Two Views of Light

Use evidence from digital science texts to defend wave-particle duality.

PHY.4.11 "Enrichment: Research digital nonfictional text to defend the wave-particle duality of light (i.e., wave model of light and particle model of light)."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline observations that support the wave model and circle observations that support the particle model. Write W beside each wave-model observation and P beside each particle-model observation so you can use both kinds of evidence in a claim.

What Can Light Do?

1. A student preparing a science-fair claim opens the online textbook *University Physics Volume 3* from OpenStax. It describes light passing through two narrow slits and landing on a screen. Instead of making just two bright stripes, the light produces a repeating pattern of bright and dark bands. The wave model explains the pattern: light waves from the slits overlap, reinforcing at bright bands and canceling at dark bands. A simple model of light as tiny pellets following straight paths cannot explain those alternating bands. The student records the pattern as evidence, not as proof that light is always a wave.

2. Next, the student reads NobelPrize.org's online explanation of the photoelectric effect. In this experiment, light shines on a metal surface, and electrons can leave the metal. Even very intense light fails to release electrons if its frequency is below a threshold for that metal. Above the threshold, electrons can escape, even when the light is dim. The particle model explains the threshold: light transfers energy in packets called photons. Each photon has energy set by its frequency, so increasing brightness at a frequency below the threshold adds photons but does not give any one photon enough energy.

3. The student compares the two digital texts instead of treating either result as the whole story. The slit pattern challenges a pellets-only account, while the frequency threshold challenges an account based only on a continuous wave's total energy. In the particle model, higher frequency means more energy per photon, while greater brightness at a fixed frequency means more photons arriving. These claims do not mean a photon is a miniature ball or that light switches identities between experiments. Together, the results support wave-particle duality: different experimental observations require both wave behavior and quantized energy in a useful model of light.

2 ANSWER WITH EVIDENCE

Use the passage

1. Which observation in the slit experiment supports the wave model, and how does the model explain it?

2. How does the particle model explain why dim light above the threshold frequency can release electrons?

3. Use the below-threshold observation to explain why increasing brightness does not always release electrons.

4. How do the observations described in the two online texts support a defense of both models rather than only one?

3 YOUR TURN

Your own words

A classmate claims, "Because the slit experiment shows waves, photons must be imaginary." Write a 70 to 100 word reply that uses evidence from both online texts, explains why each model is needed, and identifies what the claim overlooks.

ANSWER KEY

Two Views of Light

PART 1 · READ AND MARK

Underline observations that support the wave model and circle observations that support the particle model. Write W beside each wave-model observation and P beside each particle-model observation so you can use both kinds of evidence in a claim. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Which observation in the slit experiment supports the wave model, and how does the model explain it?	**The screen shows alternating bright and dark bands. Waves from the slits reinforce at bright bands and cancel at dark bands.**
2	How does the particle model explain why dim light above the threshold frequency can release electrons?	**An individual photon above the threshold frequency has enough energy to release an electron, even when relatively few photons arrive.**
3	Use the below-threshold observation to explain why increasing brightness does not always release electrons.	**Even intense light below the threshold releases no electrons. Greater brightness adds photons, but each photon still has too little energy.**
4	How do the observations described in the two online texts support a defense of both models rather than only one?	**The slit pattern described by OpenStax supports wave behavior. The photoelectric threshold described by NobelPrize.org supports energy arriving in photons. Both observations are needed to account for light's behavior.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

The slit experiment described in OpenStax's online physics text produces alternating bright and dark bands. Overlapping waves explain those bands, so the wave model has evidence behind it. But the wave result does not rule out photons. NobelPrize.org's account of the photoelectric effect describes a frequency threshold: below it, even bright light cannot free electrons from a metal. Photon energy depends on frequency, not just brightness. The classmate's claim overlooks this threshold. Both wave behavior and energy transferred in photons are needed to explain the two observations.

Accept equivalent descriptions of interference and the photoelectric threshold. The final response should use evidence from both digital texts and explain why evidence for waves does not rule out photons.