

McGraw-Hill Ryerson

**BC Science
CONNECTIONS**

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BC Science Connections 8

UNIT 3

Energy can be transferred as both a particle and a wave

TOPIC 3.3

How does light behave when it encounters different materials and surfaces?



Light is *weird*.

What questions do you have based on observations you make in the following pictures?







Passion Fruit
Cheese Cake
百香芝士蛋糕

\$4.13
Per slice

Tiramisu
提拉米蘇

\$3.85
Per slice



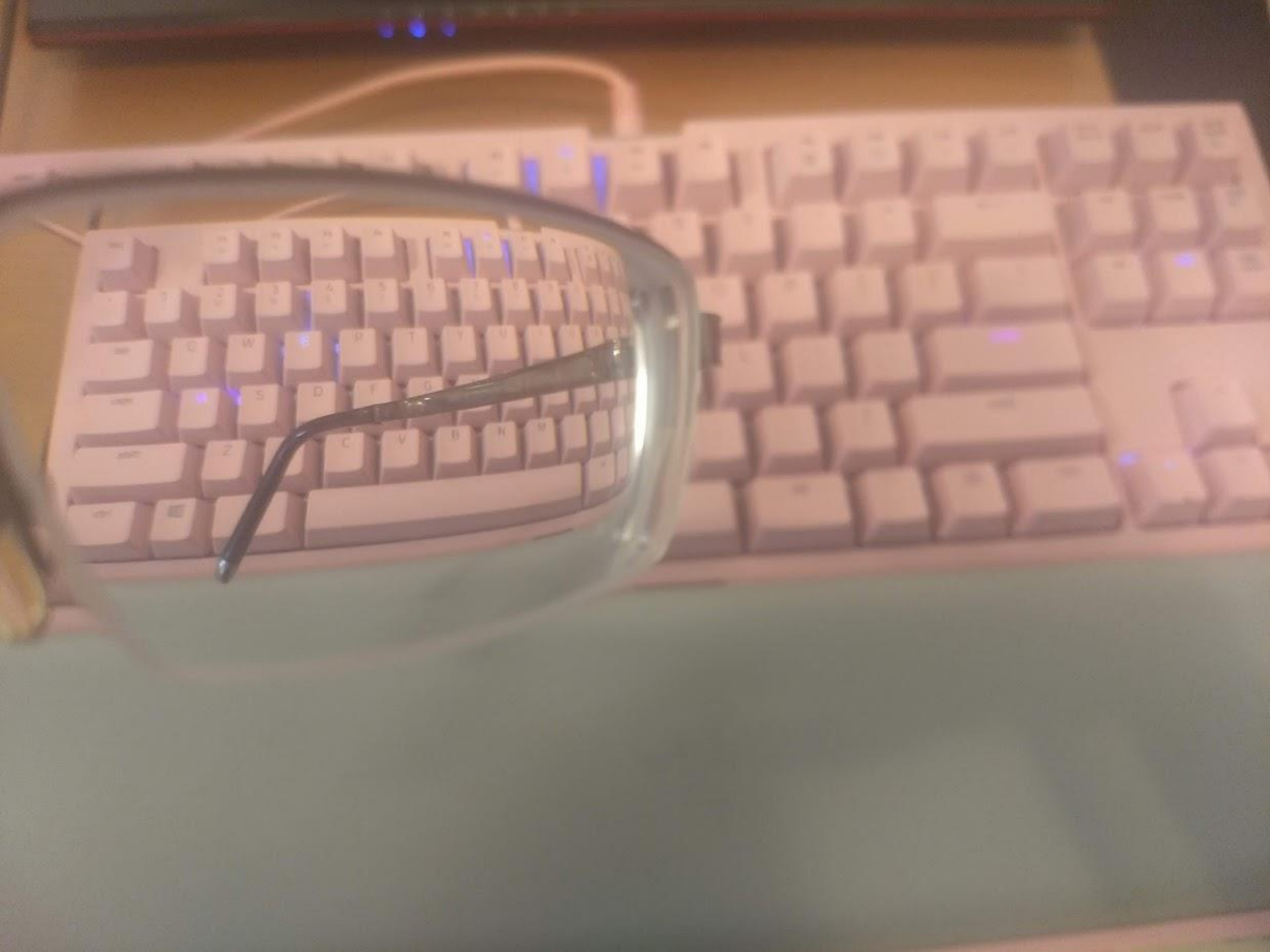
Black Forest Cake
黑森林蛋糕

\$3.85
Per slice

Fresh Mango Cake
鮮芒果蛋糕

\$4.39
Per slice









Topic 3.3: How does light behave when it encounters different materials and surfaces?

- Light can be reflected, absorbed, transmitted, or refracted.
- Light behaves in different ways when it encounters different materials.



Light from a lighthouse needs to be visible through dense fog.

Concept 1: Light can be reflected, absorbed, transmitted, or refracted.

- Light can be:
 - Reflected
 - Absorbed
 - Transmitted
 - Refracted



Light is being reflected, refracted, absorbed, and transmitted in this photo of Elk Lakes Provincial Park.

Reflection: Light Bounces Off

Reflection:

- Process in which light “bounces off” a surface and changes direction
- Two types of reflection:
 - Reflection off an extremely smooth surface
 - Reflection off a rough surface



Figure 3.17: Emerald Lake in Yoho National Park has an extremely smooth surface in which an image is visible.

Reflection Off an Extremely Smooth Surface

- **Examples:** mirrors, a very still body of water
 - When they reflect light, the pattern of reflected rays are similar to the pattern of the incoming rays
 - This similarity lets you see an image when the light reaches your eye (example: your “reflection” in a mirror)



Figure 3.18: Light rays reflecting off a smooth surface have a pattern similar to incoming rays.

Reflection Off a Rough Surface

- **Example: Paper**
 - When reflected rays hit the rough surface of the paper, they scatter in different directions
 - Pattern of reflected rays is not similar to incoming rays, so no image appears
 - Some reflected rays reach your eyes, which make the paper visible

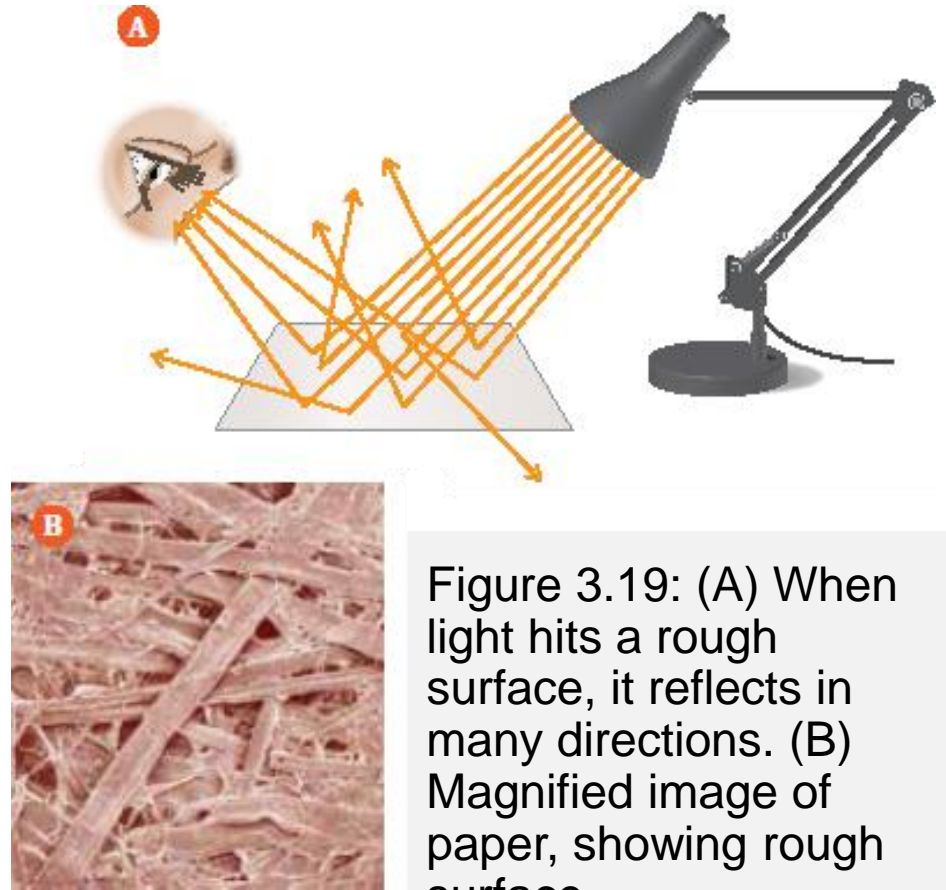


Figure 3.19: (A) When light hits a rough surface, it reflects in many directions. (B) Magnified image of paper, showing rough surface

Absorption: Light Energy is Trapped

- **Absorption:** the process in which light energy is trapped in an object as heat
- **Example 1:** a printed black letter on a piece of paper
 - Reflection off a rough surface (paper) lets you see the paper
 - Printed letter is made up of black ink that absorbs the incoming light
 - No rays reflect off the letter, so it looks black



Figure 3.20A: Rays that hit the black letter are absorbed, so the letter looks black.

Absorption: Light Energy is Trapped

- **Example 2:** a printed blue letter on a piece of paper
 - Reflection off a rough surface (paper) lets you see the paper
 - Printed letter absorbs all colours except blue
 - Blue wavelengths are reflected from the letter into your eyes, so it looks blue

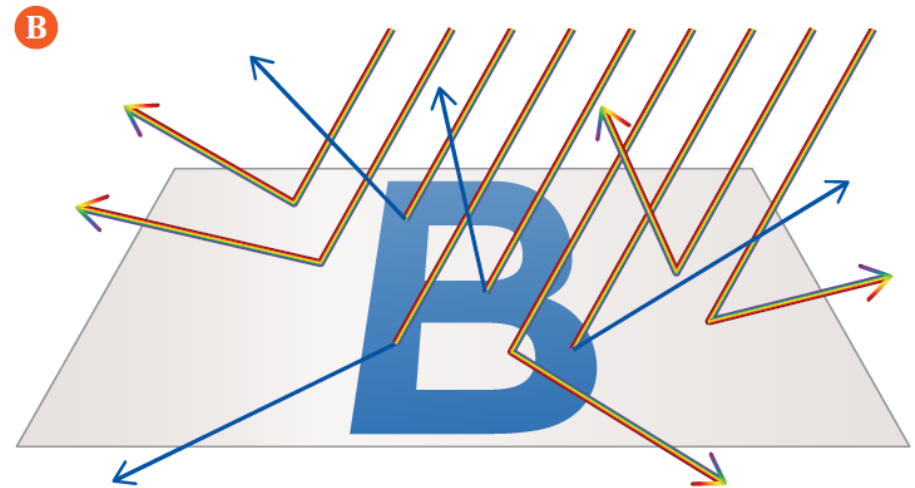
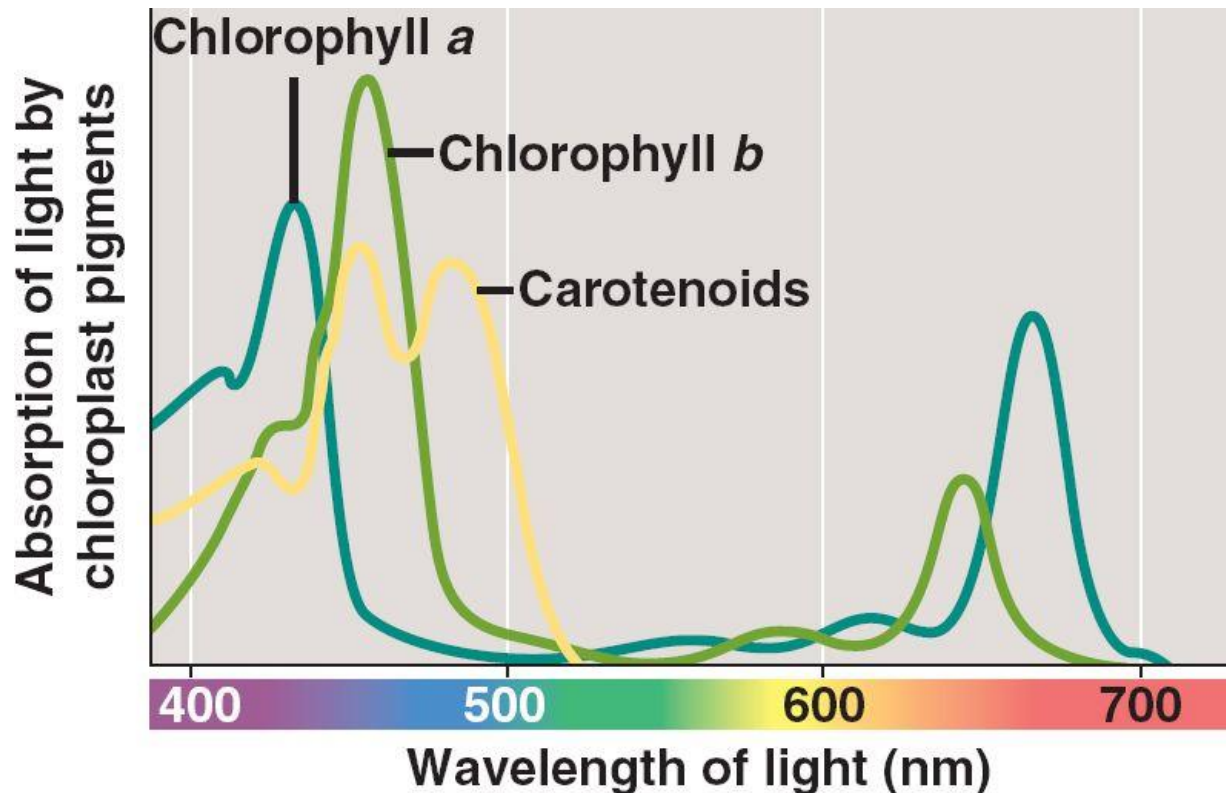


Figure 3.20B: The blue letter absorbs all wavelengths of light except blue. Only the blue light reaches your eye.

Case Study: Chlorophylls

Leaves get their colour from pigments inside them. The absorption spectrum shows which wavelengths these pigments absorb.

Use the absorption graph to explain why chlorophyll appears green, and carotenoids appear yellow or red.



Case Study: Glow-in-the-dark Eyes

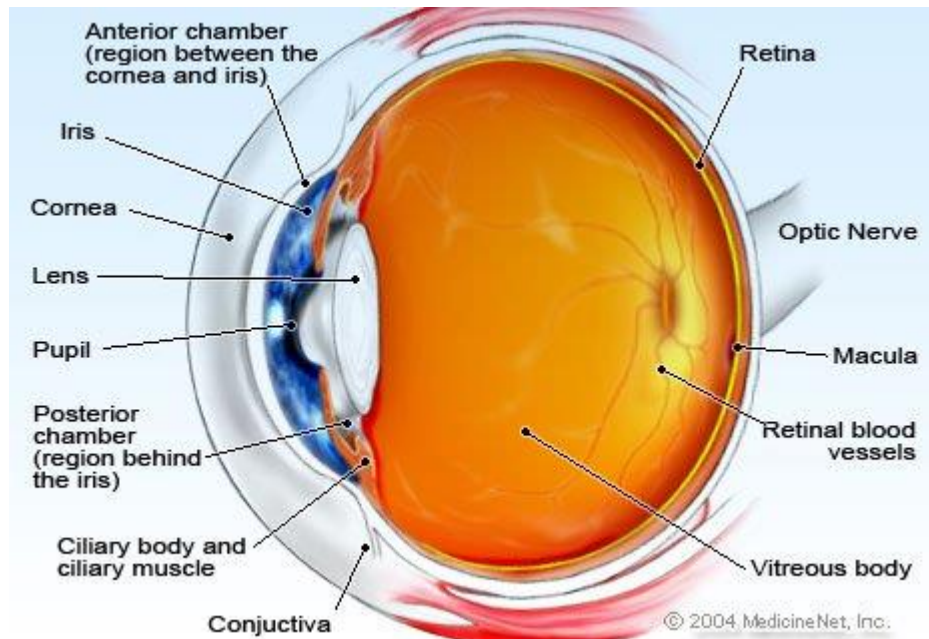
What is happening here? Make a prediction using the vocabulary and concepts we learned about today.



Case Study: Glow-in-the-dark Eyes

Red-eye in humans:

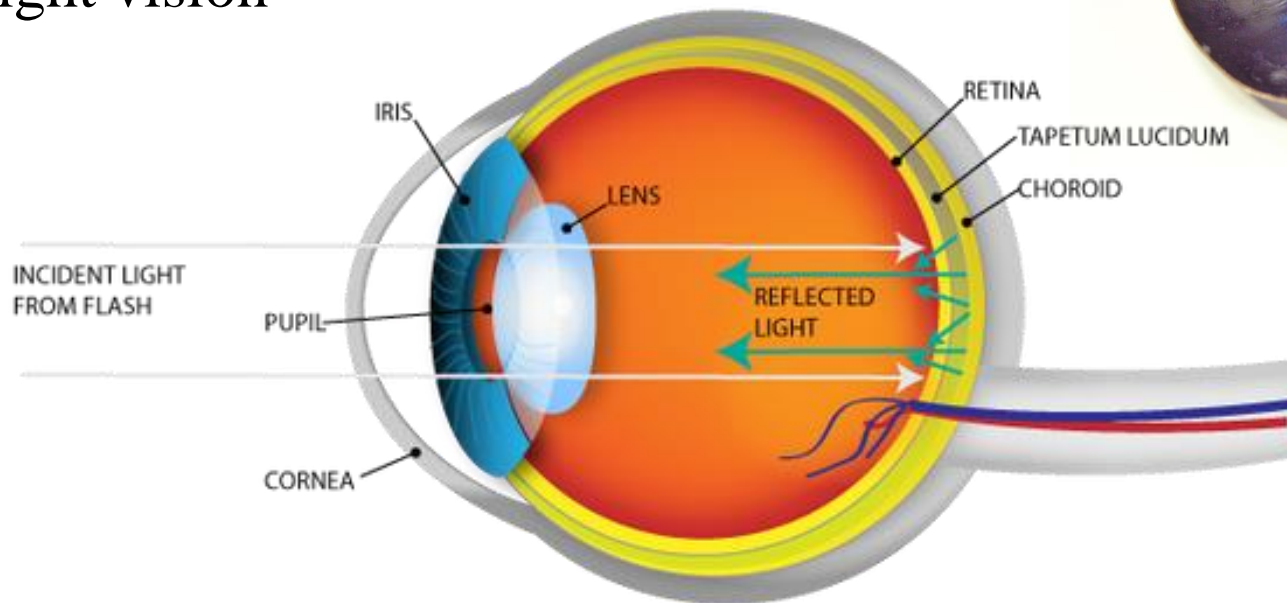
- “Flash” of photography happens too quickly for iris to contract and block out light
- Light reflects off retina
- Retina is orange-red because of blood vessels



Case Study: Glow-in-the-dark Eyes

Tapetum in deer, cats, cows, etc:

- Tapetum = reflective layer *behind* retina
- Reflects light so that it travels through retina twice, is more likely to be detected
- Night vision



Transmission: Light Passes Through

- **Transmission:** the process in which light passes through a medium and keeps travelling
 - When light passes through a material, that material is called a *medium*
 - Different materials transmit different amounts of light
 - Example: clear glass window transmits more light than a sheet of paper

Refraction: The Path of Light Bends

- **Refraction:** the process in which light changes direction when it moves from one medium to another
- **Example:** Light bends as it moves from air to water



Figure 3.21: The beam of red light allows you to see the path of light bend as it enters and leaves the water.

Discussion Questions

- Use a flowchart to describe what can happen to light when it strikes an object.
- The Moon is not a source of visible light. Why does it seem to glow brightly at night?





Classifying Colour

How would you describe the different types of colour that exist in our world?

Classifying Colour

- In general, there are two ways that colour is produced.
- Light sources:
 - Produce light on their own
 - E.g. firework, laser pointer, sun, bioluminescence
- Absorb/reflect light:
 - Need to be illuminated to see colour
 - When illuminated by light, absorbs some wavelengths and reflects others
 - E.g. flowers, hair, candy, most everyday objects

What other examples can you think of?

Concept 2: Light behaves differently when it encounters transparent, translucent, or opaque materials.

- A material can be transparent, translucent, or opaque depending on:
 - How much light it lets pass through
 - How the light behaves
 - If you can see through it

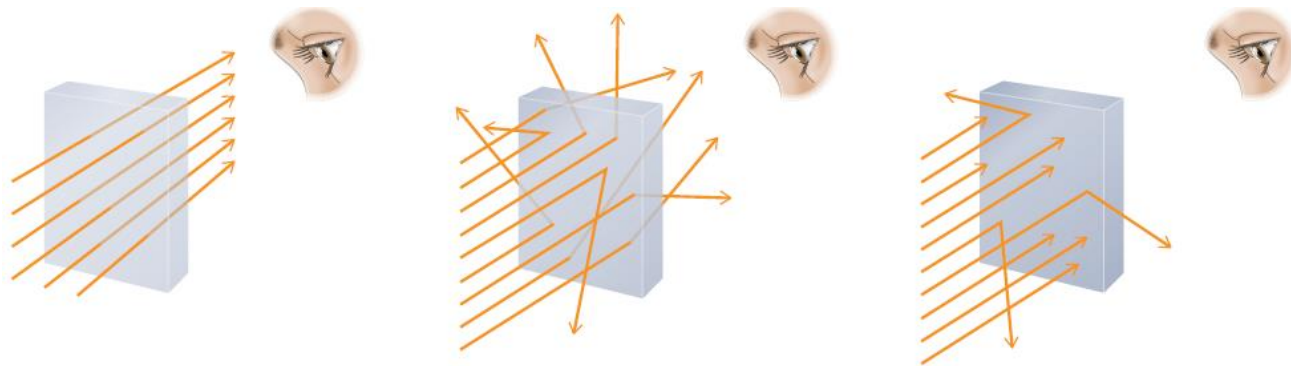
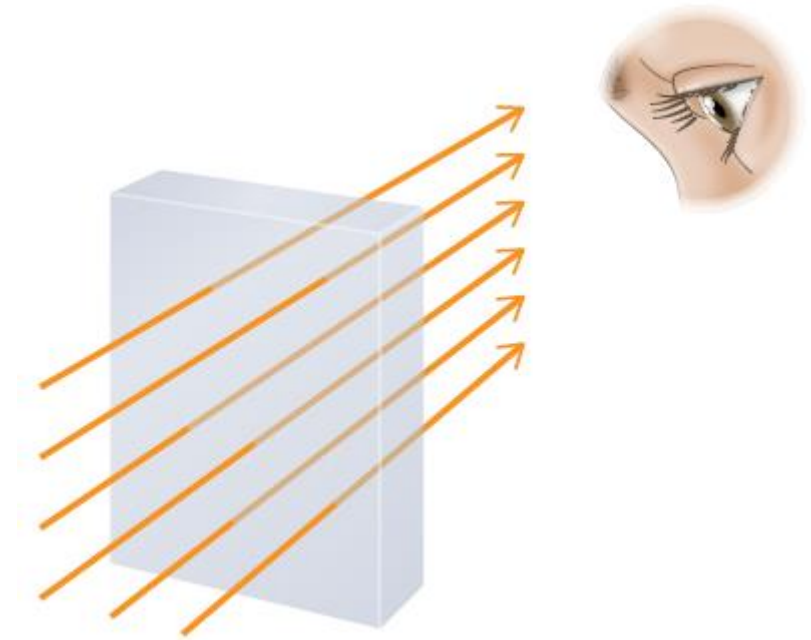


Figure 3.23: Light interacts with different materials in different ways.

Transparent Materials Transmit Light

Transparent materials:

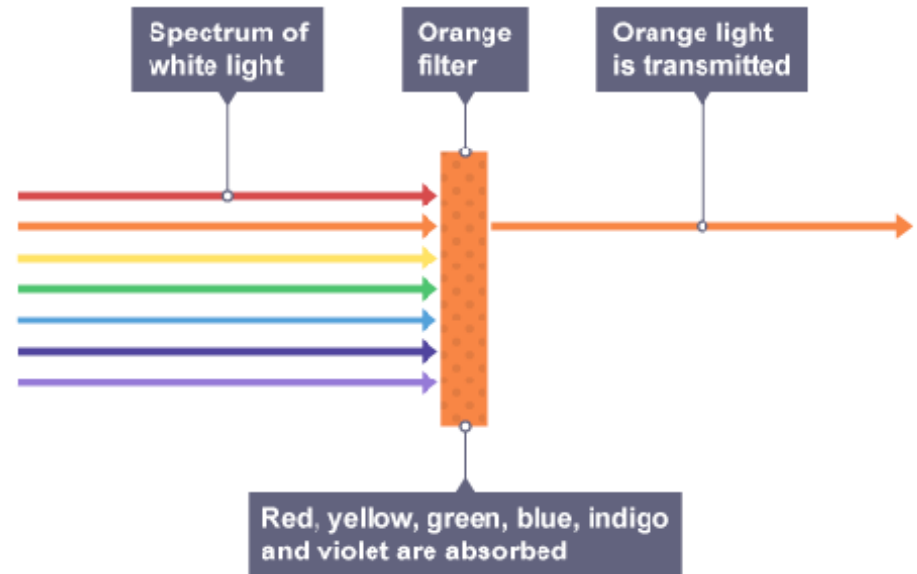
- Transmit almost all light rays
- Objects can be seen clearly through them
- Examples: clear glass, plastic, water, air



Transparent Materials Transmit Light

E.g. orange ski goggles:

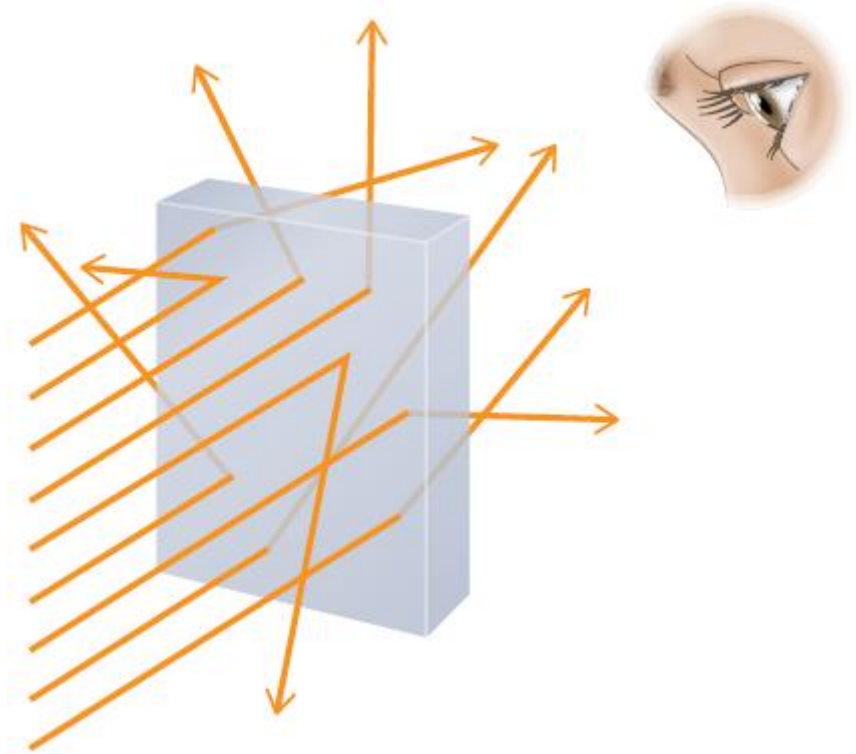
- Orange light is transmitted but other colours are absorbed
- Considered transparent because image is clear, *not* blurry



Translucent Materials Scatter Light

Translucent materials:

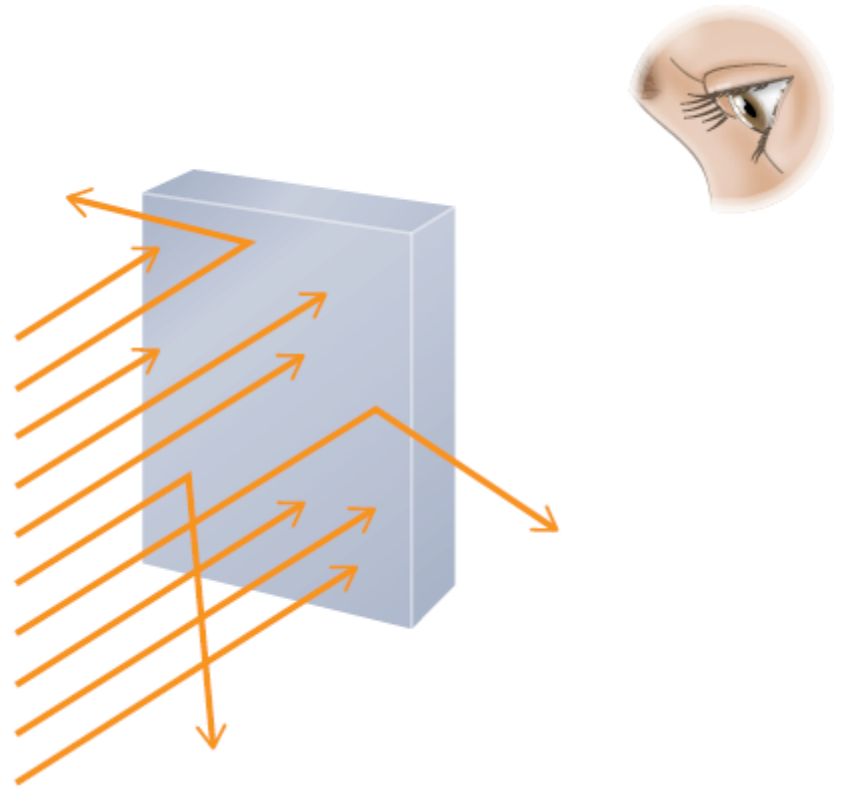
- Allow most light to pass through them
- Light is scattered in many directions as it passes through
- Objects seen through them are blurry
- Examples: frosted plastic, waxed paper



Opaque Materials Reflect and Absorb Light

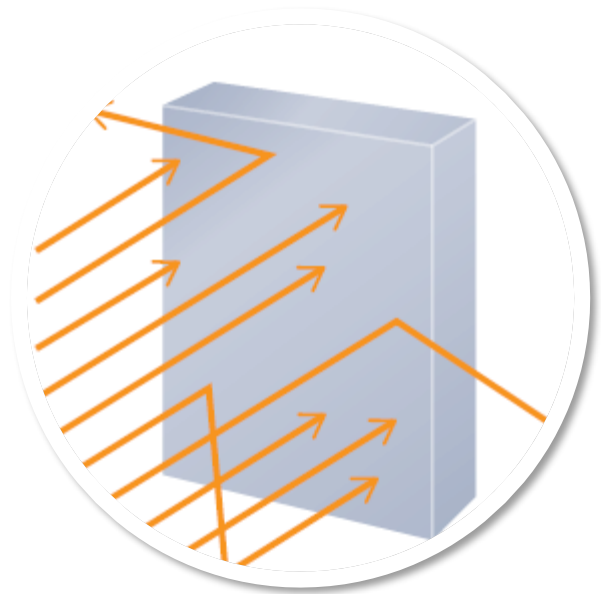
Opaque materials:

- Reflect and absorb light
- Do not allow any light to pass through them
- Objects cannot be seen through them
- Examples: wood, metal, stone



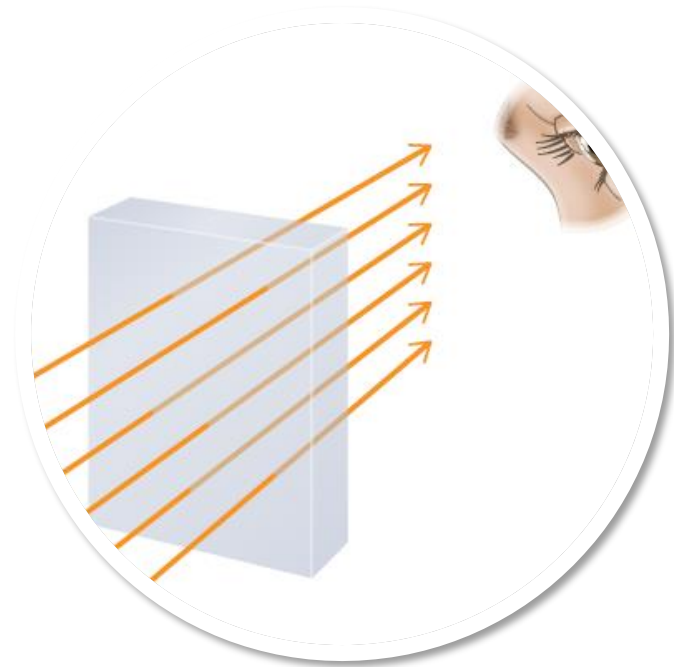
Discussion Questions

- Choose a material from your daily life.
 - a) Is the material transparent, translucent, or opaque? How could you confirm your decisions?
 - b) Explain how the material's interaction with light is related to its function.



Discussion Questions

- Some jellyfish are transparent. How might this affect their ability to survive?



Summary: How does light behave when it encounters different materials and surfaces?

- Light can be reflected, absorbed, transmitted, or refracted.
- Light behaves different when it encounters transparent, translucent, or opaque materials.

