

Lamps and Light Sources

What is Light?

Light is a form of energy that is part of the electromagnetic spectrum visible to the human eye.

The Light Spectrum

Light waves of a specific energy level will emit a particular color.

Sir Isaac Newton recognized the visible light spectrum in 1666, and he identified seven colors: red, orange, yellow, green, blue, indigo, and violet.

Newton's colors are arbitrary segments of the continuous spectrum of color.

When all of the spectral colors travel together, they combine to make white light.

What is Light?

The Speed of Light

Transparent materials cause light to refract, or bend its path, because light travels at different speeds in different mediums, like water or glass.

The speed depends on the composition and density of the medium—how many atoms are getting in the way.

The reduction in speed causes light to bend upon entry into that medium. Since different wavelengths of light bend at different angles, certain materials can act as prisms, causing white light to visibly split apart into its spectrum.

The Properties of Light

Light can also reflect, or bounce, off objects. This is what causes us to see.

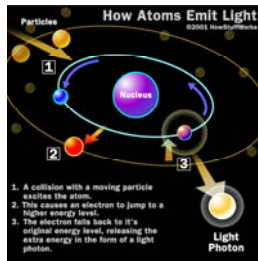
Light rays emitted from a light source reflect off objects in all directions and transmit the image of that object to your eye.

Objects with very smooth surfaces, like mirrors, reflect light so well that they redirect it in a single direction.

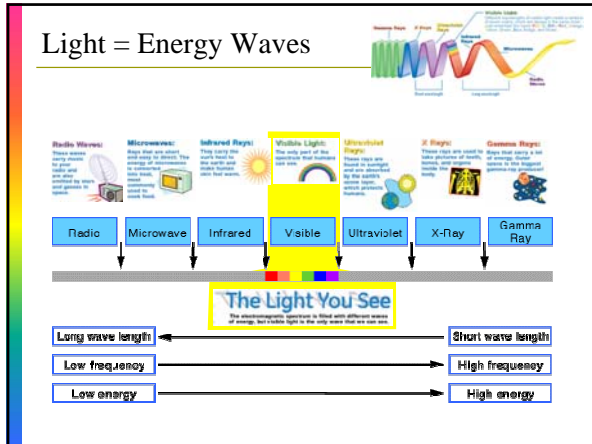
What is Light?

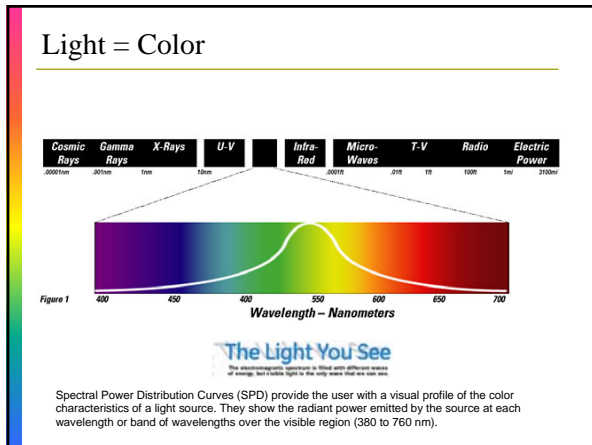
There are two different ways of talking about light:

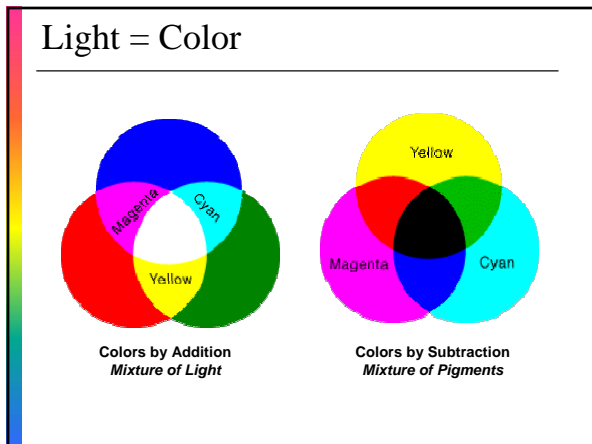
- There is the "particle" theory, expressed in part by the word **photon**.
- There is the "wave" theory, expressed by the term **light wave**.



Lamps and Light Sources



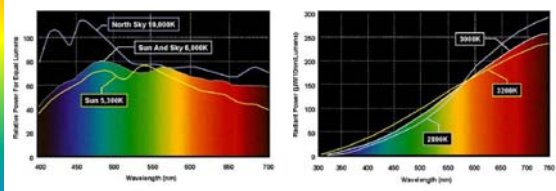




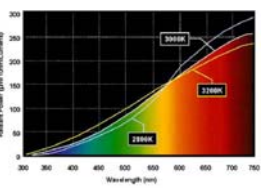
Lamps and Light Sources

Light = Color

Natural Light *Daylight*




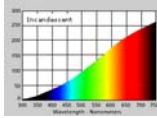
Electric Light *Incandescent*




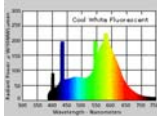
Incandescent Lamps and Natural Daylight produce smooth, continuous spectra.

Light = Seeing Color



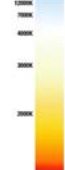


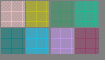




Light = Measuring Color

- **Correlated Color Temperature (CCT)**
color appearance of various light sources
- **Color Rendering Index (CRI)**
how a light source renders the color of objects





Lamps and Light Sources


Correlated Color Temperature

color appearance of various light sources

The higher the color temperature (CCT), the "cooler" the color of the lamp is in appearance.

The lower the color temperature (CCT) the "warmer" the color the lamp is in appearance.

This color temperature is measured in Kelvin.







2200° 2700° 4100°

Correlated Color Temperature

color appearance of various light sources

Kelvin Temperature

| | | | |
|------|------|---------------------|-------------------------------------------------------------------------------------|
| Cool | 9000 | North Blue Sky |  |
| | 8500 | | |
| | 8000 | | |
| | 7500 | | |
| | 7000 | | |
| | 6500 | Overcast Day |  |
| | 6000 | | |
| | 5500 | Direct Sunlight |  |
| | 5000 | | |
| | 4500 | | |
| | 4000 | | |
| | 3500 | | |
| | 3000 | | |
| | 2500 | | |
| | 2000 | Fire / Candle light |  |
| Warm | 1500 | Hot Embers | |

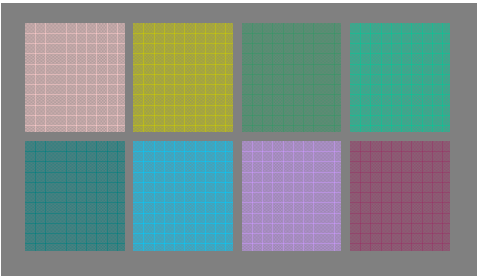
Daylight Fluorescent
Cool White Fluorescent
4100K Fluorescent
3500K Fluorescent
3000K Fluorescent
Warm White Fluorescent

Mercury
Metal Halide
3000K Metal Halide
Halogen
Incandescent
High Pressure Sodium

Color Rendering Index

how a light source renders the color of objects

Test Colors



Lamps and Light Sources

Light = Seeing Colors

Incandescent / Halogen GE Cool White Ceramic Metal Halide

SP30 SP35 HPS

http://www.gelighting.com/en/business_lighting/education_resources/learn_about_light/color_lamp.htm

Electric Sources

Lamps for General use

| | | |
|-----------------------------|--------------------------------------------------------------------------------------------------------------|--------------------|
| INCANDESCENT LAMPS | DISCHARGE LAMPS | Solid State |
| Standard Incandescent Lamps | Fluorescent Lamps • Compact • Linear | White LED |
| Halogen / Quartz Lamps | HID Lamps • Metal Halide • High Pressure Sodium • Mercury • High • Low Pressure Sodium | RGB LED's |

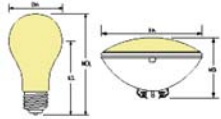
Lamp Shape Nomenclature

| BULB | NAME | WATTAGE RANGE | TYPICAL APPLICATION |
|------|--------------------------------|---------------|--------------------------------------------|
| | Cone | 4-7W | Nightgigs |
| | Straight | 3-40W | Sign, Decorative, High Intensity Appliance |
| | Chandelier (Bowl or Torpedo) | 13-60W | Chandeliers and Decorative light fixtures |
| | Flame | 18-60W | Decorative light fixtures |
| | Tubular | 6-60W | Appliances, Appliances, Fluorescent |
| | Globe | 10-100W | Kitchen, Bath, Decorative Lighting |
| | Pearl Stringneck | 60-1000W | Most commonly used as Utility or Three-Way |
| | Aldblu | 15-250W | General-purpose lighting |
| | Reflector | 30-1000W | Indoor Directional or Down Lighting |
| | Upright Reflector | 60-120W | Indoor or Directional Down Lighting |
| | Parabolic Aluminized Reflector | 35-500W | Indoor/Outdoor Directional Lighting |
| | Directional Reflector | 40-100W | Indoor Directional or Down Lighting |
| | Bulbous Reflector | 75-150 | Indoor Directional or Down Lighting |
| | Globe Tubular | 75 | Outdoor Post Lamp Fixtures |

Lamps and Light Sources

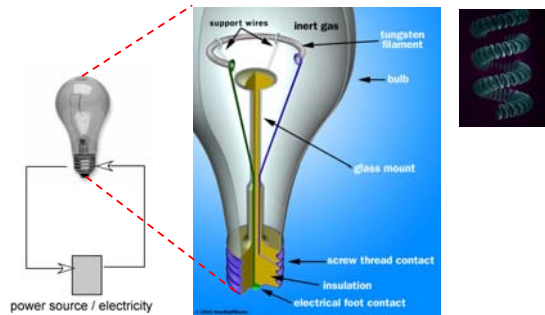
Lamp Shapes

BULB IDENTIFICATION



DIA: Diameter of bulb at widest point.
 MOX: Maximum Overall Length including base or pins.
 LCL: Distance between the center of the arc tube and the Light Center Length reference plane.
 Note: Lamp drawings are not drawn to scale. Be alert to check size and dimension information when identifying each lamp.
 To convert inches to millimeters, multiply the dimension (in inches) by 25.4 (i.e. 1.0" x 25.4 = 25.4 mm).

How Incandescent Lamps Work

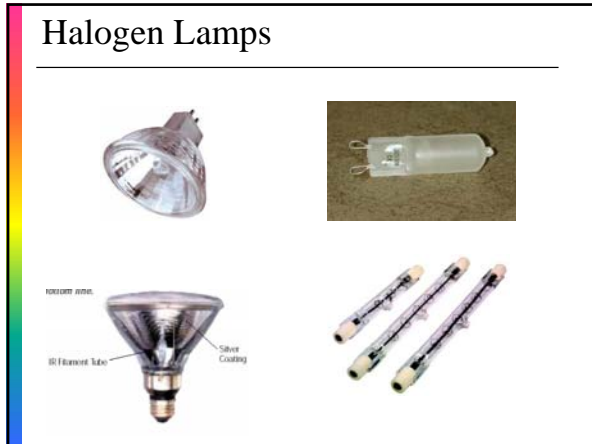


Attributes and Options - Incandescent

- Varied wattages, sizes, shapes, and bases
 - Finishes
 - Clear
 - Inside Frosted
 - Coated (Softwhite)
 - Dimming
 - Yes
- Do not require a ballast
 - Warm color appearance with a low color temperature and excellent color rendering (CRI 100)
 - Compact light source
 - Simple maintenance due to screw-in Edison base
 - Less efficacious light source
 - Shorter service life than other light sources in most cases
 - Filament is sensitive to vibrations and jarring
 - Bulb can get very hot during operation
 - Must be properly shielded because incandescent lamps can produce direct glare as a point source
 - Require proper line voltage as line voltage variations can severely affect light output and service life

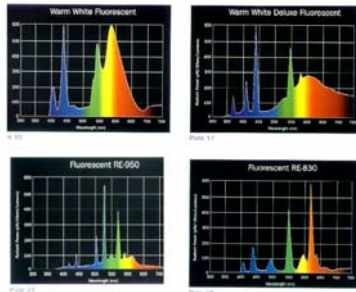
Lamps and Light Sources

Halogen Lamps



Spectral Power Distribution Curves

Fluorescent



Fluorescent Lamps produce a combined spectrum -- a continuous or broad spectra from their phosphor, plus the line spectra of the mercury discharge.



Lamps and Light Sources

How Fluorescent Lamps Work

Inside a Fluorescent Lamp

- Contact Pins
- Glass Tube
- Electrode
- Inert Gas
- Mercury
- Internal Phosphor Coating

The Physics of Fluorescent Lamps

- Free electrons (e^-) and ionized gas (Ar^+) collide with internal coating...
- Through the collision...
- The energy of the electrical current...

continue >

T5 .625" Diameter or 5/8" **T8** 1" Diameter or 8/8" **T12** 1.5" Diameter or 12/8"

Fluorescent Lamp Design...the old way

How the Starter Switch Works

- Initial current causes electrical arc between electrodes, which ionizes gas.
- Heat from the light bends bimetallic strip, which opens the switch, which turns off the starter light.
- The bimetallic strip cools and returns to its original position. Current flows through the ionized gas in the tube.

Fluorescent Lamp Design...the way today

How Fluorescent Lamps Work

Electrode Mercury Phosphor Coating Argon Gas Pins

Ballast

Press the switch to turn on the light

Lamps and Light Sources

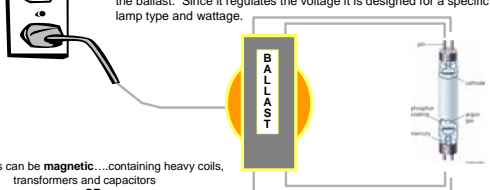
Ballast A ballast connects in between the line and the lamp

Ballasts perform three main functions

1. They start the lamp.
2. They take the line voltage (120/240/277/480) and step it up or down as required by the lamp.
3. They make sure the lamp operates in a stable mode by regulating the current

The Uniqueness Rule

✓ Ballasts are made specifically for the lamp they are designed to operate. You cannot simply replace a lamp with a different type without changing the ballast. Since it regulates the voltage it is designed for a specific lamp type and wattage.



Ballasts can be **magnetic**...containing heavy coils, transformers and capacitors
OR
 Ballasts can be **electronic**... lightweight, efficient and operate at high frequency


Attributes and Options - Fluorescent

- Varied wattages, sizes, shapes, and bases
- Finishes
 - Coated only – coating determines color
- Long Life
- Dimming
 - Yes, with dimming ballast and specific dimmers

– Require a ballast - Requires compatibility with ballast
 – Range of color temperatures and color rendering capabilities
 – Low surface brightness compared to point sources
 – Cooler operation
 – More efficacious compared to incandescent
 – Ambient temperatures and convection currents can affect light output and life
 – All fixtures installed indoors must use a Class P ballast that disconnects the ballast in the event it begins to overheat, high ballast operating temperatures can shorten ballast life
 – Options for starting methods and lamp current loadings
 – Low temperatures can affect starting unless a "cold weather" ballast is specified

Electrical Lighting: HID

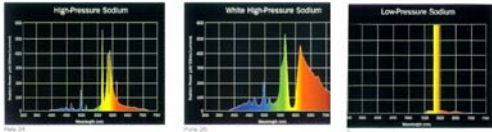
- Mercury lamp:
 - Uses radiation from mercury vapor for illumination
- Metal halide (MH) lamp:
 - Utilizes chemical compounds of metal halides and possibly vapors of metals such as mercury
- High-pressure sodium (HPS) lamp:
 - Uses sodium vapor for illumination



Lamps and Light Sources

Spectral Power Distribution Curves

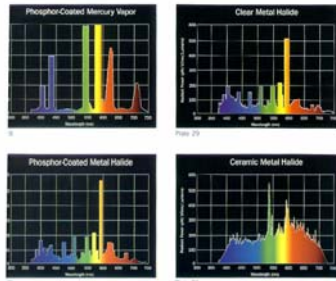
HID:
High Pressure Sodium



High Intensity Discharge Lamps (HID) produce light in discrete lines or bands (used in spectral analysis to identify or fingerprint the material producing the light).

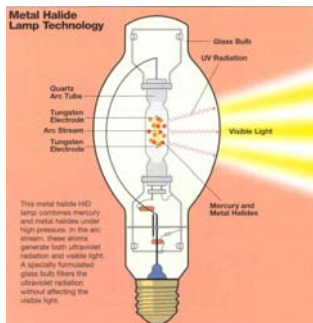
Spectral Power Distribution Curves

HID:
Metal Halides



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High Intensity Discharge



Lamps and Light Sources

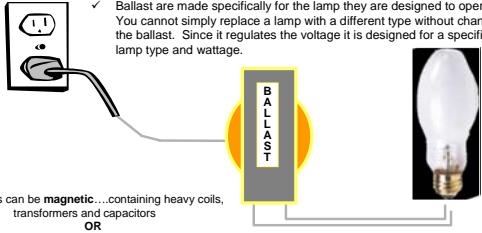
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2. They take the line voltage (120/240/277/480) and step it up or down as required by the lamp.
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The Uniqueness Rule

- ✓ Ballasts are made specifically for the lamp they are designed to operate. You cannot simply replace a lamp with a different type without changing the ballast. Since it regulates the voltage it is designed for a specific lamp type and wattage.



Ballasts can be **magnetic**...containing heavy coils, transformers and capacitors
OR
 Ballasts can be **electronic**... lightweight, efficient and operate at high frequency



Attributes and Options - HID

- Varied wattages, sizes, shapes, and bases
- Finishes
 - Clear, Coated, Colored
- Operates with Ballast
- Burning Position Critical
- Dimming
 - No
 - Multi-level Switching possible

- Ambient temperature does not affect light output, although low ambient temperatures can affect starting, requiring a special ballast

- Compact light source
- High lumen packages
- Point light source
- Range of color temperatures and color rendering abilities depending on the lamp type
- Long service life
- Line voltage variations, possible line voltage drops, and circuits sized for high starting current requirements must be considered

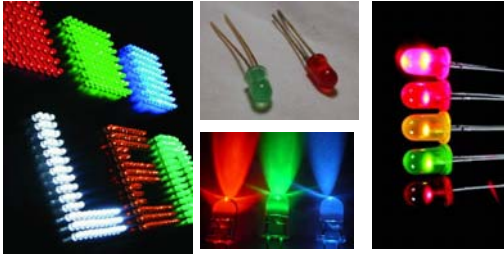
Lamp Manufactures

| | |
|-------------------------------------------------------------------------------------|------------------------------------------------------------|
|  | General Electric www.gelighting.com |
|  | Philips www.lighting.philips.com |
|  | Osram/Sylvania www.sylvania.com |
| Others | |
|  | Venture Lighting http://www.venturelighting.com/ |
|  | Ushio America Inc http://www.ushio.com/ |

Lamps and Light Sources

Special Sources

- Light-emitting diodes (LEDs):
 - Semi-conductor devices that have a chemical chip embedded in a plastic capsule



LED

RGB Lighting Systems

Specify color intelligent LED lighting systems for indoor and outdoor applications in a multitude of sizes and shapes. View wall washing fixtures to learn details on customizable lighting systems, complete with controller and power supply options.

Linear Lighting Systems light planes and other light architectural surfaces.



Beard View Systems are designed to be looked at, not to illuminate surfaces.



Wall Washing Systems project light against surfaces.



LED

IntelliWhite

Introducing IntelliWhite™ the next milestone in the evolution of intelligent LED lighting. These first-of-their-kind, intelligent illumination systems combine advanced high-brightness white LEDs with Color Kinetics' digital control expertise to enable traditional and completely new uses of high-quality white light. Learn more...

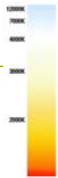
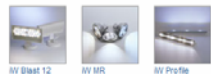
Read more about

Color Temperature And LED Lighting and other related white papers.

Color Temperature Controllable

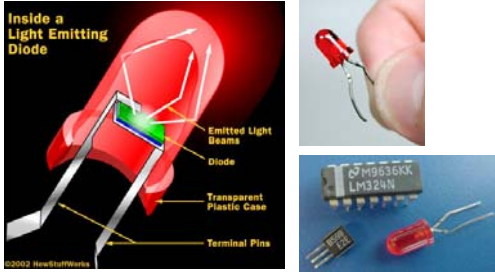


Products to be Replaced - click on images below to learn about replacement products



Lamps and Light Sources

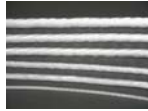
How LED's Work



Fiber Optics Systems

Components:

1. Remote Illuminator
2. Cables
 - Glass
 - Plastic
3. End Fitting



Side Emitting Fiber Optic



Lamps and Light Sources

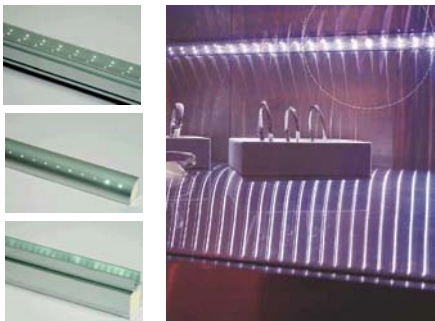
End Lights - Stars



End Lights



Bars



Lamps and Light Sources

Electroluminescent

- <http://www.ceelite.com/products/lamps.asp>

