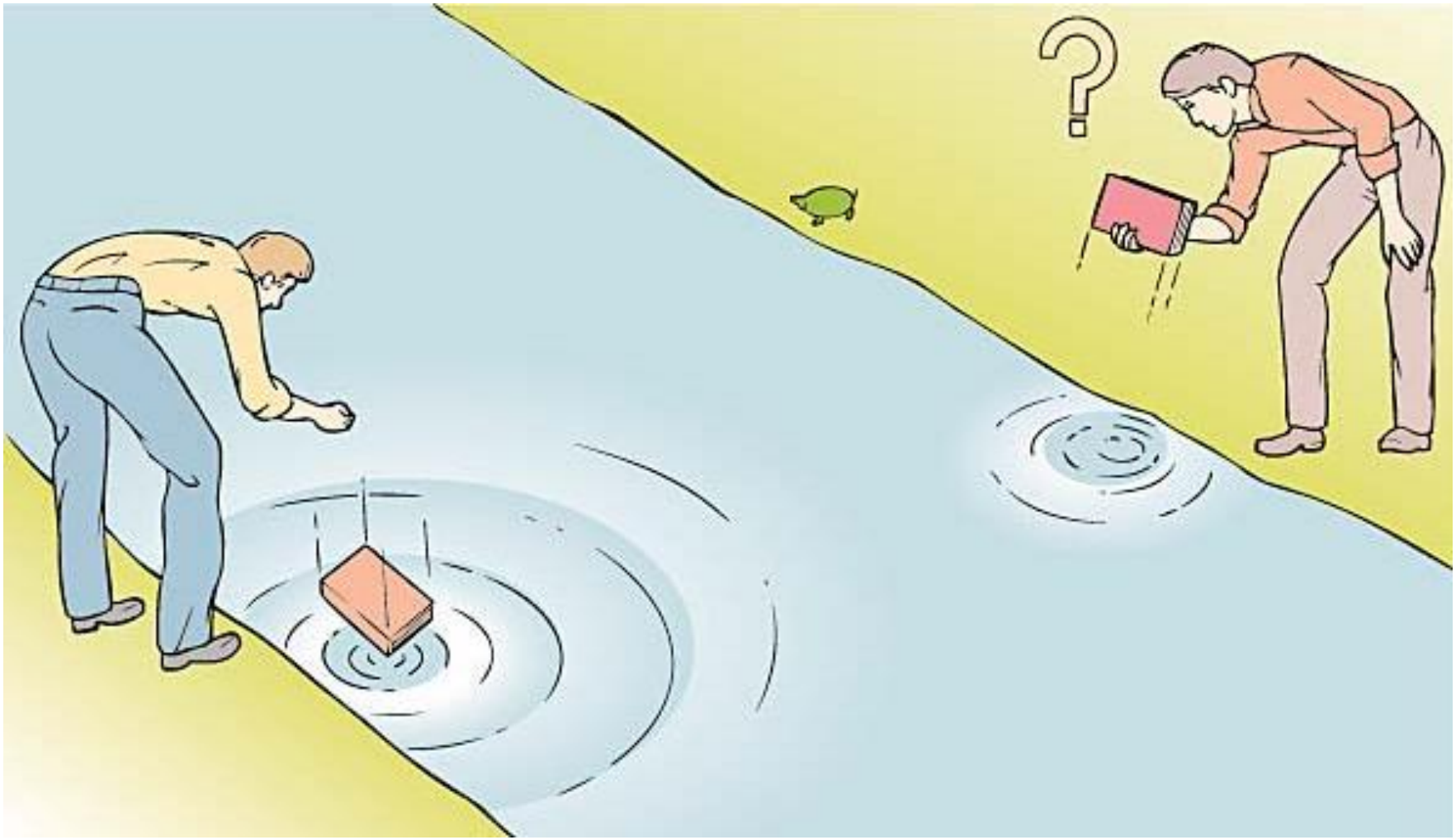
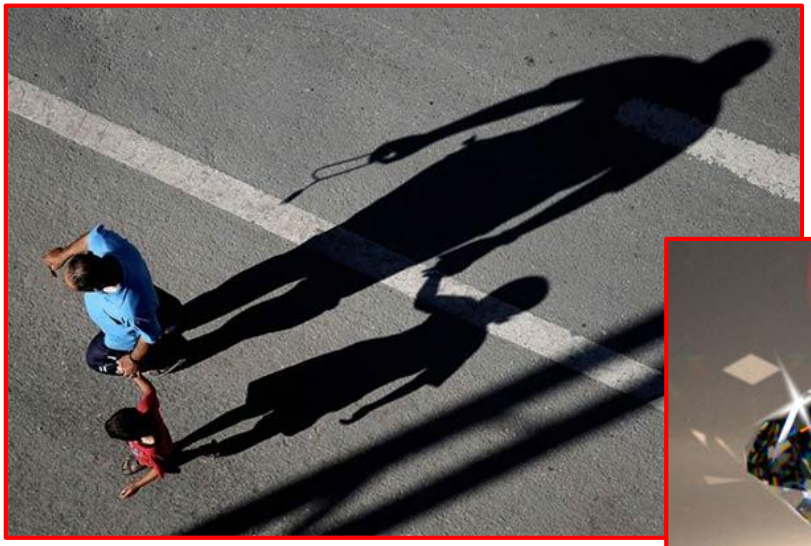


It would seem very strange if there were not a sharp distinction between objects and waves in our everyday world. Yet this appears to be the nature of LIGHT

Observed Properties of Light



Observed Properties of Light

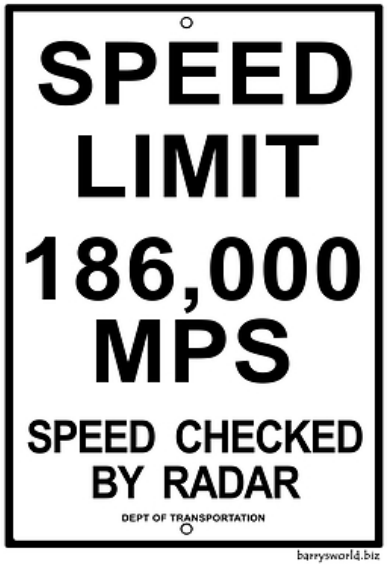
- Light travels in straight lines (*shadows*)
- Speed of light is the highest known!
- Light can be bright or dim (*intensity*)
- Light can be different colors (*dispersion*)
- Light can bounce off surfaces (*reflection*)
- Light can, or cannot go through substances (*transmission*/*absorption*)
- Light slows down in media (*refraction*)
- Light can bend at an opening or edge (*diffraction*)

Speed of Light

Measurement History

- Empedocles (finite) vs Aristotle (infinite)
- 1638, Galileo (two lanterns): "extraordinarily rapid"
- 1676, Ole Roemer (moons of Jupiter): 214,000 km/s
- 1704, Isaac Newton: "different colors travel same speed"
- 1729, James Bradley (stellar aberration): 301,000 km/s
- 1849, Hippolyte Fizeau (toothed wheel): 314,000 km/s
- 1862, Léon Foucault (rotating mirror): 299,796 km/s
- 1972-1976 (laser method): 299,792 km/s
- 1983, the 17th CGPM: defined as exact constant

Speed of Light

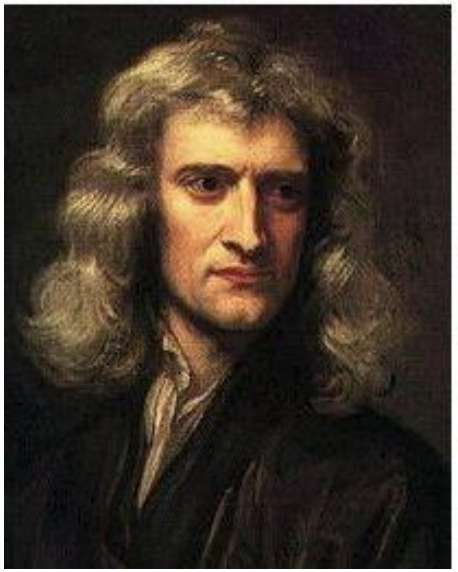


The <u>speed of light in a vacuum</u>, denoted *c*, is constant throughout the Universe.

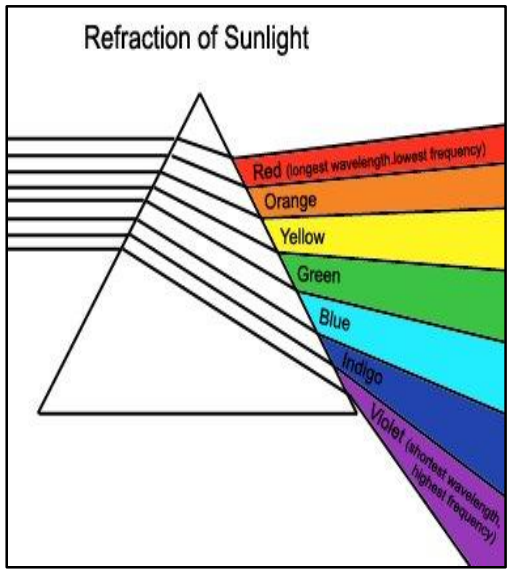
- ***c*** **is the maximum speed at which all matter and information in the Universe can travel.**
- ***c* = 299,792,458 meters/second (~186,000 mps)**
- **<u>Scale sense</u>: it takes ~8 minutes for light to travel all the way from the Sun to the Earth.**
- **When light travels <u>through matter</u>, its speed can <u>change</u>, but can never be larger than *c* (inside a *diamond*, light is *slowed down to less than 80,000 mps*).**

Decomposition of Sunlight

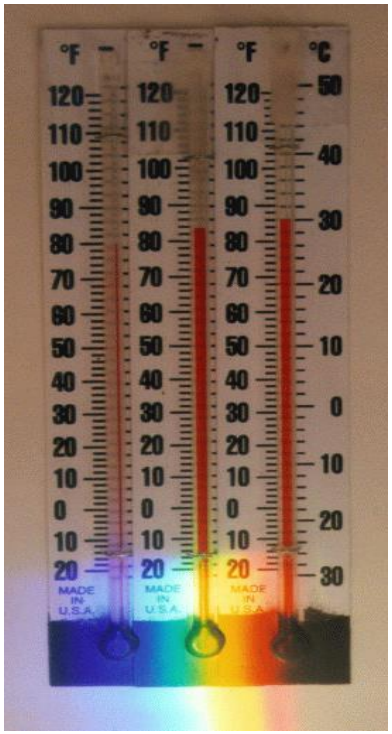
Isaac Newton, 1665



Common (Aristotle) wisdom:
white light is the purest form - colored light must therefore have been altered somehow…



- Newton **shined a beam of sunlight through a glass prism** and showed that it decomposed into a **spectrum** cast on the wall – therefore all the colors were together in the sunlight.
- He thought he then should be able to combine the colors of the spectrum and make the light white again: he placed another prism upside-down in front of the first prism. The band of colors combined again into white sunlight.
- Newton was the first to prove that **white light is made up of all the colors that we can see**.



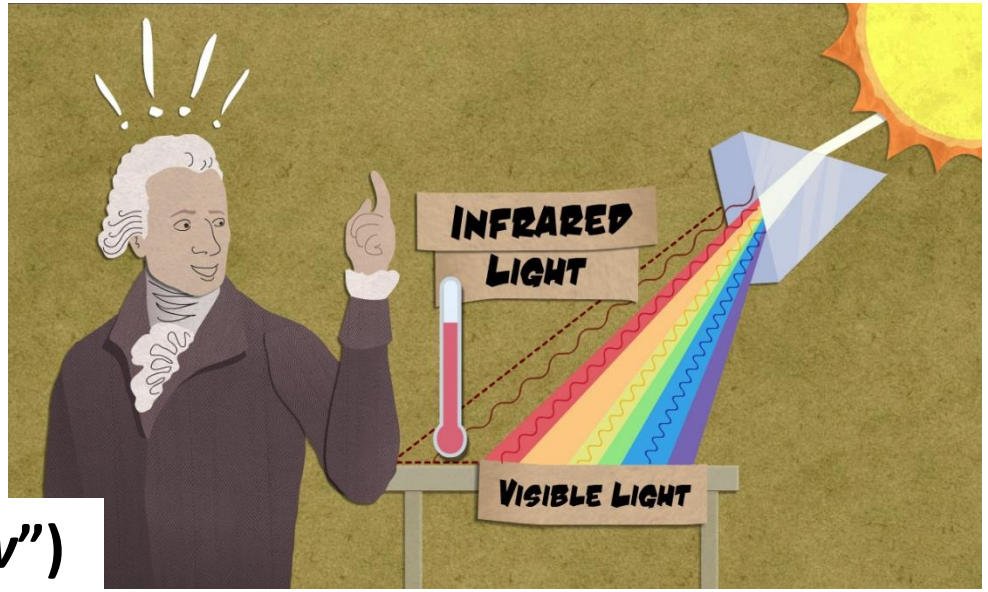
Infrared Light Discovery

Friedrich Herschel, 1800

Measured <u>temperature</u> of different colors of light.

- **Observed the increase in temperature as he moved the thermometer <u>from violet</u> through blue, green, yellow, and orange <u>to red</u> where it reached its peak…**
- **…and moved the thermometer just outside the red portion of the spectrum in an area that – to the human eye – contained no light at all…**

- **"Invisible rays" in this area had the highest temperature of all.**
- **First time anyone had demonstrated that there were forms of radiation that humans couldn't see.**



Infrared (from Latin "*below*")

Ultraviolet Light Discovery

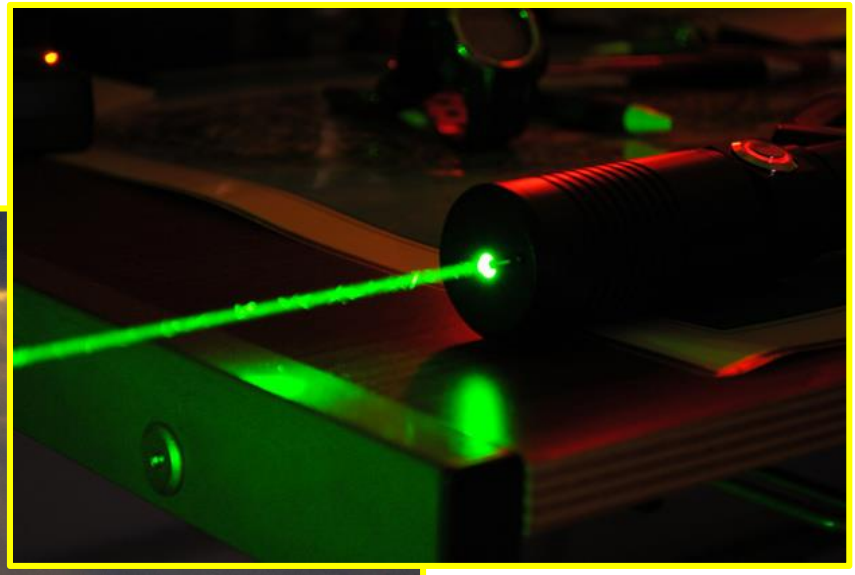
Johann Ritter, 1801

Measured the effect of different colors of light on a light-sensitive chemical, silver chloride.

- In the **red** portion of the spectrum darkening of the chemical was relatively **slow**.
- Progressing through orange, yellow, green, blue, and violet, he observed that each new batch of silver chloride grew darker faster…
- …and placed the chemical **just outside the violet** portion of the spectrum in an area that – to the human eye – contained no light at all…
- **"Invisible rays"** in this area had the **greatest effect** (fastest darkening) **of all**.
- Same experiment can be done using a sheet of photographic paper.

Ultraviolet
(from Latin "*beyond*")

Rays of Light…



what are they made of ?

Is This a Familiar Sight?

Waves of Water in the Ocean