Light Basics

Dual Nature of Light

Light is said to have a dual nature. This means that we can consider light to be a wave and we can consider it to be a particle. Light has properties of both a WAVE and a PARTICLE.

Light as a Particle

A light particle is called a photon.

The speed of light, c, is 3.0×10^8 m/s.

Light as a Wave

If we consider light to be a wave, then the wave propagates at the speed of light (3.0×10^8 m/s)

Amplitude (A)

Frequency (f)

Wavelength (λ)

Remember that for all colors $c = f\lambda$

Examples:

1. What is the frequency of yellow light if it has a wavelength of 570 nm?

2. What is the wavelength of x-rays if they have a frequency of 6×10^{16}Hz?

Types of Objects and Materials

Luminous

Non-Luminous

Types of Light Sources (Luminous Objects)

Incandescent

Luminescent

Fluorescent

Phosphorescent

Size of Light Source

Some Light Phenomena

Reflection

Refraction

Diffusion

Dispersion

Diffraction

Absorption

Scattering

Some Properties of Light

Light travels in a straight Line

A ray of light is the path along which light energy is carried. We use an arrow to represent a ray of light

Shadows, Umbra, Penumbra

A point source produces a clear cut shadow. The shadow is upright (not upside down).

A large source (or two point sources) produces a shadow where some areas are partially lit.

Umbra: Area that does not receive any light

Penumbra: Area that receives some light

Examples:

1. Determine the regions of umbra and penumbra produced on the screen

2. What happens to the region of umbra on the screen as the screen gets closer to the object causing the shadow?

3. What happens to the region on the screen as the object causing the shadow gets closer to the light source?

Application of Shadows: Eclipses

Solar eclipse:

Lunar eclipse

A few more examples

1. In which position(s) is the moon in the Earth's penumbra?

2. In which region(s) of the Earth can a total solar eclipse be seen?

The Pinhole Camera

The pinhole camera (aka obscura) illustrates the fact that light travels in a straight line.

This is how it works:

The images produced by a pinhole camera are

Example: Consider the object below, which is located through a pinhole camera

R

1. What would the image look like on the screen of the pinhole camera?

2. What happens to the image seen on the pinhole camera screen when the pinhole camera gets closer to the object? When it gets further?

3. What happens to the image seen on the pinhole camera screen when the screen within the pinhole camera gets closer to the pinhole? When it gets further?

Some vocabulary and symbols:

Object:

Image:

d_o: distance from the pinhole to the object

d_i: distance from the pinhole to the image

** always measure distances from the pinhole! Beware of signs!!

h_o: height of object

h_i: height of image

Beware of signs!!

Magnification with the Pinhole Camera

Magnification (M): factor by which the height of the object is reduced/enlarged in order to obtain the image

Examples:

1. Using a pinhole camera, you look at a tree that is 4 m high. On the screen of the pinhole camera, the tree appears to be only 2 cm high. What is the magnification?

2. You are observing a firefly that is 1.5 cm long. The image of the firefly measures 4.5 cm. What is the magnification?

3. When you look at a candle through a pinhole camera the image you see is 4 times smaller than the actual candle. What is the magnification of the pinhole camera?

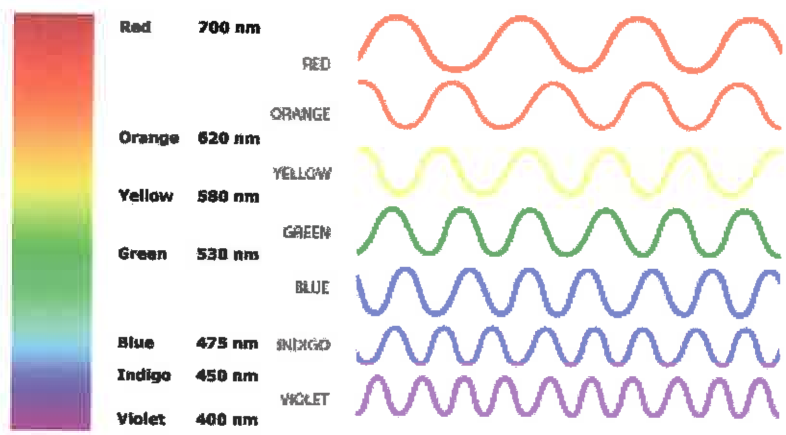
4. Using a pinhole camera you wish to produce an image of a house that would be 100 times smaller than the actual house. The screen of your pinhole camera is located 30 cm away from the pinhole. How far from the house should you position the pinhole of your camera in order to obtain the desired image?

Colours

White light is composed of

Different colours of light

Wavelengths of Different Colours of Light



Colour Theory

Primary colour of light

Primary colour of pigment (paint)

Adding light

Blue light + red light

blue light + green light

red light + green light

Adding pigment

Magenta + yellow

magenta + cyan

cyan + yellow

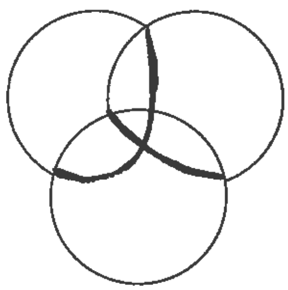
Adding light:

Adding pigment:

Summary

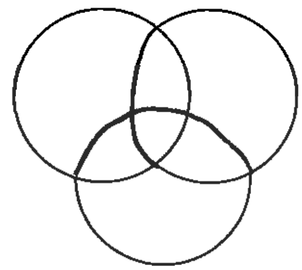
Colour theory (additive)

Adding light of different colours



Colour theory (subtractive)

Adding pigment of different colours (ex paint)



Coloured Items

Object that appear GREEN reflects

absorbs

Object that appear RED reflects

absorbs

Object that appear BLUE reflects

absorbs

Looking at coloured items in different colours of light

- Remember that objects only appear to be certain colours because they REFLECT light of a certain colour. So an apple does not look red because it is red; it looks red because it reflects red light.
- Objects that do not reflect any light are black.

Examples:

1. What is the colour of a red apple in white light?
    a. Red light
    b. White light
    c. Blue light
    d. Green light

2. Lisa is wearing a blue shirt. She goes to a party where there is a "light" show. The dance floor is successively lit by a red light, by a blue light and by a white light. What is the colour of Lisa's shirt as viewed in different lights?

3. A singer is giving a show. She is wearing a white shirt and a red pair of pants. A green light is lighting the stage. What colour do her shirt and pants appear on stage?

Colour Filters:

Remember that light of different colours has different wavelengths. This is called the visible spectrum.

Colour filters are substances that allow specific wavelengths of lights (specific colours) through. Filters absorb colours of light.

Ex: a red filter lets________________through

absorbs______________________________

In reality filters are not pure. They do not let only one colour through; they also allow adjacent colours through. (See ROYGBIV)

Ex:

1. A composed (not pure) yellow lets ________________________________ through.
2. Two filters are placed in front of the same white light source. The light from the source first goes through the orange filter ten through the green filter. What is the colour of the light that passes through the second filter?