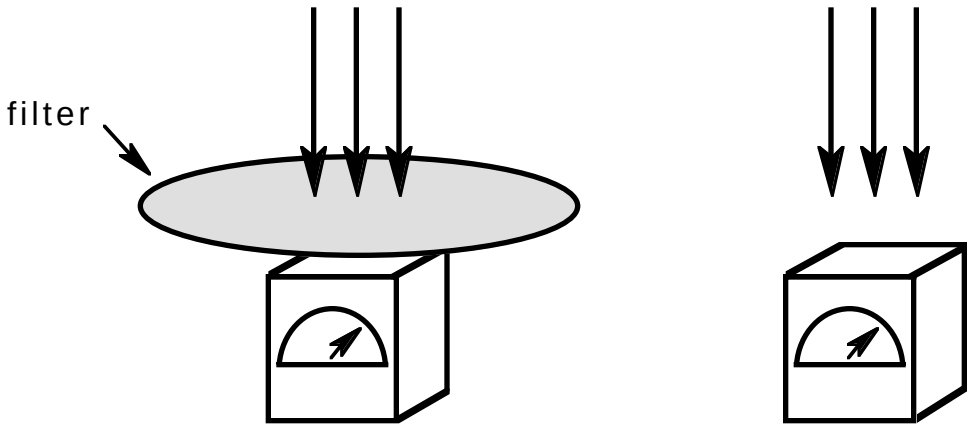

Figure 3. Measurement of transmittance with an illuminance meter. Transmittance is the ratio of the reading with the filter over the meter to that of the meter without the filter.

NEUTRAL DENSITY FILTERS

Some filters have constant transmittance throughout the visible spectrum, i.e. τ_λ is independent of λ. These are called neutral density filters. The transmittance of a neutral density filter is often characterized by its ND number defined as

$$ND=\log(1/\tau).$$

The ND numbers are convenient to work with since the ND number of two or more superimposed neutral density filters is just the sum of the ND numbers of each individual filter.