WAVES, SOUND & PHYSICAL OPTICS DAY 5: THE DOPPLER EFFECT

CED 14.5 · Skill 3.C · FRQ: Qualitative/Quantitative Translation

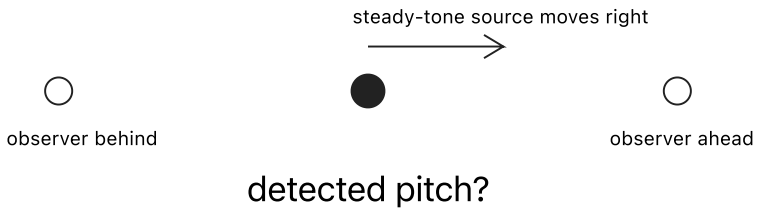
PREDICT

A steady siren approaches, passes, and recedes. Compared with the emitted pitch, the pitch heard while approaching is:

A. higher **B. lower** **C. unchanged** **D. silent**

Commit before hearing or viewing the demonstration.

SOURCE AND OBSERVERS BEFORE WAVEFRONTS ARE REVEALED



WHAT THE OBSERVER ENCOUNTERS

Approaching motion increases the rate at which wavefronts reach the observer. Receding motion decreases it.

NOTES / REASONING

ONE SOURCE FREQUENCY, TWO SPACINGS

Suppose a source emits one crest each period. In one period the wave advances $0.75\,\mathrm{m}$, while the source advances $0.15\,\mathrm{m}$.

1. Find the spacing between successive wavefronts ahead of the source.

2. Find the spacing behind the source.

3. Use those spacings to explain the higher pitch ahead and lower pitch behind without claiming that emitted frequency changed.

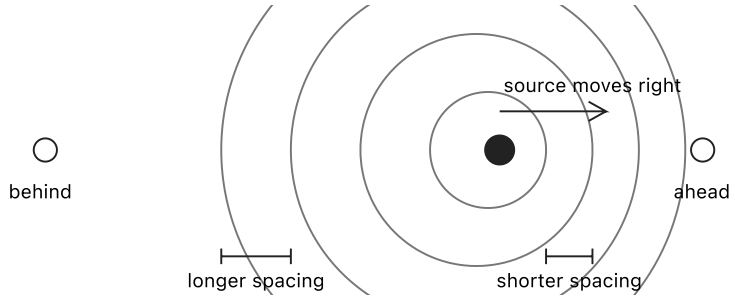
SOURCE MOTION AND OBSERVER MOTION

Situation	Spatial pattern in medium	Observed frequency
source approaches stationary observer	bunched ahead	higher
source recedes	stretched behind	lower
observer moves toward stationary source	unchanged spacing	higher encounter rate

Explain why a moving observer can hear a Doppler shift even though spatial wavefront spacing is unchanged.

READ A WAVEFRONT MAP

MOVING-SOURCE WAVEFRONT MAP



1. Label the higher-frequency and lower-frequency observers on the diagram.

2. A source emits 4.0 crests each second whether at rest or moving. State the emitted frequency in both cases.

3. Arrival intervals are $0.20\,\text{s}$ while approaching and $0.32\,\text{s}$ while receding. Find both observed frequencies.

4. State the corresponding light shifts for an approaching and receding galaxy.