

A chalkboard with physics diagrams and a tray of chalk. The chalkboard is dark blue and has several diagrams drawn on it. On the left, there are two intersecting yellow lines forming an 'X'. In the center, there are two blue curved lines, one above the other, resembling a sine wave or a lens. To the right, the word 'CINEMA' is written in yellow chalk, though it is partially obscured and blurry. In the foreground, a wooden tray holds several pieces of chalk in various colors: blue, orange, and yellow. The background is slightly out of focus, showing a blackboard and some other items on a desk.

Conceptual Physics

Chapter 27: Light
Mr. Miller



What is light?

- Light is the visible part of the electromagnetic spectrum.



27.1 Early Concepts of Light

- Newton believed that light consisted of tiny particles, which was supported by the fact that light traveled in straight lines.



27.1 Early Concepts of Light

- Huygen believed that light traveled in waves because it spread out like other types of waves.
- Huygen theory lost to Newton because Newton was more famous.



27.1 Early Concepts of Light

- Thomas Young's double slit experiment resulted in obvious wave behavior and seemed to firmly support the wave theory of light over Newton's particle theory.

27.1 Early Concepts of Light



Time for a Gizmo!



27.1 Early Concepts of Light

- Einstein in 1905 explained the photo electric effect which explains that light consists of particles, called photons.



27.1 Early Concepts of Light

- Finally scientists finally agree that light is sometimes a particle and sometimes a wave, depending on how you look at it.

Light Duality Movie



Dr. Quantum's Double Slit Experiment
Is light a wave or a particle?



27.2 Speed of Light

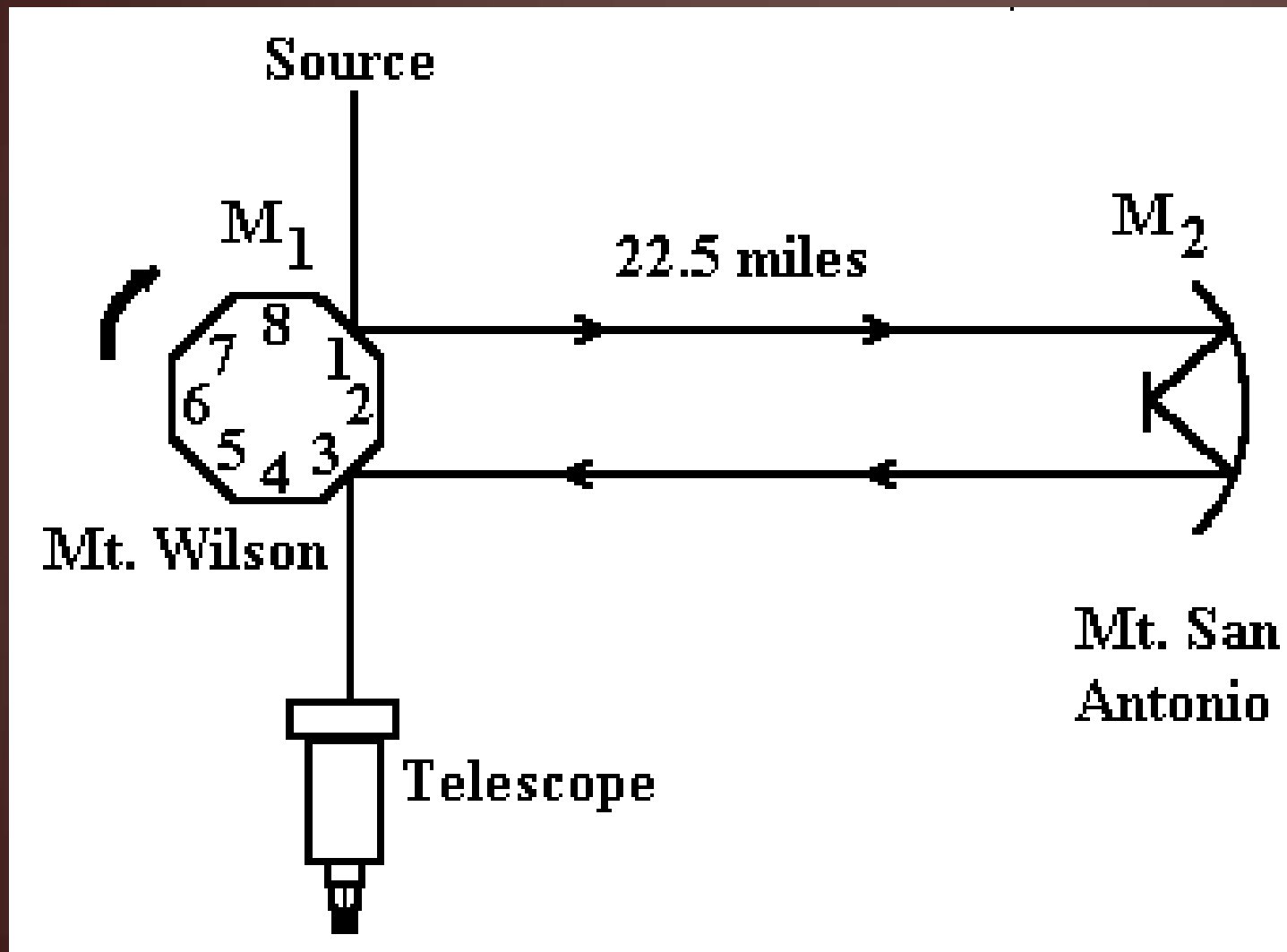
- Light travels at 3×10^8 m/s
- Many scientists used the stars and planets to help determine this measurement.



27.2 Speed of Light

- Albert Michelson performed the most famous experiment for measuring the speed of light.

27.2 Speed of Light



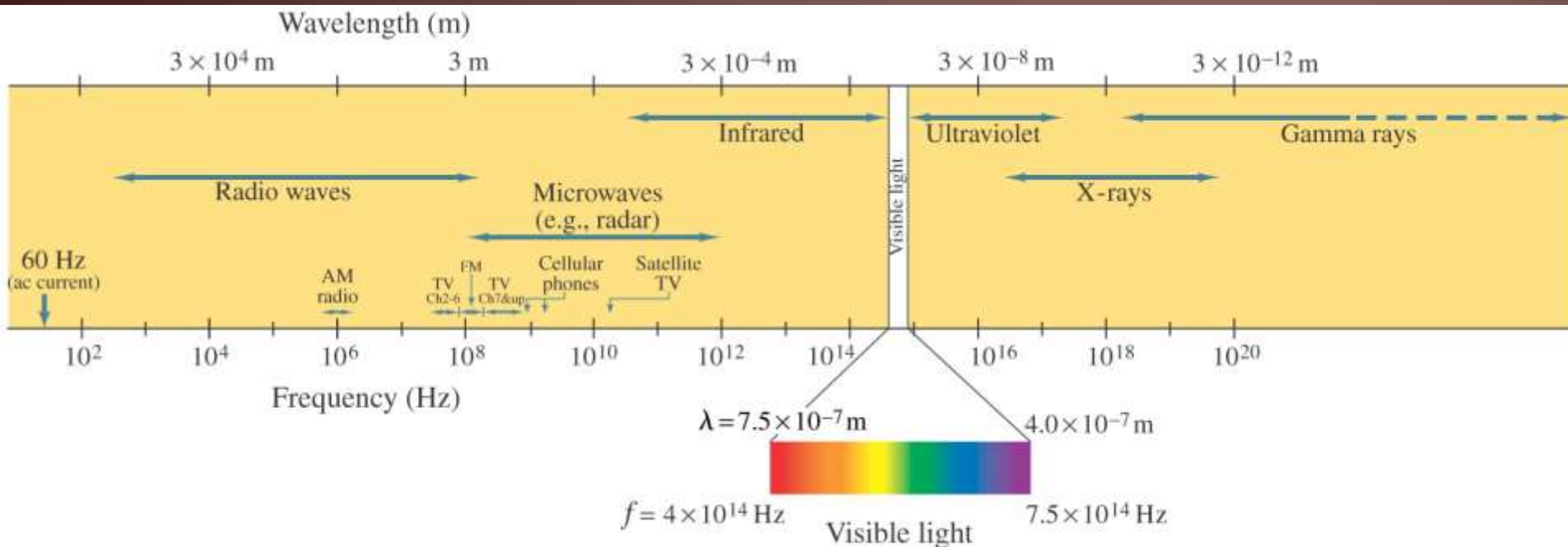
Speed of Light Experiment



Time for a Gizmo!

27.3 Electromagnetic waves

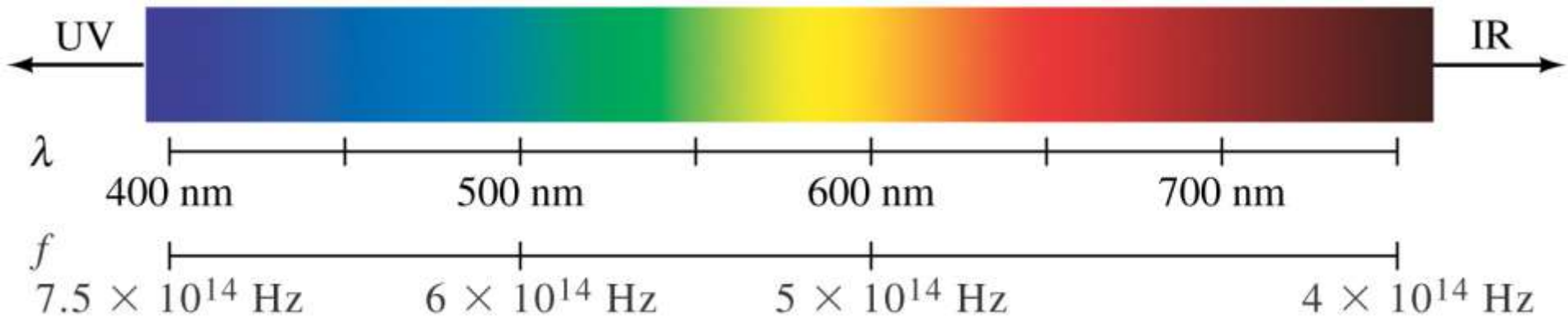
Electromagnetic waves can have any wavelength; we have given different names to different parts of the wavelength spectrum.



27.3 Electromagnetic waves

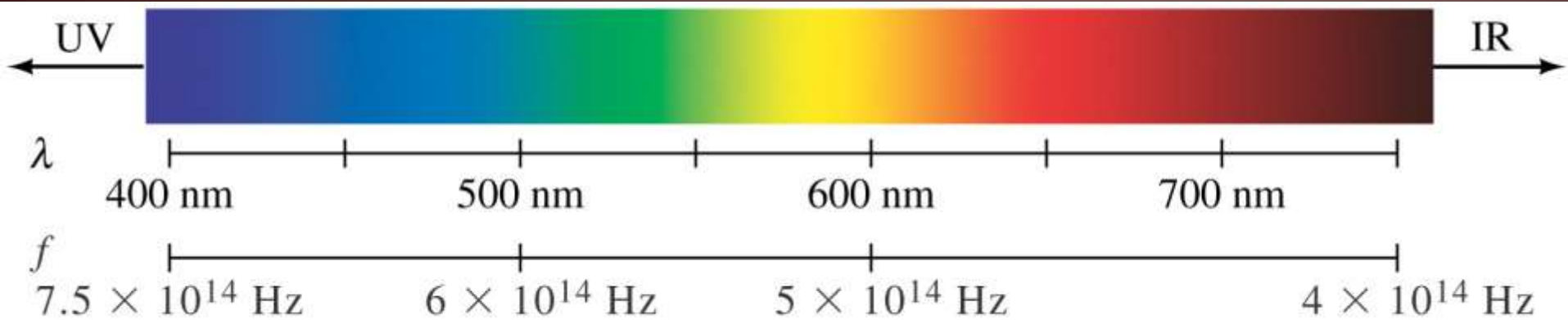
Wavelengths of visible light: 400 nm to 750 nm

Shorter wavelengths are ultraviolet; longer are infrared



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Electromagnetic Spectrum Movie



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What are all the parts of the electromagnetic spectrum?



27.4 Light and Transparent Materials

Light is energy in an electromagnetic wave that is generated by vibrating electric charges.



27.4 Light and Transparent Materials

When light passes through or hits materials it excites the electrons of the material.



27.4 Light and Transparent Materials

How excited the material gets depends on the frequency of the light and the natural frequency in the material.



27.4 Light and Transparent Materials

Transparent materials let light travel through but not without slowing it down.

27.4 Light and Transparent Materials

In a vacuum:

Speed of Light = $c = 3.00 \times 10^8$ m/s

In water:

Speed of Light = $0.75c = 2.25 \times 10^8$ m/s

In glass:

Speed of Light = $0.67c = 2.01 \times 10^8$ m/s

In a diamond:

Speed of Light = $0.40c = 1.20 \times 10^8$ m/s

27.4 Light and Transparent Materials

Glass is only transparent to visible light, not ultraviolet or infrared light.

This is why glass heats up in the sun because it is absorbing the infrared part of the electromagnetic spectrum.



27.5 Opaque Materials

Opaque materials do not allow light to pass through them but rather absorb the light or reflect it.



27.5 Opaque Materials

Opaque materials do not allow light to pass through them but rather absorb the light.

When light strikes an opaque object its electrons get excited and translate that random kinetic energy into heat energy.



27.5 Opaque Materials

Metals are opaque materials as well, but they reflect light rather than absorb it.

This is because when light strikes a metal the excited electrons in the metal do not store that energy but rather reemit it as visible light.



27.5 Opaque Materials

The atmosphere is transparent to visible light and infrared but opaque to ultraviolet light.

This is a good thing because ultraviolet light is what causes sunburns.



27.5 Shadows

Shadow – location where light rays cannot reach

Umbra – total shadow

Penumbra – partial shadow

Shadows



Time for a Gizmo!



27.5 Shadows

Shadows can also occur when light is bent when passing through transparent material.

Light travels at different speeds due to temperature and that difference bends the light forming different shapes of shadows.

A close-up photograph of several pieces of chalk in various colors (blue, white, yellow) resting on a wooden chalkboard. The background is slightly blurred, focusing on the chalk.

27.7 Polarization

Light travels in transverse waves,
not longitudinal.

The reason we know is because of
polarization.

A close-up photograph of several pieces of chalk in various colors (blue, pink, yellow) resting on a light-colored wooden surface, likely a chalkboard. The background is blurred, showing more of the wooden surface and some indistinct shapes.

27.7 Polarization

A wave is polarized if it only vibrates back and forth in one direction.

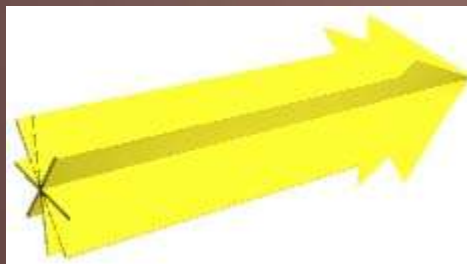
Common light sources (light bulbs, flames, sun) emit light that is not polarized.

27.7 Polarization

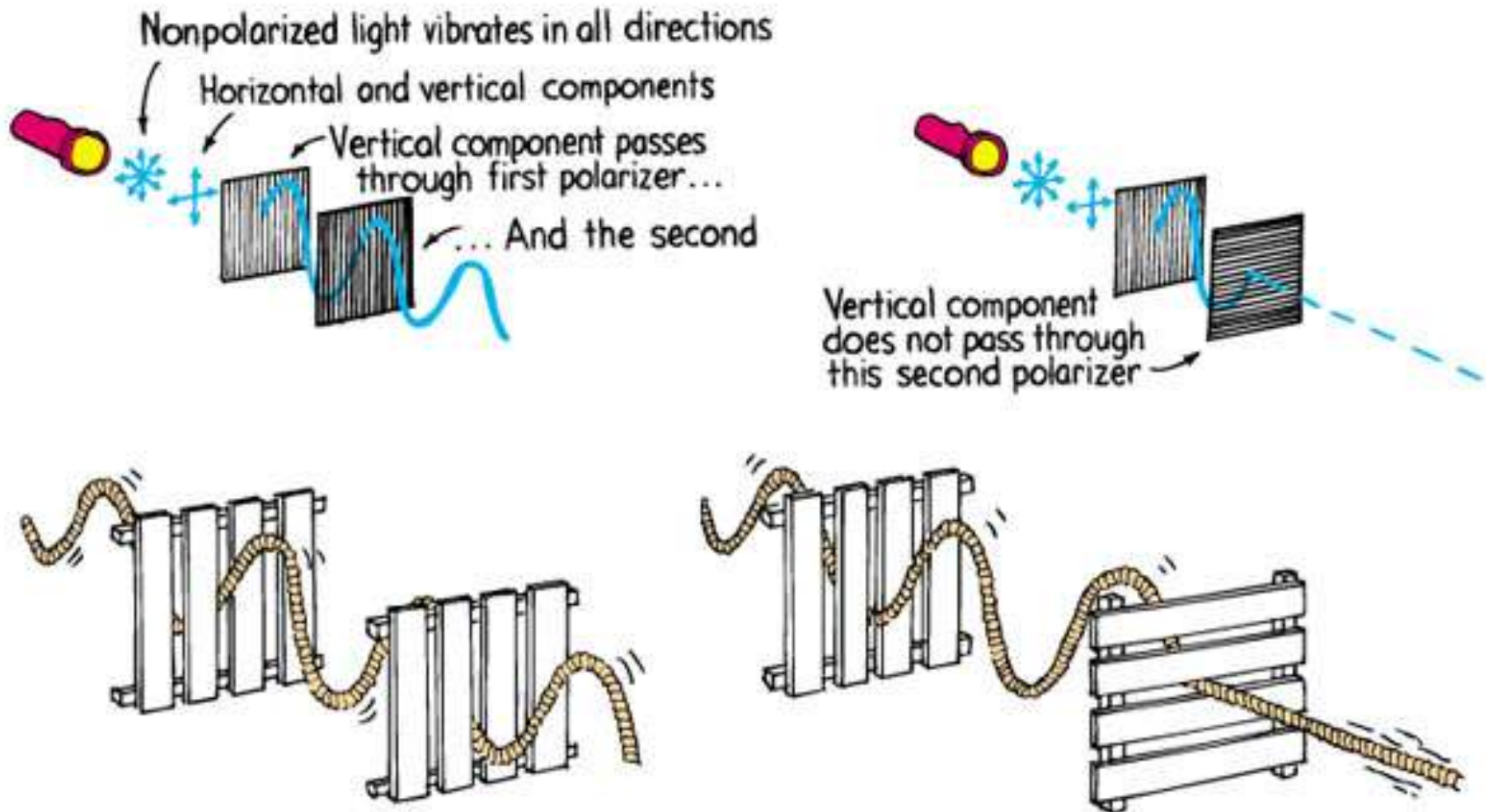
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27.7 Polarization



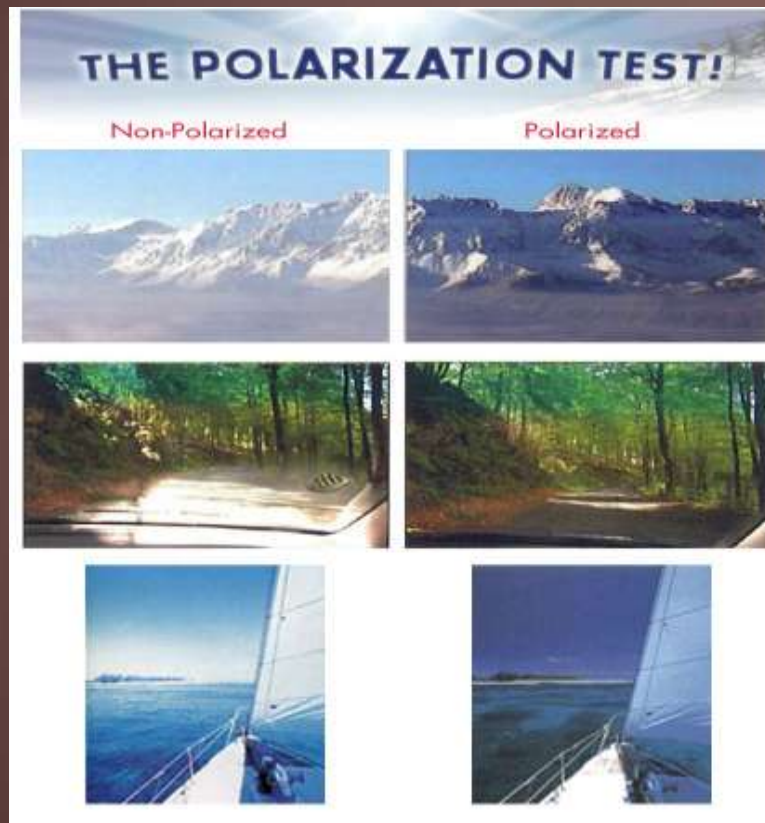
Polarization



Time for a Gizmo!

27.7 Polarization

Light that reflects off of a surface is horizontally polarized.



27.7 Polarization movie



Polarization movie

27.7 Polarized Light and 3D Viewing

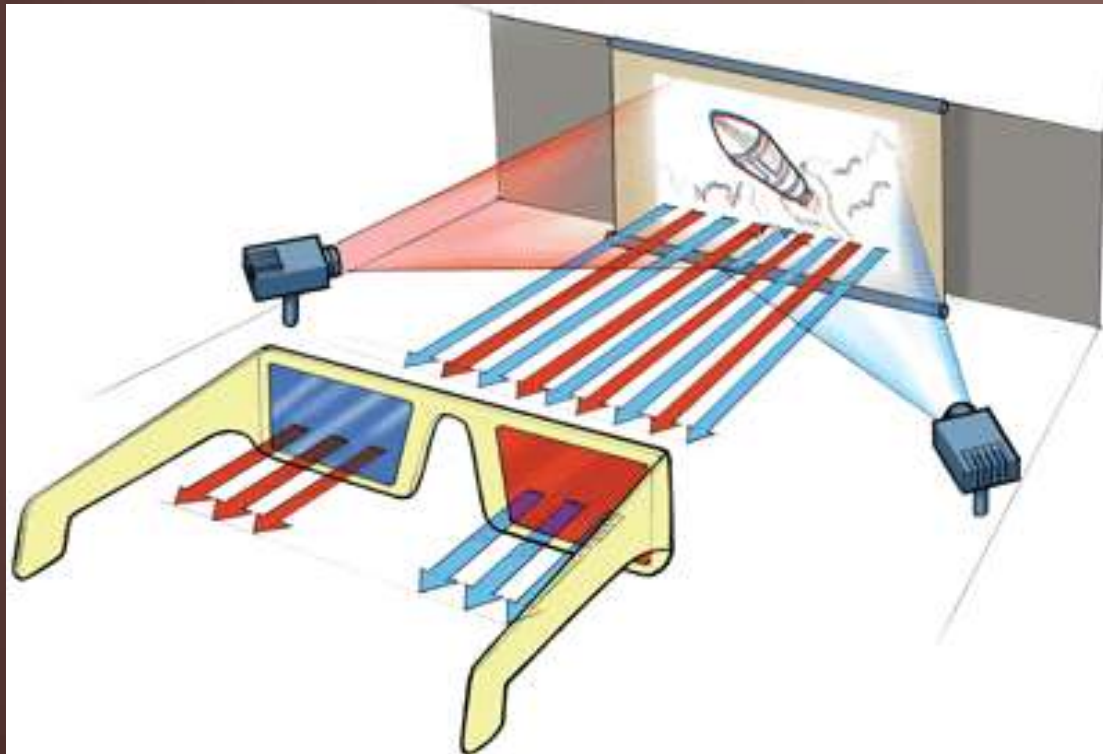
- A stereogram is composed of two photographic images placed side by side. The image on the left is what your left eye would see if you were looking at the picture in real life. The right shows what your right eye would see.

27.7 Polarized Light and 3D Viewing

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27.7 Polarized Light and 3D Viewing

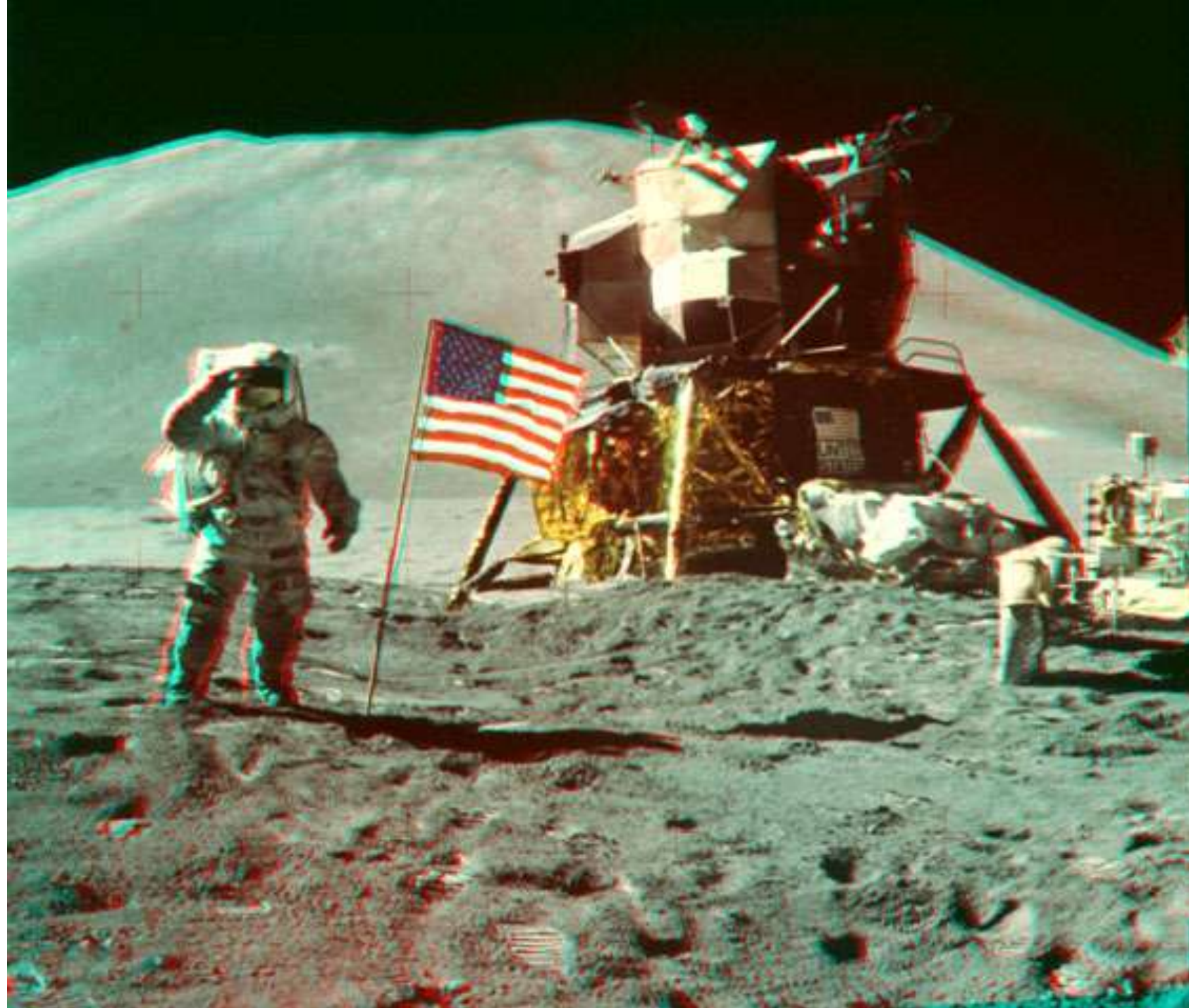
The red and blue lenses filter the two projected images allowing only one image to enter each eye.





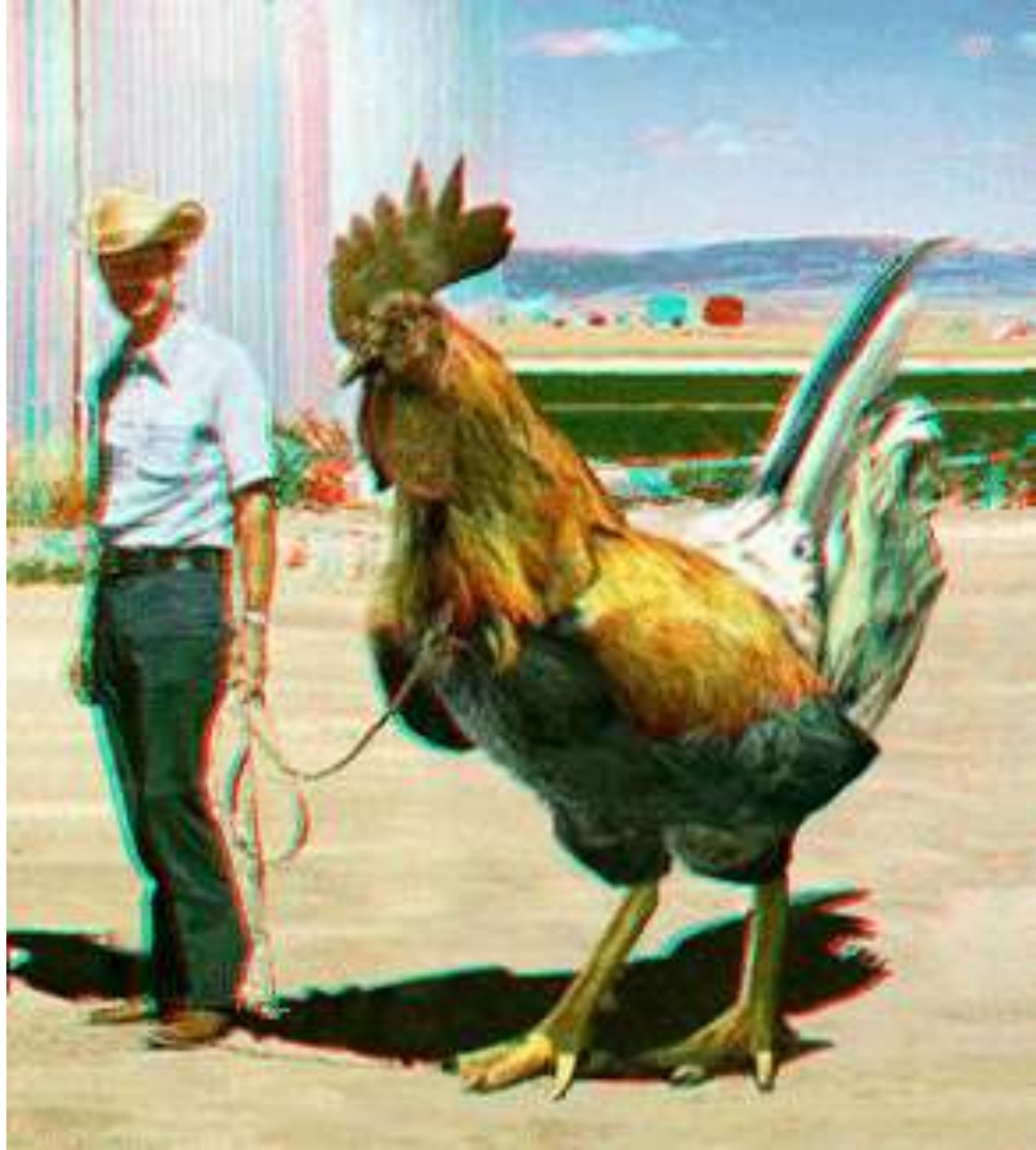
- Mark Twain (Samuel Langhorne Clemens) at work -
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Monsters vs.

Aliens

Movie Trailer

MAGIC



EYE







