## STUDY GUIDE

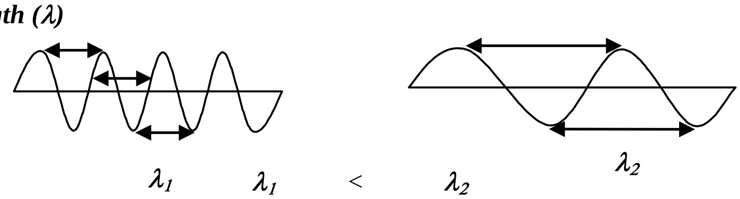
### EXAMPLE QUESTIONS FOR ART HISTORY

- Construct a timeline of art history based on colored pigments
- What is the oldest, allegedly manmade, art object ever discovered?
- What is important about the Venus of Willendorf?
- List three pigments used in cave painting
- If you were alive in 25,000BC how will you make black paint?
- Please order these metals according to their appearance in art history (oldest first)
    - Gold, Silver, Iron, Bronze, Billion
- List at least three pigments that were used in Egyptian times
- What is the difference between a Fresco and a Painting?
- What is the importance of the Stele of Hammurabi?
- Where (City) were the first plaster human figures created?
- List three materials that were carved in ancient times that survive today
- What is imperial purple?
- What is the difference between a dye and a pigment?
- Name two of the red pigments used by Egyptian artists
- What is important about Egyptian blue?
- Egyptian paintings do have green as a color, how did they do it?
- If I need to make blue tempera what should I do?

### LIGHT MATTER AND COLOR

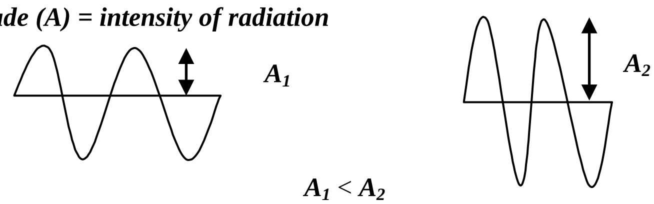
Examine the following diagrams that illustrate four basic concepts of the **wave theory of light**. Based upon the information found in this model, discuss and answer the critical thinking questions.

***Wavelength ($\lambda$)***



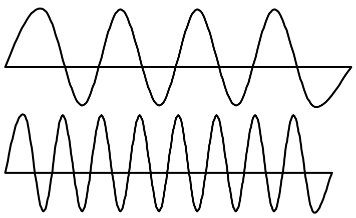

| Color | Wavelength |
|---|---|
| Red | 647-700 nm |
| Orange | 585-647 nm |
| Yellow | 575-585 nm |
| Green | 491-575 nm |
| Blue | 424-491 nm |
| Violet | 400-424 nm |

***Amplitude (A) = intensity of radiation***




***Frequency ($\nu$) = cycles per second***

$\nu_1$ $\nu_2$



$\nu_1 < \nu_2$

***Energy (E)* high** ⟵⟶ low
***E***

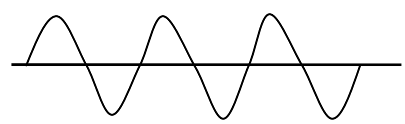
$\lambda$ = $10^{-14}$m ________ $10^{-11}$m ________ $10^{-8}$m ________ $10^{-5}$m ______________________ $10^{1}$m
$\nu$ = $10^{23}$Hz ________ $10^{21}$Hz ___ $10^{18}$Hz ___________ $10^{12}$Hz ______________ $10^{9}$Hz $10^{6}$Hz

| gamma rays | x-rays | Ultraviolet | Visible | Infrared | Microwave | Radio and TV |
|---|---|---|---|---|---|---|

**Use the information from the model to answer questions 1-4.**

1) If $\lambda_1$ and $\lambda_2$ represent opposite ends of the range of colored wavelengths, what colors do they each represent?
2) If $A_2$ is greater than $A_1$ which one would represent the brighter light?
3) Which of the two waves passing by the observer has the higher frequency? $\nu_1$ or $\nu_2$?
4) What is the relationship between wavelength, frequency, and energy of electromagnetic radiation?

5) What is the difference between a **luminous** object and an **illuminated** object?
6) Why do many puddles of water found in parking lots or gas stations exhibit bright multicolored bands on their surface?
7) Why do clouds appear to be white when we know they are composed of colorless water droplets?
8) Why is the "head" of foam on beer white when we know the beer itself is a yellow or dark brown color?
9) If radiation is illustrated as a wave as in the figure to the right
   a) What part of the picture represents the intensity or brightness of the radiation? What is this called?
   b) What part represents the wavelength? Show it and give its symbol.

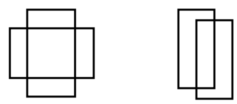


10) What quantity (length, volume, mass) are each of the following representing?
    a) Angstrom
    b) milliliter
    c) decimeter
    d) nanogram
    e) micrometer
11) Rank the following from smallest to largest.
    a) 1 mm
    b) 1 nm
    c) 0.001 m
    d) 10 meter
    e) 1 km
12) In the table below rank the types of electromagnetic radiation using a scale of 1 to 5 (1=lowest or smallest, 5 = highest or longest) according to wavelength, frequency, and energy.

| | Wavelength | Frequency | Energy |
|---|---|---|---|
| Ultraviolet | | | |
| X-rays | | | |
| Sound | | | |

Visible
Infrared

13) What are the seven colors of the visible spectrum?
14) What is considered to be the wavelength range for the visible light spectrum?
15) What is the difference between a continuous spectrum and a bright line spectrum?
16) Why can you see yourself if you look at a mirror but you can't see yourself if you look at a piece of white paper?
17) What is the difference between **refraction** and **diffraction** of light?
18) What is meant by the term **refractive index**?
19) What happens when you look through one polarizing filter at a shiny surface?
20) What happens when you place two rectangular polarizing filters on top of each other oriented as in the following two diagrams?



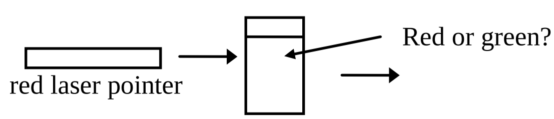
21) How does an incandescent bulb give off light?
22) Diagram what happens when white light falls on the following types of matter:
    a. Transparent, colorless substance
    b. Translucent, colorless substance
    c. Opaque, white substance
    d. Opaque, black substance
    e. Transparent, colored object
    f. Opaque, colored object

23) Examine the following pairs of diagrams. Which substance will absorb more light?

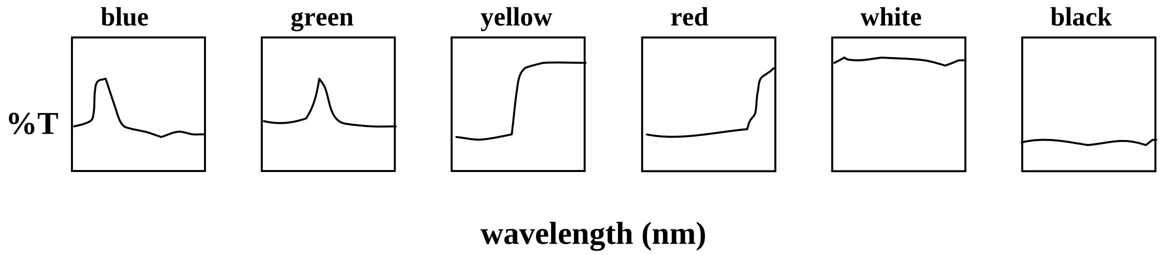
a)


b)

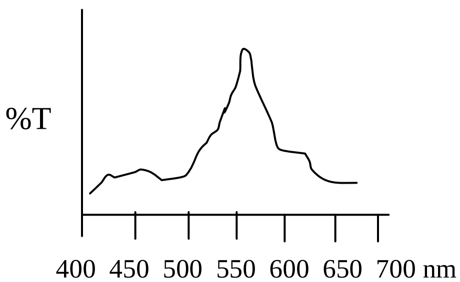

24) Will a beam of red laser light pass through a green solution or a red solution?

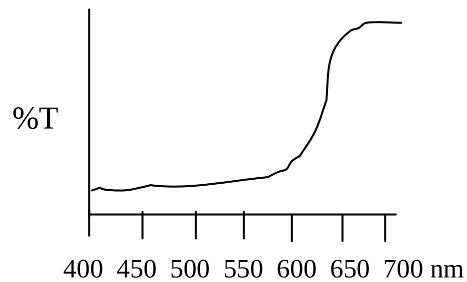


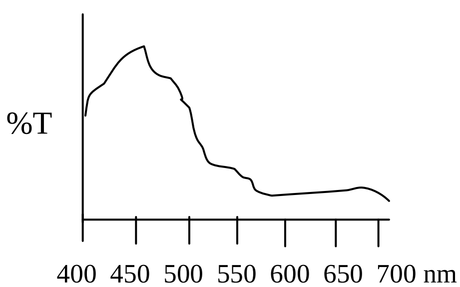

25) The following graphs show example **spectral curves** for non-ideal blue, green, yellow, red, white and black colored materials.

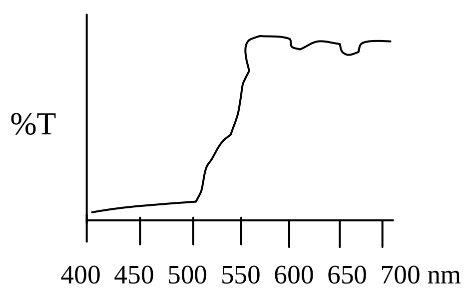



Examine the following spectral transmittance or absorbance curves and determine the color of the filter used to prepare each one.



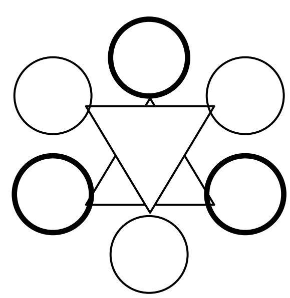




**Additive Color Mixing — The Mixing of Colored Lights**

The three primary additive colors (RGB) will be used as three colored filters placed in front of a bright white light source to produce a beam of colored light. Then two or more colored beams will be directed toward a white screen and overlapped to generate a new color. We will mix the light from the filters according to the scheme in Table 1 below. First predict what color you think you will see and then record the actual color you observe.

| Colored Filters Added | Color Predicted | Actual Observed Color |
|---|---|---|
| R + B | | |
| B + G | | |
| R + G | | |
| R + B + G | | |

Based on your observations complete the following color wheel for **additive color mixing** placing the primary colors (RGB) in the circles with the darker lines and the secondary colors in the appropriate circles between the two mixed primary colors**.**



Next we will use the same technique to mix the lights beams produced from the secondary additive colors. Keep in mind what you just learned above
Again first predict what color you think you will see and then record the actual color you observe.

| Colored Filters Added | Color Predicted | Actual Color Observed |
|---|---|---|
| C + M | | |
| M + Y | | |
| C + Y | | |
| C + M + Y | | |

**Subtractive Color Mixing — The Mixing of Colored Materials**

The R, G, B and Y, M, C filters can also be used in a subtractive mode rather than an additive mode by placing one colored filter over another different colored filter on any white light source such as an overhead projector. This simulates the subtractive mixing of colored pigments, paints, inks, dyes and other colored materials. In subtractive mixing of colors one must consider what wavelengths of light (colors) are removed (not transmitted) by each colored filter. Again predict the color first then record the actual color observed.

| Superimposed Filters | Color Predicted | Actual Color Observed |
|---|---|---|
| R + B | | |
| R + Y | | |
| B + Y | | |
| R + Y + B | | |

Each of the three filters, Y, M and C, ideally transmits two colors:

Y transmits R + G
M transmits R + B
C transmits G + B

Therefore, when these filters are superimposed over a white light source, more than one spectral region is transmitted by two filters. For example, since C transmits both G and B, and M transmits both R and B, then both C and M transmit B, so blue light will shine through both and the appearance of the two superimposed filters will be blue. Now we will mix the Y, M and C filters subtractively to observe what colors are produced when the different colored filters are overlapped. Record your predictions and your observations.

| Superimposed Filters | Color Predicted | Actual Color Observed |
|---|---|---|
| C + Y | | |
| C + M | | |
| M + Y | | |
| C + M + Y | | |

**Colored Objects in Colored Lights**

Lets examine some colored objects under different colors of illuminating light and see what happens. Record the color of the object under white light and then record the color of illuminating light and the objects' color under that light.

| Color Under White Light | Illuminating Light Color | Color Under Colored Light |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

See how well you understand subtractive and additive color mixing by answering the following questions?

a) A cardboard square appears blue in ideal blue light and green in ideal green light, and almost black in red light. What color is it?

b) An opaque cardboard square looks black in ideal blue light , green in ideal green light, green in cyan light, and red in red light. What color is it?

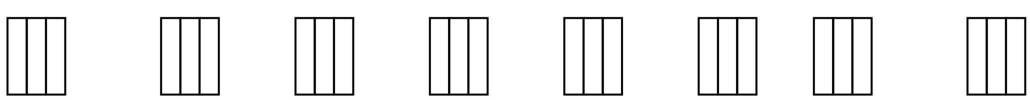
c) A cardboard square looks blue when viewed through an impure blue filter, green when viewed through an impure green filter, and black when viewed through a red filter. What color is it?

**Additive or Subtractive Color Mixing**

**<u>Color Television and Computer Monitors</u>**

A color television set picture tube or a computer monitor has more than 300,000 colored **phosphor** dots arranged in groups of three on its surface. Inside the tube are three electron guns — one for each color — that constantly scan the screen emitting electron beams in response to the video signal picked up by the TV antenna. When the phosphors are struck by the electron beam, they glow their respective color and form the color picture.

Draw a picture of the three colored phosphors when you look at something white, yellow, red, blue, green, black, cyan, and magenta in color.



white yellow red blue green black cyan magenta

What kind of color mixing is taking place (additive or subtractive)?

**TERMS AND DEFINITIONS**

- Electromagnetic radiation
- Wavelength (l)
- Emission
- Transmission
- Diffraction
- Diffraction grating

- Frequency (n)
- Amplitude (A)
- Speed of light (c)
- Electromagnetic spectrum
- Visible light
- Ultraviolet radiation
- Infrared radiation
- Nanometer
- Luminous object
- Illuminated object
- Spectroscope
- Continuous spectrum
- Discrete or line spectrum
- Wave theory
- Particle (photon, quantum) theory

- Absorption
- Specular reflection
- Diffuse reflection
- Scattering
- Angle of incidence
- Angle of reflection
- Normal
- Refraction
- Refractive index
- Density
- Transparent
- Translucent
- Opaque
- Constructive interference
- Destructive interference

- Polarized light
- Beer's Law
- Lambert's Law
- Selective absorption or transmission of light
- Linear relationship
- Inverse relationship
- Spectrophotometer
- Spectral transmission curve
- Spectral absorption curve
- Spectrally pure or ideal color
- % Transmittance (%T)
- Absorbance (A)

- Metric system
- Base unit
- prefix
- meter
- Gram
- Liter

- Kilo
- Centi
- Milli
- Micro
- Nano
- Angstrom

- Fahrenheit
- Celsius
- Centigrade
- Kelvin
-
-

- Hue (color, tint)
- Value (brightness)
- Saturation (purity)_
- primary colors
- secondary colors
- complementary colors
- additive color mixing
- subtractive color mixing
- vision persistence
- pointillism

- Phosphors
- Moiré effect
- Four-color process
- Rod cells
- Dichromatic vision
- simultaneous contrast
- spatial effects of color
- Trichromatic theory
- Opponent-process theory

- Retina
- Fovea
- Cone cells
- Achromism (monochromism)
- Munsell Color System
- RGB Color System
- CIE Chromaticity diagram