Physical Optics Review

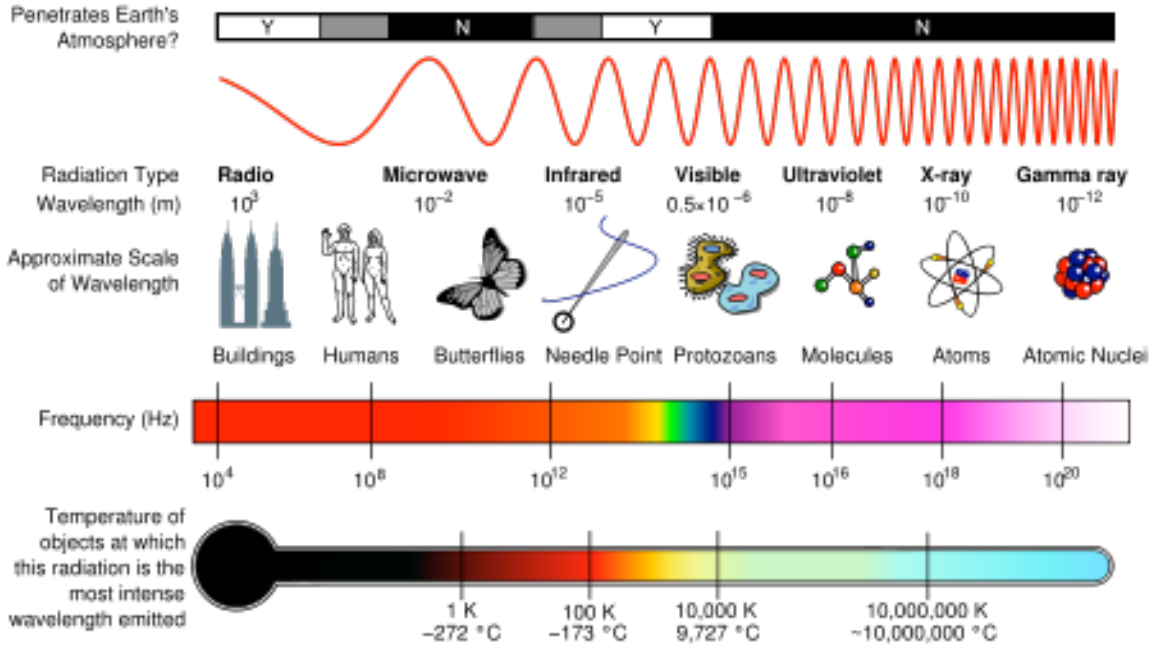
Newton-light is particles…Huygens-light is waves
Newton's view carried the day (based primarily on reputation)

Young's double slit experiment—used monochromatic light to produce interference fringes on a screen after passing through a single slit, then through a double slit. Demonstrated that light has two wave properties, INTERFERENCE and DIFFRACTION. Made a strong case that light is a wave.

Maxwell—determined the speed of light using constants from electrical effects and magnetic effects and a calculus equation for waves, thus validating the wave model. Supported light being an electromagnetic wave.

Wave effects—Reflection, refraction (blue refracts more), diffraction (red diffracts more)

Electromagnetic Spectrum (image from Wikipedia):



Polarization—light waves have an orientation that is "blocked" by filters with the opposite orientation. "Picket fence effect." Light is also polarized by reflection (parallel to the reflecting surface). Can't polarize compression waves like sound, only transverse waves.

Photoelectric effect—metals emit electrons when illuminated by light. Problem—the emitted electrons don't increase in energy with increasing light intensity (as would be predicted by a wave nature), and there are no electrons emitted below a certain frequency regardless of intensity (again, contrary to a wave model). Einstein proposed that

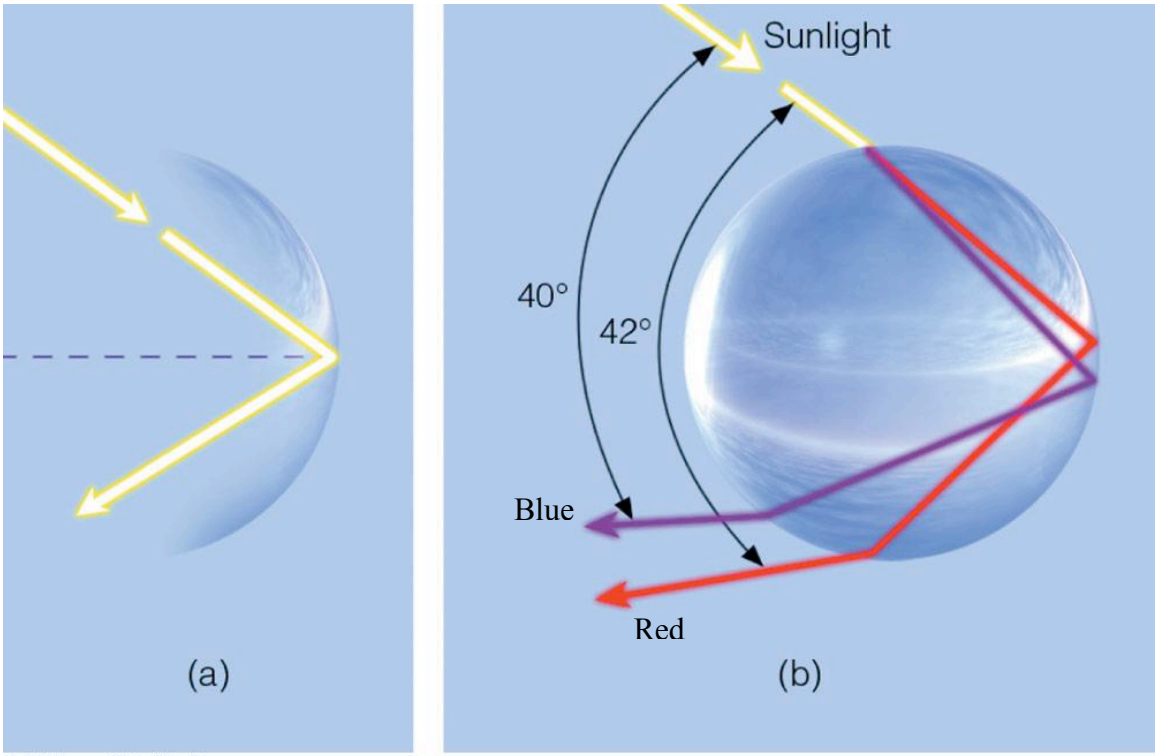
quantizing light into small particles (photons) would explain the effect conceptually and mathematically (won Nobel Prize). Made a strong case that light is a particle.

Scattering—high frequency (high energy) photons are scattered to the side most easily, thus the sky is blue, and sunsets are red. Scattering also accounts for the occasional visibility of light beams such as headlights in the fog or lasers in smoke or CO_2.

Colors in CDs, DVDs, etc.—reflected light from closely spaced sources interferes causing some colors to intensify (constructive interference) while some disappear (destructive). Colors arranged like a rainbow.

Colors in thin films—soap bubbles and oil films produce colors since the reflections at the "front" and "back" of the film interfere constructively/destructively at certain frequencies. Lots of green and purple (and some orange) due to the variable thickness of the film and the way different colors interfere together.

Rainbows—are caused by the refraction (dispersion) of different frequencies to slightly different angles and the reflection of the separated frequencies off of the "back" of the raindrop. Bottom of drops turns red, middle turns blue/violet. (Image from Vermont State College)



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Nature of light—neither a particle nor a wave, it is something that can display the properties of both. Modeled by Feynman in quantum electrodynamics.