Light on Trial

Weigh evidence for light's wave and particle behavior.

PHS.6.8 "Enrichment: Debate the particle/wave behavior of light."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline two observations that support wave-like behavior, circle two that support photon-like behavior, and write 1 beside a limitation of the continuous-wave-only model and 2 beside a limitation of the fixed-path pellet model.

Two Exhibits, One Light

1. At a science museum, a laser shines toward a barrier with two narrow slits. A screen beyond it records bright and dark bands, even though light can reach the screen through either slit. Waves passing through the slits can overlap: where their effects reinforce, a bright band forms; where they cancel, a dark band forms. The laser can be turned down until the screen registers separate, localized flashes. After many flashes, the same band pattern appears. If equipment makes it possible to tell which slit each flash came through, the band pattern disappears. No individual flash draws a wavy line across the screen.

2. Across the room, a metal plate is illuminated, and an instrument detects electrons leaving its surface. With this particular metal, red light causes no emission, even when the red beam is made brighter. Blue light does cause emission, even when the blue beam is dim. A brighter blue beam can release more electrons, but it does not increase the maximum energy of the released electrons. Increasing the blue light's frequency can raise that maximum energy. In the photon model, each electron absorbs energy from one photon; photon energy depends on frequency. Brightness mainly changes how many photons arrive each second.

3. Imagine two debaters watching these exhibits. One insists that light is only a continuous wave; the other pictures light as tiny solid pellets moving along fixed paths. Both descriptions face a challenge. A continuous wave model that spreads energy smoothly struggles to explain why brighter red light never releases electrons from this plate. A fixed-path pellet picture does not, by itself, explain the bands built from separate flashes when no path is recorded. Physicists use quantum theory to predict both kinds of results: light propagates with wave-like probabilities and exchanges energy in discrete amounts. A model's value depends on what it predicts.

2 ANSWER WITH EVIDENCE

Use the passage

1. Which observation at the slit exhibit supports a wave model of light? Explain why.

2. Which result at the metal plate supports a photon model rather than a continuous-wave-only model? Explain why.

3. Why do the separate flashes at the slit exhibit challenge a fixed-path pellet model?

4. A debater says one simple model can explain both exhibits on its own. Use one result from each exhibit to evaluate that claim.

3 YOUR TURN

Your own words

A technician claims that making the red beam ten times brighter than the dim blue beam will make it release electrons from the same metal plate. In four sentences, predict what each beam will do, explain the photon model's prediction, give one argument a wave-only debater might raise from the slit exhibit, and respond using evidence from both exhibits.

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PART 1 · READ AND MARK

Underline two observations that support wave-like behavior, circle two that support photon-like behavior, and write 1 beside a limitation of the continuous-wave-only model and 2 beside a limitation of the fixed-path pellet model. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Which observation at the slit exhibit supports a wave model of light? Explain why.	**The bright and dark bands support a wave model because waves passing through the slits can reinforce or cancel one another.**
2	Which result at the metal plate supports a photon model rather than a continuous-wave-only model? Explain why.	**Brighter red light releases no electrons, while dim blue light does. In the photon model, energy per photon depends on frequency, not brightness.**
3	Why do the separate flashes at the slit exhibit challenge a fixed-path pellet model?	**Separate flashes build a band pattern when no path is recorded. Pellets traveling only along fixed paths do not, by themselves, explain that pattern.**
4	A debater says one simple model can explain both exhibits on its own. Use one result from each exhibit to evaluate that claim.	**The slit bands support wave-like behavior that fixed-path pellets do not explain by themselves. The metal plate's frequency threshold challenges a continuous-wave-only model, so neither simple model explains both exhibits.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

The brighter red beam will not release electrons, but the dim blue beam will. The photon model predicts this because red photons lack the required energy, while blue photons have enough. A wave-only debater might point to the slit bands as evidence that light behaves like a wave. Those bands matter, but they do not erase the plate's frequency threshold, so a continuous-wave-only model cannot explain both exhibits.

Accept equivalent explanations that connect slit bands to wave-like behavior and the metal plate's frequency threshold to photon energy. Students should not claim that the slit results make the photoelectric evidence irrelevant, or vice versa.