

Sunlight 1

Sunlight

Sunlight 2

Observations about Sunlight

- Sunlight appears whiter than most light
- Sunlight makes the sky appear blue
- Sunlight becomes redder at sunrise and sunset
- It reflects from many surfaces, even nonmetals
- It bends and separates into colors in materials
- Sunlight a key source of renewable energy

Sunlight 3

5 Questions about Sunlight

- Why does sunlight appear white?
- Why does the sky appear blue?
- How does a rainbow break sunlight into colors?
- Why are soap bubbles and oil films so colorful?
- Why do polarizing sunglasses reduce glare?

Sunlight 4

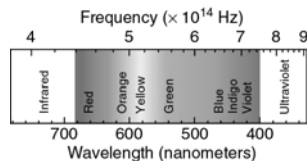
Question 1

- Why does sunlight appear white?

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Light

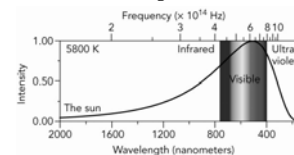
- Light is a class of electromagnetic waves
 - Long-wavelength EM waves: Radio & Microwave
 - Medium-wavelength: IR, Visible, UV light
 - Short-wavelength: X-rays & Gamma-rays



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Spectrum of Sunlight

- Sunlight is thermal radiation—heat from the sun
 - Charges in the sun's hot photosphere jitter thermally
 - Accelerating charges emits electromagnetic waves
 - The sun emits a black-body spectrum at 5800 K
- We perceive thermal light at 5800 K as “white”



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Question 2

- Why does the sky appear blue?
 - Why is the sun reddish at sunrise and sunset?

Sunlight 8

Rayleigh Scattering

- Rayleigh scattering occurs when
 - passing sunlight electrically polarizes tiny particles in the air.
 - That alternating polarization acts as a source of light waves,
 - so air particles scatter light—they absorb and then reemit it.
- Air particles are too small to be good antennas for light,
 - so long-wavelengths (reds) scatter poorly
 - while shorter-wavelengths (violets) scatter better.
- Rayleigh scattered sunlight is bluish in appearance
- The missing blue light reddens the solar disk itself
 - particularly at sunrise and sunset

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Question 3

- How does a rainbow break sunlight into colors?

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Light and Refraction

- Sunlight slows while it passes through matter
 - Light waves electrically polarize matter
 - That polarization delays the light wave's passage
 - Each material has an "index of refraction"—the factor by which it reduces light's speed.
- When light changes speed at an interface,
 - it bends toward the perpendicular if it slows down
 - it bends away from the perpendicular if it speeds up

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Light and Reflection

- Light polarizes different materials differently,
 - which affects both how fast light travels in them and
 - relationship between its electric & magnetic fields.
- Changes in how light travels causes reflections
 - Sunlight partially reflects from most surfaces
 - Sunlight reflects almost completely from metals

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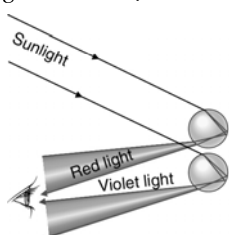
Light and Dispersion

- The different colors of light in sunlight
 - have different frequencies
 - and polarize a material slightly differently,
 - so they travel at slightly different speeds.
 - Violet light usually travels slower than red
- Refraction (bending) depends speed change
 - so violet light usually bends more than red

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Rainbows

- Occur when sunlight encounters water droplets
 - and undergoes refraction, reflection, and dispersion.



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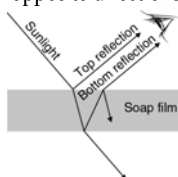
Question 4

- Why are soap bubbles and oil films so colorful?

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Light and Interference

- Overlapping waves superpose and may interfere
- Light following different paths can interfere
 - constructively if fields point in the same direction
 - or destructively if fields point in opposite directions.
- The two reflections from a soap or oil film interfere
- Different colors often interfere differently



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Question 5

- Why do polarizing sunglasses reduce glare?

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Reflection of Polarized Light

- Angled reflections depend on polarization
- When light's electric field is parallel to a surface
 - there is a large fluctuating surface polarization
 - and thus a strong reflection.
- When electric field is perpendicular to a surface
 - there is a small fluctuating surface polarization
 - and thus a weak reflection.
- Glare is mostly polarized parallel to the surface

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Polarization and Sunlight

- Polarizing sunglasses
 - block horizontally polarized light
 - and thus block glare from horizontal surfaces.
- Rayleigh scattering has polarizing effects,
 - so much of the blue sky is polarized light, too.

Summary about Sunlight

- Sunlight is thermal light at about 5800 K
- It undergoes Rayleigh scattering in the air
- It bends and reflects from raindrops
- It interferes colorfully in soap and oil films
- It reflects in a polarizing fashion from surfaces