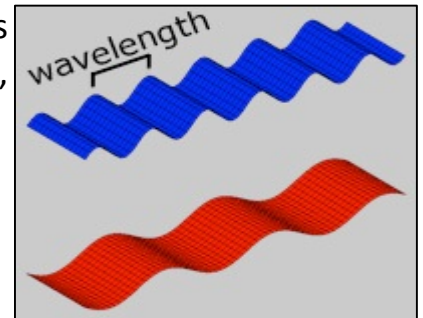


# How Are Rainbows Formed?

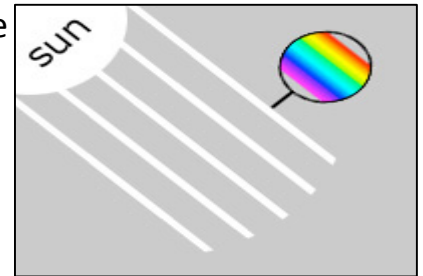
By Dr. Hany Farid, Dartmouth College

Sunlight is composed of light of varying wavelengths. Short wavelength light appears blue, violet and indigo, and long wavelength light appears red, orange and yellow. When sunlight enters a raindrop in the air, the light splits into a multitude of colors. This light then reflects off the back of the raindrop and re-emerges in the direction in which the light first entered. The light emerging from many raindrops creates a rainbow. Read on for a more detailed explanation.

**Fact 1.** Light travels in waves. The light's wavelength determines its perceived color. Short wavelength light, for example, appears blue, and long wavelength light appears red.



**Fact 2.** Sunlight is composed of light of many wavelengths. In the range that we can see, this includes the colors of the rainbow.

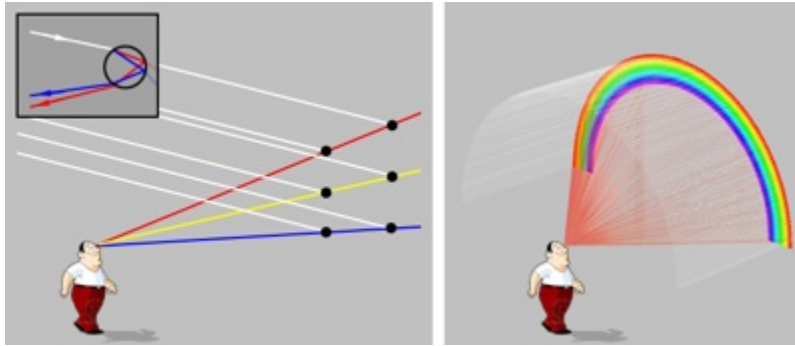


**Fact 3.** When light enters water, it bends (refracts). The amount of bending depends on the wavelength of light. As a result, the light splits into its component colors.



When a ray of sunlight enters a raindrop, it bends (refracts). The light then strikes the back of the raindrop, where some of the light passes through and some is reflected. As the light exits the raindrop, it is refracted again. The angle at which the light emerges depends on the wavelength of light. This path is illustrated in the small box below, where only the bending of two wavelengths (blue and red) are shown.

Consider now the diagram on the left. The sun is behind you (white rays) and there is rain in front of you (black dots). As the sunlight enters each raindrop, the light is refracted and reflected as described above. Because the sun is so far away, the rays of sunlight are nearly parallel to one another. As a result, the angle between the red line and each ray of sunlight striking a raindrop on that line will be the same. So, the light that reaches your eye along this ray will be of the same wavelength (color). The same is true for the yellow, blue, and intermediate lines corresponding to each color of the rainbow.



Consider now the diagram on the right which explains why the colors of a rainbow form an arc. The angle between the incoming rays of sunlight (white) and all of the red lines, forming a circular cone, have the same angle. As a result, the light that reaches your eye along these lines have the same wavelength (color). The same is true for each band of the rainbow.

The reason that rainbows are somewhat rare is that you will only see them when there is rain in front of you and somewhat in the distance, and the sun is behind you and fairly low on the horizon.

Name: \_\_\_\_\_ Date: \_\_\_\_\_

1. What is sunlight composed of?

- A** light of a single color
- B** light traveling at different speeds
- C** light of varying intensity
- D** light of varying wavelengths

2. What does the author explain in the first paragraph of the text?

- A** how light travels
- B** how a rainbow is formed
- C** why rainbows are shaped like an arc
- D** why rain causes light to split into separate colors

3. Read these sentences from the text.

"Sunlight is composed of light of varying wavelengths. [...] When light enters water, it bends (refracts). The amount of bending depends on the wavelength of light. As a result, the light splits into its component colors."

What can you conclude based on this evidence?

- A** Each wavelength of light bends the same amount when it enters water.
- B** When light enters water, its wavelength is altered.
- C** Each component color of light has a different wavelength.
- D** The component colors of light all have the same wavelength.

4. When would you be most likely to see a rainbow?

- A** in the evening on a partly rainy, partly sunny day
- B** in the morning on a bright, sunny day
- C** in the evening on a cloudy, rainy day
- D** at noon on a partly cloudy day

5. What is the main idea of this text?

- A** Sunlight is composed of light of varying wavelengths. Short wavelength light appears blue, and long wavelength light appears red.
- B** Rainbows form when sunlight enters raindrops, splits into different color components, and then re-emerges from the raindrops.
- C** The colors of a rainbow form an arc because of the angles at which light of different wavelengths reaches your eye.
- D** You will only see rainbows when there is rain in front of you and somewhat in the distance, and the sun is behind you and fairly low on the horizon.

6. Why might the author have chosen to list Facts 1, 2, and 3 separately instead of describing them in one paragraph?

- A to emphasize the importance of these facts to the way rainbows form
- B to show that these facts are not related to each other in any way
- C to indicate that these facts do not affect the way rainbows form
- D to make the explanation of how rainbows form seem more complicated

7. Choose the answer that best completes the sentence.

Light's wavelength determines its perceived color; \_\_\_\_\_, short wavelength light appears blue.

- A initially
- B for instance
- C however
- D similarly

8. When light enters water, it bends. What does the amount of bending depend on?

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**9.** For a rainbow to form, sunlight needs to enter and then re-emerge from raindrops. Describe what happens to the light between when it first enters a raindrop and when it comes out of the raindrop. Support your answer with evidence from the text.

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**10.** Why might you only see a rainbow when rain is in front of you? Support your answer with evidence from the text and images.

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