

Unit 4:
Light and Optics

Section 1: Our knowledge about light and vision comes from explanations, inventions, and investigations.

Learning Outcomes:

- Identify challenges in explaining light and vision
- Investigate light beams and identify phenomena that show the nature of the light



Investigation!

Light Facts

Search the classroom to find the 18 facts about light energy. Some may be sneaky - DON'T give them away!

Light

Light is a form of energy we can see.

Remember that energy is NOT matter so it is not made of particles.

Energy (The ability to do work) cannot be created or destroyed - it can only be **transferred OR transformed**.



A GUIDE TO THE ENERGY OF THE EARTH



Types of Energy



Mechanical
Energy



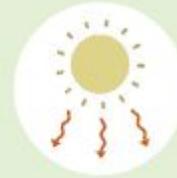
Thermal
Energy



Nuclear
Energy



Chemical
Energy



Electromagnetic
Energy



Sonic
Energy



Gravitational
Energy



Kinetic
Energy



Potential
Energy



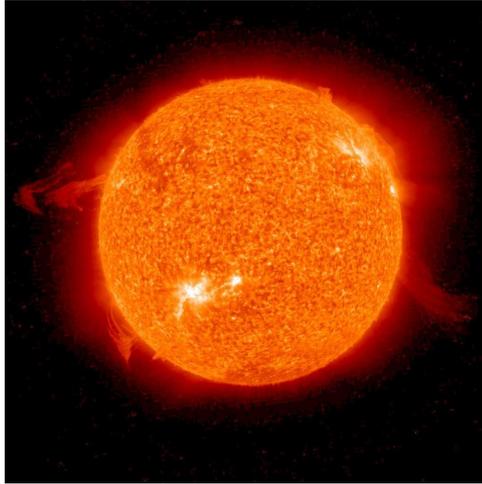
Ionization
Energy

Luminous vs. Non-luminous

Luminous - an object that emits its own light.

Examples:

- Sun
- Stars
- Lightbulbs



Non-luminous - objects that do not reflect their own light.

Examples:

- Moon
- Wood
- Metal



Vision and Challenges

Our eyes can only see an object if light is emitted from or bounces off the object. It also must be in a direct path to our eyes to make vision possible.

Archimedes

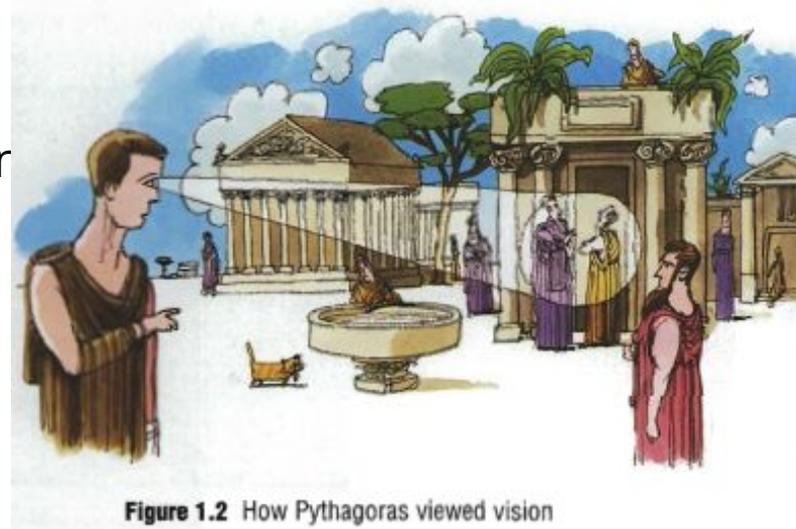
Devised a plan to burn enemy ships using mirrors to reflect the sun.



Pythagoras

Pythagoras believed light consisted of beams and these beams came from a person's eyes in straight lines. Therefore sight occurred when the beams touched the objects a person was looking at.

Problem: *Can you see a problem with this theory?*



Timeline

1ST IDEA – PYTHAGORAS (GREEK) [6TH BC]

- Human produced straight beams of light from our eyes, when they hit an object they could see it.
Problem – We cannot see in the dark.

2ND IDEA – EUCLID (GREEK)

- Discovered that light travels in straight lines

3RD IDEA – PTOLEMY (GREEK) [1ST AD]

- Discovered that light “bends” as it passes from air to glass.
- Light travels faster through air than in fluids

Timeline

4TH IDEA – AL-HAYTHAM (ARABIAN) [1000 AD]

- First to accurately describe how vision worked.
- Light bounces off objects and then travels to the eyes, not what Pythagoras thought!

5TH IDEA – NEWTON (ENGLISH)

- By shining a light through a prism he demonstrated that white light is actually a mixture of different colors of light.

6TH IDEA – OLE ROMER (DANISH) [1676]

- First reasonably accurate measurement of the speed of light.

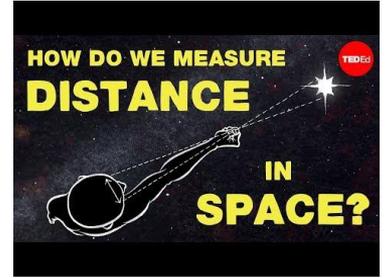
Measured by watching the moon Io eclipse over Jupiter, noted the amount of time it took to eclipse Jupiter was greater when Earth was farther away from Jupiter.

7TH IDEA - Albert A. Michelson (USA) [1920]

- Found that light travels 299 798 km/s (pretty darn close) actual speed of light in a vacuum is roughly 300 000 km/s.

Refined Romer's experiment by using the tops of two mountains.

Fun Fact - Light Year



Not actually a measurement of **TIME** but actually the **DISTANCE** that light travels in space in one year.

~ 9 460 500 000 km

Relate it:

A light beam takes 8 minutes to travel the 93 million miles (150 million km) from the sun to the Earth.

The closest star to Earth, other than the sun, is [Alpha Centauri](#) at some 4.4 light-years away.

Assignment

Sources of Light

You will learn about, describe and create a poster on a source of light and its characteristics.

Natural Light Sources

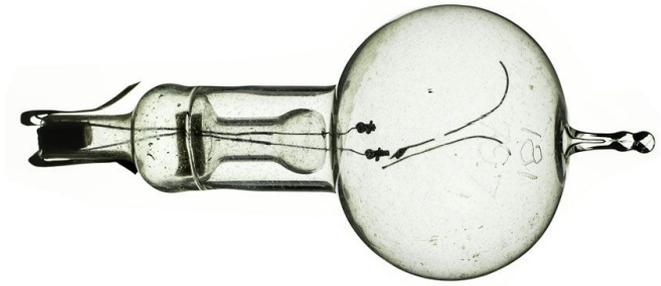
These are not man-made in any way.

Examples: Sun, stars, lightning, etc.

Energy transformations are more complicated.



Incandescent Light Sources



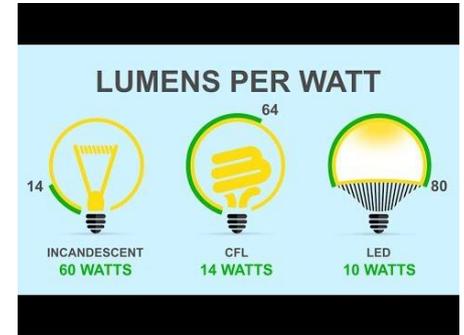
Original carbon-filament bulb by Thomas Edison.

An object or material is heated to the point it glows.

Examples: older light bulbs, fire, etc.

Basically, an incandescent light bulb is a controlled fire on display. As the filament continues to burn, particles fly off the filament. And when there are no more particles to burn, the light bulb burns out.

Heat is part of the energy transformation.



Fluorescent Light Sources

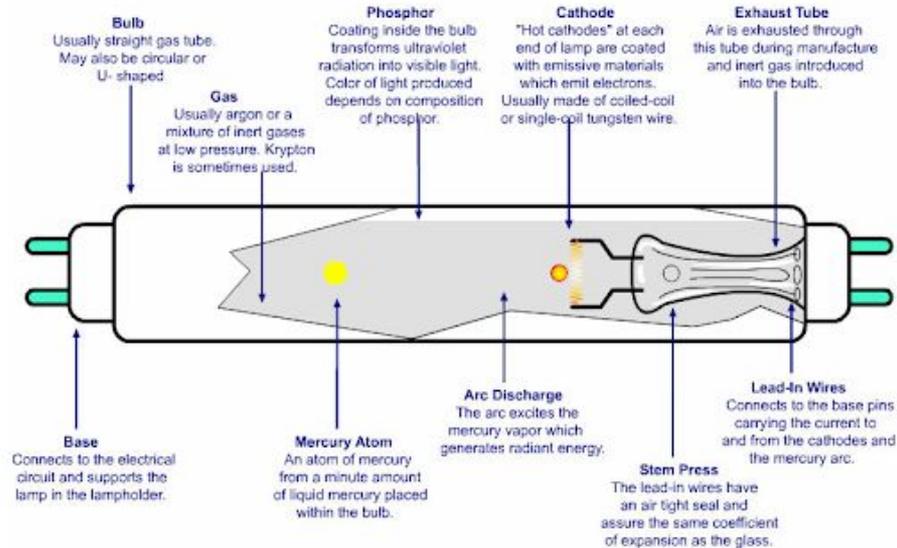
UV energy is stored by some particles and released as visible light once they interact with phosphor.

Examples: fluorescent light bulbs

A fluorescent light source is a tube containing mercury vapor and lined with a phosphor. When current is passed through the vapor the strong ultraviolet emission excites the phosphor, which emits visible light.

Energy conversion:

Electrical - UV - Visible Light



Phosphorescent Light Sources

UV energy is stored by particles and re-emitted as visible light over a period of time.

Examples: glow in the dark stickers

An object absorbs light energy and gradually releases it, even after the original light source is removed.

Energy transformation:

Visible - UV - visible



Chemiluminescent Light Sources

Chemicals mix and one product of their reaction is the release of light energy.

Examples: Glow sticks

*Two chemicals react to form an excited (high-energy) intermediate, which breaks down releasing some of its energy as photons of **light**.*

Energy transformation:
Chemical - Visible Light



Bioluminescent Light Source

Chemical reactions occur in a living organism to produce light.

Examples: Fireflies

Energy transformation:
Chemical - Visible Light



Properties of Light

Because of research through the years we now know that light has four main properties;

1. Light travels in straight lines
2. Light can be reflected
3. Light can bend
4. Light is a form of energy

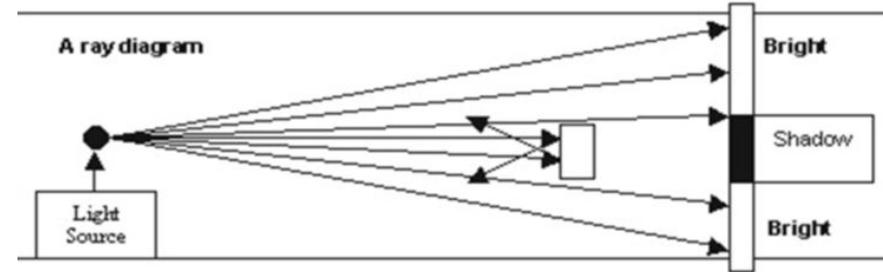


1. Light Travels in Straight Lines

A “**ray**” is an imaginary line showing the path the light travels. We could draw infinite rays to represent light, instead we draw a select few

Because of this principle, the ray model of light can help to explain certain properties of light.

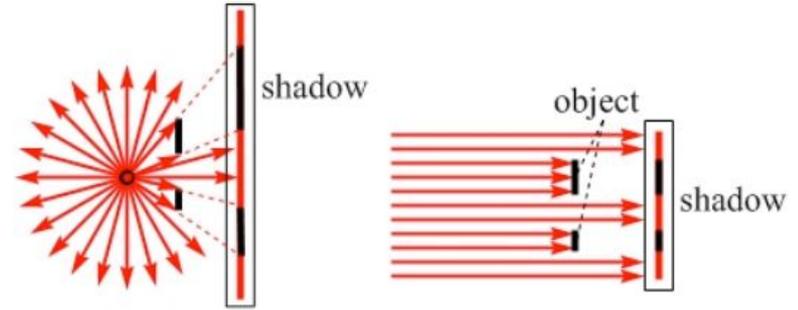
Ray diagrams can help to demonstrate brightness or intensity of light through changes in distance.



Shadows

The ray model helps to explain how shadows can be formed when an object blocks the ray of light.

When the light source is a point source, the shadow is generally larger than the object casting the shadow. When the light rays are all going in the same direction, however, the shadow is the same size of the object when the shadow is cast on a surface that is perpendicular to the light rays.



Properties of light

Light travels in straight lines until it strikes a surface. The type of surface the light hits will determine how the light continues. A surface may be;

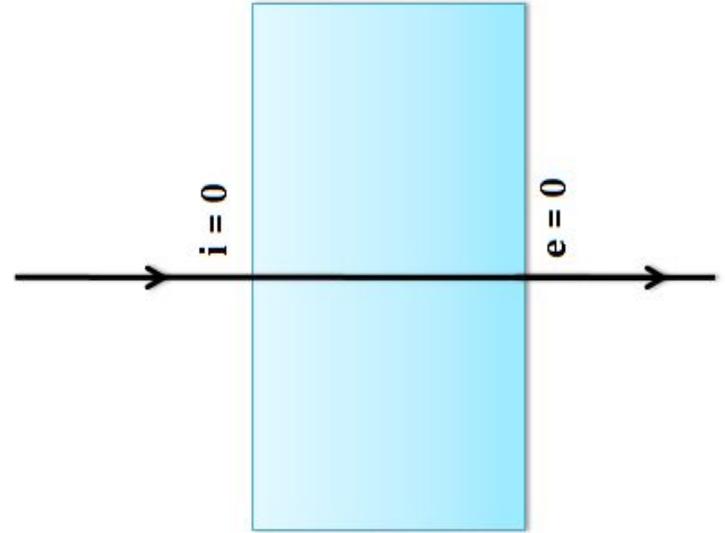
1. Transparent
2. Translucent
3. Opaque



Transparent

If a surface is transparent, light passes through it nearly or wholly undiffused, so that one can see clearly the details of whatever is on the other side.

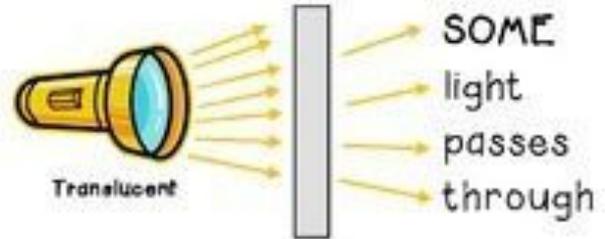
Ordinary glass windows and clear plastic are transparent.



Translucent

If a surface is translucent, light passes through but is diffused so that one cannot see clearly the details of whatever is on the other side.

Frosted glass, and wax paper are examples of translucent materials.

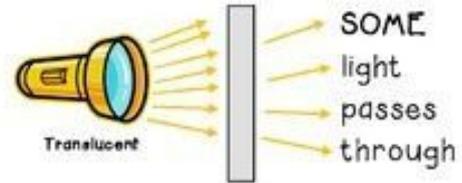
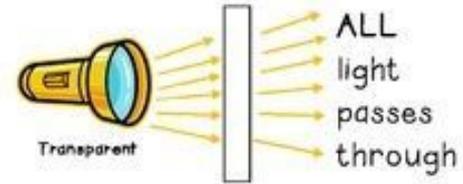


Opaque

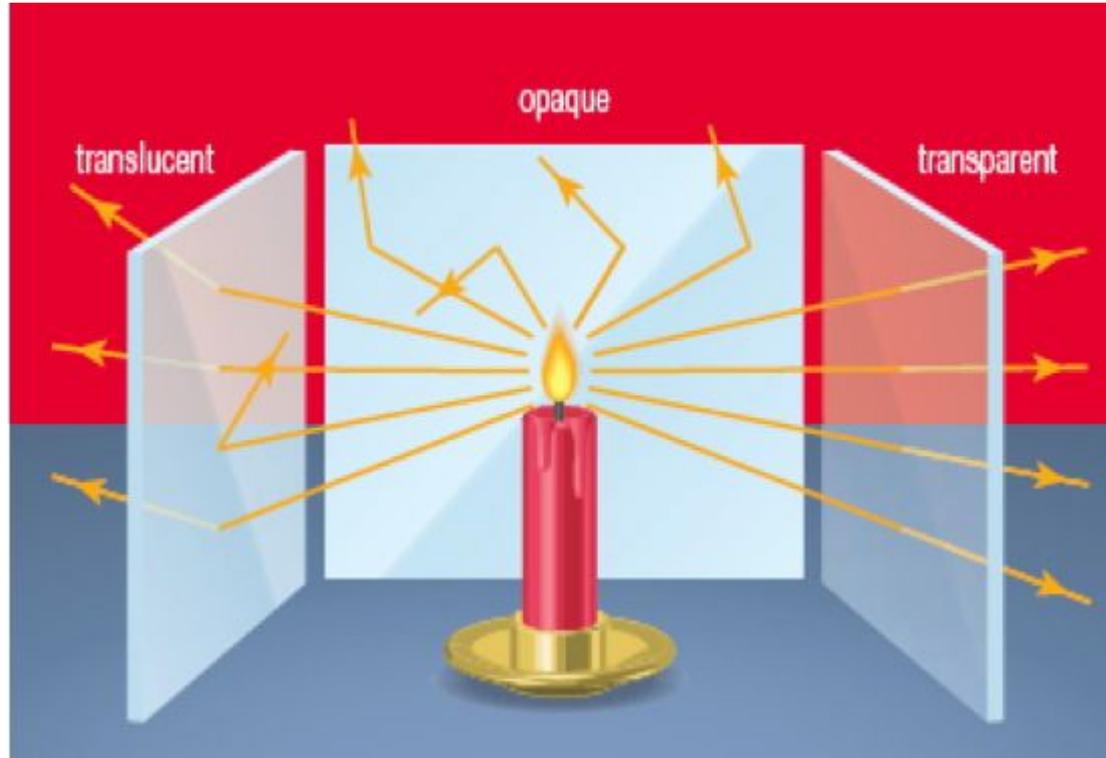
A surface that permits no light to pass through it is opaque. You cannot see anything through an opaque object.

A door, or brick wall are example of opaque objects

Translucent, Transparent & Opaque



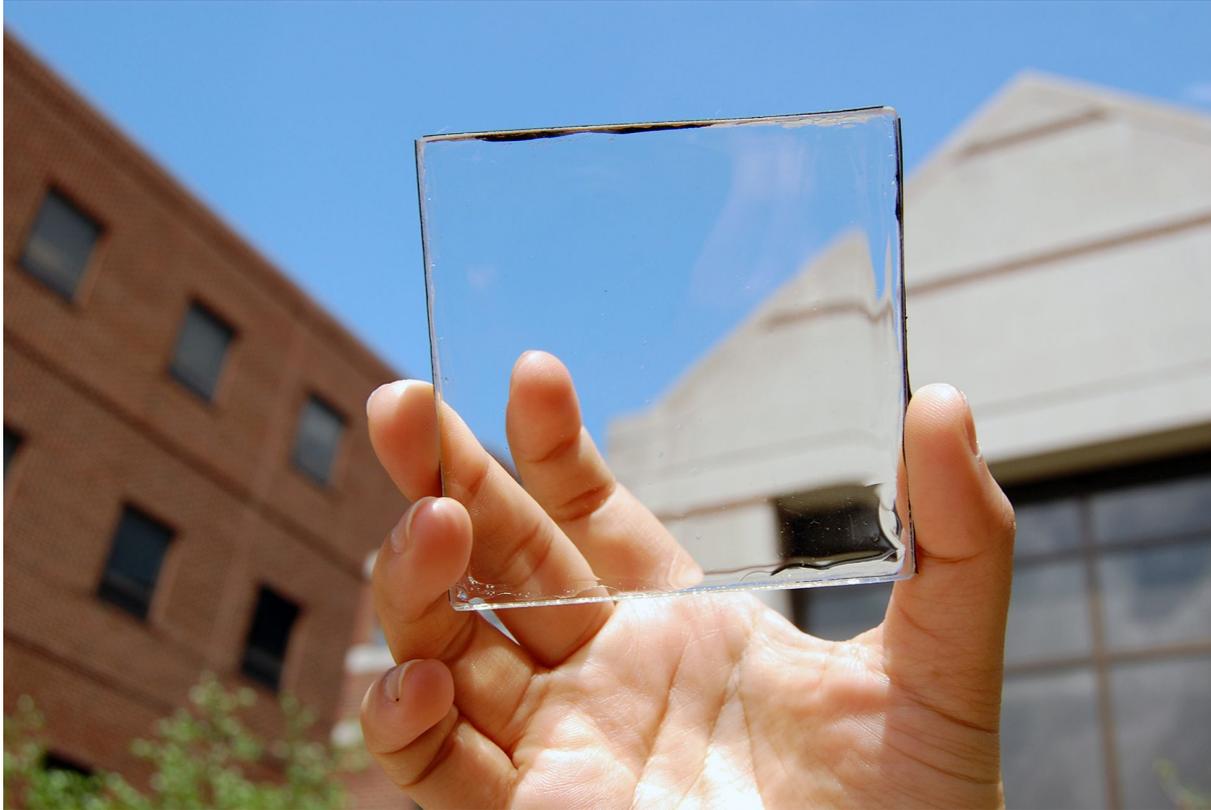
Transparent, Translucent and Opaque



Transparent, translucent or opaque?



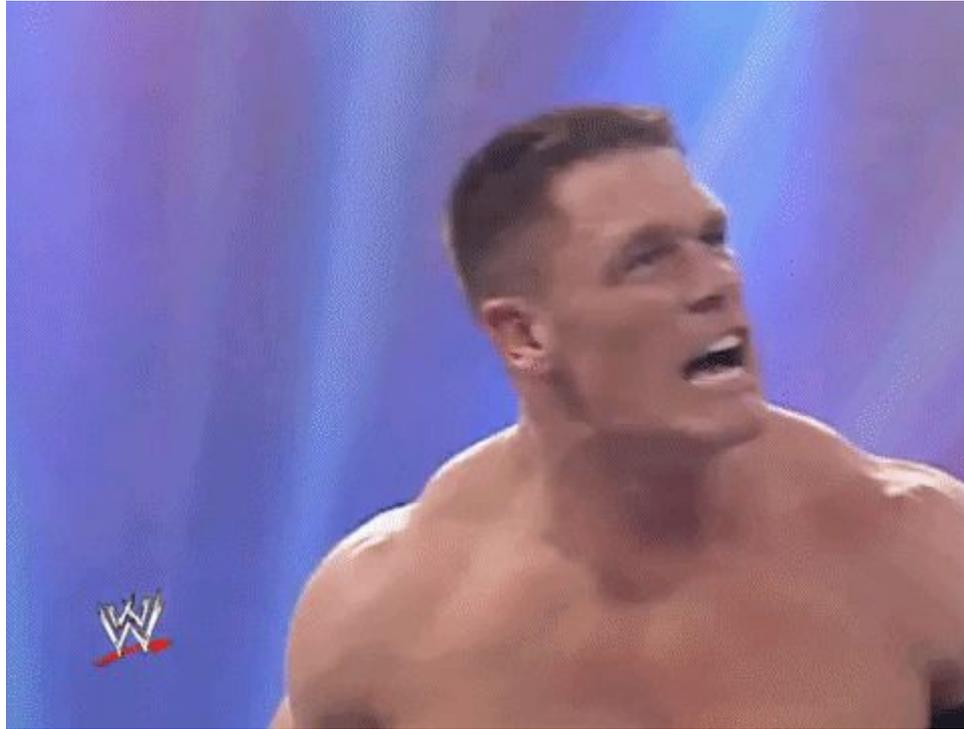
Transparent, translucent or opaque?



Transparent, translucent or opaque?



Transparent, translucent or opaque?



Why is glass transparent?



Review

- a) What is an example of a transparent object?
- b) What does the ray diagram look like for an opaque object?
- c) How does a ray of light travel?

