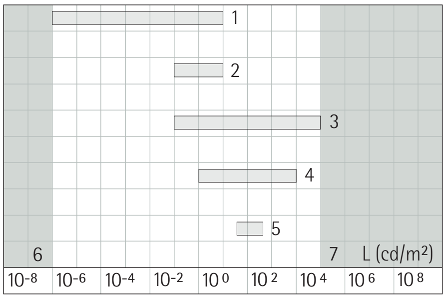
Typical illuminances E and luminances under daylight and electric light.

	E (lux)
Sunlight	100 000
Overcast sky	10 000
Task lighting	1 000
Circulation zone lighting	100
Street lighting	10
Moonlight	1

	L (cd/m²)
Sunlight	1 000 000 000
Incandescent lamp (matt finish)	100 000
Fluorescent lamp	10 000
Sunlit Clouds	10 000
Blue sky	5 000
Luminous ceiling	500
Louvred luminaires	100
Preferred values in interior spaces	50–500
White paper at 500 lx	100
Monitor (negative)	10–50
White paper at 5 lx	1



Luminance range L of rod vision (1), mesopic vision (2) and cone vision (3). Luminances (4) and preferred luminances (5) in interior spaces. Absolute threshold of vision (6) and threshold of absolute glare (7).

to define ways of lighting which will optimise the performace of specific activities. Investigations have been carried out especially in office and traffic situations to study the respective visual tasks and a wide range of activities and to determine the conditions required for optimum perception. Standards and recommendations for the lighting of workplaces and traffic systems are based on the findings of this research.

There is, however, another basic need for visual information that goes beyond the specific information required for a particular activity. This requirement for information is not related to any particular situation, it is the result of man's biological need to understand the world around him. Whereas you can enable a person to work more effectively by creating optimum perceptual conditions for certain activities, man's feeling of well-being in his visual environment depends on satisfying his biological need for information.

Much of the information required results from man's need to feel safe. To be able to evaluate a danger you have to be able to comprehend the structure of your environment. This applies both to orientation – knowing where you are, which route you are on, and what the potential destinations may be – and knowledge about the qualities and peculiarities of the environment you find yourself in. This knowledge, or lack of information, determines the way we feel and our behaviour. It can lead to a feeling of tension and unrest in unknown or potentially dangerous situations, or relaxation and tranquility in a familiar and safe environment. Other information about the world around us is required to allow us to adapt our behaviour to the specific situation. This may include knowledge of weather conditions and the time of day as well as information relating to other activities occurring in the given environment. Should this information not be available, e.g. in large, windowless buildings, the situation is often interpreted as being unnatural and oppressive.

A third area arises from man's social needs. The need for contact with other people and the demand for a private sphere are somewhat contradictory and have to be carefully balanced. The focus on which visual information is to be taken in is, therefore, determined by the activities being performed in a given environment and man's basic biological needs. Areas that promise significant information – be it in their own right, or through accentuation with the aid of light – are perceived first. They attract our attention. The information content of a given object is responsible for its being selected as an object of perception. Moreover, the information content also has an influence on the way in which an object is perceived and evaluated.

The glare phenomenon illustrates this particularly well. If the exterior lighting is especially strong, an opal glass window will produce glare, a fact that can be explained physiologically by the great contrast between the luminance of the window and the considerably lower luminance level of the surrounding wall surface. In the case of a window that provides an interesting view outside, the contrast is greater, but the feeling that we are being subjected to disturbing glare does not arise. Glare can, therefore, not only be explained from a physiological standpoint, as it occurs when a bright surface with no information content attracts our attention. Even high luminance contrasts are felt to be glare-free, if the area perceived offers interesting information. It is therefore clear that it is not practical to stipulate photometric quantities – e.g. luminance or illuminance limits – out of context, since the actual perception of these photometric quantities is influenced by the processing of the information provided.

2.2

Terms and units

In lighting technology a number of technical terms and units are used to describe the properties of light sources and the effects that are produced.

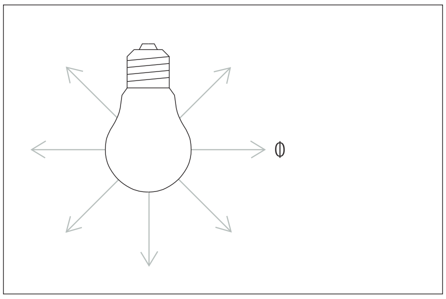
2.2.1 Luminous flux

$[\Phi]$ = Lumen (lm)

Luminous flux describes the total amount of light emitted by a light source. This radiation could basically be measured or expressed in *watt*. This does not, however, describe the optical effect of a light source adequately, since the varying spectral sensitivity of the eye is not taken into account.

To include the spectral sensitivity of the eye the luminous flux is measured in *lumen*. Radiant flux of 1 W emitted at the peak of the spectral sensitivity (in the photopic range at 555 nm) produces a luminous flux of 683 lm. Due to the shape of the V (λ) curve the same radiant flux will produce correspondingly less luminous flux at different frequency points.

The amount of light emitted by a light source is the luminous flux Φ.



2.2.2 Luminous efficacy

$$\eta = \frac{\Phi}{P}$$

$$[\eta] = \frac{lm}{W}$$

Luminous efficacy describes the luminous flux of a lamp in relation to its power consumption and is therefore expressed in lumen per watt (lm/W). The maximum value theoretically attainable when the total radiant power is transformed into visible light is 683 lm/W. Luminous efficacy varies from light source to light source, but always remains well below this optimum value.

2.2.3 Quantity of light

The quantity of light, or luminous energy (US), is a product of the luminous flux emitted multiplied by time; luminous energy is generally expressed in klm·h.

$$Q = \Phi \cdot t$$

$$[Q] = lm \cdot h$$

2.2.4 Luminous intensity

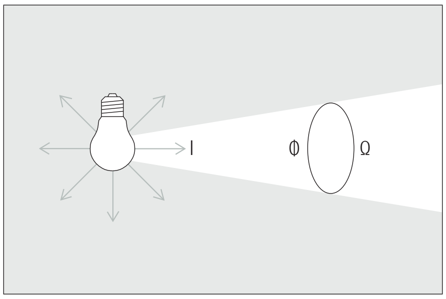
An ideal point-source lamp radiates luminous flux uniformly into the space in all directions; its luminous intensity is the same in all directions. In practice, however, luminous flux is not distributed uniformly. This results partly from the design of the light source, and partly on the way the light is intentionally directed. It makes sense, therefore, to have a way of presenting the spatial distribution of luminous flux, i.e. the luminous intensity distribution of the light source.

$$I = \frac{\Phi}{\Omega}$$

$$[I] = \frac{lm}{sr}$$

$$\frac{lm}{sr} = \text{Candela (cd)}$$

Luminous intensity I is the luminous flux Φ radiating in a given direction per solid angle Ω.



The unit for measuring luminous intensity is candela (cd). The candela is the primary basic unit in lighting technology from which all others are derived.
The candela was originally defined by the luminous intensity of a standardised candle. Later thorium powder at the temperature of the solidification of platinum was de-