



Light and Sound

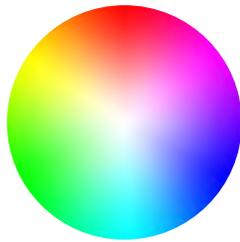
Light



White light is the sum of all the visible colors.



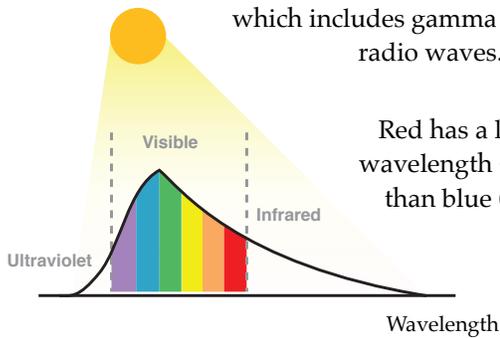
Pink Floyd
Dark side of the moon



Light



Light is part of the electromagnetic spectrum,
which includes gamma rays to
radio waves.



Red has a longer
wavelength (~700 nm)
than blue (~400 nm)

Reflection



photo: B. Herbert

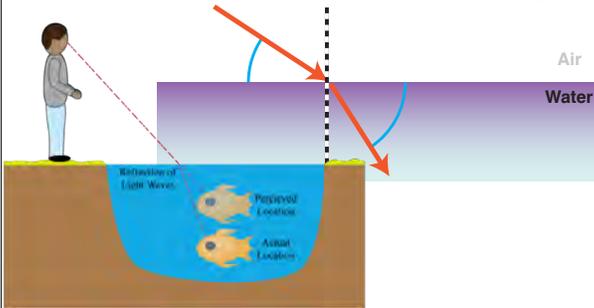


Refraction



Speed of wave propagation depends on density of the medium it is passing through.

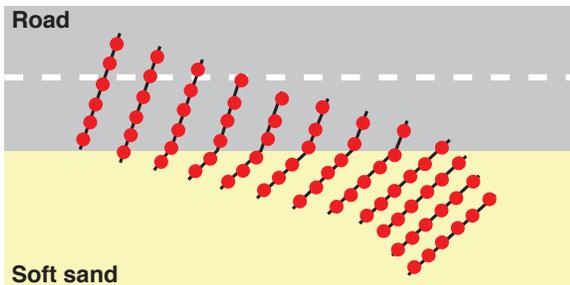
Waves bend towards the slower region.



Refraction



The marchers on sand travel slower than those on the road.





Refraction

Waves bend towards the slower region.

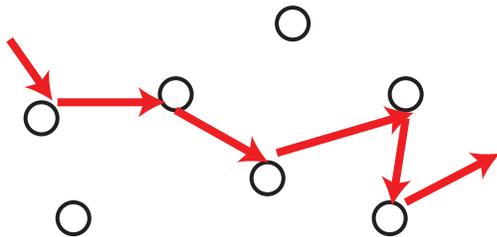
Speed of light in water is $\frac{3}{4}$ of the speed of light in air.

Sound travels three times faster in water than in air.



Scattering

Wave bounces off molecules in a single medium, eventually loses energy





Scattering

Scattering is like reflection, only more random



Clouds and haze are good examples



Absorption

Wave interacts with molecule and transfers it's energy to the molecule.

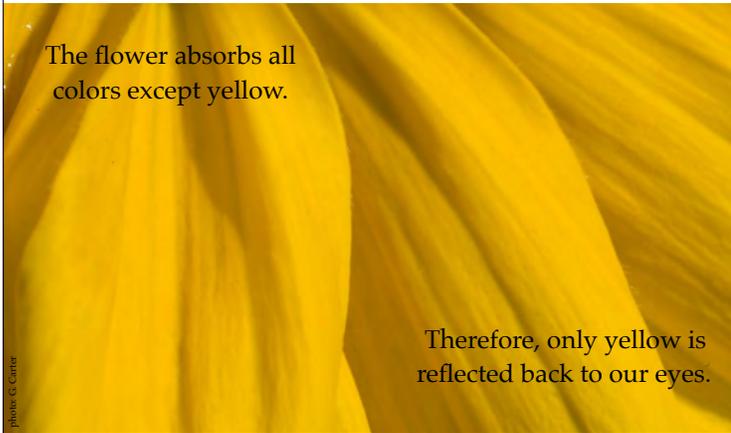


Energy causes molecule to vibrate, which in turn generates heat.



Absorption

The flower absorbs all colors except yellow.

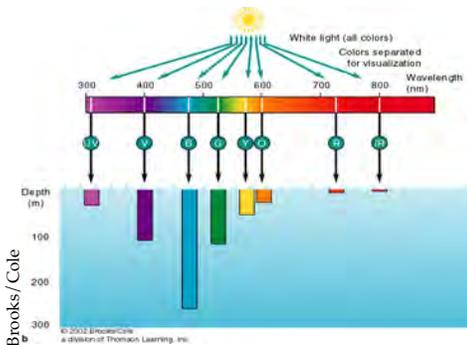


Therefore, only yellow is reflected back to our eyes.



Light in the Ocean

When light enters water, the red end of the spectrum is absorb first.



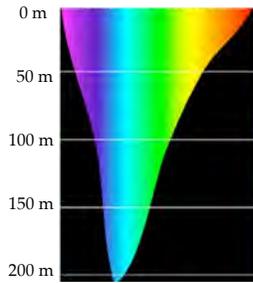
99% absorbed by

UV	31 m
V	107 m
B	254 m
G	113 m
Y	51 m
O	25 m
R	4 m
IR	3 m

Light in the Ocean



When light enters water, the red end of the spectrum is absorb first.



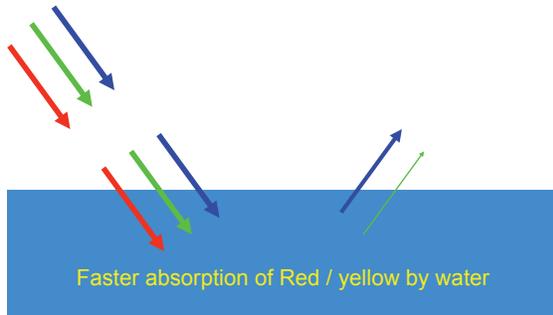
Blue light penetrates furthest.

That's why the ocean is blue.

Why is the ocean blue?



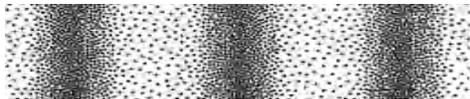
White sunlight is a mixture of all colors



Sound in the Ocean



Sound propagates as compression waves.



As waves, sound can Reflect, Refract, Scatter, and Absorb (like light and water waves).

Higher frequencies are absorbed faster.



Speed of Sound

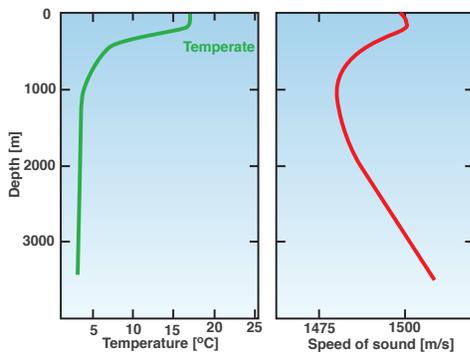
The average speed of sound in seawater is 1,500 m/s (3,345 mph).

Speed of sound varies with depth, because it

- 1) increases with increasing **temperature**
- 2) increases with increasing **pressure**



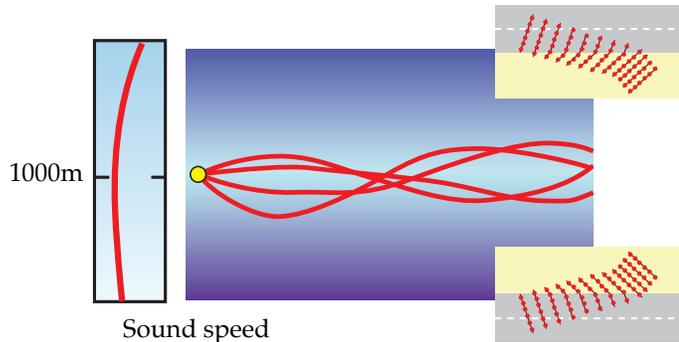
Speed of Sound





Sound Channel

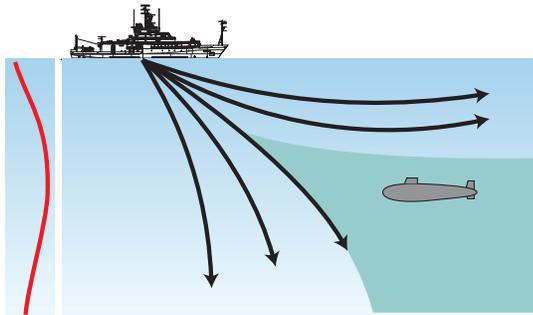
Waves refract towards slower regions.





Shadow zones

Sound speed maxima (near 80m depth) causes sound to refract away.

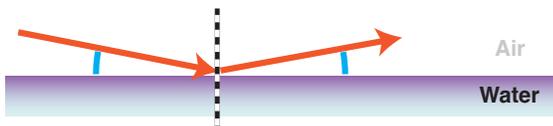




Why can't you hear

people yelling when you are underwater?

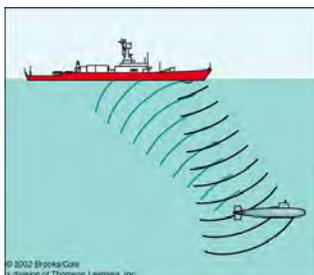
Speed of sound is 3x higher in water than air so end up with a reflection instead of refraction





SONAR

SOund Navigation And Ranging



When **sound waves reflect** from an object, they can be used to tell how far that object.

Mapping the Ocean floor



with sound



HMIRG, SOEST/UH

Some key ideas



- ✦ Like other waves, light and sound reflect, refract, scatter, and absorb.
- ✦ White light contains all colors.
- ✦ Object's color result from wavelengths not being absorbed.
- ✦ Light does not penetrate far in the ocean.
- ✦ Blue light penetrates furthest.
- ✦ Sound is a wave of compression.
- ✦ Speed of sound increases with temperature and pressure.
- ✦ Low frequency sounds travels further than high frequency sounds.
- ✦ Sound channel is at the minimum in sound speed.
