Electromagnetic Waves - Outline

1. Identify the components of the electromagnetic spectrum.
2. Calculate the frequency or wavelength of electromagnetic radiation.
3. Recognize that light has a finite speed.
4. Describe what electromagnetic waves are and how they are produced.
5. Recognize that electricity and magnetism are two aspects of a single electromagnetic force.
6. Explain how electromagnetic waves transfer energy.
7. Describe various applications of electromagnetic waves.
8. Recognize how additive colors affect the color of light and when primary colors of light are mixed, what is the resulting color
9. Recognize how pigments affect the color of reflected light when primary color pigments are mixed, what is the resulting color
10. Explain how linearly polarized light is formed and detected

Notes

- Electromagnetic Waves

  - ✓ Electromagnetic Waves:

  - ✓ Electromagnetic Spectrum:

  - ✓ Speed of Light (Speed of Electromagnetic Waves):

- Propagation of Electromagnetic Waves

  - ✓ James Clerk Maxwell:

  - ✓ Heinrich Hertz:

  - ✓ Electromagnetic Force:

  - ✓ What Produces Electromagnetic Waves?:

- ✓ How is the Energy Transferred?:

- ✓ Electromagnetic Radiation:

- ✓ Photon:

- <u>The Electromagnetic Spectrum</u>
  - ✓ Radio Waves:

  - ✓ Microwaves:

  - ✓ Infrared:

  - ✓ Visible Light:

  - ✓ Ultraviolet:

  - ✓ X-Rays:

  - ✓ Gamma Rays:

- Color
  - ✓ Primary Colors of Light:
  - ✓ Additive Properties of Light:
  - ✓ Subtractive Properties of Light (dyes or pigments):
- Polarization of Light Waves:
  - ✓ Linear Polarization:
  - ✓ Polarization of Light by Transmission:
  - ✓ Polarization of Light by Reflection and Scattering:

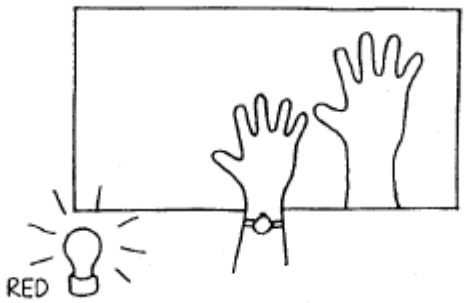
- **Sample/Practice Problems**

A. Characteristics of Light – Blue Study Guide, page 79

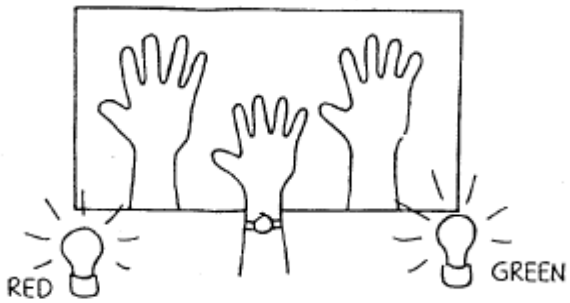
B. Electromagnetic Waves – Blue Study Guide, page 118

C. Color

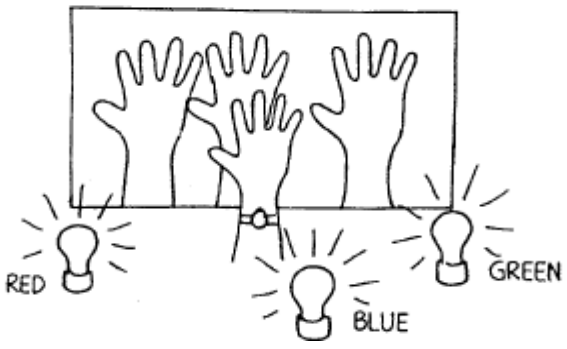
1. The sketch shows the shadow of your hand held in front of a white screen in a darkened room. The light source is red, so the screen looks red and the shadow looks black. Color the sketch with colored markers, or label the colors with pen or pencil.



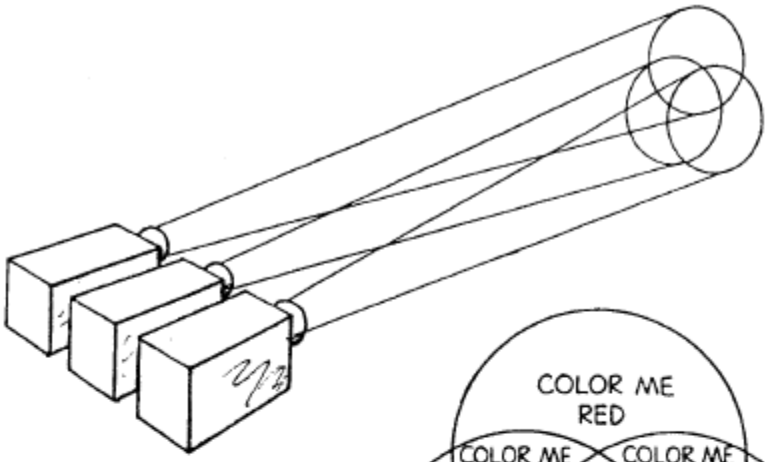
2. A green lamp is turned on and makes a second shadow. The formerly black shadow cast by the red light is no longer black, but is illuminated with green light. So it is green. Color or mark it green. The shadow cast by the green lamp is not black, because it is illuminated with the red light. Color or mark its color. The background receives a mixture of red and green light. Figure out what color the background will appear, then color or label it.

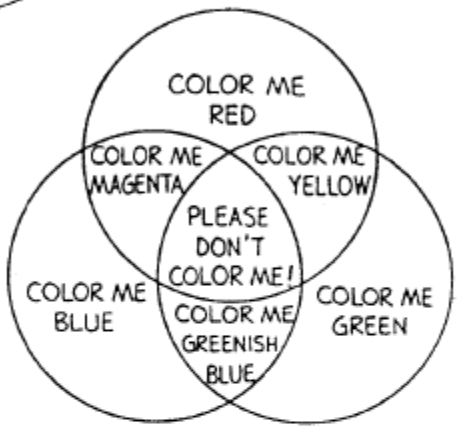


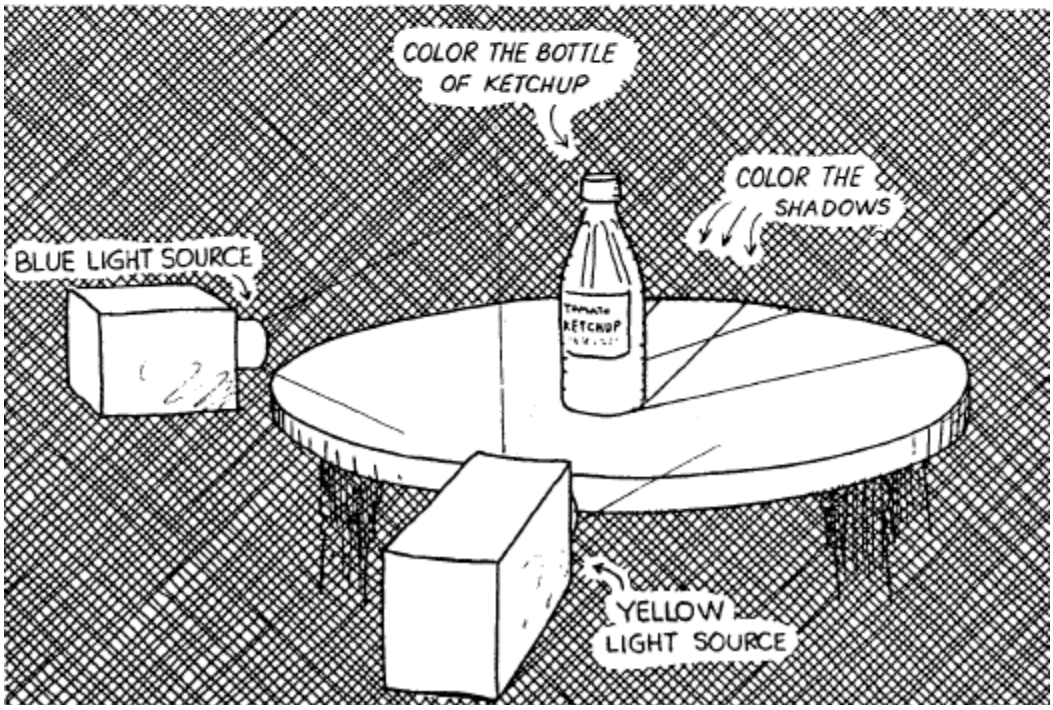
3. A blue lamp is turned on and three shadows of your hand appear. Color or label the appropriate colors of the shadows and the background.



4. If you have colored markers, have a go at these.

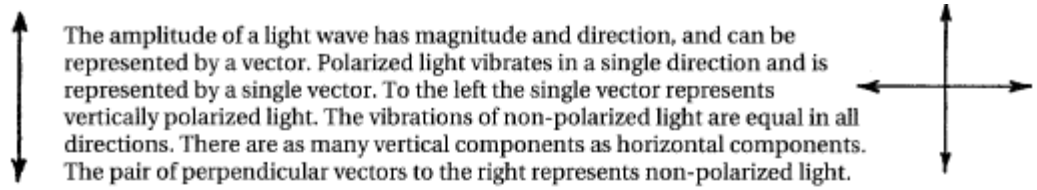






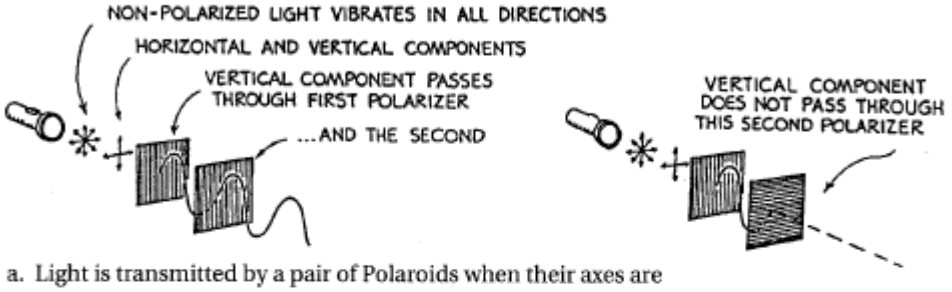
D. Color – Blue Study Guide, page 76

E. Polarization



The amplitude of a light wave has magnitude and direction, and can be represented by a vector. Polarized light vibrates in a single direction and is represented by a single vector. To the left the single vector represents vertically polarized light. The vibrations of non-polarized light are equal in all directions. There are as many vertical components as horizontal components. The pair of perpendicular vectors to the right represents non-polarized light.

1. In the sketch below non-polarized light from a flashlight strikes a pair of Polaroid filters.



a. Light is transmitted by a pair of Polaroids when their axes are

(aligned) (crossed at right angles)

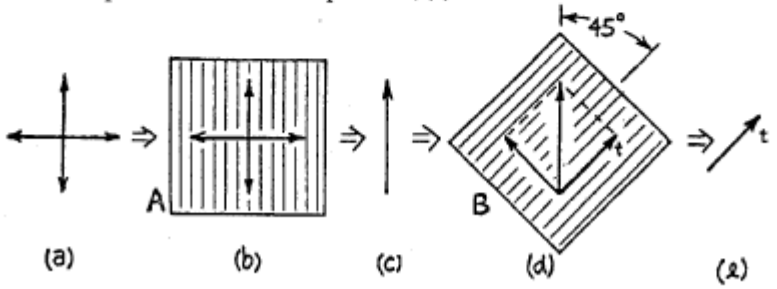
and light is blocked when their axes are

(aligned) (crossed at right angles)

b. Transmitted light is polarized in a direction

(the same as) (different than) the polarization axis of the filter.

2. Consider the transmission of light through a pair of Polaroids with polarization axes at 45° to each other. Although in practice the Polaroids are one atop the other, we show them spread out side by side below. From left to right: (*a*) Nonpolarized light is represented by its horizontal and vertical components. (*b*) These components strike filter A. (*c*) The vertical component is transmitted, and (*d*) falls upon filter B. This vertical component is not aligned with the polarization axis of filter B, but it has a component that is — component *t*; (*e*) which is transmitted.



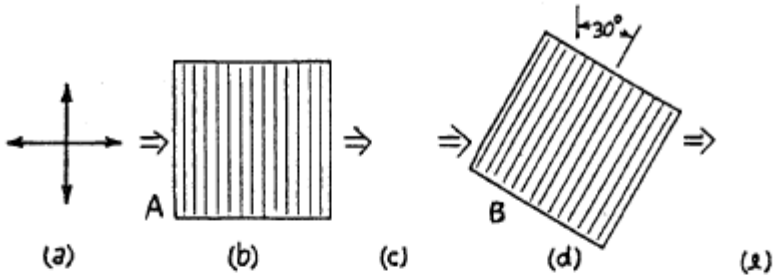
a. The amount of light that gets through Filter B, compared to the amount that gets through Filter A is

(more) (less) (the same)

b. The component perpendicular to *t* that falls on Filter B is

(also transmitted) (absorbed)

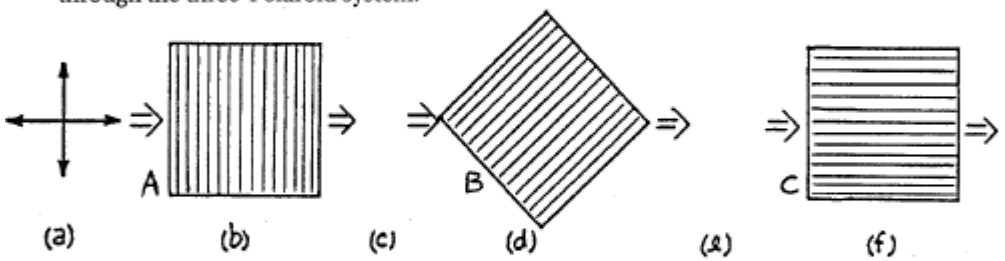
3. Below are a pair of Polaroids with polarization axes at 30° to each other. Carefully draw vectors and appropriate components (as in Question 2) to show the vector that emerges at *e*.



a. The amount of light that gets through the Polaroids at 30°, compared to the amount that gets though the 45° Polaroids is

(less) (more) the same)

4. Figure 27.19 in your textbook shows the smile of Ludmila Hewitt emerging through three Polaroids. Use vector diagrams to complete steps *b* through *g* below to show how light gets through the three-Polaroid system.



5. A novel use of polarization is shown below. How do the polarized side windows in these next-to-each-other houses provide privacy for the occupants? (Who can see what?)