PHYSICS		
HS-PS4-3: Waves and their Applications in Technologies for Information Transfer		
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.		
Clarification Statement: Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include resonance, interference, diffraction, and photoelectric effect.		
Assessment Boundary: Assessment does not include using quantum theory.		
Evidence Statements: HS-PS4-3		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
Engaging in Argument from Evidence Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed worlds. Arguments may also come from current scientific or historical episodes in science. Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. **Connections to Nature of Science** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence.	**PS4.A: Wave Properties** [From the 3–5 grade band endpoints] Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other. (Boundary: The discussion at this grade level is qualitative only; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.) **PS4.B: Electromagnetic Radiation** Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features.	**Systems and System Models** Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.
Connections to other DCIs in this grade-band: HS.PS3.D ; HS.ESS1.A ; HS.ESS2.D		
Articulation of DCIs across grade-bands: MS.PS4.B		
NJSLS- ELA: RST.9-10.8, RST.11-12.1, RST.11-12.8		
NJSLS- Math: MP.2, HSA-SSE.A.1, HSA-SSE.B.3, HSA.CED.A.4		

5E 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.	
Engage Anticipatory Set	Do Cellphones Cause Brain Tumors? https://www.youtube.com/watch?v=wU5XkhUGzBs
	Electromagnetic Investigations- Day 1

Exploration Student Inquiry	It's important to balance theory with observations and to provide evidence for any claim. Students will apply this thinking to four big ideas in electromagnetics. http://betterlesson.com/lesson/636830/electromagnetic-investigations-day-1 Electromagnetic Investigations- Day 2 It is important to balance theory with observation - particularly, as is the case with electromagnetics, when the theory is not intuitive. http://betterlesson.com/lesson/636213/electromagnetic-investigations-day-2 Electromagnetic Investigations- Day 3 It's important to balance theory with observations and to provide evidence for any claim. Students will apply this thinking to four big ideas in electromagnetics. http://betterlesson.com/lesson/637306/electromagnetic-investigations-day-3
Explanation **Concepts and Practices**	In these lessons Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): PS4.A: Wave Properties [From the 3–5 grade band endpoints] Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other. (Boundary: The discussion at this grade level is qualitative only; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.) PS4.B: Electromagnetic Radiation Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features.
Elaboration Extension Activity	A Closer Look at Photoelectric Effect Data from different metals show similarities and differences in the photoelectric effect, highlighting fundamental physics phenomena. http://betterlesson.com/lesson/638454/a-closer-look-at-photoelectricity
Evaluation Assessment Tasks	Assessment Task A: Electromagnetic Investigations Following this three day investigation, students should: Evaluate the given evidence for interference behavior of electromagnetic radiation to determine how it supports the argument that electromagnetic radiation can be described by a wave model. Evaluate the phenomena of the photoelectric effect to determine how it supports the argument that electromagnetic radiation can be described by a particle model. Evaluate the given claims and reasoning for modeling electromagnetic radiation as both a wave and a particle, considering the transfer of energy and information within and between systems, and why for some aspects the wave model is more useful and for other aspects the particle model is more useful to describe the transfer of energy and information.