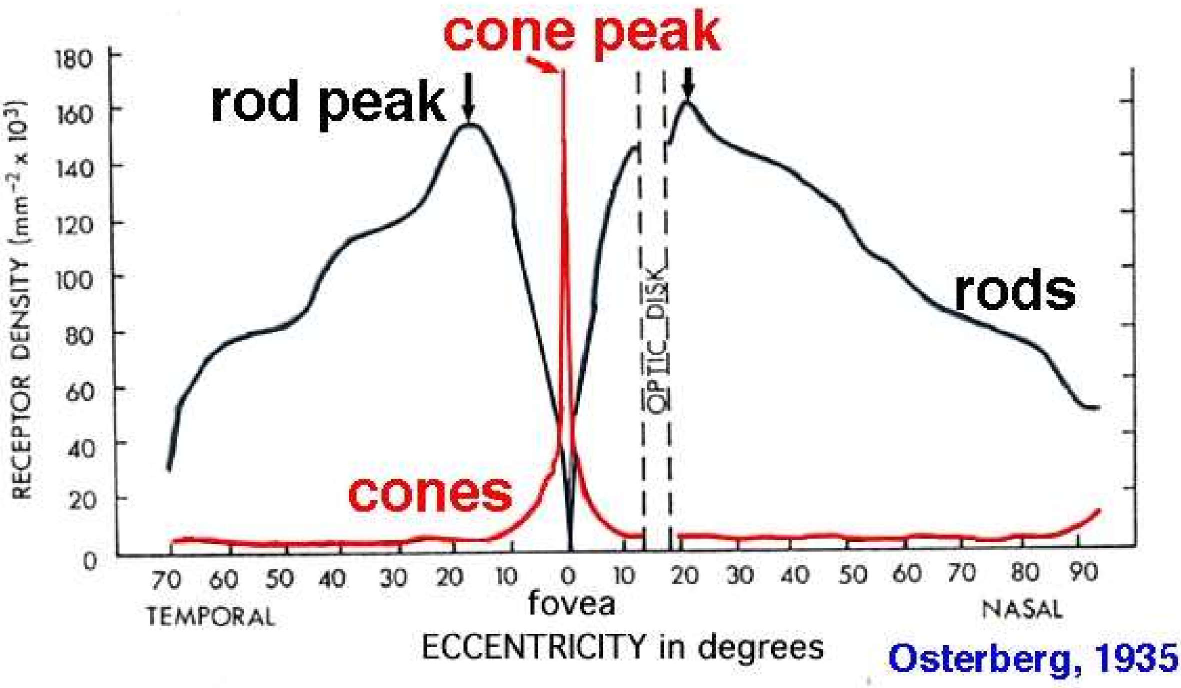
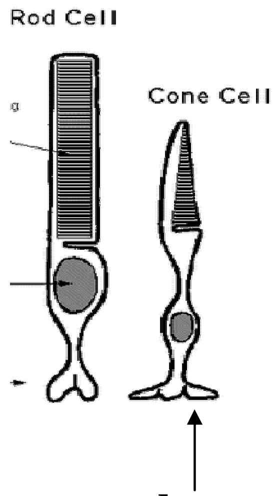
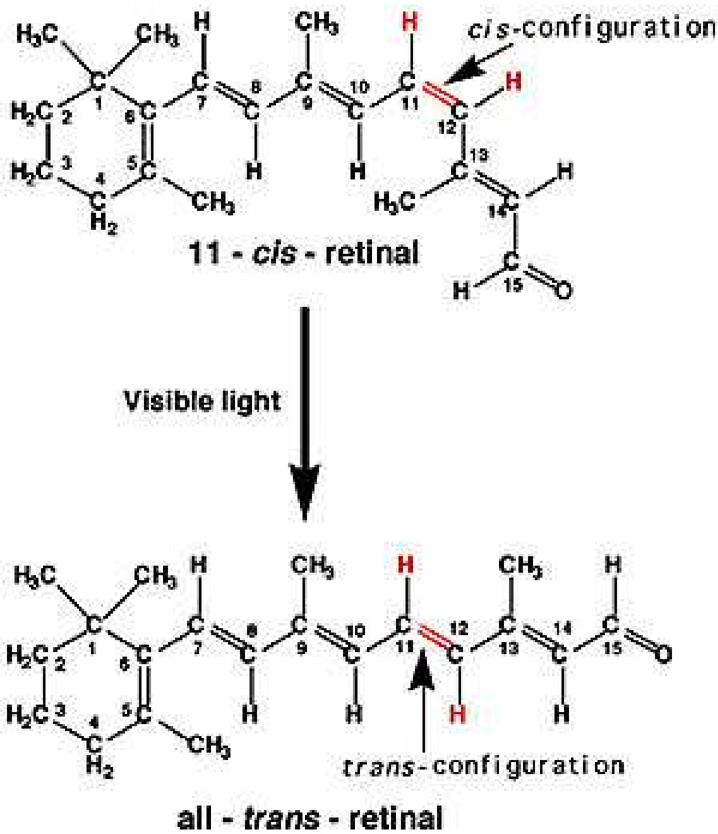
Colors





color:

The beginning of vision: light-induced twisting of a *retinal* molecule



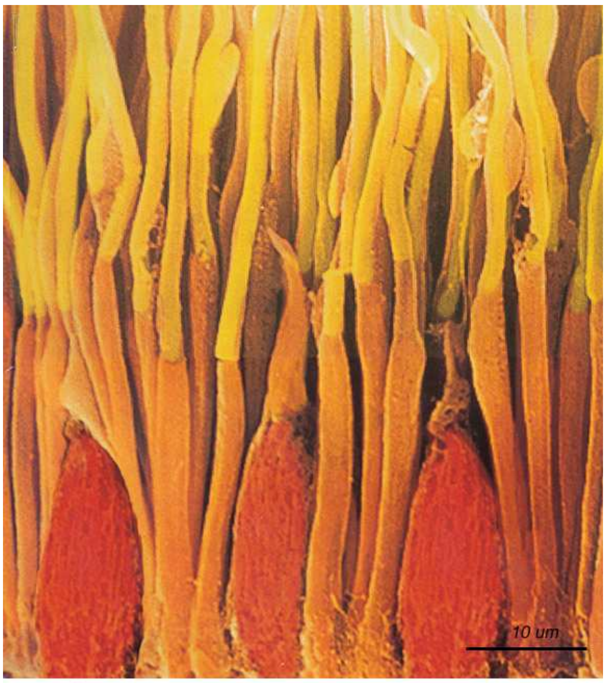
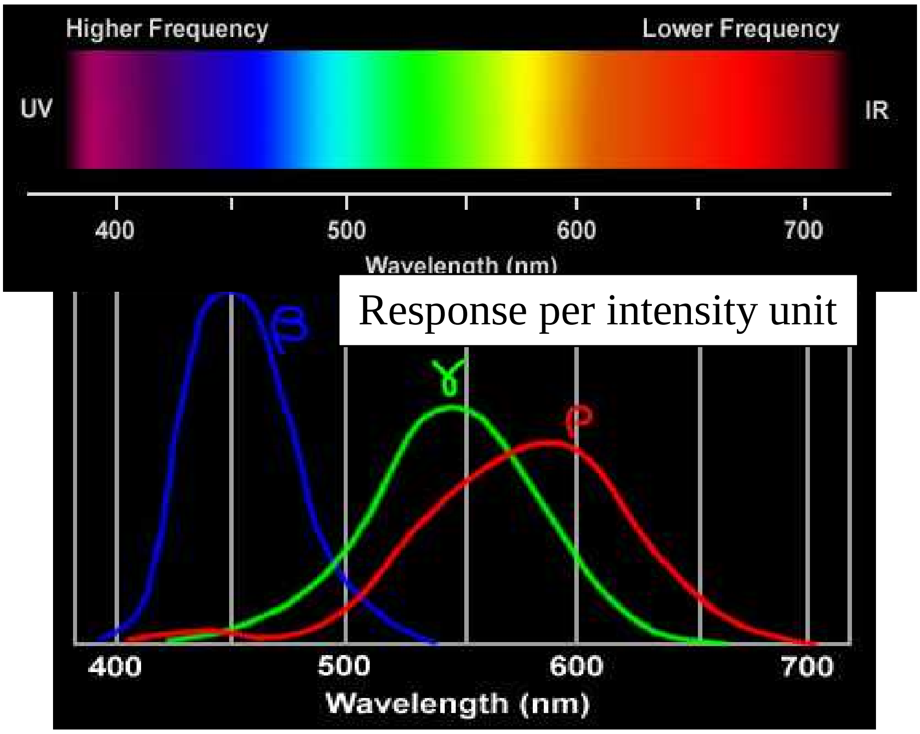


Fig1b. Scanning electron micrograph of the rods and cones of the primate retina. Image adapted from one by Ralph C. Eagle/Photo Researchers, Inc.



Rainbow colors are perceived from light of narrow band of ω,λ. (Also from broad spectra with same stimulus ratios). Not all colors are present in the rainbow.

Vector nature of color: Color is determined by the *relative stimuli* to three cone cells. $[S_\rho, S_\gamma, S_\beta]$.

Orange color: $[S_\rho, S_\gamma, S_\beta]$ =

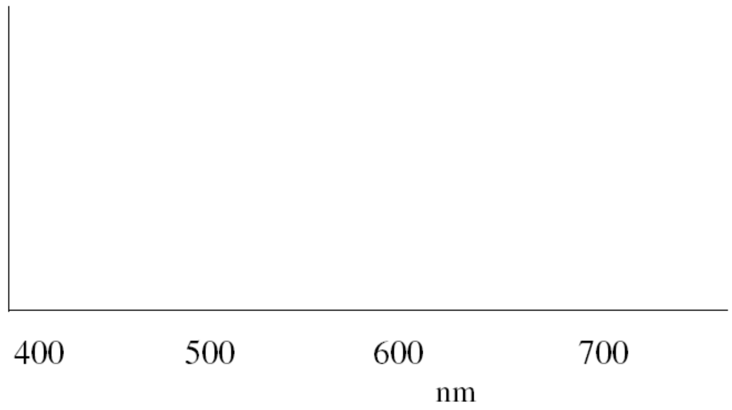
- Narrow-band 600 nm light gives this ratio
- Infinite number of other spectra give it too:
  Same color from 550 nm + 650 nm light: relative I's:

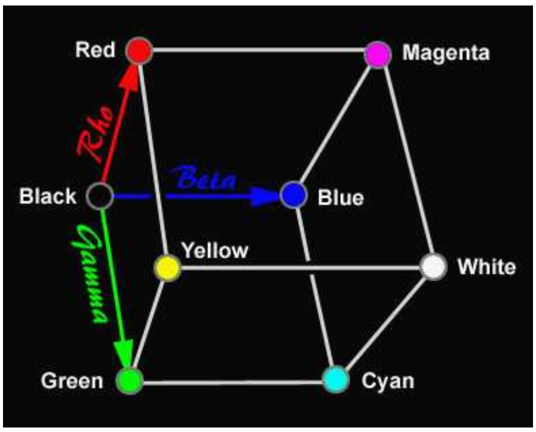
Why isn't brown e.g. [4, 2, 1] in the rainbow?

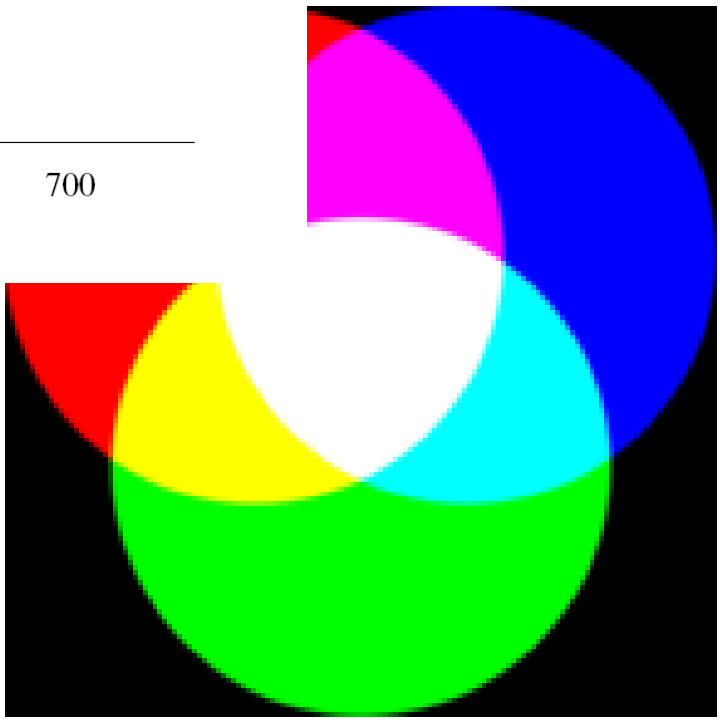
Additive coloring (light emission, projection)

Can reach any point in $[S_\rho, S_\gamma, S_\beta]$ space (any color) by superimposing three **primary colors** with varying intensities, (basis vectors).

Requirements for primary colors:

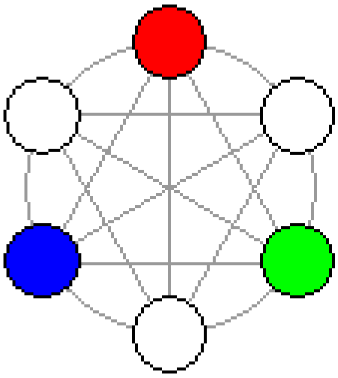


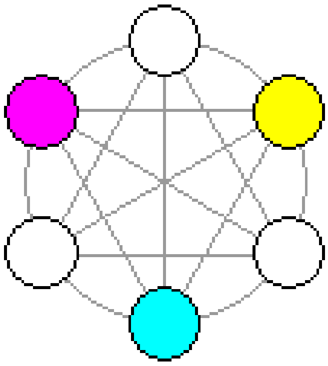


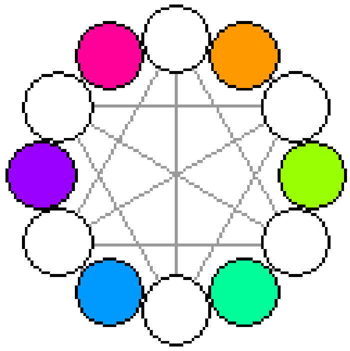


Common primaries: (R,G,B). Define (R,G,B)=(1,1,1) (as the intensities necessary for the stimuli to be perceived as white.

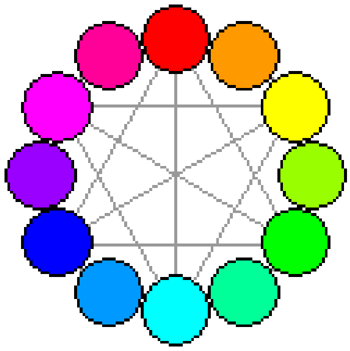
2-D representation:







Secondary colors:
Magenta:
Cyan:
Yellow



Orange RGB=

A color's complement is…

____

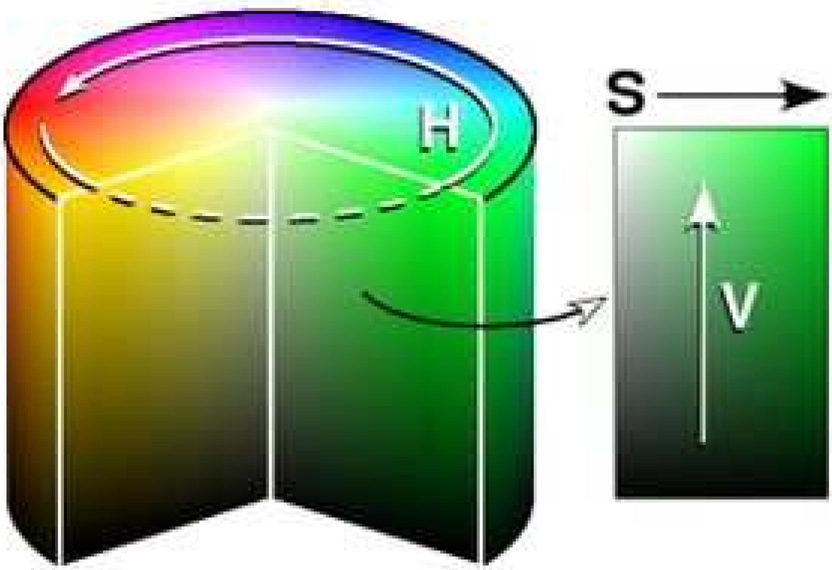
One color system (HSV)

Hue: basic “color”: from *differences* in R, G, B

Value (brightness)
from *factor* multiplying ratio to give intensity

Saturation: degree differences stand out above “white” backgrount (flat RGB background)

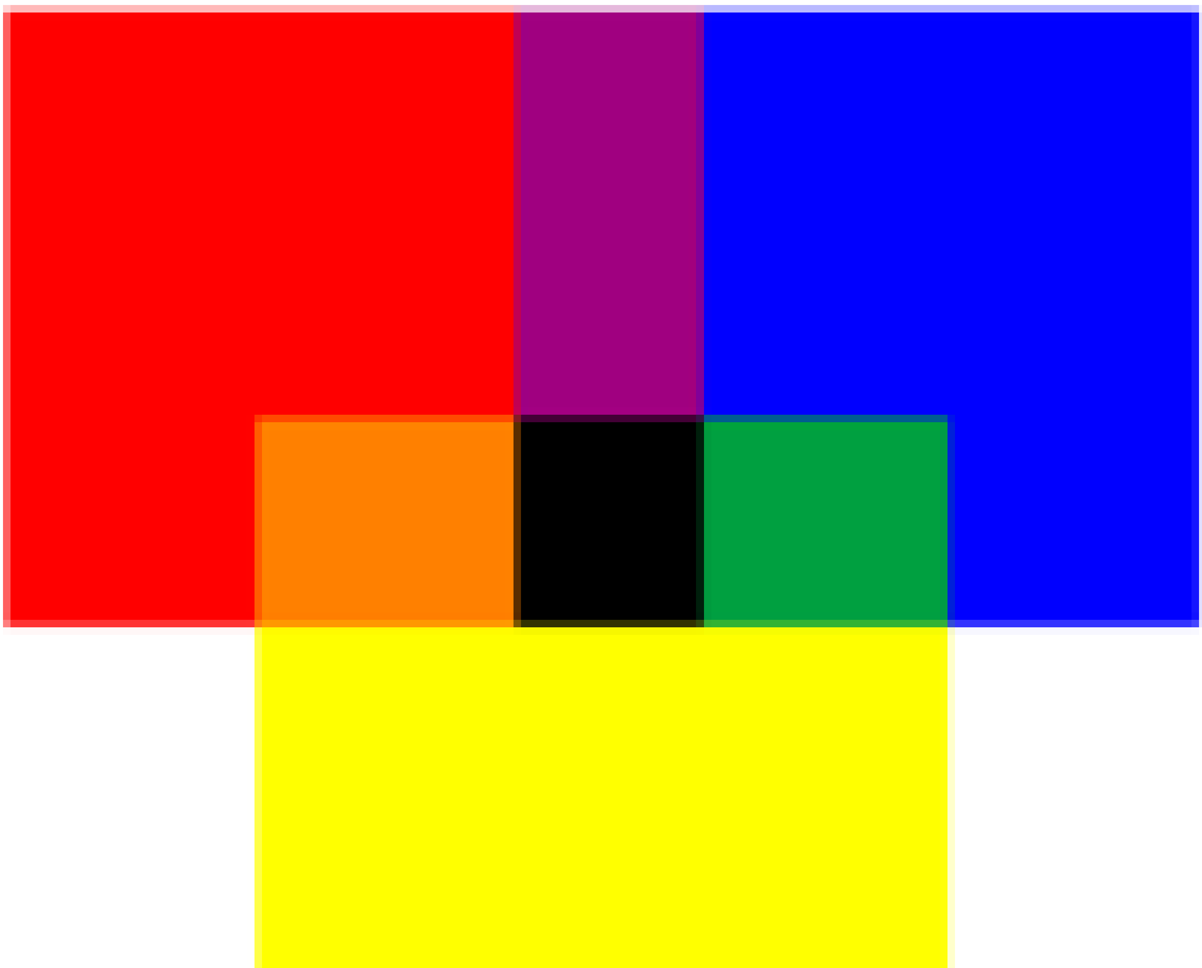
Hue: Orange
Orange, fully saturated: (R,G,B) =
Orange, less saturated (pastel): (R,G,B) =
Orange, less bright: (R,G,B) =



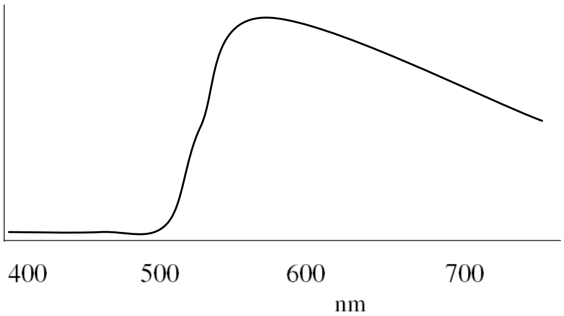
Subtractive coloring

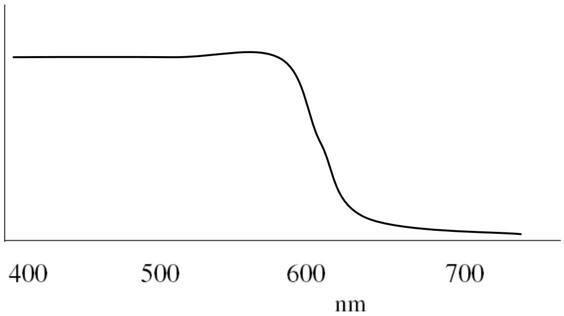
(mixing of absorptive pigments to subtract part of white spectrum)

paints, inks, crayons



Two pigment transmission functions. Mixed?





Subtractive coloring: pigments act like filters!

Except for interference films, essentially *all* techniques to coloring objects are based on **absorption**, **transmission** and **scattering** (*not* reflection).

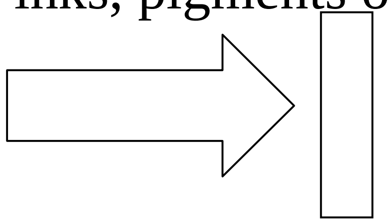
A blue ink absorbs_________ and transmits _________

A yellow ink absorbs_______ and transmits__________

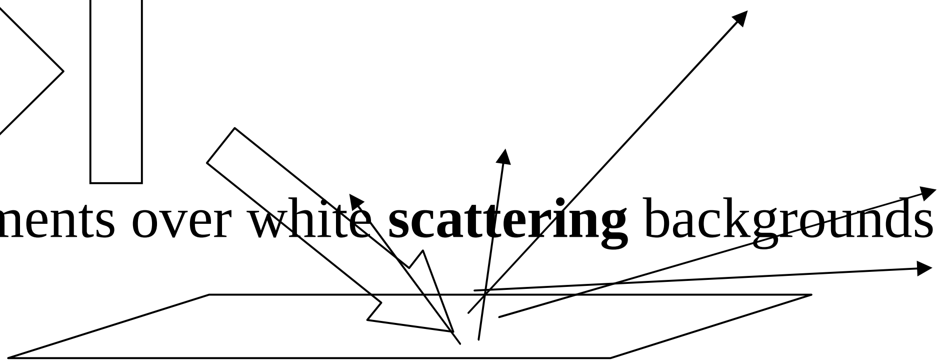
A red ink absorbs__________ and transmits__________

Some will say that a blue ink "reflects" blue light….why wrong? They actually *reflect* best where they _________ best (where n, κ change most). Put them on _______ surface to test!

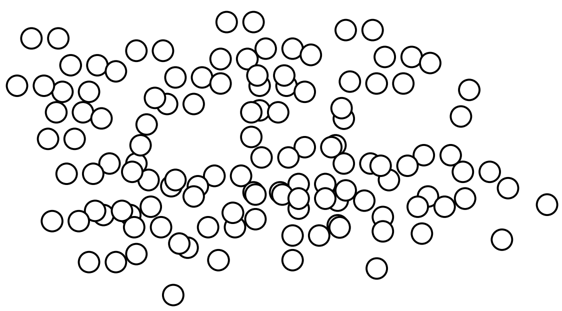
clear inks, pigments on transparent media



clear inks, pigments over white **scattering** backgrounds

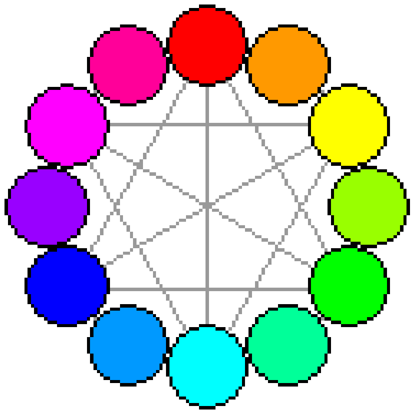


paint: absorbing inks and pigments mixed with white-scattering spheres (TiO_2)



P1. What RGB color ratio is complementary to violet (1,0,2)?

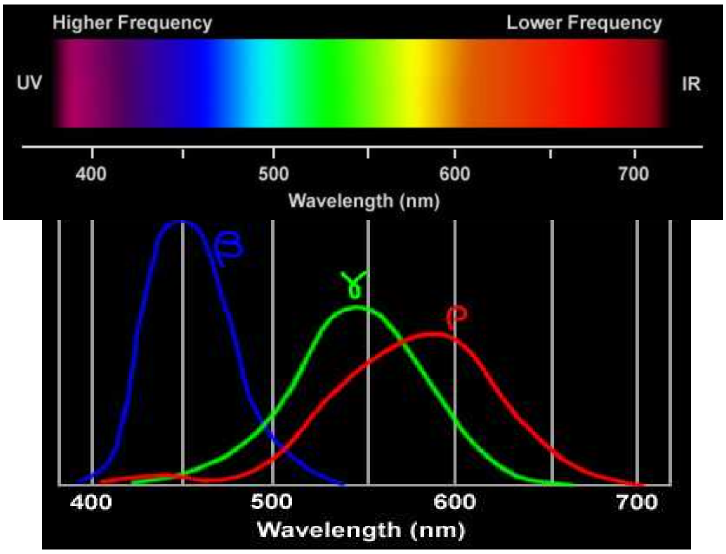
P2. What color is this?



P3. If white is (1,1,1), what is grey?

P4. Write an (RGB) ratio would give pink (a pastel)?

P5. By what approximate factor is violet light (400 nm) scattering efficiency greater than deep red light (700 nm) scattering?



P4. Argue from the response curve why red and cyan should be complementary in addition

P5. The spectrum on the left is is one way to get white light. Sketch possible transmission functions for yellow and blue pigments. Show they transmit green light when the two pigments are added.