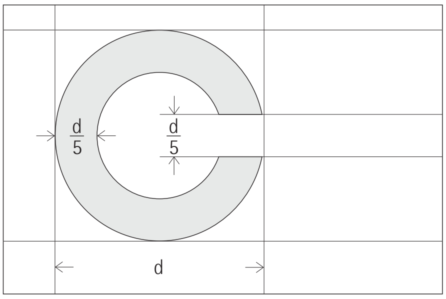
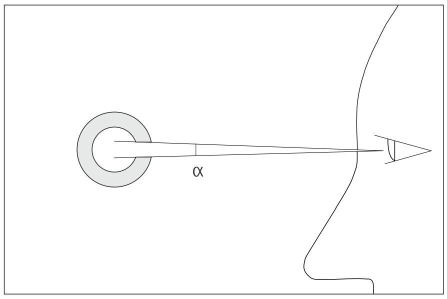
The Landolt ring for determining visual acuity. The visual task is to determine the position of the opening in the ring. The gap is 1/5 of the ring's diameter.



The angle of vision α is calculated from the width of the opening of the smallest detectable Landolt ring and the distance of the viewer from the image. Visual acuity S is its reciprocal value. A visual acuity of 1 is recorded when the gap in the ring can be recognised at an angle of vision of α = 1' (1/60°).



$$S = \frac{1}{\alpha}$$

$[\alpha]$ = min

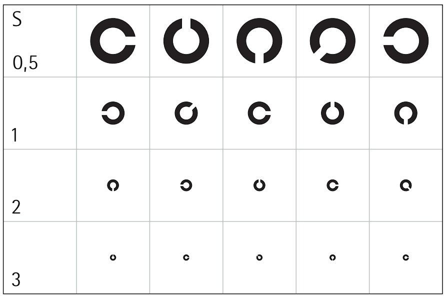


Table for determining the reader's visual acuity S from a distance of 2 m.

E (lx)	
20	Minimum value in interior spaces, excluding working areas Illuminance level required for recognising facial features
200	Minimum illuminance for workplaces in continuous use
2 000	Maximum illuminance at standard workplaces
20 000	Illuminance level for special visual tasks e.g. in operating theatres

Typical illuminance levels E in interior spaces.

E (lx)	
20–50	Paths and working areas outdoors
50–100	Orientation in short-stay spaces
100–200	Workrooms that are not in continuous use
200–500	Simple visual tasks
300–750	Visual tasks of average degree of difficulty
500–1000	Difficult visual tasks, e.g. office work
750–1000	Complicated visual tasks, e.g. precision assembly work
1000–2000	Extremely complicated visual tasks, e.g. inspection and control
> 2000	Additional lighting for difficult and complicated tasks

Recommended illuminance levels E according to the CIE for various activities.

visual tasks require up to 2000 lux, in special cases, e.g. in operating theatres, up to 10000 lux. The preferred illuminance level at the workplace ranges between 1000 and 2000 lux.

International guidelines for illuminance levels range in values from 20 to 2000 lux and are therefore within the above-mentioned framework. The recommended illuminance levels are mainly a consequence of the degree of difficulty of the visual task in contrast to the immediate environment, whereby extremely detailed visual tasks, where there is little contrast to the surrounding area, require the highest illuminance levels.

Following a set of fixed rules for overall illuminance levels as laid down in the standards for the lighting of workplaces, which is generally what lighting design amounts to in practice, includes minimal consideration regarding actual perception. It is not the luminous flux falling on a given surface – illuminance – that produces an image in the eye. It is the light that is emitted, transmitted or reflected by the surfaces. The image on the retina is created entirely by the luminance pattern of the perceived objects, in the combination of light and object.

Recommendations have also been laid down for luminance levels, that is to say for maximum luminance contrasts between visual task and surrounding area. Likewise for absolute luminances that are not to be exceeded, for example of luminous ceilings or luminaires in spaces equipped with VDT workstations. The object is again is to optimise visual performance at the workplace.

In addition to these guidelines there is also a set of general recommendations for luminance distribution in the entire space. It is assumed that a space with low luminance contrasts will appear to be monotonous and uninteresting and a space with stark contrasts restless and irritating.

For some time now more systematic approaches to comprehensive lighting design have been made based on the results of research on luminance distribution. In Waldram's "designed appearance" concept or Bartenbach's idea of "stable perception", in particular, there have been attempts to control the visual appearance of the overall environment (mood, atmosphere) through the purposeful arrangement of luminances.

Any attempt to design a lighting installation based on quantitative data is bound to lead to problems. This applies to overall illuminance stipulations and luminance scales as well as to sets of given luminance patterns.

Visual perception is a process which allows us to gain information about objects in the world around us using the medium of light. A process that is therefore basically influenced by three factors: light, object and perceiving being. A design concept that is restricted to fixed illuminance criteria is only concerned with the aspect of the light. Illuminance is therefore inadequate as a basis for predicting visual effect, especially as it is not itself perceptible.

When planning luminance distribution it is not only the light that is taken into consideration, but the correlation of the light with the objects in the space. Luminance is the basis of the brightness we perceive, which means that the perceptual process is taken into account, at least up to the moment an image is projected onto the retina.

But luminance and luminance distribution do not provide an adequate basis for the planning of visual impressions – attention has yet to be paid to the perceiving individual. The pattern of luminances projected onto the retina is not the end product, but simply forms the basis for a complex process at the end of which is the image we actually see. This involves innumerable aspects: laws of gestalt, constancy phenomena, expectations and the information content of the object that is being perceived.

The aim of perception is not just to register luminous phenomena, but to gain information about the environment. It is not the luminances produced by an accumulation of objects that are interesting, but rather the information about the quality of these objects and about the lighting conditions under which this quality can be perceived.

This is why the image that we actually perceive is not identical to the pattern of luminances on the retina, although it is based on this luminance pattern. A white body has different luminance qualities depending on the lighting situation. Evenso, it is always perceived as being uniformly white, because the lighting situation is registered and taken into account when the image is being processed. The formation of shadows on a spatial body – its luminance pattern – is not interpreted as being unevenly lit, but as a feature of a three-dimensional form. In both cases the characteristics of the object and the type of lighting are interpreted from the perceived luminance pattern simultaneously. These simple examples are clear evidence of the important part psychological processing has to play in the creation of the final perceived image.

When a lighting design concept purposefully strives to achieve specific visual effects it must involve all factors related to the perceptual process. Lighting design cannot be restricted to the observance of illuminance or luminance levels, of light and object alone, even when this approach effectively results in optimum perceptual conditions at workplaces, for example. Apart from considering the qualities of the light to be applied lighting design must – as an integral part of the design of the environment – also take into account the interaction of light source, object and perceiver, as governed by the laws of perceptual psychology, in each respective situation.

2.5.2 Diffuse light and directed light

Having dealt with light quantity, consideration must be given to the quality of light, the difference between diffuse light and directed light being one of the most important aspects. We are familiar with these different forms of light through our everyday experience with daylight – direct sunlight when the sky is clear and diffuse light when the sky is overcast. Characteristic qualities are the uniform, almost shadowless light we experience under an overcast sky, in contrast to the dramatic interplay of light and shade in bright sunlight.

Diffuse light is produced by extensive areas that emit light. These may be extensive, flat surfaces, such as the sky in the daytime, or, in the field of artificial lighting, luminous ceilings. In interior spaces diffuse light can also be reflected from illuminated ceilings and walls. This produces very uniform, soft lighting, which illuminates the entire space and makes objects visible, but produces reduced shadows or reflections.

Directed light is emitted from point light sources. In the case of daylight this is the sun, in artificial lighting compact light sources. The essential properties of directed light are the production of shadows on objects and structured surfaces, and reflections on specular objects. These effects are particularly noticeable when the general lighting consists of only a small portion of diffuse light. Daylight, for example, has a more or less fixed ratio of sunlight to sky light (directed light to diffuse light) of 5:1 to 10:1.

In interior spaces, on the other hand, we can determine the ratio of directed and diffuse light we require or prefer. The portion of diffuse light decreases when ceiling and walls receive too little light, or when the light falling on a surface is absorbed to a large extent by the low reflectance of the environment. This can be exploited for dramatic effects through accent lighting. This technique is often applied for the presentation of objects, but is only used in architectural lighting when the concept intends to create a dramatic spatial effect.

Directed light not only produces shadows and reflections; it opens up new horizons for the lighting designer because of the choice of beam angles and aiming directions