Slide A

Navigate

Turn and Talk

Why do we think some forms of high-frequency EM radiation (UV, X-rays, and gamma rays) would cause more damage than others?

➔Be ready to share your ideas.

Slide B

Navigate

With your group

Use the Electromagnetic Radiation Cards to answer the following questions:

1. What type of damage do you think some of these types of EM radiation cause to the matter they interact with (e.g., microorganisms, cells)?
2. Which wave properties might influence how EM radiation interacts with matter?

➔Be ready to share your ideas with the class.

Slide C

Navigate

Turn and Talk

- Would changing the amplitude of any wave (sound, light, string) cause a change in the amount of energy that wave can transfer? Why?
- Would changing the frequency of any wave cause a change in the amount of energy that wave can transfer? Why?
- What do you think these changes might mean for an EM wave?

➔Be ready to share your ideas.

Slide D

Use a Slinky to Test Ideas

With your class

How could we use our slinkies from Lesson 3 to test whether increasing the frequency or amplitude increases the energy of the wave?

Slide E

Change Slinky Amplitude and Frequency

With your group

Stretch out your slinky. Make a low-amplitude, low-frequency wave.

Consider the energy it takes to...

- ...increase the frequency of the slinky wave.
- ...increase the amplitude of the slinky wave.
- ...increase both amplitude and frequency together.

Would we see the same patterns in light waves?

➔Be ready to share your findings with the class.

Consider Other Known Waves

With your class

Light and sound are different types of waves.

How might increasing the amplitude and frequency of light be like increasing the amplitude and frequency of sound?

➔Be ready to share your findings with the class.

Consider Increases in Energy

Individual Think Time

- Do you think increasing the energy of a wave increases the risk of harm?
- If so, what do you think causes more harm: an increase in amplitude or an increase in frequency? Why?

➔ Be ready to share your ideas with the class.

Slide H

Investigate Evidence about Light

With a partner

Read through some excerpts from medical, health, and wellness studies. Look for any information about amplitude and frequency.

- Take notes in the table.
- Consider what evidence does and does not make sense with our ideas about frequency and amplitude.
- Discuss Questions 1 and 2 with your partner.

	Low amplitude (dimmer) EM radiation	High amplitude (brighter) EM radiation
infrared (lower frequency)		
visible (middle frequency)		
UV light (high frequency)		
x-ray (higher frequency)		

Collect Further Evidence about Light

With your class

- What other measurements might show us more evidence about how different amplitudes and frequencies of EM radiation interact with matter?
- What might we see by testing different frequencies and amplitudes?

Collect Further Evidence about Light

With your class

Watch the video. Use the appropriate sections of your table to track the electron flow produced by the solar cell.

higher value = more electrons emitted

	Low amplitude (dimmer) EM radiation	High amplitude (brighter) EM radiation
infrared (lower frequency)	small heater =	large heater =
visible (middle frequency)	small LED =	large lamp =
UV light (high frequency)	small UV =	large UV =
x-ray (higher frequency)		

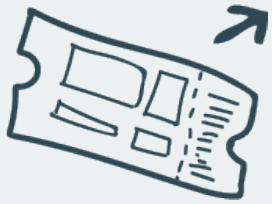
Look for Patterns

With your class

- What patterns do we notice about how EM radiation of high/low frequency and high/low amplitude impacts matter?
- Which causes gr
humans?
- Which causes gr
a solar cell?
- Can we explain t

	Low amplitude (dimmer) EM radiation	High amplitude (brighter) EM radiation
infrared (lower frequency)	small heater =	large heater =
visible (middle frequency)	small LED =	large lamp =
UV light (high frequency)	small UV =	large UV =
x-ray (higher frequency)		

Exit Ticket



Exit Ticket

- Which causes greater changes in matter (humans and/or solar cells): high amplitude or high frequency?
- What evidence do we have from class to support your answer?
- What other details would we need in order to figure out why we see this pattern?

Navigation

With your class

In the exit tickets, a lot of people were curious about why a higher frequency increased the risk of skin cancer.

- What other details would we need in order to figure out why a higher frequency results in more damage?

Navigation

Turn and Talk

One way to evaluate a model more deeply is by using an *analogy*.

- What sorts of analogies could apply to our wave model of EM radiation?
- What details would this analogy need to contain?

Consider a Water Wave Analogy

With a partner

- Read through Part A carefully, paying close attention to details about amplitude and frequency.
- Answer Questions 1-4 in Part B to consider what the water wave analogy can and cannot explain about:

a) skin cancer risk

b) electrons from a solar cell

→ Be ready to share your ideas with the class.

Consider Implications for Our Wave Model

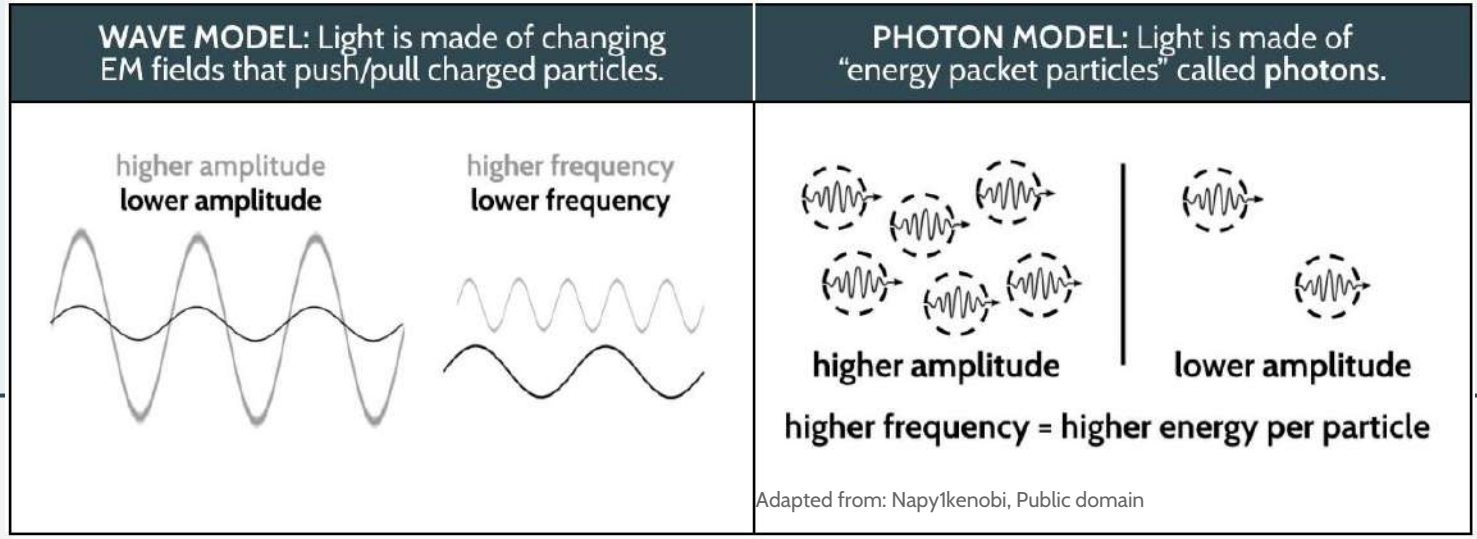
With your class

- Do the patterns we noticed match your prediction for the water wave analogy:
  - a) skin cancer risk?
  - b) electrons from a solar cell?
- What does this say about our wave model of EM radiation?
- How do you think scientists deal with situations where new evidence doesn't quite fit their current model?
- If we were to look at a new model, what kind of data would we want to look for?

Consider a New Model

With your class

- What do you notice about the **photon model** of EM radiation?
- Read the introduction to the *Photon Model* reading.



Consider a New Model

With a partner

- Read Part 1, then write your answers to Question 1 in the table.
- Halfway through Part 2, discuss ideas about Question 2 with your partner before going on. Underline 1-2 key sentences in Part 2.

Consider Evidence to Evaluate Merits

With a partner

- In Question 3, consider examples of evidence that we have encountered so far. Which model works best for each example?
- If you can, go on to Question 4.

Share Your Ideas and Get Feedback

With your group

- Join up with another pair to make a group of 4. Then take turns sharing ideas.

Sharing Ideas		Asking Questions
Question 3:	→	*"Why did you think...?"*
Share your ideas on which model works better and why.		
OR Question 4:	→	*"In your analogy, what represents ionization?"*
Share your analogy.		*"In your analogy, what objects absorb and emit photons?"*

Determine Merits of Both Models

With your class

- **Question 3:** Which model works best for explaining examples of evidence we've seen so far?
- Record consensus ideas.

Wave Model	Photon Model

Navigation

On your own

Use words and/or pictures to add definitions for these terms to your Personal Glossary.

- ionizing radiation
- photon
- photovoltaic material

With your class

Revisit the Driving Question Board.

- What questions do we still have about EM radiation and its uses?

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