

Light & Lighting

Lighting

- Lighting is the use of light to achieve a practical or enjoyable effect.
- Lighting includes the use of both artificial light sources as well as natural illumination by capturing daylight.
- Lighting plays a vital role in the quality of our daily lives.
- Good lighting is both a science and an art, combining knowledge of physics, engineering, design, physiology and psychology.

Lighting considerations

- At work in offices, production or logistical facilities, good lighting brings employee satisfaction, performance, comfort and safety.
- In shops, galleries and public places, it creates ambience and helps to accentuate the architectural environment.
- While in the home, it not only lights our tasks but builds a comfortable, welcoming atmosphere that makes our homes a pleasure to live in.
- Lighting influence an atmosphere in affecting mood, wellbeing and health.

Lighting considerations

- The last items to be considered when budgeting a building project is lighting.
- Cheaper alternatives may decrease employee productivity and motivation, leading to more errors and failures, or even worse accidents.
- Must be careful to avoid overlighting the space.
- Not only does overlighting waste energy, but it can also reduce lighting quality.
- Gains in productivity may be much more valuable than the energy savings associated with lighting technologies.

Light Sources

- Non-Electric sources
 - Candle
 - Kerosene Lantern
 - Illuminating gas flame
- The first electric arc was discovered by Davy in 1801.
- Edison's first successful incandescent lamp in 1879.

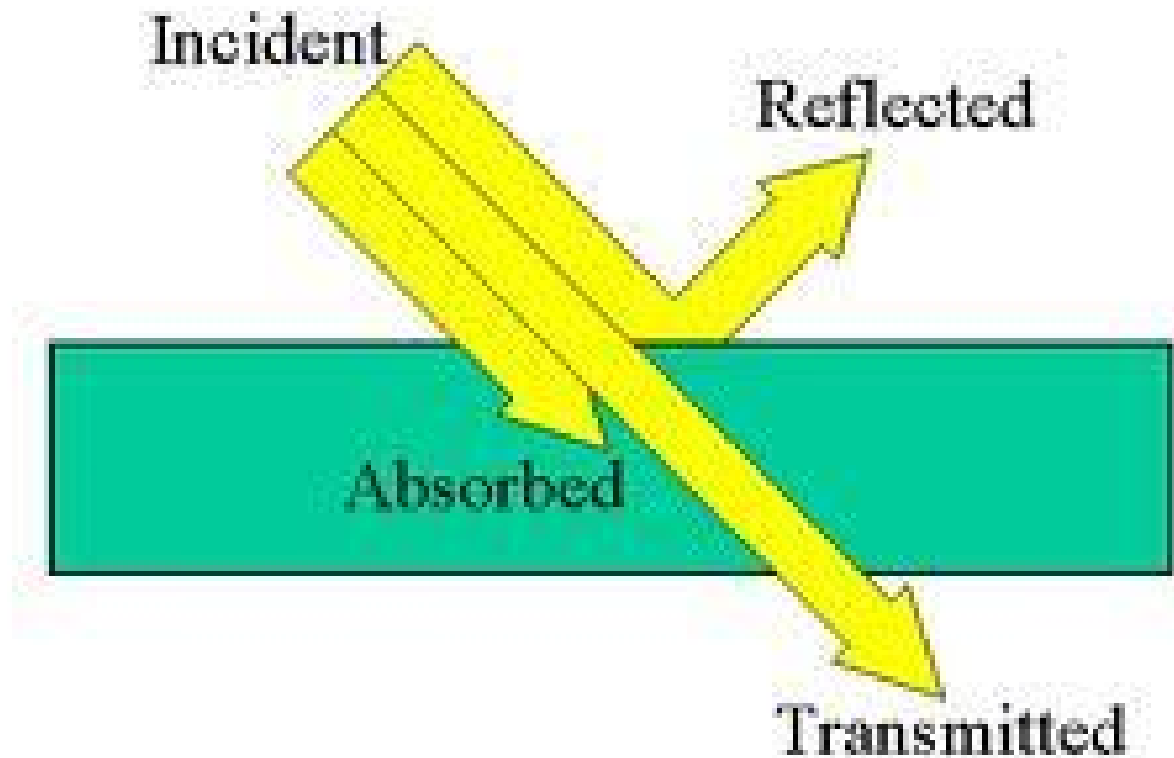
Light Sources

- Electric sources
 - Incandescent lamp
 - Electric discharge
 - Arc lamps
 - Fluorescent
 - Lasers
 - Neon signs
 - LED-LCD displays
 - Luminaries

Light's behaviour

- Whenever light strikes a surface, three possibilities are open: it is reflected, absorbed or transmitted.
- Often a combination of two or even all three effects occurs.
- So the three behaviours are
 - Reflectance
 - Absorption
 - Transmission

Light's behaviour



Reflectance

- Less than a few percent for very dark surfaces like black velvet, to over 90% for bright surfaces such as white
- The amount of reflected light depends on
 - the type of surface,
 - angle of incidence and
 - spectral composition of the light

Type of surface and angle of incidence

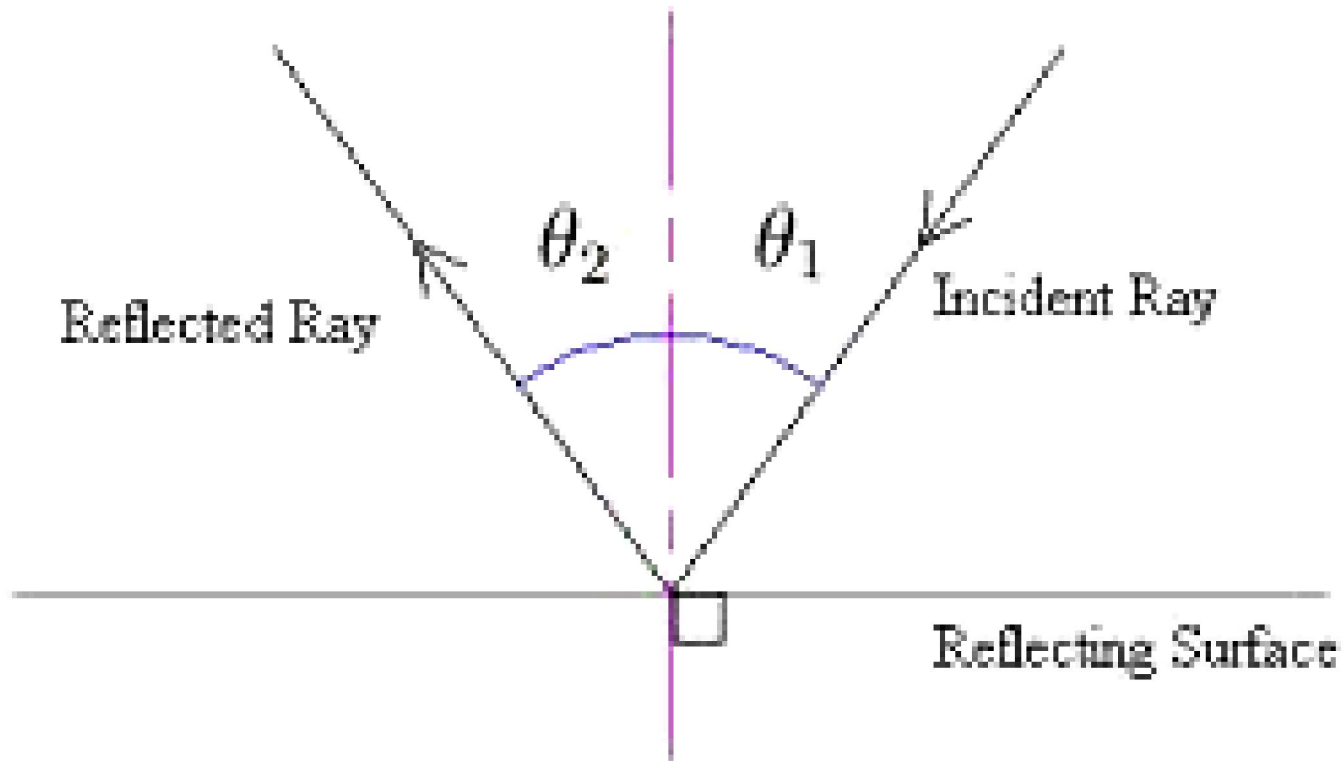
- Rough surfaces diffuse the light by reflecting it in every direction
- Smooth surfaces like the surface of still water or polished glass reflect the light back undiffused, making the surface act as a mirror.
- A ray of light striking a mirrored surface at an angle will be reflected back at the same angle on the other side.
- Law of reflection that is given as:

$$\text{angle of incidence} = \text{angle of reflection}$$
- Curved mirror reflectors are widely used for focusing light, dispersing it or creating parallel or divergent beams.

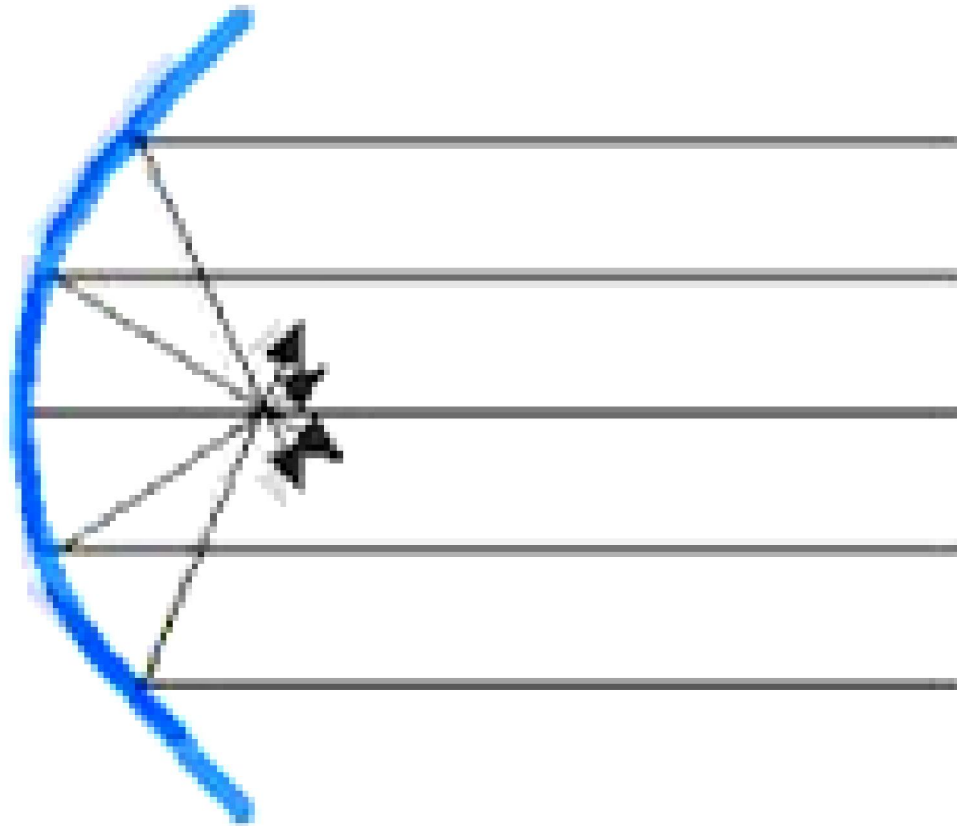
Law of reflection

Law of Reflection:

$$\theta_1 = \theta_2$$



Curved mirror reflections



Absorption

- If the material's surface is not entirely reflecting or the material is not a perfect transmitter, part of the light will be absorbed.
- It 'disappears' and is basically converted into heat.
- The percentage of light absorbed by a surface depends on both the angle of incidence, and on the wavelength.
- The absorption of light makes an object dark to the wavelength of the incoming radiation.

Absorption

- Some materials are opaque to some frequencies of light, but transparent to others.
- Glass is opaque to ultraviolet radiation below a certain wavelength, but transparent to visible light.
- Wood is opaque to visible light.

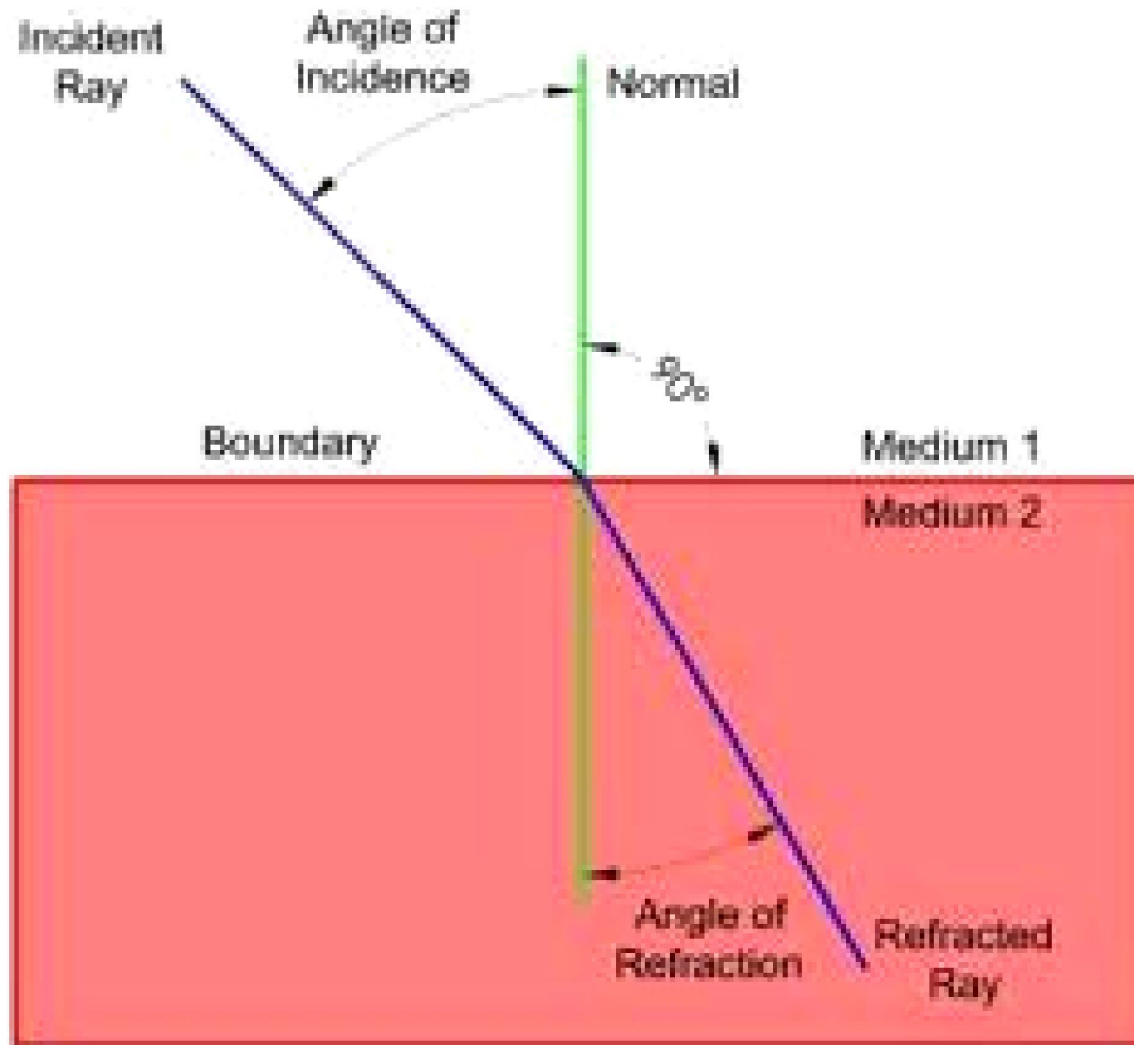
Transmission

- Transparent materials transmit some of the light striking its surface, and the percentage of light that is transmitted is known as its transmittance.
- Clear water and glass have high transmittance whereas paper, transmit only a small percentage of this light.

Refraction

- If a light ray passes from one medium into another of different optical density, the ray will be 'broken'.
- Caused by the change of speed of the light as it passes between transparent media of different optical densities.

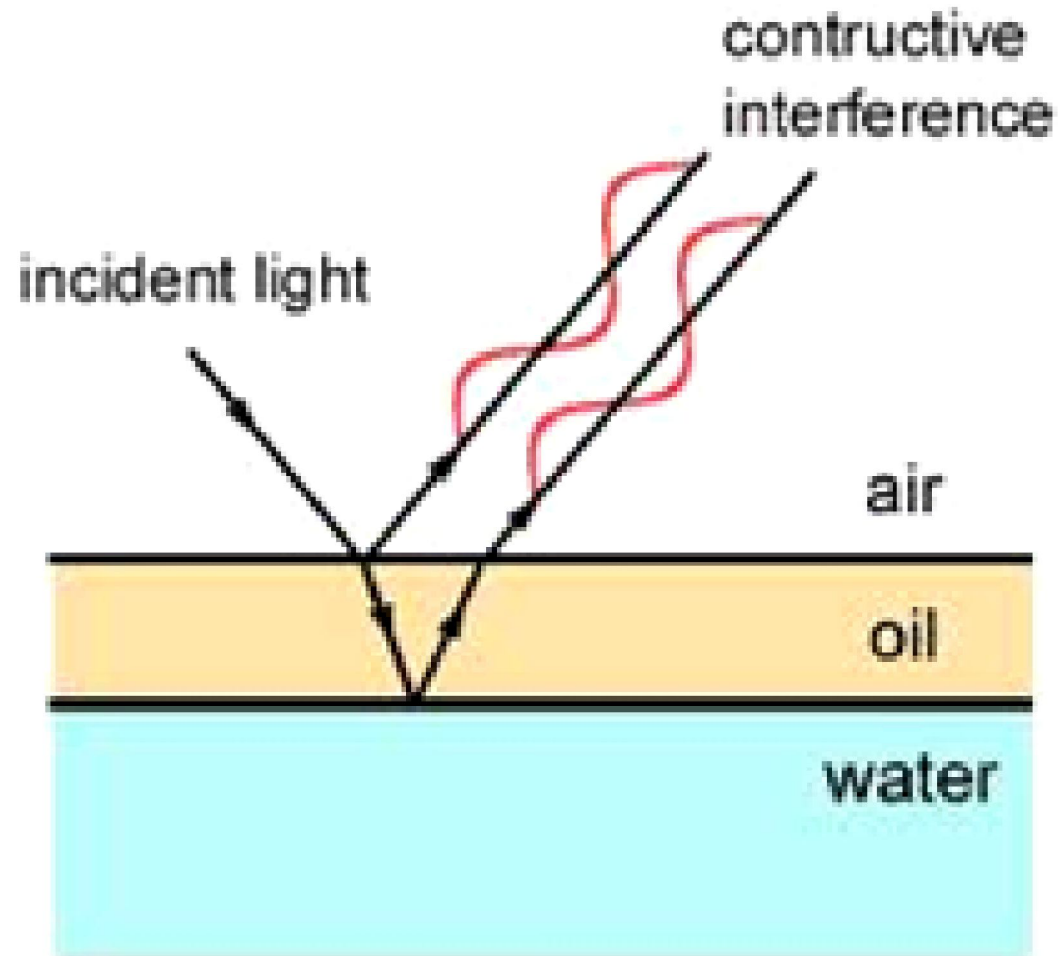
Refraction



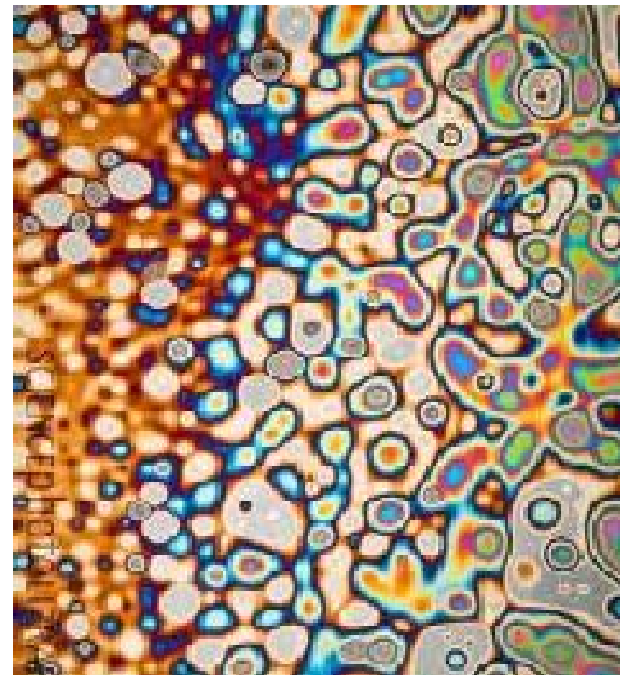
Interference

- When there is a thin film of oil floating on the surface of a pool.
- The oil will display a brilliant pattern of colours or rainbows, even when illuminated by white light.
- Different parts of the oil film cause the different wavelengths in the white light to interfere and produce different wavelengths
- Various colours are generated, depending on the thickness of the film where the interference occurs.
- Other examples are soap bubbles, or at the surface of a CD.

Interference on oil



Interference



Determining Target Light Levels

- The Illuminating Engineering Society of North America (IESNA) has developed a procedure for determining the appropriate average light level for a particular space.
- Recommends a target light level by considering the following.
 - the task(s) being performed (contrast, size, etc.)
 - the ages of the occupants
 - the importance of speed and accuracy

Determining Target Light Levels

- The appropriate type and quantity of lamps and light fixtures may be selected based on the following
 - fixture efficiency
 - lamp lumen output
 - the reflectance of surrounding surfaces
 - the effects of light losses from lamp lumen
 - depreciation and dirt accumulation
 - room size and shape
 - availability of natural light (daylight)