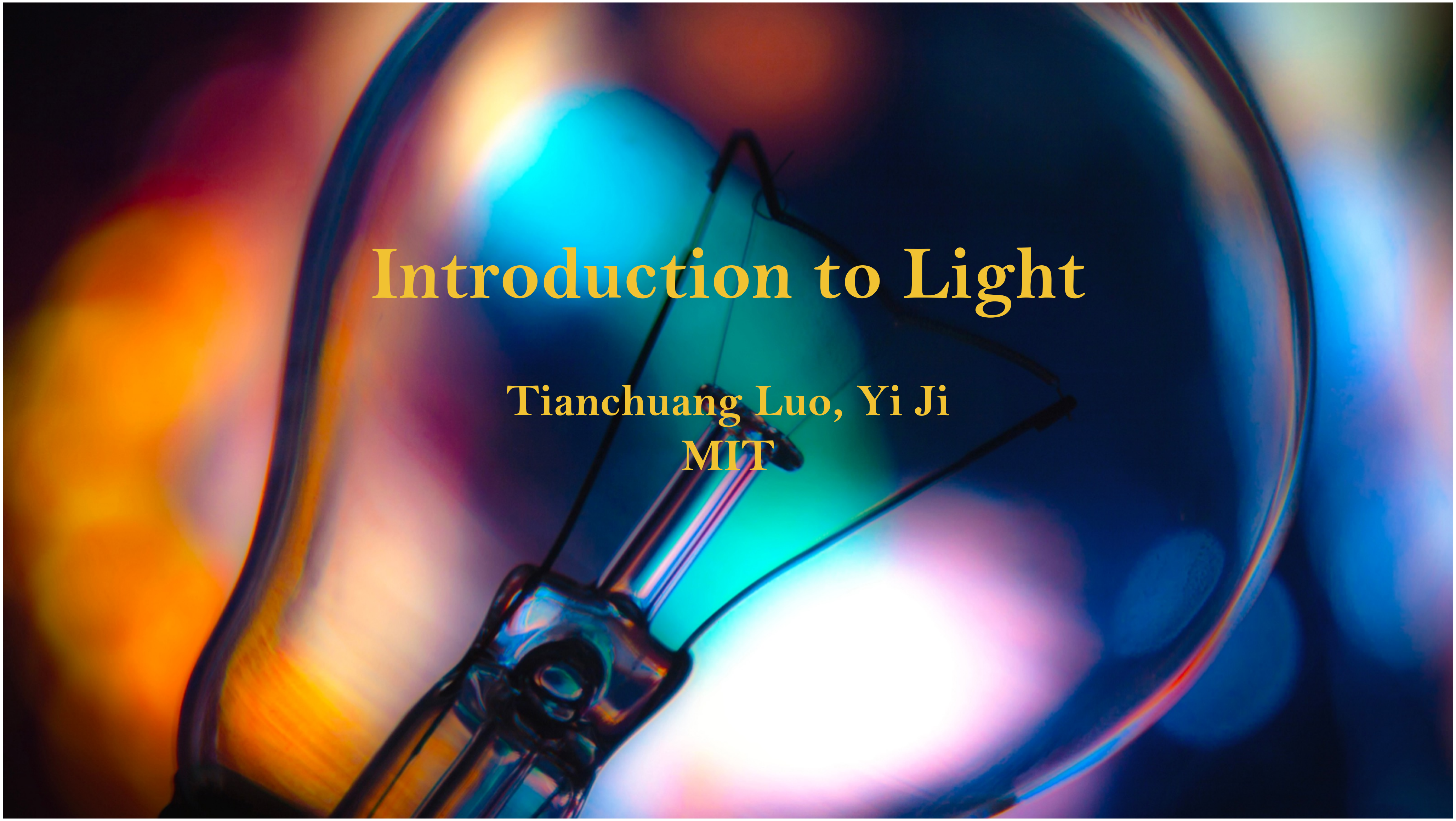

Introduction to Light

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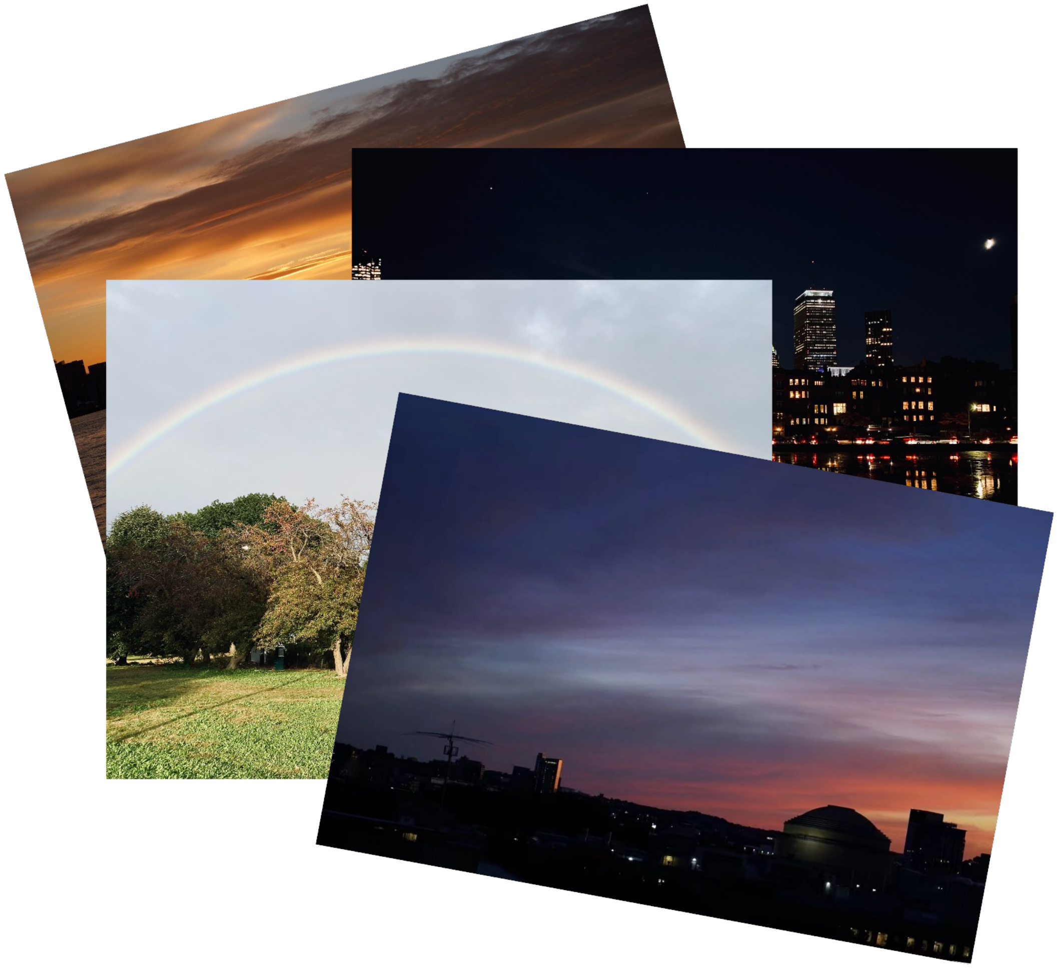
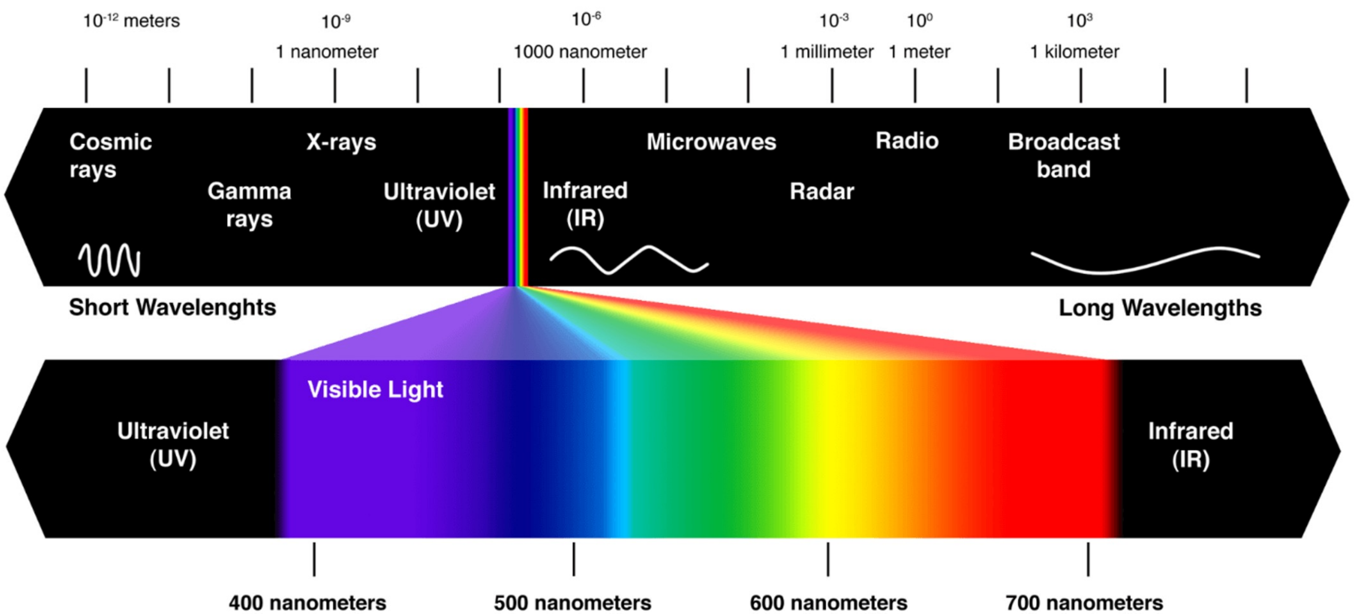
MIT

What do you know about "light"



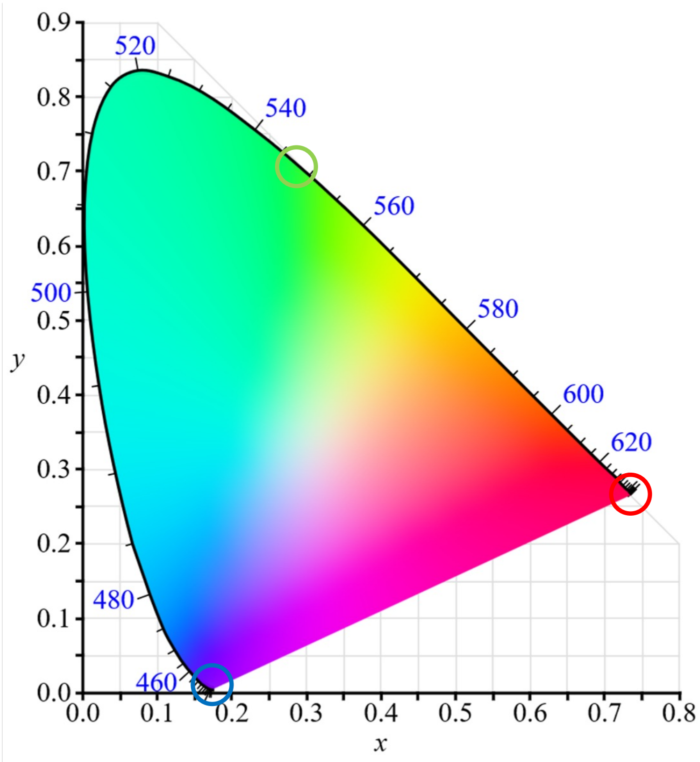
Dispersion
Refraction
Reflection
…

The Color of Light



How do we characterize the color of light?

The Color of Light



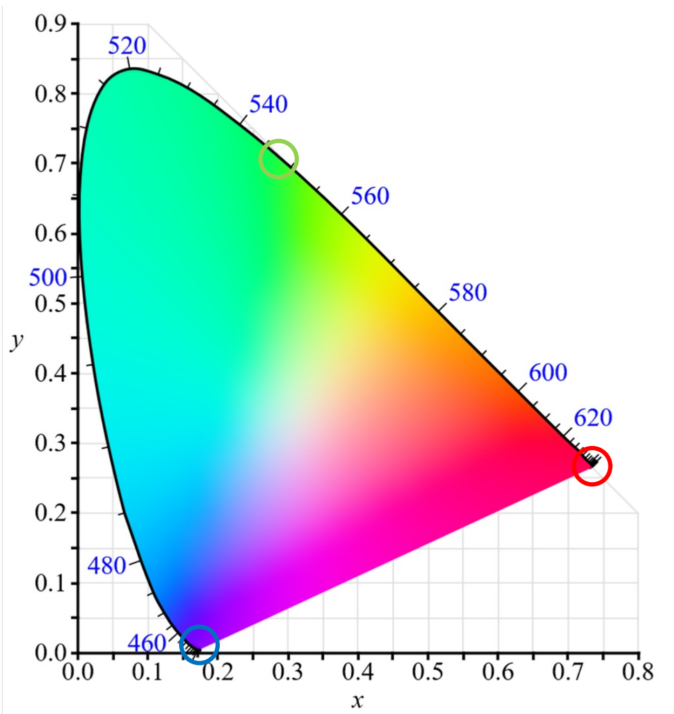
chromaticity diagram

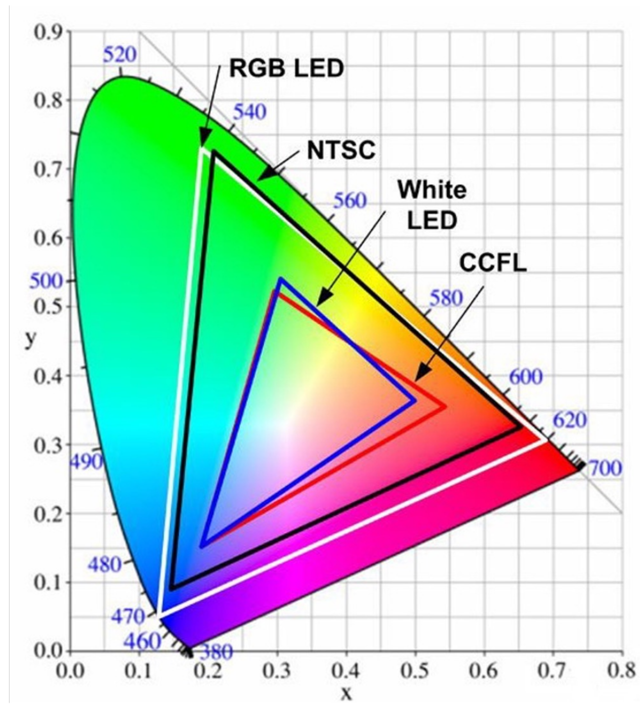
Do you know primary colors?

Red	700 nm
Green	546.1 nm
Blue	435.8 nm

Questions

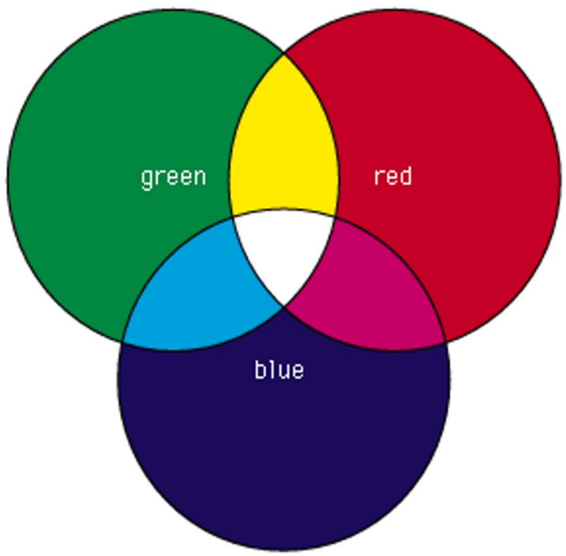
1. Can all the color be represented by RGB lights?



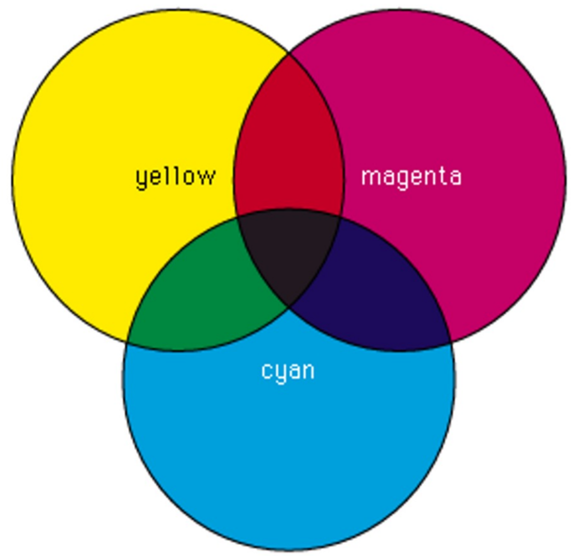


Questions

2. What are the basic colors in painting? How are they related to the primary colors?

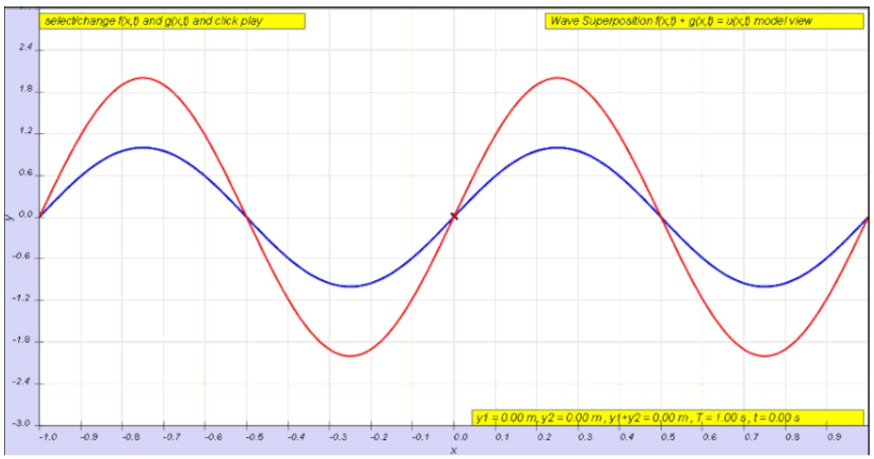


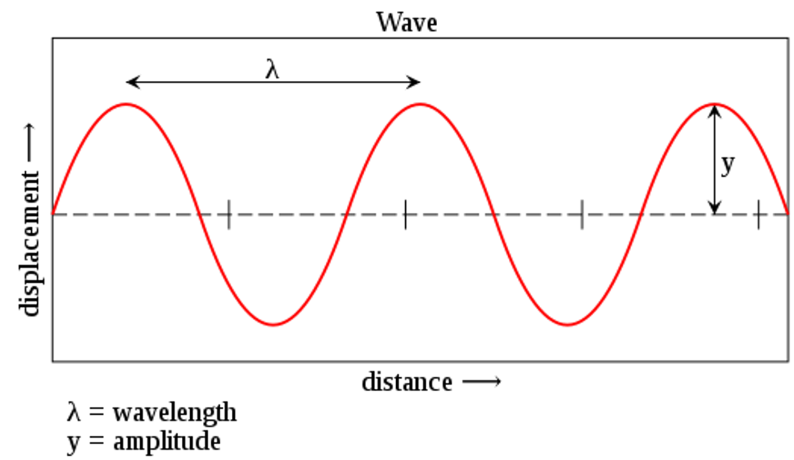
Adding colors to “black”



subtracting colors from white

Describing a Wave

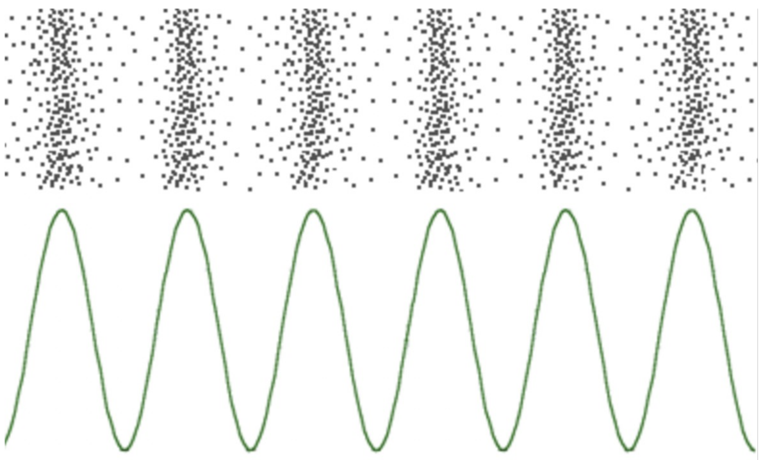


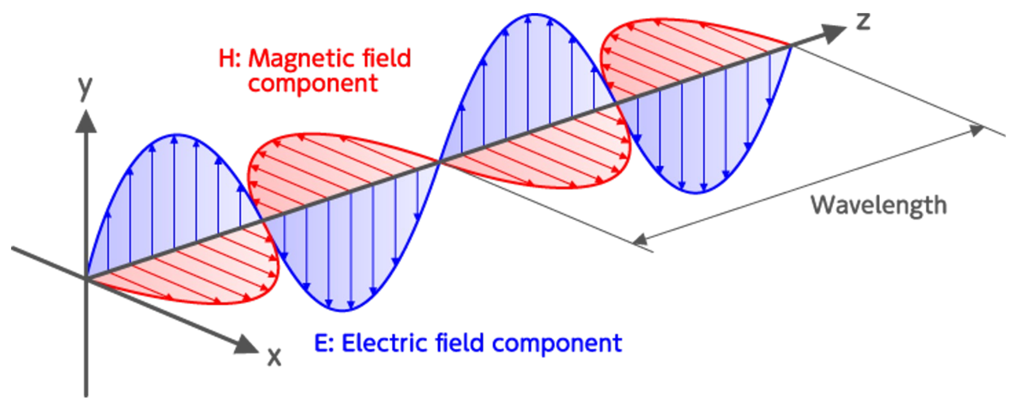


- What parameters can we use to describe a wave? Wavelength λ, period T (or frequency ν), amplitude y_0
- What is the mathematical description of a wave? $y = y_0 \cos[2\pi(x/\lambda - \nu t)]$
- What is the speed of light? $c = \lambda\nu$

Light as electromagnetic wave

- What's the difference between a sound wave and light?



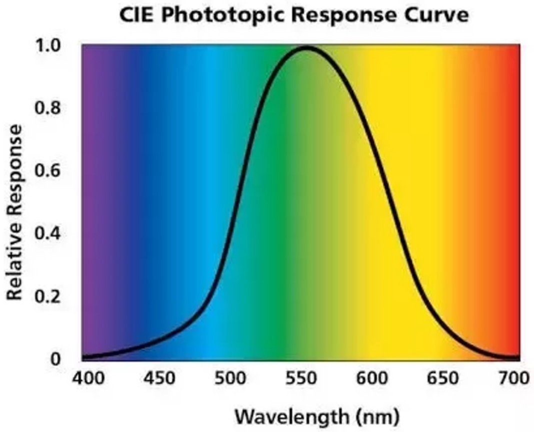


Electric Field and Magnetic Field

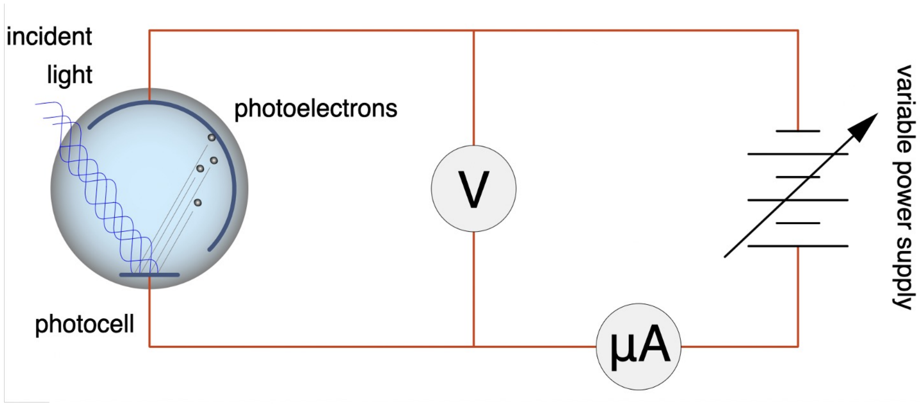
Light as electromagnetic wave

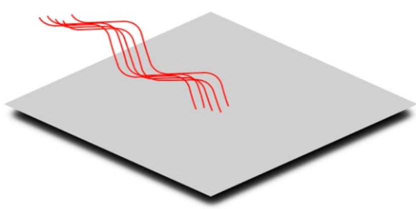
- What determines the intensity of light?

Does the same intensity appear as the same brightness to the eye?

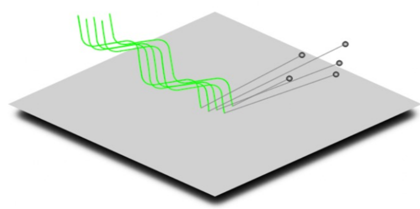


Photoelectric Effect

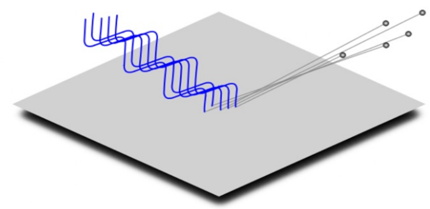




Red light does not eject photoelectrons (even if it is very bright).



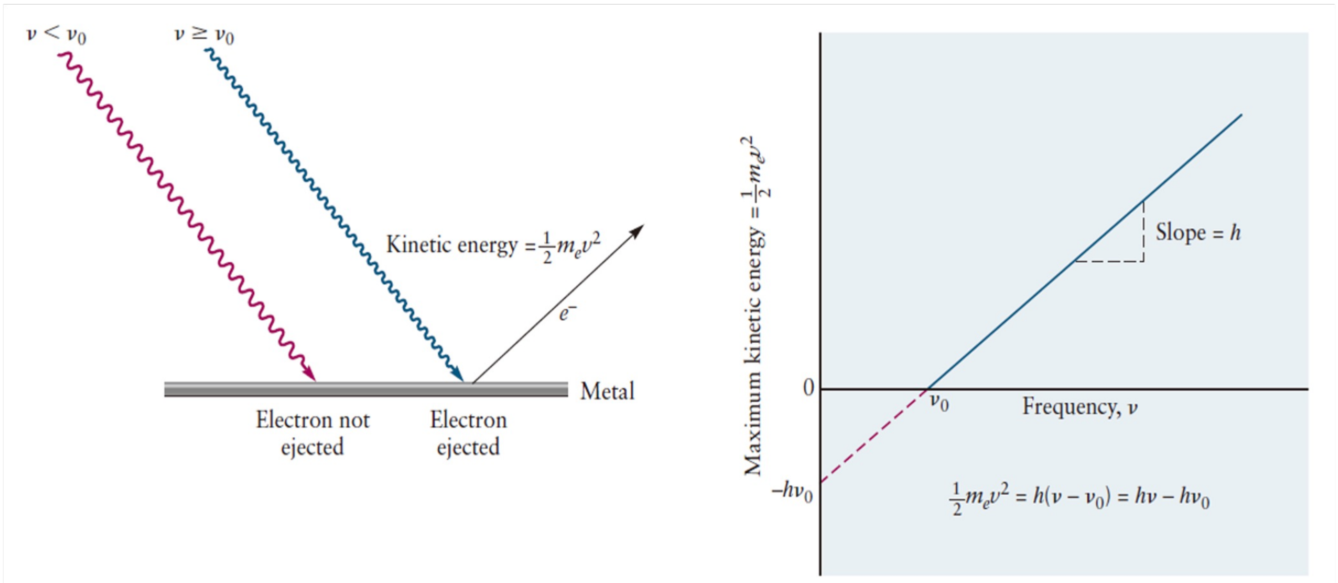
Green light does eject photoelectrons (even if it is very dim).



Blue light ejects photoelectrons with more energy than green light (even if it is very dim).

Heinrich Hertz, 1887

Photoelectric Effect



Energy of light is absorbed in small “packages”. the package size is proportional to light frequency.

$\boldsymbol{E = h\nu}$

$h = 6.626 * 10^{-34}$ J · s (Planck Constant)

ν (light frequency)

E (photon energy)

Exercise

1. What is rough order of magnitude of photon emitted from a light bulb per second? On average what is the time for one photon to be emitted?

Exercise

2. What is the absolute distance limit that you cannot see a signal light?

Take home message

- Light can be seen as "waves"
  Wavelength λ, speed of light *c*, frequency ν (or f)
  $c = \lambda\nu$, $y = y_0\cos[2\pi(x/\lambda - \nu t)]$

- Light can also be seen as "particles"
  Photon: unit energy *E*, momentum *pc*
  $E = h\nu$

Question:
Can particles be seen as "waves"?