Harbor Wave Signals

Compare sonar and radio waves using evidence from a data table.

PS.2 "Obtain, evaluate, and communicate information to compare and contrast the properties of mechanical and electromagnetic waves as they relate to real-world applications. a..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Circle the two pairs of waves that travel through the same medium, underline the rule linking speed, frequency, and wavelength, and number the two ways receivers detect waves.

Finding and Reporting an Obstacle

1. A harbor crew needs to locate a submerged obstacle and send its position to a ship above the water. Sonar sends sound through seawater and times an echo reflected by the obstacle. Sound is a mechanical wave, so it requires matter to travel. Radio is an electromagnetic wave that can travel through air or empty space.

2. The table compares waves traveling in the same medium within each pair. Wave speed equals frequency multiplied by wavelength. In seawater, the sonar waves travel about 1,500 meters per second; in air, radio waves travel about 300 million meters per second. These speeds depend on the medium, so frequency alone cannot predict wavelength across the two pairs.

WAVE MEASUREMENTS

Wave and medium	Frequency	Wavelength	Speed
Sonar sound, seawater	10 kHz	0.15 m	1,500 m/s
Sonar sound, seawater	20 kHz	0.075 m	1,500 m/s
Radio, air	100 MHz	3 m	300,000,000 m/s
Radio, air	200 MHz	1.5 m	300,000,000 m/s

3. An underwater microphone receives the returning sound and converts its vibrations into an electrical signal. A ship's antenna receives radio waves and produces an electrical signal from their changing electric fields. For either type of wave, greater amplitude carries more energy when other conditions stay the same. Increasing a transmitter's amplitude does not change that wave's frequency or speed.

2 ANSWER WITH EVIDENCE

Use the passage

1. Use the 10 kHz sonar row to calculate wave speed from frequency and wavelength. Does your result match the table?

2. Compare the two radio rows. How does wavelength change when frequency doubles in the same medium?

3. The 200 MHz radio wave has a longer wavelength than the 20 kHz sonar wave. Why does this not contradict the relationship you found in question 2?

4. If the sonar transmitter increases amplitude but keeps frequency the same, what happens to the wave's energy and speed?

3 YOUR TURN

Your own words

Design a harbor alert that uses sonar to detect an underwater obstacle and radio to warn a ship. In three or four sentences, explain what each receiver detects, predict how doubling each signal's frequency in the same medium would affect its wavelength, and explain why the two waves have different speeds.

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PART 1 · READ AND MARK

Circle the two pairs of waves that travel through the same medium, underline the rule linking speed, frequency, and wavelength, and number the two ways receivers detect waves. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Use the 10 kHz sonar row to calculate wave speed from frequency and wavelength. Does your result match the table?	**10,000 Hz × 0.15 m = 1,500 m/s. Yes, it matches.**
2	Compare the two radio rows. How does wavelength change when frequency doubles in the same medium?	**Frequency doubles from 100 to 200 MHz, while wavelength halves from 3 to 1.5 m.**
3	The 200 MHz radio wave has a longer wavelength than the 20 kHz sonar wave. Why does this not contradict the relationship you found in question 2?	**The waves travel through different media at very different speeds. Wavelength halves when frequency doubles only if speed stays the same.**
4	If the sonar transmitter increases amplitude but keeps frequency the same, what happens to the wave's energy and speed?	**The wave carries more energy, while its speed stays the same.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would send a sonar pulse through seawater and use an underwater microphone to detect its echo from the obstacle. I would send the obstacle's position by radio through air, where the ship's antenna detects the changing electric field. If I doubled either signal's frequency without changing its medium, its wavelength would halve. The waves have different speeds because they are different kinds of waves traveling through different media.

Accept equivalent calculations and explanations. For wavelength predictions, students must keep the medium and wave speed unchanged.