

The background features abstract, overlapping green geometric shapes, primarily triangles and polygons, in various shades of green, creating a modern and dynamic visual effect. The word "Illumination" is centered in a green, sans-serif font.

Illumination

What is Illumination ?

- ▶ Lighting or illumination is the deliberate use of light to achieve practical or aesthetic effects. Lighting includes the use of both artificial light sources like lamps and light fixtures, as well as natural illumination by capturing daylight.
- ▶ Illumination is defined as the energy of light (ϵ) striking a surface of specific unit area per unit time.

ILLUMINATION

- ▶ This definition determines the amount of light that covers a surface.
- ▶ If Φ is the luminous flux and S is the area of the given surface then the illuminance E is determined by $E = \Phi / S$.
- ▶ The unit of illumination in SI system is lux.
- ▶ One lux (lx) is the illuminance of 1 m^2 surface area uniformly lighted by 1 lm of luminous flux.

Lighting Terminology

- ▶ **WAVELENGTH** (nanometres)

Visible light is just a small part of the spectrum of electromagnetic radiation that includes radio waves, heat, light, microwaves etc. Each type of radiation covers a range of wavelengths that are measured in nanometres (one millionth of a millimetre).

- ▶ **COLOUR TEMPERATURE** (Kelvin)

A hot object radiates a specific range of wavelengths that appear as a particular colour depending on the object's temperature. The temperature is expressed in Kelvin (K), the scientific temperature unit. Degrees Celsius can be easily converted to Kelvin by adding 273.

► SPECTRAL CHART (RGB)

The phosphors in a lamp are made from a mixture of fluorescent powders emitting primary colours, which combine to produce white light. The lamp colour can be expressed as the individual wavelengths of these phosphor components. For example Red = 611nm, Green = 544nm and Blue = 435nm.

► VISUAL PERCEPTION

The human visual system has a stronger response to green than to other colours. All units indicating the illumination in terms of the human visual perception are adjusted to the equivalent brightness at 555nm, which is the wavelength of green light. All other units explained below are adjusted to compensate for the relative sensitivity of the eye to green light.

► **LUMINOUS INTENSITY (Candela)**

Luminous intensity is a measurement the light radiating from the lamp in a particular direction, disregarding the intensity of light in other directions. The Candela figures for a source need to be given for specific directions but are independent of distance from the lamp.

► **LUMINANCE (Candela per Square Metre)**

The Candela does not represent the brightness looking directly at the source itself. A small point source may have the same Candela measurement as a large diffuse source that is not perceived as so intensely bright.

► **LUMINOUS FLUX (Lumens)**

The perceived total amount of useful light from a source is the sum of the Candela measurements in all directions. It is measured in Lumens (lm). The figure is also independent of distance from the lamp and says nothing of the direction of the light, the intensity of the source or the brightness of an illuminated surface, just the total visible light in all directions.

► **ILLUMINANCE (Lux)**

The perceived brightness of the light falling on a surface illuminated by the lamp and is measured in Lumens per square metre or its equivalent, Lux. Illumination values will decrease with distance from the lamp and are not generally useful in describing lamp performance unless a distance is quoted.

► **LUMINOUS EFFICIENCY (Lumens per Watt)**

This is a measure of how much total effective light in all directions (Lumens) is produced per Watt of electrical power consumed.

► **LIFE EXPECTANCY (Hours)**

Although a lamp may continue to function electrically, the light output and efficiency degrades over time. The life of a lamp is defined as the operating time for light output to fall to fifty percent of its original lumen figure.

► **NOMINAL POWER (Watts)**

Most suppliers provide a nominal power rating, rather than the actual power consumption of the lamp under specific conditions. The actual power consumption at the lamp input of most extra low voltage DC lamps at normal battery voltage is typically ten to twenty percent below the nominal rating.

Laws of illumination

- ▶ The law states that Illuminance at a point on a plane is proportional to the cosine of the angle of light incident (the angle between the direction of the incident light and the normal to the plane). It is the point source Illuminance equation.
- 1. Illumination is directly proportional to the luminous intensity of the source.
- 2. Inverse square law - The illumination of a surface receiving its flux from a point source is inversely proportional to the square of the distance between the surface and the source.
- 3. Lambert's cosine law - The illumination of a surface at any point is proportional to the cosine of the angle between the normal at the point and the direction of the luminous flux.

luminous flux

- ▶ In photometry, luminous flux or luminous power is the measure of the perceived power of light. It differs from radiant flux, the measure of the total power of electromagnetic radiation, in that luminous flux is adjusted to reflect the varying sensitivity of the human eye to different wavelengths of light.

Lux meter

- ▶ Lux meters are used for measuring brightness in lux, fc or cd/m^2 . Some lux meters are equipped with an internal memory or data logger to record and save measurements. The measurement of light intensity with a lux meter is becoming increasingly important in the workplace due to safety concerns.

What is the purpose of Lux meter?

- ▶ Lighting professionals use a light meter (also called an illuminance meter or lux meter) to measure the amount of light in a space/on a particular work surface. The light meter has a sensor that measures the light falling on it and provides the user with a measurable illuminance reading.

Ambient lighting

- ▶ Ambient lighting is also called general lighting, and it's the most basic of the three types of lighting. It's the natural light from your windows, and the lighting that substitutes for natural light. Among the fixtures that provide ambient lighting are: Chandeliers and other ceiling fixtures.
- ▶ Ambient lighting is especially important in hallways and stairs for optimal orientation and visibility. It also is useful in kitchens or home offices, where fixtures with wide light beams provide a consistent level of lighting.

Ambient Lighting: First Layer of Home Lighting

- ▶ Ambient lighting is also called general lighting, and it's the most basic of the three types of lighting. It's the natural light from your windows, and the lighting that substitutes for natural light.
- ▶ Among the fixtures that provide ambient lighting are:
 - ▶ Chandeliers and other ceiling fixtures
 - ▶ Light kits on ceiling fans
 - ▶ Track lighting
 - ▶ Recessed ceiling lights
 - ▶ Torchieres
 - ▶ Wall sconces providing enough light to do more than spotlight an area

Most people understand the need for ambient lighting, but too many stop there. Ambient lighting is just the base, upon which you must add the other two layers of lighting.

Task lighting

- Often task lighting refers to increasing illuminance to better accomplish a specific activity. However, the illuminance level is not the only factor governing visibility. Contrast is also important, and a poorly positioned light source may cause contrast reduction, resulting in loss of visibility. The most important purpose of task lighting in the office is not increasing illuminance, but improving contrast. General lighting can be reduced because task lighting provides focused light where needed.

Task Lighting: Second Layer of Home Lighting

- ▶ Task lighting is just what it sounds like: it's the light you need to perform tasks—reading, studying, cooking, applying makeup, etc.
- ▶ Task lighting fixtures include:
- ▶ Table lamps
- ▶ Desk lamps
- ▶ Swing arm lamps
- ▶ Under counter lights
- ▶ Pendant lights
- ▶ Directed track or recessed lights
- ▶ Vanity lights
- ▶ Adjustable floor lamps

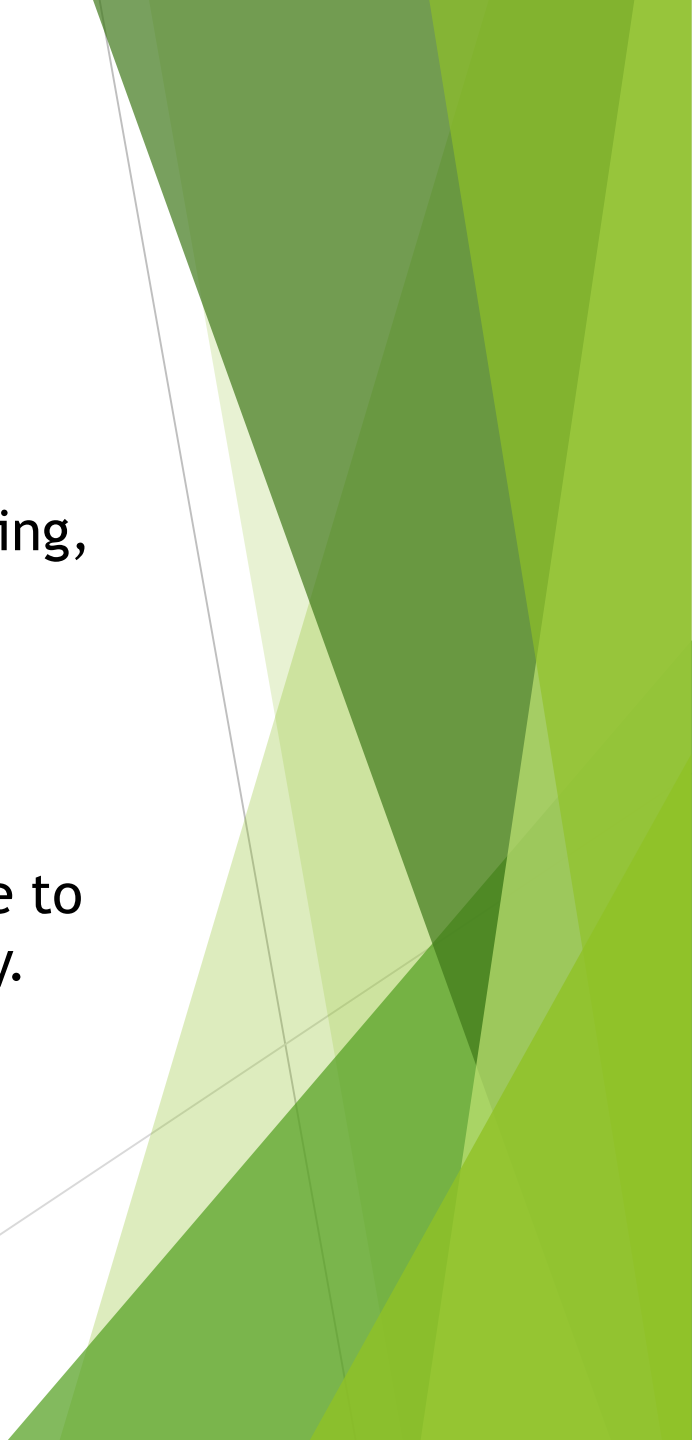
Before you select task lighting, make of list of the activities you need to perform in each room.

Accent lighting

- ▶ Accent lighting focuses light on a particular area or object. It is often used to highlight art or other artifacts. Common types of accent lights include wall sconces, floodlights, recessed lights, torchere lamps, or track lighting. The brighter light from the accent lamp creates visual interest to a room. Accent lights may also be used in practical applications to shine light on a stairway, such as in movie theaters, or to light walkways.

Accent Lighting: Third Layer of Home Lighting

- ▶ Some people think of accent lighting as mood lighting, and it is, but it's much more than that.
- ▶ In addition to providing atmosphere and influencing mood, accent lighting is used to highlight architectural features and important objects, and to draw attention away from the things that aren't as pleasing. Even though accent lighting can disguise decorating blunders, it's the most often-forgotten of the three types of lighting.
- ▶ Some examples of accent lighting are:
 - ▶ Can lights and uplights
 - ▶ Picture lights
 - ▶ Candlelight
 - ▶ Directed track or recessed lights
 - ▶ Niche lighting
 - ▶ Chandeliers with dimmer switches
 - ▶ Wall sconces
 - ▶ Lighting inside glass or wire door cabinets
 - ▶ Light bridges on media furniture

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- ▶ Notice that chandeliers and wall sconces can double as accent lighting, especially when you install dimmer switches. Track and recessed lighting can function as any of the three layers of lighting, depending on how you direct them.
 - ▶ When you plan your accent lighting, ask yourself how you want each room to feel, and which elements you want to highlight or hide. Consider the location of paintings or particularly beautiful pieces of furniture that you want to feature. Now is your chance to think of your home as a work of art, and to light it appropriately.

Direct Lighting

- ▶ Direct lighting is nothing but a fixture on ceiling and casting light downwards used in offices, homes. Direct lighting come in a wide variety of styles from iron to Zinc Alloy and with the lamp from LED to halogen. ... Direct lighting is usually mounted on the ceiling to provide uniform lighting.
- ▶ Direct lighting is when the majority of the light spread of a fixture falls on a specific object or area. ... Indirect light is the light spread that lands outside of the direct scope and lights objects other than those in the direct illumination spread.

Indirect Lighting

- ▶ The technique of indirect lighting (sometimes called uplighting) uses one or more fixtures to aim light onto the ceiling and upper walls, which act as reflectors and distribute the light evenly throughout the room. Indirect lighting is a form of ambient lighting.
- ▶ With indirect lighting, the source of light is hidden and the light spreads through the room via reflection on the ceiling, floor, or wall, as such eliminating dazzle and shadows. For a proper and balanced use, it is essential that indirect lighting is planned into the project right from the start.
- ▶ Indirect lighting minimizes shadows and reflected glare. It is especially appropriate for rooms with reflective surfaces such as computers or televisions. For other critical visual tasks, a supplementary task light may be required.
- ▶ For highest efficiency, the ceiling should be painted white, or a very light color. Paint should be matte rather than glossy. To prevent bright reflected "hot spots" move the light source away from the reflector wall or ceiling.

Natural lighting

- Natural lighting, also known as day lighting, is a technique that efficiently brings natural light into your home using exterior glazing (windows, skylights, etc.), thereby reducing artificial lighting requirements and saving energy. Natural lighting has been proven to increase health and comfort levels for building occupants.

Artificial Lighting

Artificial light is human-made and can emanate from sources including fire, candlelight, gaslight, electric lamps and so on. This allows lighting to create a range of effects according to the requirements of a space.

Artificial light is generally easily manipulated to achieve the required lighting outcome. All artificial light can be turned on and off with a switch.

Daylighting

- ▶ Daylighting is the practice of placing windows, skylights, other openings, and reflective surfaces so that sunlight (direct or indirect) can provide effective internal lighting. Particular attention is given to daylighting while designing a building when the aim is to maximize visual comfort or to reduce energy use. Energy savings can be achieved from the reduced use of artificial (electric) lighting or from passive solar heating. Artificial lighting energy use can be reduced by simply installing fewer electric lights where daylight is present or by automatically dimming/switching off electric lights in response to the presence of daylight - a process known as daylight harvesting.



What are the benefits of daylight?

- ▶ Daylighting has been associated with improved mood, enhanced morale, less fatigue, and reduced eyestrain (Robbins, 1986). Many studies show that the performance and productivity of workers in office, industrial, and retail environments can increase with the quality of light.

Daylight factor

- ▶ A daylight factor (DF) is the ratio of the light level inside a structure to the light level outside the structure. It is defined as:
... Light entering through the window but reaching the point only after reflection from an internal surface, known as the internally reflected component (IRC).
- ▶ Daylight Factor is typically calculated by dividing the horizontal work plane illumination indoors by the horizontal illumination on the roof of the building being tested and then multiplying by 100.
- ▶ DF is the ratio of the internal light level to the external light level.
- ▶ $DF = (E_i / E_o) \times 100\%$

Energy Efficient Lighting

- ▶ When the energy usage of a product is reduced without affecting its output or final response or user comfort levels is referred as energy efficiency. An energy efficient product consumes less energy to perform the same function when compared to the same product with more energy consumption.
- ▶ The energy efficiency in the lighting sector gives the required illumination level of the lighting scheme for the application it has been designed for, while consuming the least amount of energy. Simply, energy efficient lighting can save the electricity while maintaining good quality and quantity of the light.

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- ▶ Energy efficient lighting involves in replacement (or re-lamping) of traditional lamps (such as incandescent lamps) with that of energy efficient such as fluorescent lamps, CFL lamps and LED lamps. It also incorporates proper lighting controls such as timer controls, PIR and ultrasonic sensors based controls, etc.
- ▶ Use of energy efficient lighting equipment such as low energy halogen lamps, fluorescent tubes and LED (light emitting diode) in combination with electronically controlled systems for dimming, automatic shut off, etc. is continuously developed as the focus on energy and environment has increased. The new technology has been applied only to a limited extent to the shipping industry and standard normal design does not include low energy lighting. Implementing energy efficient light system will in addition reduce the maintenance hours and operating cost.