Light, Two Ways

Choose the model that best explains each observation.

HS-PSII-9.2 "Explain how electromagnetic waves interact with matter both as particles (i.e., photons) and as waves and be able to apply the most appropriate model to any particular scenario."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline two observations best explained by the wave model and circle two best explained by the photon model. Number each mark to match the paragraph where you found it.

What Does the Light Reveal?

1. At a science museum, one beam of light can lead to two different explanations. In the wave model, light has a wavelength, and overlapping waves can reinforce or cancel each other. The orientation of a light wave's electric field also matters when light meets certain materials. In the photon model, light arrives in packets of energy called photons. Each photon's energy depends on frequency, not on the total brightness of the beam. Blue light has a higher frequency than red light, so one blue photon carries more energy than one red photon. The best model depends on what an observation reveals.

2. At one station, blue light shines on a metal plate and electrons leave its surface. A red lamp aimed at the same plate does not release electrons, even when the red lamp is made brighter. For this metal, the energy needed to free an electron falls between the energies of a red photon and a blue photon. At another station, a beam passes through two narrow slits and strikes a screen. The screen shows alternating bright and dark bands. Light from the two openings reaches some points together, while at other points the contributions cancel. Both stations involve light meeting matter, but they reveal different behavior.

3. At a third station, a rotating polarizing filter changes the brightness of light that has already passed through a fixed polarizing filter. Each filter transmits mainly light whose electric field oscillates along its transmission direction. When the filters' directions are perpendicular, much less light passes through both. Nearby, a sensitive camera records faint light as separate electronic detections. An absorbed photon can transfer energy to a charge in the camera sensor, leading to one detection event. Turning up the source increases the number of events, not the energy of each photon if the light's color stays the same.

2 ANSWER WITH EVIDENCE

Use the passage

1. Why does making the red lamp brighter fail to release electrons from the metal? Choose a model and use evidence from the passage.

2. Which model best explains the bright and dark bands beyond the two slits? Explain how the bands form.

3. Which model best explains why rotating a polarizing filter changes how much light passes through both filters? Use the filters' directions in your answer.

4. The camera records more detections when the source gets brighter but stays the same color. Which model best explains the detections, and what changes?

3 YOUR TURN

Your own words

Invent two interactions between electromagnetic waves and matter that are not described in the passage. In 4 to 6 sentences, describe an observation for each, choose the wave model for one and the photon model for the other, and explain the evidence for each choice.

ANSWER KEY

Light, Two Ways

HIGH SCHOOL · HS-PSII-9.2

PART 1 · READ AND MARK

Underline two observations best explained by the wave model and circle two best explained by the photon model. Number each mark to match the paragraph where you found it. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Why does making the red lamp brighter fail to release electrons from the metal? Choose a model and use evidence from the passage.	**The photon model fits. Each red photon has less energy than the metal requires to free an electron, and increasing brightness does not raise the energy of each photon.**
2	Which model best explains the bright and dark bands beyond the two slits? Explain how the bands form.	**The wave model fits. Waves from the slits reinforce at bright bands and cancel at dark bands.**
3	Which model best explains why rotating a polarizing filter changes how much light passes through both filters? Use the filters' directions in your answer.	**The wave model fits because transmission depends on the direction in which the light's electric field oscillates. Perpendicular filter directions let much less light through.**
4	The camera records more detections when the source gets brighter but stays the same color. Which model best explains the detections, and what changes?	**The photon model fits because absorbed photons can cause separate detections. More photons produce more events, while each photon's energy stays the same.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

In a microwave oven, some spots in food heat faster than others. A wave model explains this because reflected microwaves overlap, producing stronger electric fields in some places than in others. Under a UV lamp, fluorescent ink absorbs ultraviolet light and then glows visibly. A photon model fits because an absorbed UV photon transfers energy to the ink, which can emit a lower-energy visible photon.

Accept other scientifically accurate interactions if the student identifies a distinct observation for each and explains why wave behavior or energy transfer by photons is the better model.