Two Views of Light

Use experimental evidence to choose a model of light.

PH.PS4.3 "Develop an argument for how scientific evidence supports the explanation that electromagnetic radiation can be described either by the wave model or the particle model, and in some situations one model is more useful than the other."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline two observations that support the wave model, circle two observations that support the particle model, and number the two situations where the passage explains which model is more useful.

Light in Two Museum Rooms

1. At a science museum, a narrow beam of blue light shines through two thin slits and reaches a screen. Instead of two bright stripes, visitors see many alternating bright and dark bands. Light from each slit spreads out and overlaps. In some places the waves reinforce each other; in others they cancel. Moving the slits closer changes the spacing of the bands. A wave model predicts both the bands and their changing spacing. Calling light a stream of tiny pellets traveling straight from the slits would not, by itself, explain the dark bands between bright ones.

2. In another room, light shines on a clean metal plate, and a meter detects electrons leaving it. Red light releases no electrons, even when the lamp is made much brighter. Violet light releases electrons, even at low brightness. When the violet lamp gets brighter, more electrons leave each second. The particle model explains this result by treating light as photons. Each photon carries an amount of energy set by its frequency, not by the lamp's brightness. An electron can escape this metal only if it absorbs enough energy from one photon. Violet photons have more energy than red photons.

3. Neither test proves that light changes its identity between rooms. Both tests examine electromagnetic radiation, but they ask different questions. If a museum designer needs to predict where bright and dark bands will fall, the wave model highlights overlap and wavelength. If the designer needs to choose light that will eject electrons from the plate, the photon model highlights the energy of individual photons. A brighter lamp sends more light energy each second, but it does not raise the energy of each photon when the color stays the same. The strongest explanation matches each model to the evidence it explains.

2 ANSWER WITH EVIDENCE

Use the passage

1. What observation at the two slits supports the wave model, and how does that model explain it?

2. Why does the particle model explain the different results for red and violet light on the metal plate?

3. A visitor suggests making the red lamp brighter to release electrons. Use the passage's evidence to evaluate that idea.

4. A visitor claims that the particle model should replace the wave model everywhere in the museum. What evidence challenges that claim?

3 YOUR TURN

Your own words

A new lamp has an unknown color. In 5 to 6 sentences, propose two tests using the museum equipment, predict what each could show, and argue which model best explains each result.

ANSWER KEY

Two Views of Light

HIGH SCHOOL · PH.PS4.3

PART 1 · READ AND MARK

Underline two observations that support the wave model, circle two observations that support the particle model, and number the two situations where the passage explains which model is more useful. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	What observation at the two slits supports the wave model, and how does that model explain it?	**Alternating bright and dark bands appear. Overlapping light waves reinforce at bright bands and cancel at dark bands.**
2	Why does the particle model explain the different results for red and violet light on the metal plate?	**A violet photon has enough energy to free an electron from this metal, while a red photon does not.**
3	A visitor suggests making the red lamp brighter to release electrons. Use the passage's evidence to evaluate that idea.	**Brighter red light still releases no electrons. Brightness does not increase each red photon's energy, so it cannot overcome the metal's energy threshold.**
4	A visitor claims that the particle model should replace the wave model everywhere in the museum. What evidence challenges that claim?	**The particle model explains electrons leaving the metal, but the wave model predicts the bright and dark bands and how their spacing changes when the slits move.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would aim the new lamp through the two slits and look for bright and dark bands. If bands appear, the wave model explains them as overlapping light waves. I would also shine the lamp on the metal plate and watch the electron meter. If electrons leave, the particle model explains how individual photons supplied enough energy to free them. If no electrons leave, I would make the lamp brighter without changing its color. I predict the plate would still release none if each photon has too little energy.

Accept other conditional predictions if students connect slit bands to wave interference and electron release or its absence to photon energy. The lamp's unknown color does not determine in advance whether this metal will release electrons.