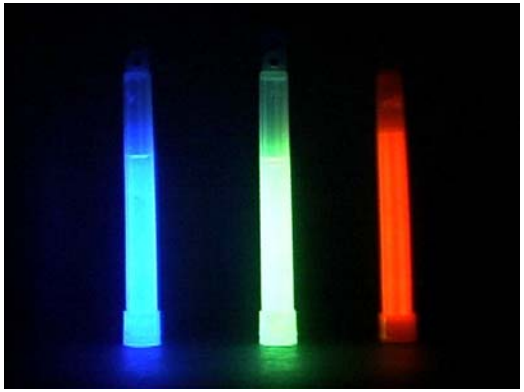
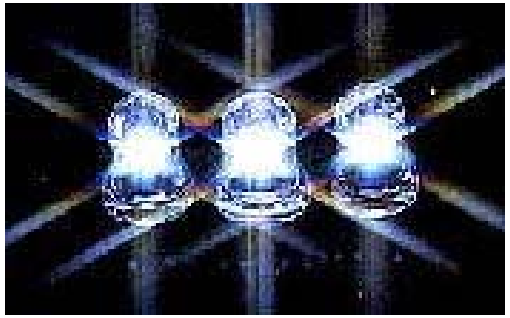
Introduction of Lighting technology





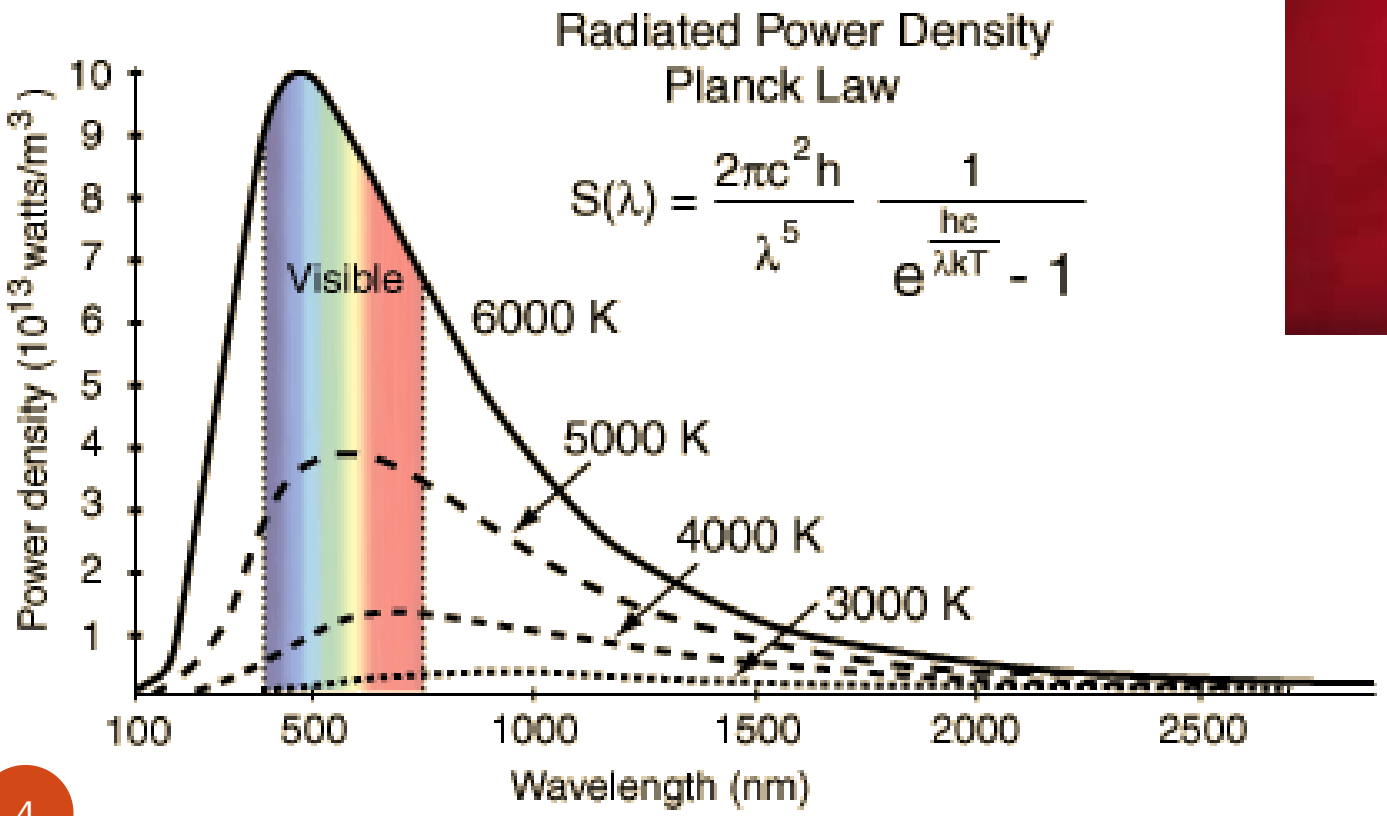
Timeline of Lighting Technology

- 3000 BC --- **candles** are invented.
- ??? BC --- **oil lamps**
- 1780 AD --- Ami Argand invents central draught fixed oil lamp
- 1784 AD --- Argand adds glass chimney to central draught lamp
- 1792 AD --- William Murdoch lights his house and office by means of gas.
- 1840 AD --- first kerosene lamps (oil lamps that burn fuel from petroleum)
- 1853 AD --- Ignacy Lukasiewicz invents **petrol lamp**
- 1802 AD --- Humphry Davy demonstrates arc-lighting in free air.
- 1815 AD --- Humphry Davy invents the miner's safety lamp.
- 1835 AD --- James Bowman Lindsay demonstrates a light bulb based electric lighting system to the citizens of Dundee.
- 1841 AD --- Arc-lighting used as experimental public lighting in Paris
- 1856 AD --- glassblower Heinrich Geissler confines the electric arc in a tube.
- 1867 AD --- A. E. Becquerel demonstrates the first **fluorescent lamp**
- 1875 AD --- Henry Woodward patents the electric light bulb.
- 1876 AD --- Pavel Yablochkov invents the Yablochkov candle, the first practical carbon arc lamp, for public street lighting in Paris.
- 1879 AD --- Thomas Edison and Joseph Wilson Swan patent the **carbon-thread incandescent lamp**.
- 1889 AD --- Incandescent gas mantle invented, revolutionises gas lighting.
- 1893 AD --- Nikola Tesla uses cordless low pressure gas discharge lamps, powered by a high frequency electric field, to light his lab.
- 1894 AD --- D. McFarlane Moore creates the Moore tube, precursor of electric gas-discharge lamps.
- 1901 AD --- Peter Cooper Hewitt demonstrates the **mercury-vapor lamp**.
- 1911 AD --- Georges Claude develops the **neon lamp**.
- 1926 AD --- Edmund Germer patents the fluorescent lamp.
- 1962 AD --- Nick Holonyak Jr. develops the first practical **visible-spectrum light-emitting diode**

From Wikipedia, the free encyclopedia.

http://en.wikipedia.org/wiki/Timeline_of_lighting_technology

Black Body Radiation - Fire



Halogen Lamp vs. Conventional Lamp

- Tungsten wire
- Halogen (I_2) gas
- Quartz wall

- Tungsten wire
- Nitrogen or Argon gas
- Glass wall

Conventional Lamp

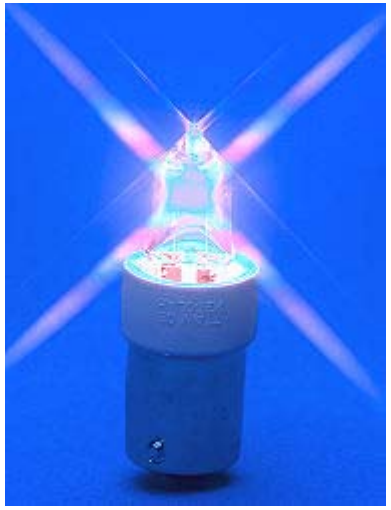
- Black-body radiation from Tungsten Wire
- Usual temperature for Tungsten wire is about 2500 °C. (melting point = 3400 °C)
- Tungsten wire will become thinner with usage and W atom will deposit on the glass wall
- Eventually the wire will break

Quartz-Tungsten-Halogen Lamp

- Black-body radiation from Tungsten Wire
- Halogen cycle:

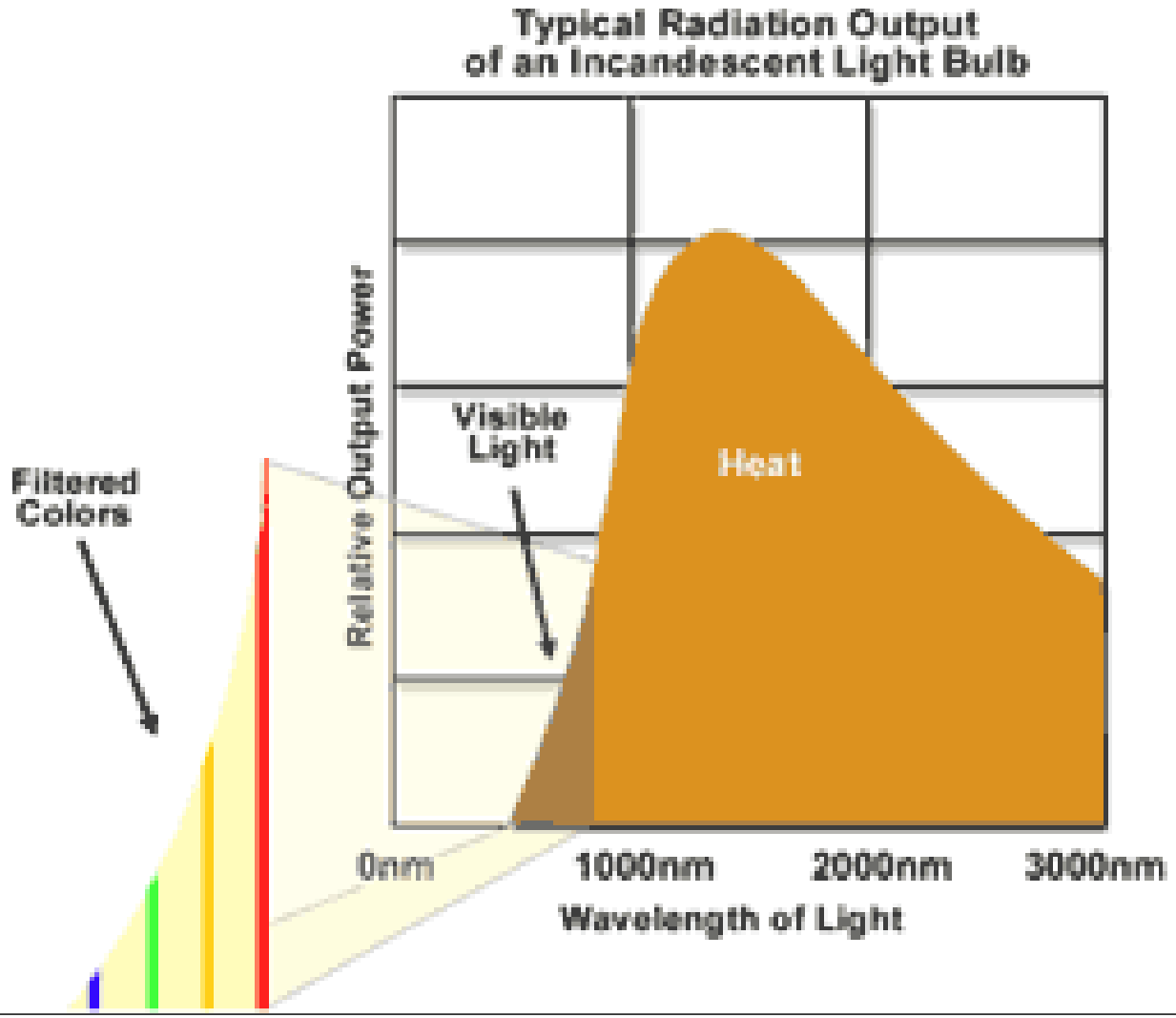
$$W + I_2 \rightarrow WI_2$$

$$WI_2 \xrightarrow{\text{several hundred degree C}} W + I_2$$

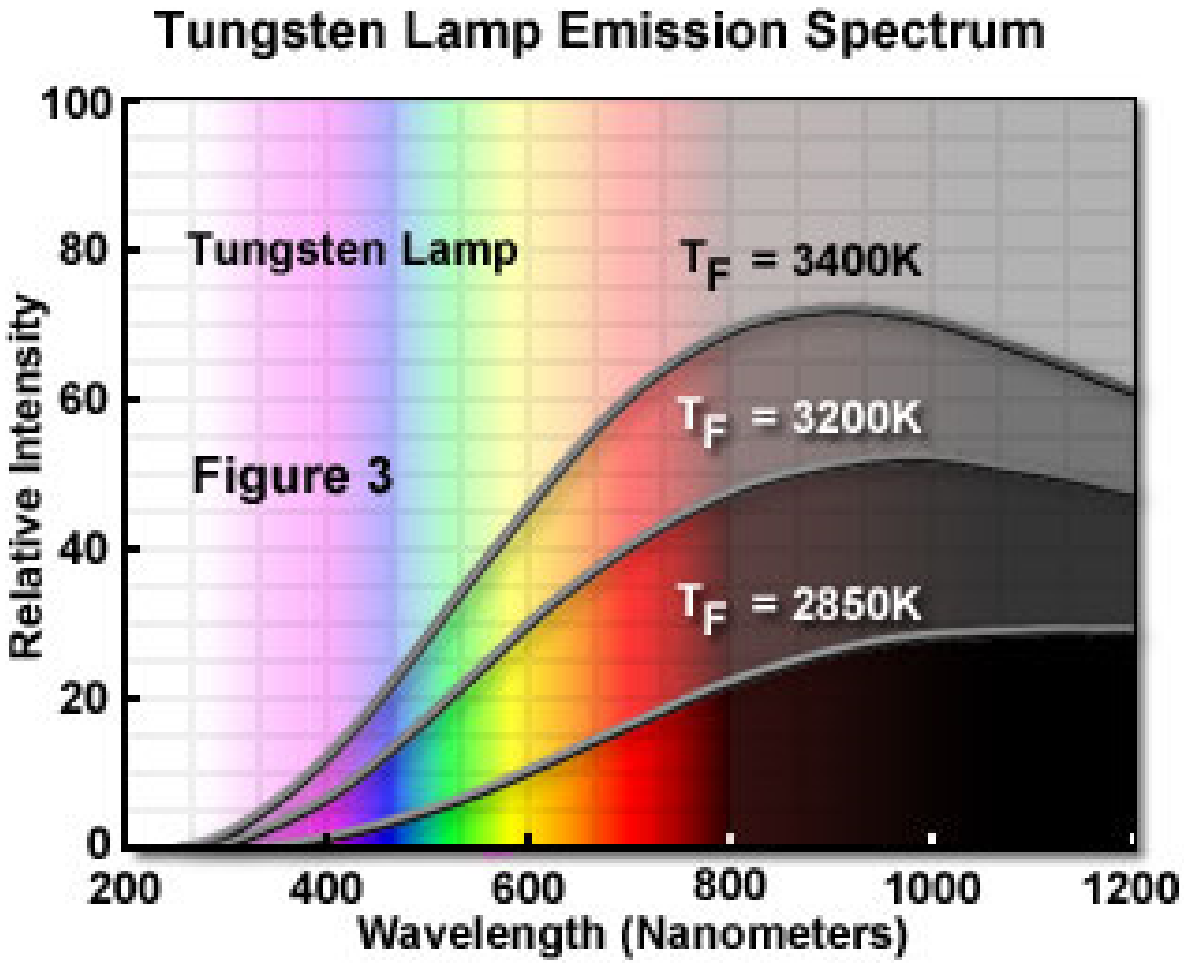


  - If the temperature of the quartz wall > 250 °C, WI_2 will not deposit on the wall and will in its gas phase.
  - Gas phase WI_2 will diffuse to high temperature tungsten will and react to form W and I_2
  - Because of high temperature:
    - quartz wall is required.
    - Lamp is usually small in size

Emission Spectrum of a typical Incandescent Lamp



Tungsten Lamp Emission Spectra



Adopted from http://micro.magnet.fsu.edu/primer/index.html

Fluorescent Lamp

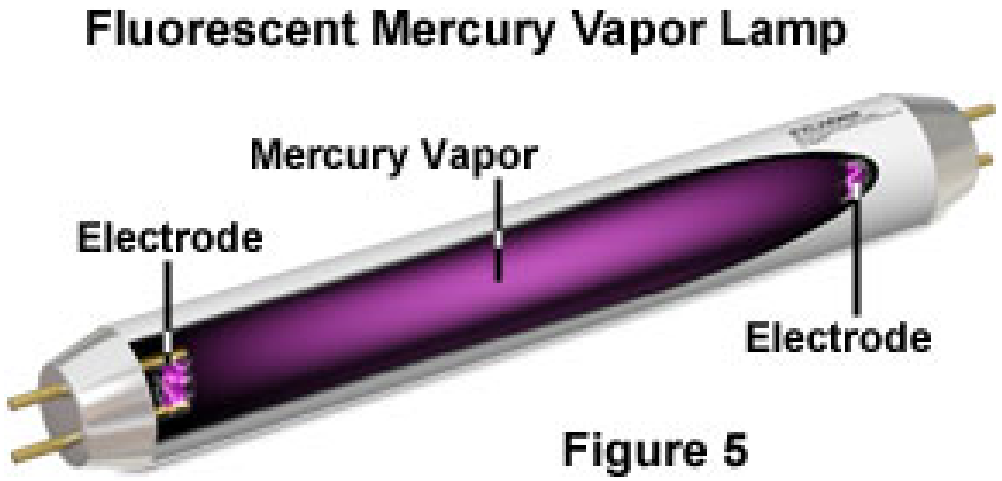
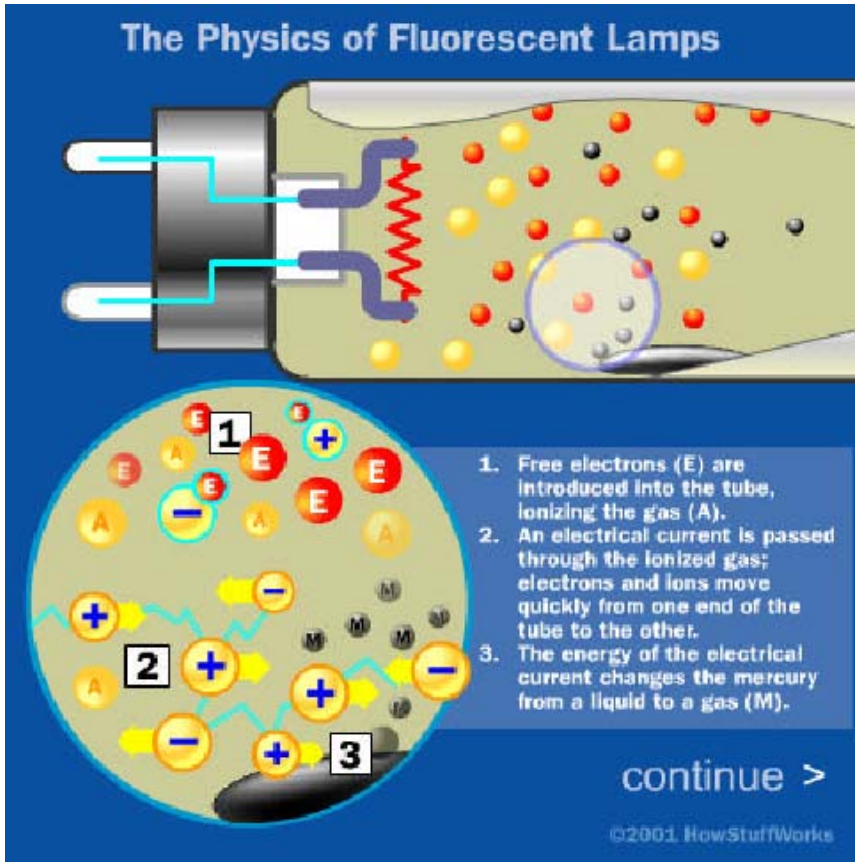


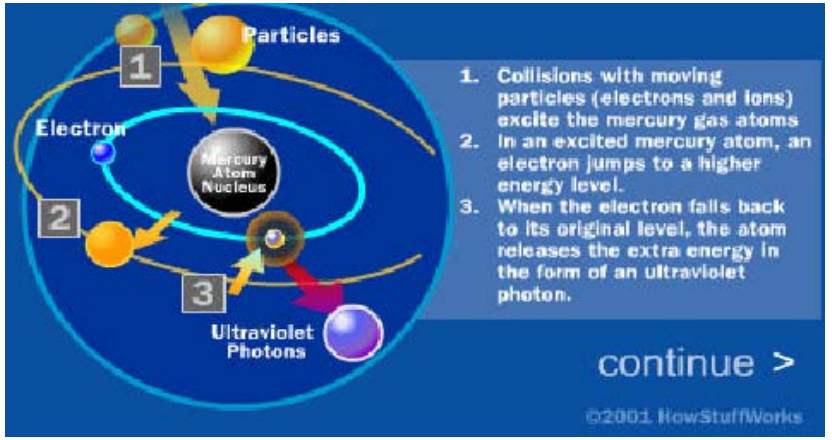
Figure 5

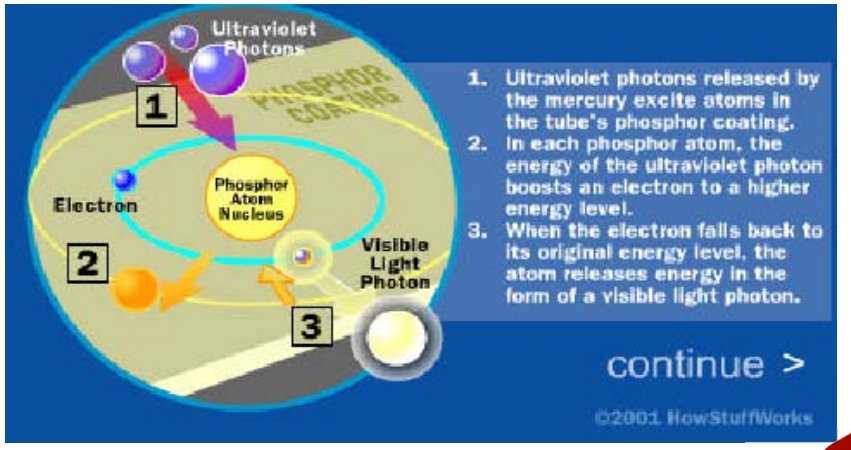
Compact Fluorescent Lamp

Adopted from http://micro.magnet.fsu.edu/primer/index.html

How a Fluorescent Lamp work?

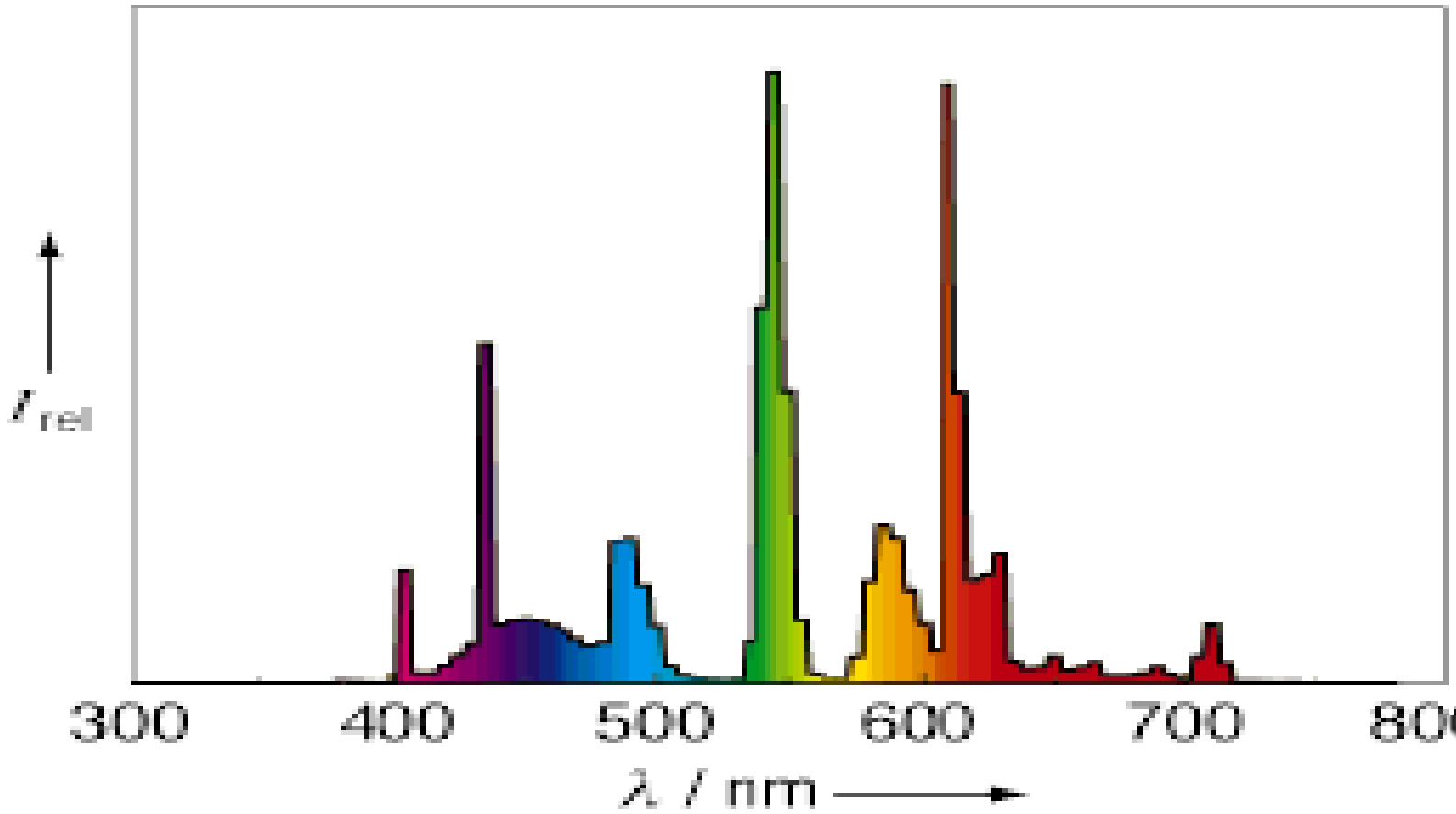




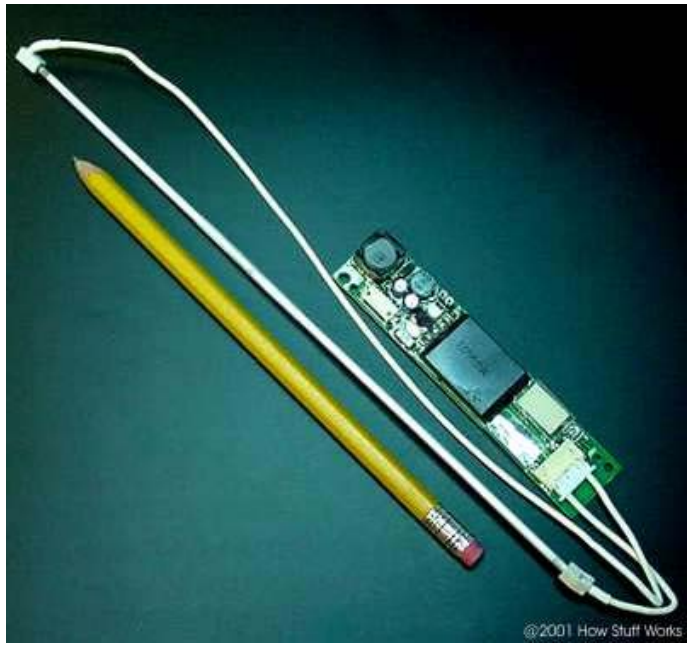


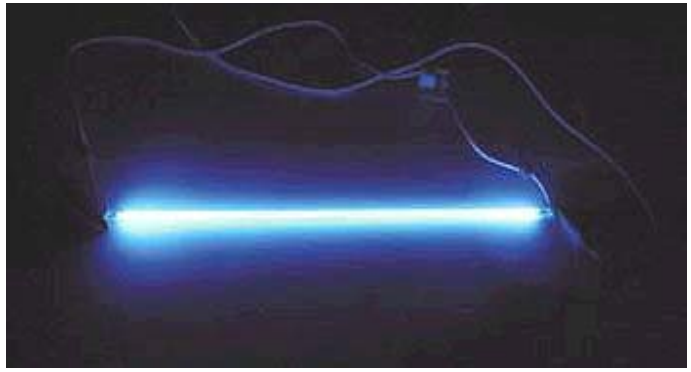
Adopted from HowStuffworks.com

Emission Spectrum of a Tricolor Fluorescent Lamp



Cold Cathode Fluorescent Lamp (CCFL)

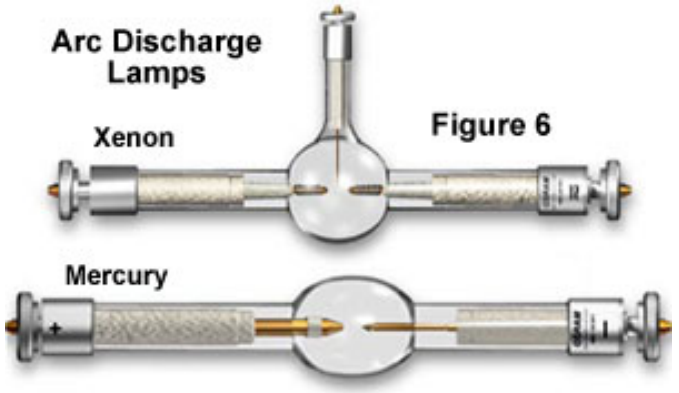


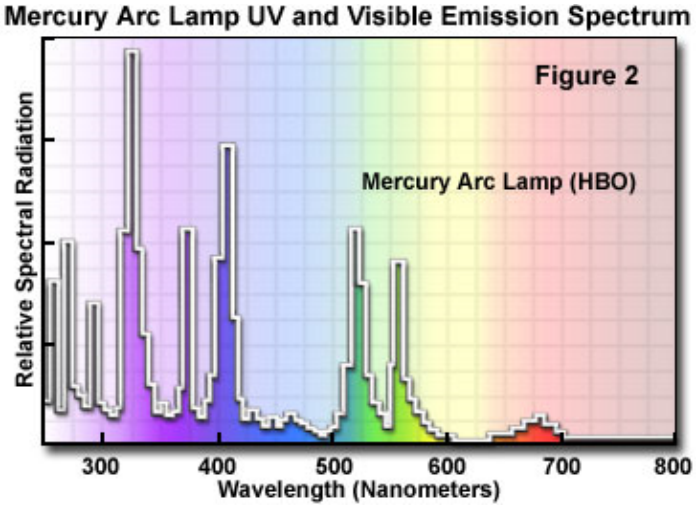


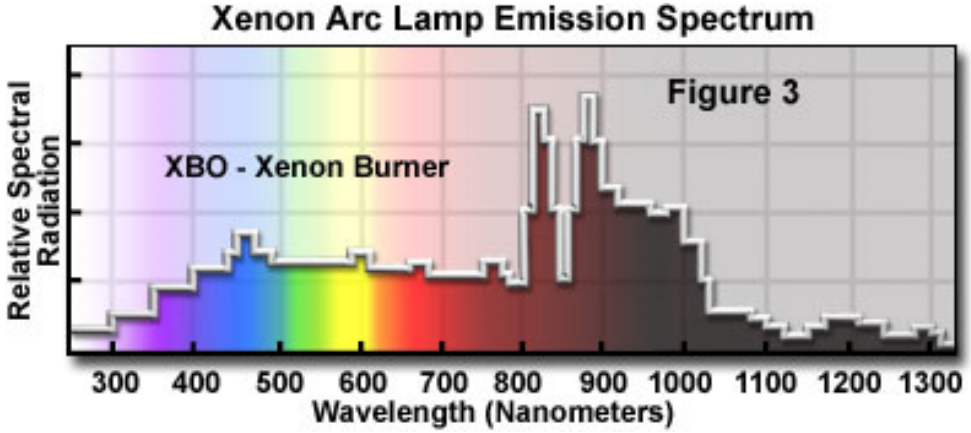
- Also called "Sub-Miniature Fluorescent Lamp (SMFL)"
- Cold cathode electrode do not rely on additional thermionic emission of electron
- Hot cathode electrode is heated by current flowing and produce enhanced emission from the lamp
- Advantage of Cold Cathode:
  - Miniaturization
  - Increased durability and lifetime
  - Simplified electrodes and reduced complexity of drive electronics

Arc Discharge Lamp

- Consists of two electrodes sealed under high pressure in a quartz glass envelope which also contains mercury or Xenon.
- depend on ionization of the gaseous vapor though a high-energy arc discharge between two electrodes to produce their intense light



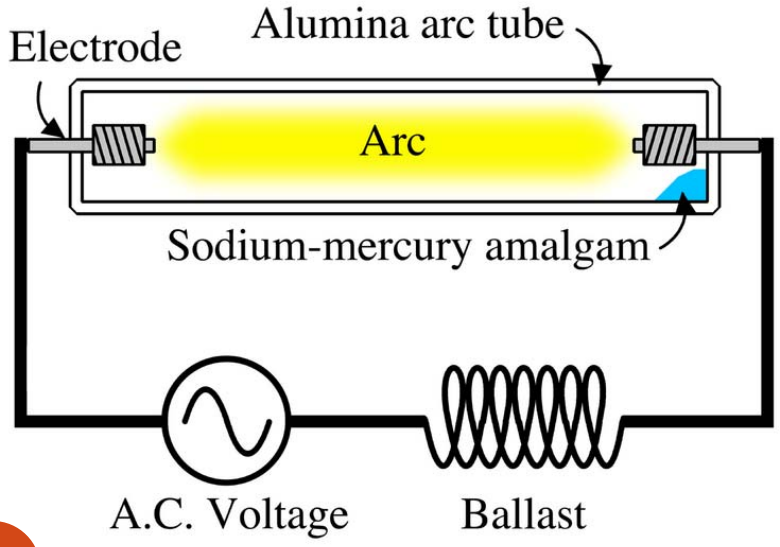




* Adopted from http://micro.magnet.fsu.edu/primer/index.html

High Pressure Sodium Lamp

- These lamps produce continuous spectrum light (not monochromatic),
- Can be used in areas where good color rendering is important
- Quite efficient — about 100 lm/W, up to 150 lm/W
- Are widely used for outdoor lighting such as streetlights and security lighting



From Wikipedia, the free encyclopedia.

http://en.wikipedia.org/wiki/Sodium_vapor_lamp

Metal Halide Lamps

- Similar to mercury vapor lamps, but instead of just mercury, they also contain sodium/scandium iodide and sometimes metals in the rare earth period combined with halogens in the halogen group of the periodic table.
- Are preferred over mercury vapor in areas where color rendition is important as they give a purer white light than mercury vapor, which tends towards the blue end of the electromagnetic spectrum
- In general,
  - metal halide lamps have better color rendering than high pressure sodium lamps
  - better efficacy than high pressure mercury lamps.
  - Compared to fluorescent lamps, they are less affected by change in ambient temperature.

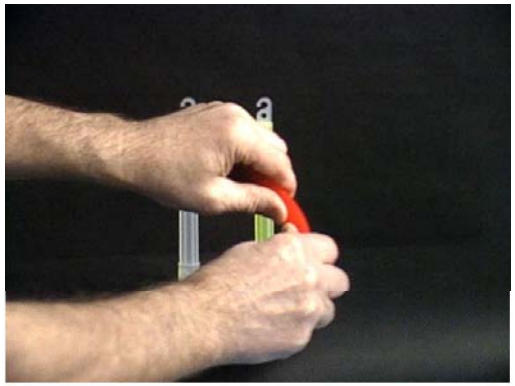
From Wikipedia, the free encyclopedia.

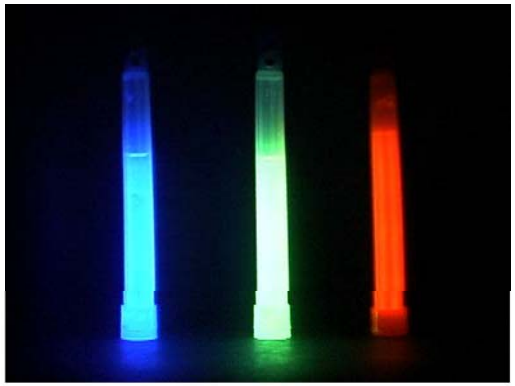
http://en.wikipedia.org/wiki/Metal_halide_lamp

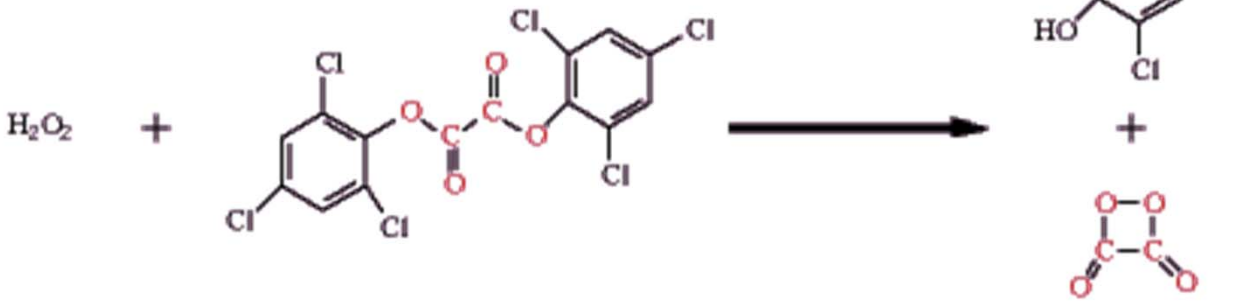
Neon Tube Lamps

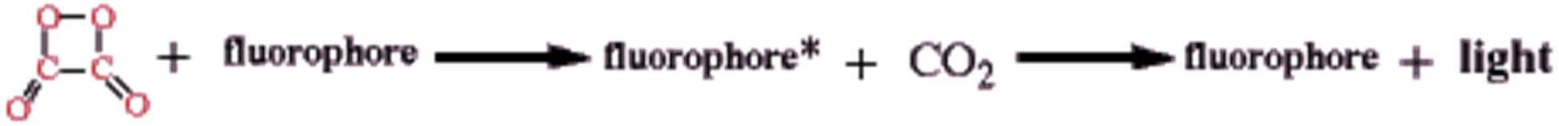
- Neon tubes actually refer to all positive-column discharge lamps, regardless of the gas filling.
- The colors in order of discovery were blue (Mercury), white (CO2), gold (Helium), red (Neon), and then different colors from phosphor-coated tubes.
- The mercury spectrum is rich in ultraviolet light which in turn excites a phosphor coating on the inside of the tube to glow.
- Phosphors are available in most any pastel colors.

Light Stick - Chemiluminescence





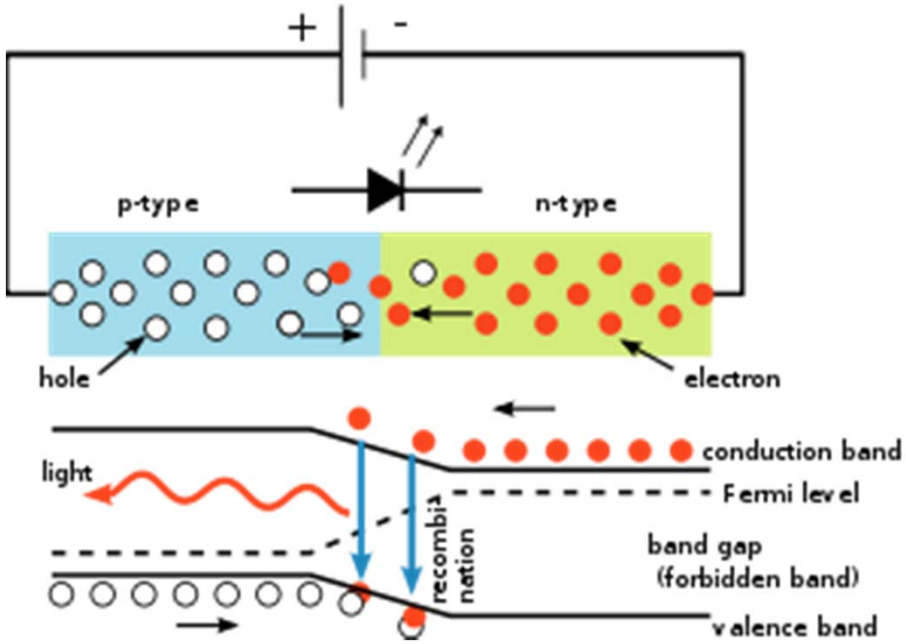


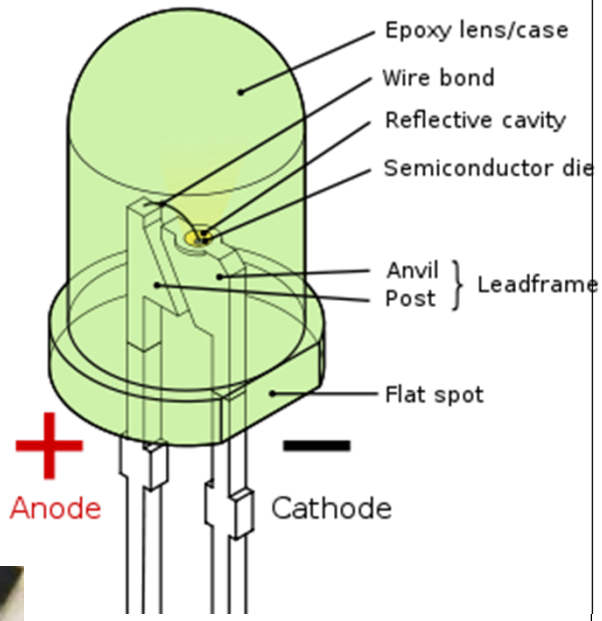


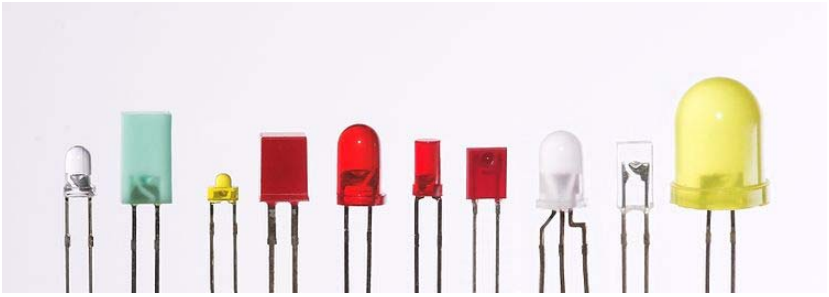
Characteristics of Existing Lights

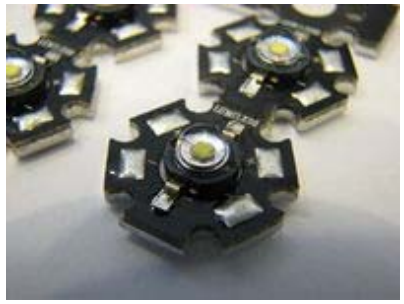
Lamp Type	Power (Watts)	Efficiency (lm/W)	Lifetime (hrs)
Standard Incandescent	15-250	8-19	750-2,500
Long Life Incandescent	135	12	5,000
Halogen	42-150	14-20	2,000-3,500
Compact Fluorescent	5-55	50-70	10,000
Standard Fluorescent	30-40	70-80	20,000
Mercury Vapor	40-1,000	50	29,000
Metal Halide	32-1,500	46-100	5,000-20,000
High Pressure Sodium	35-1,000	50-124	29,000

Light Emitting Diodes









http://en.wikipedia.org/wiki/Light-emitting_diode