Two Views of Light

Use evidence to choose a model of electromagnetic radiation.

CH.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 one observation that supports the wave model and one that supports the particle model, then number the two situations in which each model is especially useful.

Following a Light Signal

1. At a concert, an engineer sends a coded light signal toward a receiver. To study how the beam travels, she lets some of its light pass through two closely spaced slits. On a screen behind the slits, alternating bright and dark bands appear. Light from the two slits overlaps: where its waves reinforce, the screen looks bright; where they cancel, it looks dark. A stream of tiny objects traveling straight through the openings would not, by itself, predict those bands. The wave model is especially useful when the engineer needs to predict where light will spread and interfere.

2. The engineer also shines light on a metal plate that can release electrons. Bright red light releases none, but dim violet light does. Violet light has a higher frequency than red light. The particle model explains this result by treating light as photons, each carrying an amount of energy set by its frequency. An electron escapes only if one photon transfers enough energy to it. Making the red light brighter sends more photons, but it does not increase the energy of each photon. Brightness alone cannot overcome the plate's energy threshold in this test.

3. The concert receiver uses a photosensitive semiconductor rather than a bare metal plate. Light can transfer energy to charges inside the semiconductor, allowing an electrical signal to form. Its energy threshold may differ from the metal plate's threshold. These tests do not mean light changes from a wave into a particle on its way to the receiver. Instead, each model helps explain a different observation. The wave model helps the engineer plan a path through narrow openings, where spreading and interference matter. The particle model helps her consider whether photons have enough energy to produce a response in the receiver.

2 ANSWER WITH EVIDENCE

Use the passage

1. What did the engineer observe behind the two slits, and how does the wave model explain it?

2. How do the red-light and violet-light results support the particle model?

3. Why did making the red light brighter fail to release electrons from the metal plate?

4. Which model would help the engineer plan for light passing through a narrow opening, and which would help her choose light that activates the receiver? Support both choices with passage evidence.

3 YOUR TURN

Your own words

A museum alarm sends light through a narrow opening to a metal switch, but the beam spreads too widely and the switch releases no electrons. The designer proposes making the opening narrower and making the same low-frequency light brighter. Write one paragraph arguing whether each change would help, then propose a better change for each problem using evidence from both models.

Two Views of Light

PART 1 · READ AND MARK

Underline one observation that supports the wave model and one that supports the particle model, then number the two situations in which each model is especially useful. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	What did the engineer observe behind the two slits, and how does the wave model explain it?	**She observed alternating bright and dark bands. Waves from the slits reinforce at bright bands and cancel at dark bands.**
2	How do the red-light and violet-light results support the particle model?	**Dim violet light released electrons while bright red light did not. The particle model explains that violet photons have enough energy to release electrons, while individual red photons do not.**
3	Why did making the red light brighter fail to release electrons from the metal plate?	**Greater brightness adds photons but does not raise each red photon's energy above the plate's threshold.**
4	Which model would help the engineer plan for light passing through a narrow opening, and which would help her choose light that activates the receiver? Support both choices with passage evidence.	**The wave model helps plan for spreading and interference, as shown by the bands behind the slits. The particle model helps with the receiver because photons must transfer enough energy to produce an electrical response.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Neither proposed change is likely to solve the problem. Making the opening narrower can increase the beam's spreading, so the designer should try a wider opening that still aims light at the switch. The wave model helps predict this change because light spreading is a wave behavior. Making the same low-frequency light brighter adds photons but does not give each photon more energy. The metal plate test shows that electrons require photons above an energy threshold. The designer should use higher-frequency light to try to trigger the switch.

Accept other workable ways to reduce spreading, such as changing the beam path to avoid a narrow opening. For the switch, responses must distinguish photon energy from the number of photons; the new frequency must be high enough to exceed that metal's threshold.