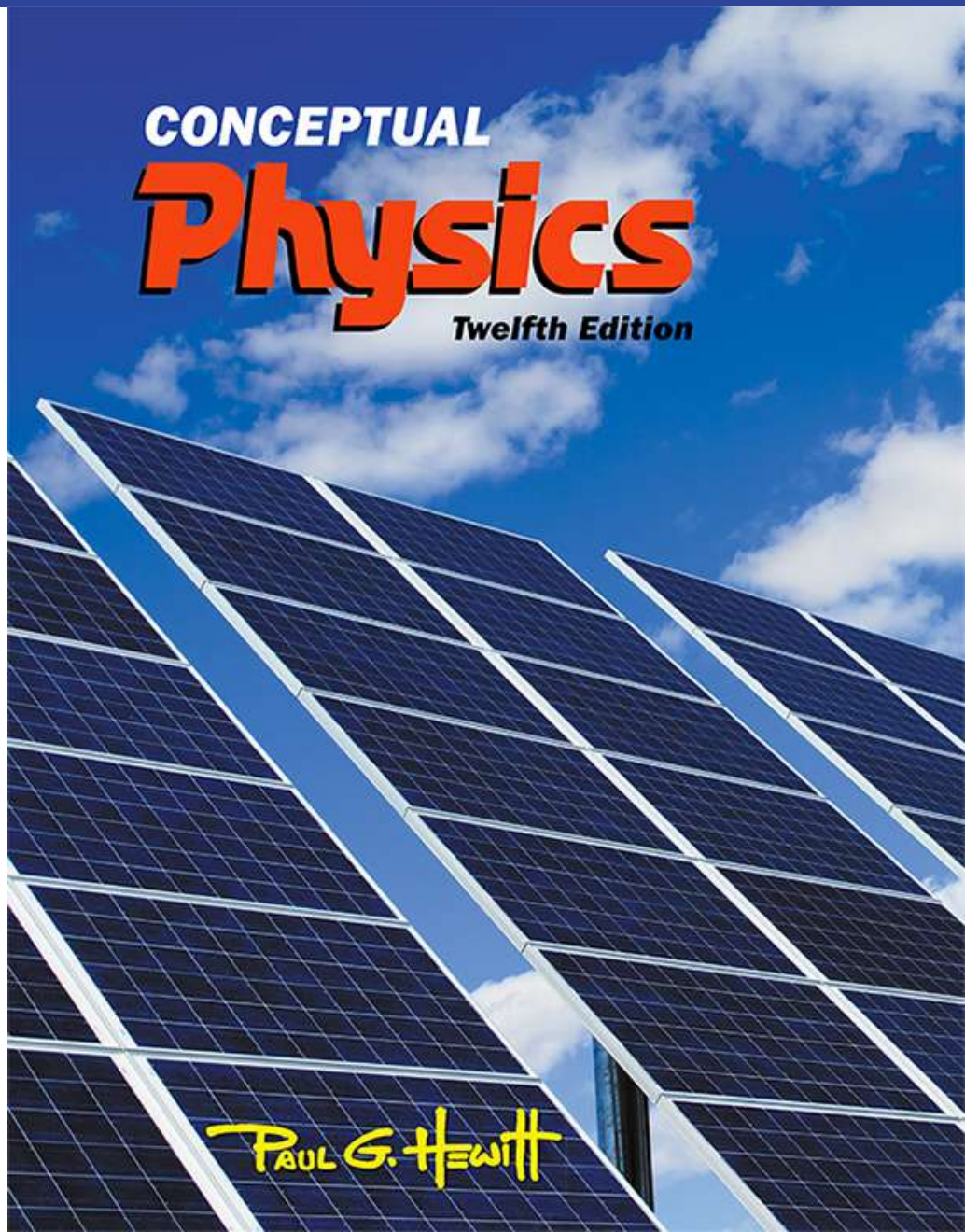
Lecture Outline

Chapter 27: Color



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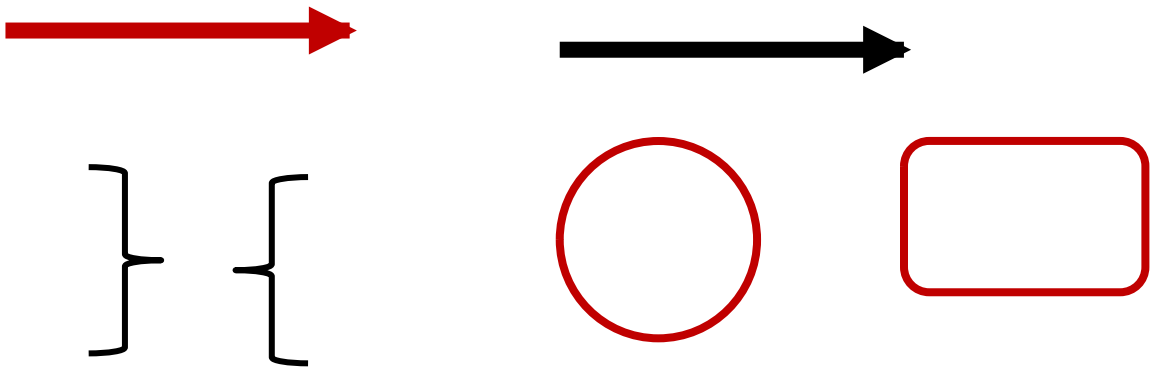

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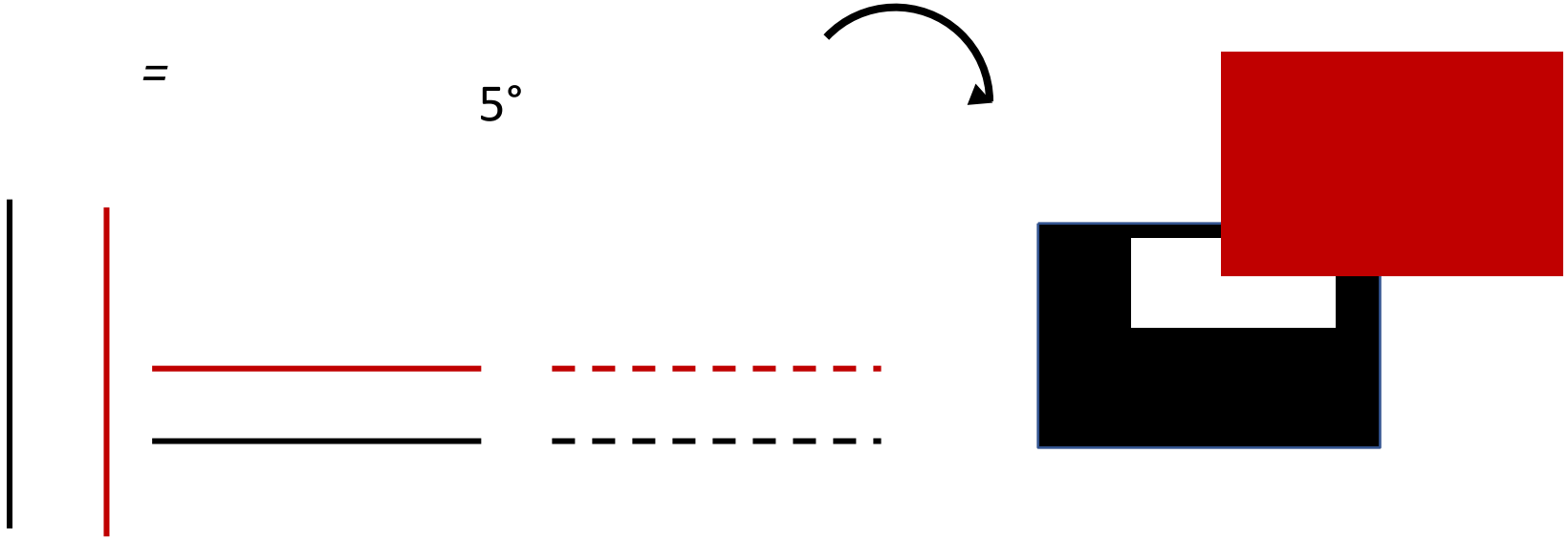
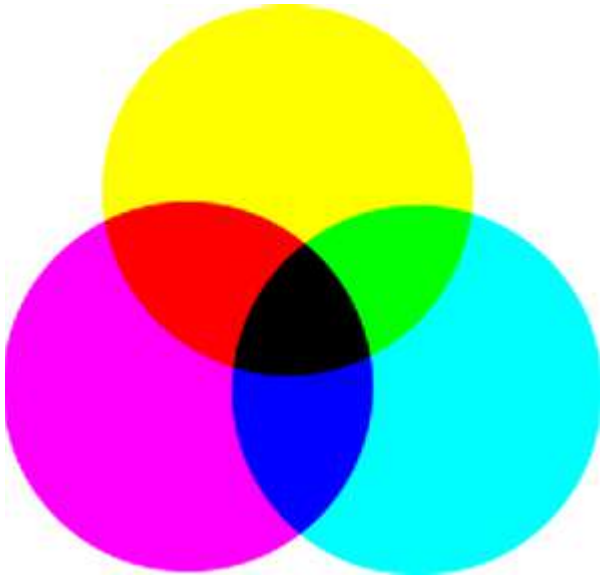


Classwork: Turn in at end of period.

Subtractive primary colors

yellow + cyan + magenta

yellow + magenta =
yellow + cyan =
cyan + magenta =



Mixing Colored Pigments

(a)

- Only three colors of ink (plus black) are used to print color photographs—(a) magenta, (b) yellow, (c) cyan, which when combined produce the colors shown in (d). The addition of black (e) produces the finished result (f).

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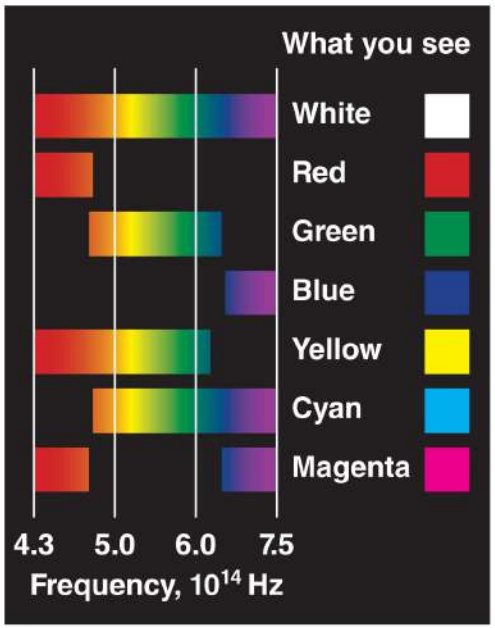
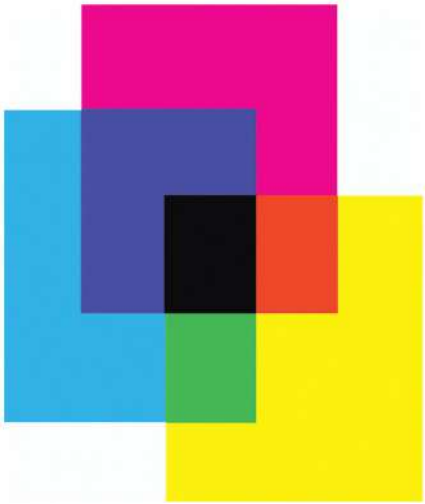
Mixing Colored Pigments, Continued

- The subtractive primary colors are cyan, yellow, and magenta.
- When white light passes through overlapping sheets of these colors, light of all frequencies is blocked (subtracted) and we have black.
- Where only cyan and yellow overlap, light of all frequencies except green is subtracted.
- Various proportions of cyan, yellow, and magenta dyes will produce nearly any color in the spectrum.





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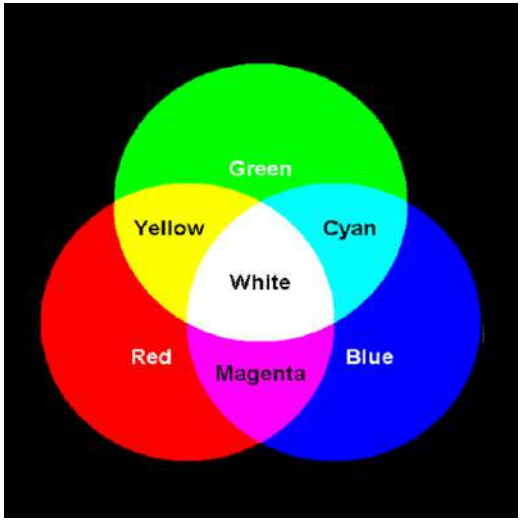
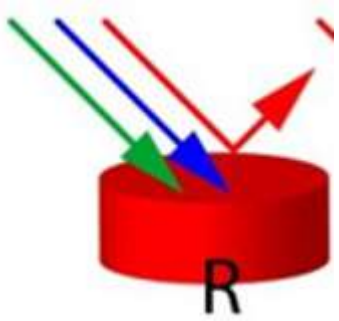
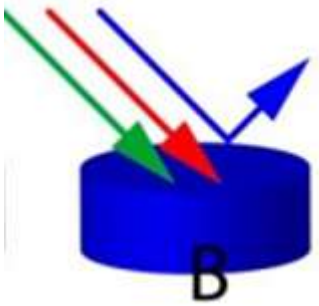
How paints work (simplified):

When you see red paint in white light, it is because the paint has absorbed the opposite color, cyan (or, green and blue). Cyan is subtracted out (removed).





green and blue (cyan) absorbed
So red reflects



green and red (cyan) absorbed
So blue reflects

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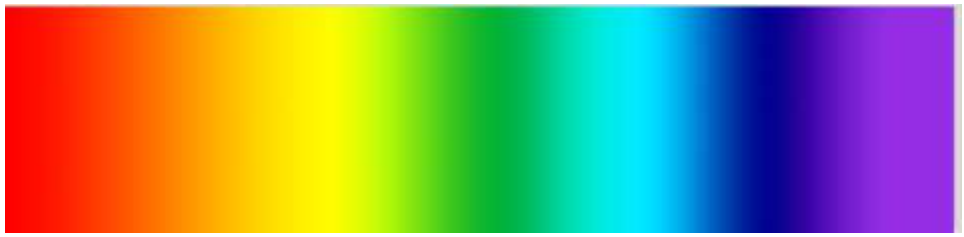
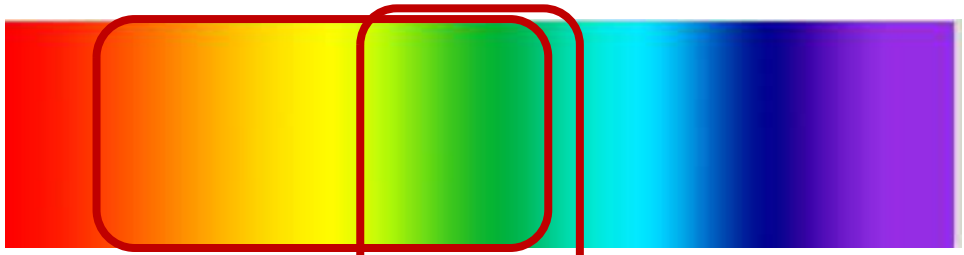
Green from mixing blue and yellow paint?

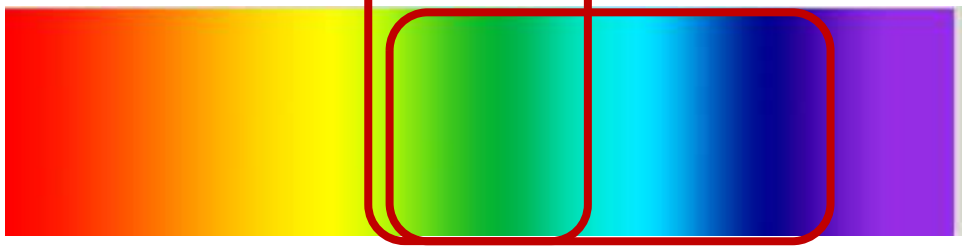
white reflects all colors and absorbs none:



yellow reflects colors near it and absorbs others:



blue reflects colors near it and absorbs others:



When green and blue paints are mixed….

…green is the only color reflected by ***both***

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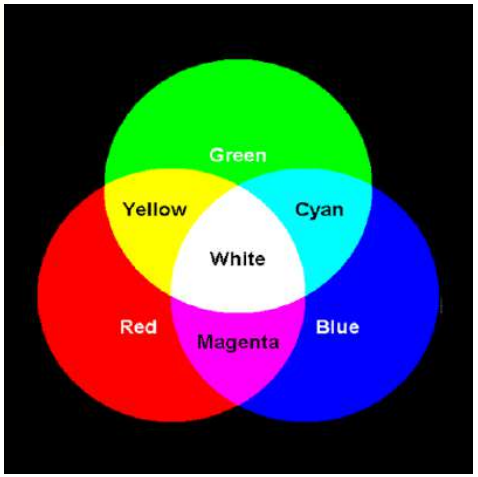
16. When something is painted red, what color is most absorbed?



17. What are the subtractive primary colors?

18. If you look with a magnifying glass at pictures in a book or magazine that are printed in full color, you'll notice three colors of ink plus black. What are these colors?

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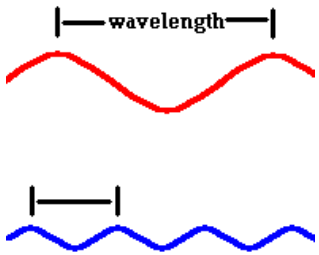
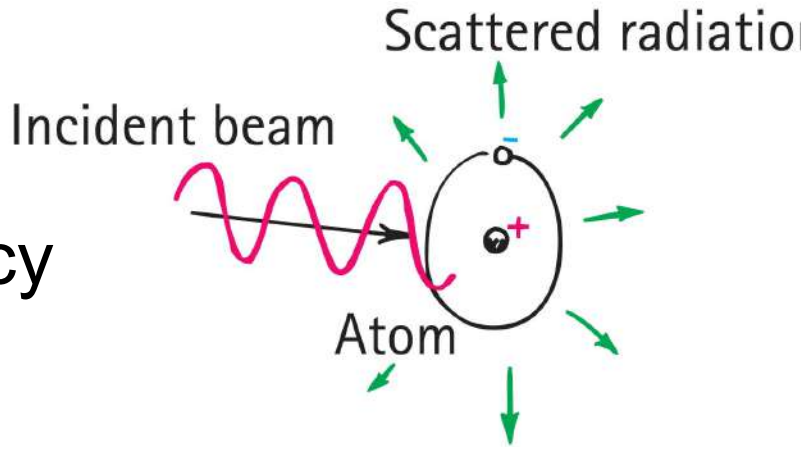
Why the Sky Is Blue?

- Results of selective scattering of N_2 and O_2 in air.
- These particles are tiny and are resonated by the higher frequencies and shorter wavelength of ultraviolet and violet (close to blue).



- The tinier the particle, the higher the frequency of light re-emits (scatters) all around it.

Same with sound---high frequency sounds resonate tiny bells….



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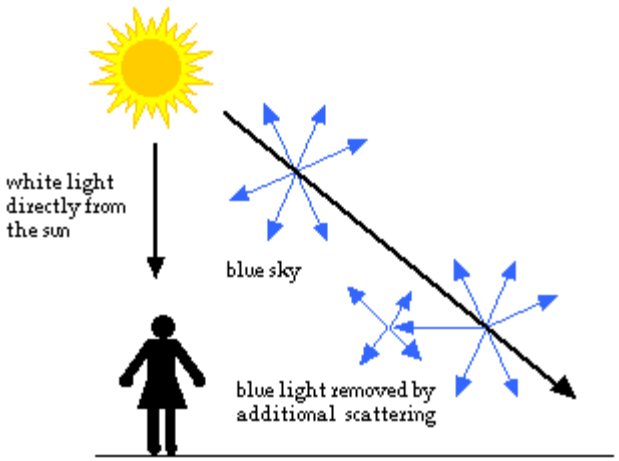

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- Our eyes are not as sensitive to the scattered UV and violet, blue light predominates in our vision.
- Red light wavelengths are longer and do not resonant O_2 and N_2. So red does not scatter much.
- → We see a blue sky, not a red one (normally).

Varies in different locations under various conditions:

Clear, *dry* day—much deeper blue sky

→ Think of Greece:

Clear, *humid* day—still beautiful blue sky

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19. Which interact more with high-pitched sounds: small bells or large bells?

20. Which interact more with high-frequency light: small particles or large particles?

21. Why does the sky normally appear blue?

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- When lots of dust particles and larger molecules, there is *a mixture of different sized particles*—less blue sky with whitish appearance.

- After heavy rainstorm (washing away of airborne particles)—deeper blue sky

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Why the Sky Is Blue
CHECK YOUR NEIGHBOR

A white sky is evidence that the atmosphere contains

A. predominantly small particles.
B. predominantly large particles.
C. a mixture of particle sizes.
D. pollutants.

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Why the Sky Is Blue
CHECK YOUR ANSWER

A white sky is evidence that the atmosphere contains

C. a mixture of particle sizes.

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22. Why does the sky sometimes appear whitish?

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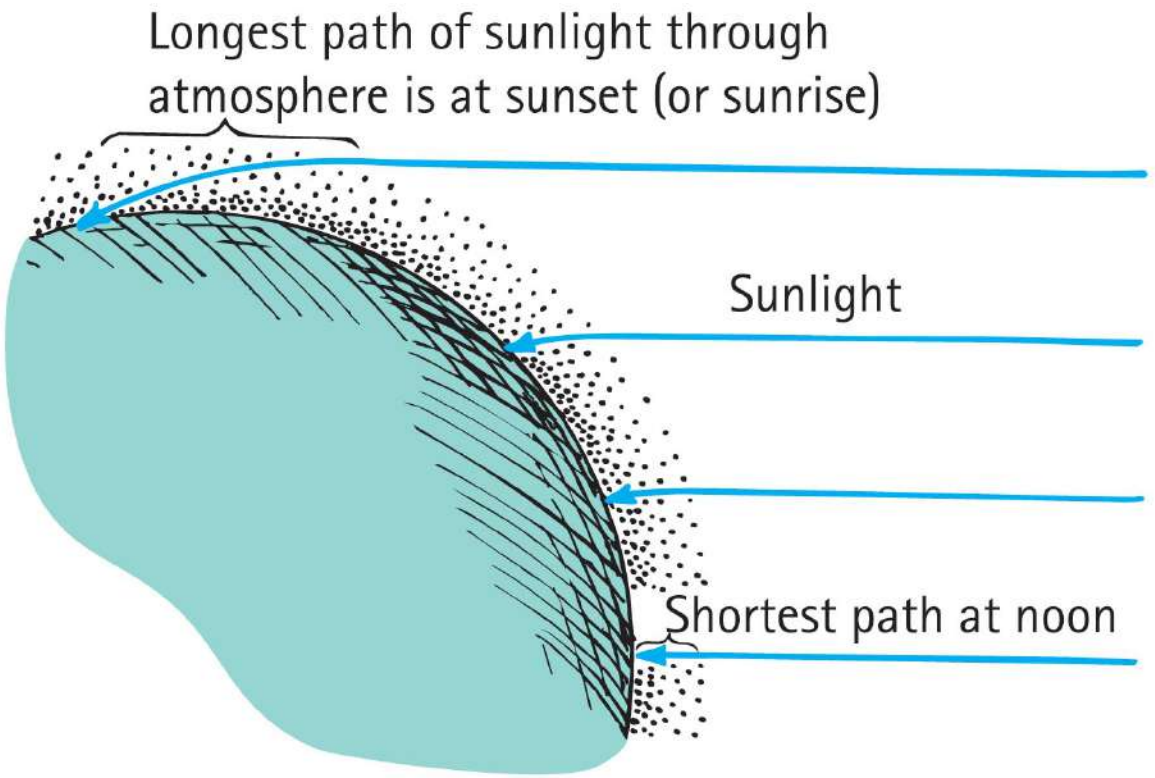
Why Sunsets and Sunrises Are Orange/Red

- Light that is least scattered is light of low frequencies, which best travel through air.
  - Red (the most)
  - Orange
  - Yellow

blue scattered



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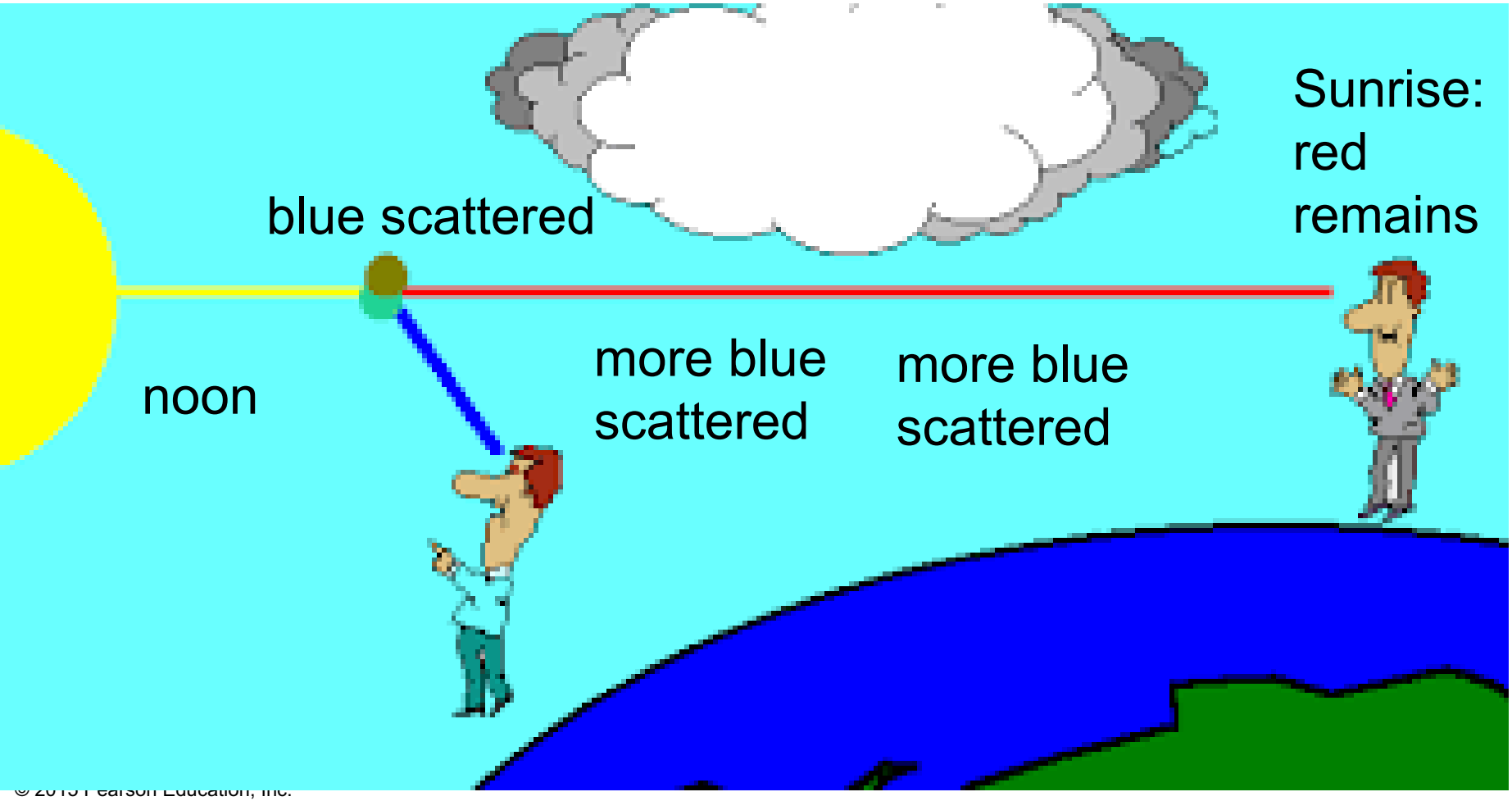
Blue is scattered out because it resonates
Red makes it through the atmosphere:



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Why Sunsets Are Red
CHECK YOUR NEIGHBOR

A variety of sunset colors is evidence for a variety of

A. elements in the Sun.
B. apparent atmosphere thickness.
C. atmospheric particles.
D. primary colors.

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Why Sunsets Are Red
CHECK YOUR ANSWER

A variety of sunset colors is evidence for a variety of

C. atmospheric particles.

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Why Sunsets Are Red
CHECK YOUR NEIGHBOR, Continued

If molecules in the sky scattered orange light instead of blue light, sunsets would be

A. orange.
B. yellow.
C. green.
D. blue.

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Why Sunsets Are Red
CHECK YOUR ANSWER, Continued

If molecules in the sky scattered orange light instead of blue light, sunsets would be

D. blue.

Explanation:

Of the colors listed, blue is closest to being the complementary color of orange.

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23. Why does the Sun look reddish at sunrise and sunset but not at noon?

24. Why does the color of sunsets vary from day to day?

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Volcanic eruptions

Put bigger particles into the air. This scatters a variety of colors.

Edvard Munch painted The Scream in 1893 soon after the eruption of Krakatoa in Indonesia.

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Now you see it….now you don’t.

Why don’t you notice the blue sky over the land in this photo from the Space Shuttle?

The land is a bright background.

Scattered blue is faint.

Best seen with a dark background (space).

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Why Clouds Are White

- Clouds
  - Clusters of various sizes of water droplets

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- Size of clusters determines scattered cloud color.
  - Tiny clusters produce bluish clouds.
  - Slightly large clusters produce greenish clouds.
  - Larger clusters produce reddish clouds.

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- Overall result is white clouds.
- Slightly larger clusters produce a deep gray.
- Still larger clusters produce raindrops.

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25. Is it scattering or reflection that accounts for the whiteness of a cloud?

26. What is the effect on the color of a cloud when it contains an abundance of large droplets?

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Why Water Is Greenish Blue

- Water molecules resonate somewhat in the visible red, which causes red light to be a little more strongly absorbed in water than blue light.
- Red light is reduced to one-quarter of its initial brightness by 15 meters of water. There is very little red light in the sunlight that penetrates below 30 meters of water.
- When red is removed from white light, the complementary color of red remains: cyan—a bluish-green color.

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Why Water Is Greenish Blue, Continued

- The intriguingly vivid blue of lakes in the Canadian Rockies is due to scattering.
- The lakes are fed by runoff from melting glaciers that contain fine particles of silt, called rock flour, which remain suspended in the water.
- Light scatters from these tiny particles and gives the water its eerily vivid color.

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27. What part of the electromagnetic spectrum is most absorbed by water?

28. What part of the *visible* electromagnetic spectrum is most absorbed by water?

29. What color results when red is subtracted from white light?

30. Why does water appear cyan?

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