Lecture Outline

Chapter 27: Color



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Classwork: Turn in at end of period.

Newton used prisms to dissect light:

Does white light contain all of the colors of the spectrum, or does the prism somehow "stain" the light?





Used another prism to recombine it.

Removing some colors produced others....

Red light only contains red light. The prism does not "stain" the light. 8. What is the evidence for the statement that white light is a composite of all the colors of the spectrum?

Color in Our World

- Color
 - Physiological experience
 - In the eye of the beholder





Color in Our World, Continued

- Color we see depends on frequency of light.
 - Lowest frequency—perceived as red
 - In between lowest and highest frequency perceived as colors of the rainbow (red, orange, yellow, green, blue, indigo, violet)
 - Highest frequency—perceived as violet
 - Beyond violet, invisible ultraviolet (UV)

Color CHECK YOUR NEIGHBOR

What can the human eye not see?

- A. Infrared radiation
- B. Ultraviolet radiation
- C. Both A and B.
- D. Neither A nor B.

Color CHECK YOUR ANSWER

What can the human eye not see?

C. Both A and B.

Classwork: Record answers.

1. Which has the higher frequency: red light or blue light?

Selective Reflection

- Selective reflection
 - We see the color of a rose by the light it reflects.



Things that emit light:













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How does light reflect off of an object?

Light is incident on an object:



electrons in atom have a natural frequency



Electromagnetic fields force the electrons in atoms to vibrate.

2. What occurs when the outer electrons that buzz about the atomic nucleus encounter electromagnetic waves?

When light strikes an object

There are two possibilities:

1/ If the light frequency resonates electrons

→ light is absorbed. Light energy heats object.
Examples: UV or IR light striking glass.

2/ If light frequency is too high or low, the light is re-emitted by the object. Then it can either:

- A) pass through if transparent (a window);
- B) or reflect
- \rightarrow light reflection is like a sound echoing

 \rightarrow the wave returns into the original medium

3. What happens to light when it falls on a material that has a natural frequency equal to the frequency of the light?

4. What happens to light when it falls on a material that has a natural frequency above or below the frequency of the light?

- Objects reflect light of some frequencies and absorb the rest.
 Rose petals absorb most of the light and reflect red.
 Objects can reflect only those frequencies present in the light.
 - Ex: A red object...



(a) appears red if white light is shined on it

- \rightarrow the object reflects the red light within white light
- (b) appears red if red light is shined on it
- \rightarrow object reflects the red light

(c) appears black if green light is shined on it

© 2015 Pason there is no red light to reflect, so it reflects no light

Black and White

Objects that... reflect all frequencies appear white. absorb all frequencies and reflect none appear black.





Which stripes get warmer?

Which stripes are brighter in the infrared?

Seeing zebras in a new light....



Incandescent vs Fluorescent







Incandescent emits lower frequencies: redder Fluorescents emit higher frequencies: bluer





Objects can only reflect frequencies in light that illuminates it.

In white light:

In red light:

In blue light:







What kind of light?



Selective Transmission

- Color of transparent object depends on color of light it transmits.
- *Pigment* (dye) are fine particles that absorb some frequencies and only transmit certain others.



 Colored glass is warmed due to the energy of absorbed light illuminating the glass.

5. What color light is transmitted through a piece of red glass?

6. How does a pigment affect light?

7. Which warms more quickly in sunlight: a colorless or a colored piece of glass? Why?

Stained glass:



Yellow glass transmits yellow light only.

Blue glass transmits blue light only.

Yellow and blue absorb other colors and warm up. White glass transmits all colors and stays coolest.

- White light from the Sun
 →Distribution of solar frequencies is uneven.
 - Most intense in yellow-green portion
 - Where our eyes are most sensitive

Radiation Curve of Sunlight: Show how much energy each frequency has in it.



It's why fire trucks are often painted yellow-green.



9. What is the color of the peak frequency of solar radiation?

10. To what color of light are our eyes most sensitive?

11. What is a radiation curve?

• The radiation curve of sunlight can be divided into three frequency regions: low, medium and high



- Each color corresponds to 1 of 3 cones in eye.
- When all 3 cones are stimulated equally, you see white light.

12. What frequency ranges of the radiation curve do red, green, and blue light occupy?

How do computer monitors and TVs produce all the colors you see?



Look closely....



Mixing Colored Light

- Additive primary colors:
 - Red, green, and blue (RGB)
 - Together they add to produce white.
 - Produce any color in the spectrum





Mixing Colored Light CHECK YOUR NEIGHBOR

Red, green, and blue light overlap to form

- A. red light.
- B. green light.
- C. blue light.
- D. white light.

D. white light.

Mixing Colored Light CHECK YOUR NEIGHBOR, Continued

When the color yellow is seen on your TV screen, the phosphors being activated on the screen are

- A. mainly yellow.
- B. blue and red.
- C. green and yellow.
- D. red and green.



Mixing Colored Light CHECK YOUR ANSWER, Continued

When the color yellow is seen on your TV screen, the phosphors being activated on the screen are

D. red and green.

Mixing Colored Light CHECK YOUR NEIGHBOR, Continued-1

A blue object will appear black when illuminated with

- A. blue light.
- B. cyan light.
- C. yellow light.
- D. magenta light.



Mixing Colored Light CHECK YOUR ANSWER, Continued-1

A blue object will appear black when illuminated with

C. yellow light.

- Primary colors
 - Combination of two of the three additive primary colors:
 - red + blue = magenta
 - red + green = yellow
 - blue + green = cyan



- magenta (red + blue) is the opposite of green
- yellow (red + green) is the opposite of blue
- cyan (blue + green) is the opposite of red.



- The shadows of the golf ball are subtractive.
 - Magenta (opposite of green)
 - Cyan (opposite of red)
 - Yellow (opposite of blue)



Mixing Colored Light, Continued-4

- Subtractive primaries are complementary to additive primaries.
 - magenta + green = white = red + blue + green
 - yellow + blue = white + red + green + blue
 - Example: color printing



Mixing Colored Light CHECK YOUR NEIGHBOR, Continued-2

A red rose will *not* appear red when illuminated only with

- A. red light.
- B. orange light.
- C. white light.
- D. cyan light.

Mixing Colored Light CHECK YOUR ANSWER, Continued-2

A red rose will *not* appear red when illuminated only with

D. cyan light.

- 9. What is the color of the peak frequency of solar radiation?
- 10. To what color of light are our eyes most sensitive?
 - 11. What is a radiation curve?

12. What frequency ranges of the radiation curve do red, green, and blue light occupy?

- 13. Why are red, green, and blue called the additive primary colors?
- 14. What is the resulting color of equal intensities of red light and cyan light combined?

15. Why are red and cyan called complementary colors?

Color blindness

is the decreased ability to see color or differences

in <u>color</u>.^[3] The most common is an <u>inherited</u> problem in the development of one or more of the three cone cells males are more likely to be color blind than females,

Normal vision

- There is no cure for color blindness.
- Special lenses may help people with red–green color blindness in bright light.^[3]

Red–green color blindness is the most common form, followed by blue–yellow color blindness and total color blindness

https://www.<u>colour-</u> <u>blindness</u>.com/colour-blindnesstests/ishihara-colour-test-plates/

https://enchroma.com/pages/get -result?color-blindness-testresult=normal-color-vision

https://www.eyeque.com/colorblindtest/result/?result=%5B%5B8%2 C0%5D%2C%5B8%2C0%5D% 2C%5B8%2C0%5D%5D