Do our eyes identify colored light by wavelength or by frequency?

Cones detect color by absorption

Suppose the index of refraction of a cone in $n_c$. If light has a frequency $f$, what is its wavelength in the cone? For a given frequency, can the wavelength ever be anything else?

Will light appear a different color to your eyes if you view it through air or through glass?
Use the xkcd from last time
Looking forward to class. I think I could solve problems if you gave them to me, but the concepts I do not feel very confident with, which unfortunately is the most important part. I'm sure after demos and discussion it will make sense. Thanks.

Does polarization happen with our own eyes? I know we have a blind spot, but are our eyes polarized?

- No.

I just need someone to talk about it. Reading it was difficult.
What kind of wave is light?
A. Longitudinal
B. Transverse
C. A combination of A and B
What does it mean to say that a given light beam is polarized? Unpolarized?

- A light beam is polarized if all waves of the beam have electric field vectors that oscillate in the same plane. An unpolarized beam will have waves with electric field vectors in several planes.
Horizontally Polarized Light

Credit: next few slides are from Dr. Durfee
Vertically Polarized Light
Diagonally Polarized Light
Circularly Polarized Light
Elliptically Polarized Light
Unpolarized Light
Circularly Polarized pictures
If you send horizontal linearly polarized light through a (perfect) vertical polarizer, how much of the light intensity will get through?

A. 0-20%
B. 20-40%
C. 40-60%
D. 60-80%
E. 80-100%
If you send circularly polarized light through a (perfect) vertical polarizer, how much of the light intensity will get through?

A. 0-20%
B. 20-40%
C. 40-60%
D. 60-80%
E. 80-100%
If you send horizontal linearly, polarized light through a (perfect) vertical polarizer, no light gets through. If you insert a diagonal polarizer at 45 degrees between the two, how much of the light intensity will now get through the final polarizer?

A. 0-20%
B. 20-40%
C. 40-60%
D. 60-80%
E. 80-100%
In the discussion accompanying the figure shown above, the text explains how a certain reflection angle can lead to polarization. In your own words, explain how this works.

- When waves are reflected off, the parallel component reflects more strongly than the perpendicular component.
- At a certain angle, the only light that reflects is oriented parallel to the surface.
S-polarization: parallel to the reflecting surface
P-polarization: both parallel and perpendicular components (partially oriented into surface)
Fresnel Coefficients

- If near perpendicular (1D Problem)

\[ r = \frac{v_2 - v_1}{v_1 + v_2} = \frac{n_1 - n_2}{n_1 + n_2} \]

\[ t = \frac{2v_2}{v_1 + v_2} = \frac{2n_1}{n_1 + n_2} \]

\[ R = |r|^2 \]

\[ T = 1 - |r|^2 \]

- For arbitrary angle (not needed for HW/exam)

\[ r_s = \frac{n_2 \cos \theta_1 - n_2 \cos \theta_2}{n_1 \cos \theta_1 + n_2 \cos \theta_2} \]

\[ t_s = \frac{2n_1 \cos \theta_1}{n_1 \cos \theta_1 + n_2 \cos \theta_2} \]

\[ r_p = \frac{n_2 \cos \theta_2 - n_2 \cos \theta_1}{n_1 \cos \theta_2 + n_2 \cos \theta_1} \]

\[ t_p = \frac{2n_1 \cos \theta_1}{n_1 \cos \theta_2 + n_2 \cos \theta_1} \]
Plots for air \((n=1)\) to glass \((n=1.5)\)

**s-polarization**

Field amplitudes vs \(\theta\)

Intensities vs \(\theta\)

**p-polarization**

Field amplitudes vs \(\theta\)

Intensities vs \(\theta\)

Brewster's angle!
Fresnel Coefficients

- If near perpendicular (1D Problem)
  
  \[ r = \frac{v_2 - v_1}{v_1 + v_2} = \frac{n_1 - n_2}{n_1 + n_2} \]
  \[ t = \frac{2v_2}{v_1 + v_2} = \frac{2n_1}{n_1 + n_2} \]
  \[ R = |r|^2 \quad T = 1 - |r|^2 \]

- For arbitrary angle (not needed for HW/exam)
  
  \[ r_s = \frac{n_2 \cos \theta_1 - n_2 \cos \theta_2}{n_1 \cos \theta_1 + n_2 \cos \theta_2} \]
  \[ r_p = \frac{n_2 \cos \theta_2 - n_2 \cos \theta_1}{n_1 \cos \theta_2 + n_2 \cos \theta_1} \]
  \[ t_p = \frac{2n_1 \cos \theta_1}{n_1 \cos \theta_2 + n_2 \cos \theta_1} \]
  
  Set numerator = 0, apply Snell’s Law…
  A big of algebra/trig…. 
  \[ \tan \theta_1 = \frac{n_2}{n_1} \]
If you send an unpolarized beam at a piece of glass at Brewster’s angle, what happens?

A. The reflected beam is partially polarized
B. The reflected beam is completely polarized
C. The transmitted beam is partially polarized
D. The transmitted beam is completely polarized
E. More than one of the above.