Light's Two Lenses

Evaluate how evidence guides the choice of a scientific model.

HS-PS4-3 "Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline each claim about what a model can explain. Circle each experimental observation, write W or P beside it for wave or particle, and draw an arrow to the claim it supports.

Choosing a Model for Light

1. Early scientists often used a wave model to explain what happens when light meets openings. In a double-slit experiment, monochromatic light passes through two narrow slits and reaches a screen. The screen shows alternating bright and dark bands, not just two bright patches. The bright bands occur where overlapping light reinforces, while dark bands occur where overlapping light cancels. This interference pattern supports the claim that light can behave as a wave. A wave model is useful here because it predicts how overlapping waves can produce a patterned distribution of light.

2. Other observations made the wave model less useful on its own. In the photoelectric effect, light shining on certain metal surfaces can eject electrons. Scientists found that below a particular light frequency, no electrons were ejected, even when the light intensity increased. Above that frequency, higher-frequency light produced electrons with greater kinetic energy. These results support a particle model in which light transfers energy in separate packets. This model explains why frequency matters so strongly. It is especially useful for explaining energy transfer between light and electrons, rather than the bright and dark bands on a screen.

3. Neither model is simply discarded when new evidence appears. Instead, scientists compare each model's claims and predictions with repeated observations, then revise explanations about where a model applies. The interference evidence does not show that the particle model is wrong, and photoelectric evidence does not erase wave evidence. Together, the results show that electromagnetic radiation can be described by either model in different situations. A useful scientific explanation names the evidence, states the claim it supports, and connects them with reasoning. Choosing the more useful model depends on the phenomenon being explained, not on declaring one model the permanent winner.

2 ANSWER WITH EVIDENCE

Use the passage

1. What did scientists observe in the double-slit experiment, and what claim did that observation support?

2. Which two photoelectric-effect observations made the wave model less useful on its own?

3. Explain why the photoelectric-effect evidence supports using a particle model for that situation.

4. According to the passage, how should scientists respond when new evidence does not fit one model well?

3 YOUR TURN

Your own words

Several antenna lengths are tested with the same radio signal. The receiver gets its strongest signal when the antenna is one-half of the signal's wavelength, and weaker signals at other lengths. In 3 to 4 sentences, state which model is more useful, identify the evidence, explain your reasoning, and tell what this result does not prove about the other model.

ANSWER KEY

Light's Two Lenses

HIGH SCHOOL · HS-PS4-3

PART 1 · READ AND MARK

Underline each claim about what a model can explain. Circle each experimental observation, write W or P beside it for wave or particle, and draw an arrow to the claim it supports. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	What did scientists observe in the double-slit experiment, and what claim did that observation support?	**They observed alternating bright and dark bands on the screen. The pattern supported the claim that light can behave as a wave.**
2	Which two photoelectric-effect observations made the wave model less useful on its own?	**No electrons were ejected below a particular frequency even when intensity increased, and higher-frequency light produced electrons with greater kinetic energy.**
3	Explain why the photoelectric-effect evidence supports using a particle model for that situation.	**The evidence shows that frequency strongly affects energy transfer to electrons. A particle model describes light as transferring energy in separate packets.**
4	According to the passage, how should scientists respond when new evidence does not fit one model well?	**They should compare model claims and predictions with repeated observations, then revise explanations about where each model applies rather than discard a model completely.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

The wave model is more useful for the antenna test. The evidence is that the receiver signal is strongest when the antenna length is one-half of the signal's wavelength and becomes weaker at other lengths. This pattern supports resonance, which is explained by waves interacting strongly at matching dimensions, but it does not prove that the particle model is false.

Accept equivalent statements that connect the antenna's strongest response at a matching length to the wave model and resonance. The response should identify evidence, make a model claim, explain the connection, and avoid claiming that one result disproves the other model.