PhysicsTutor

Doppler effect

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Problem:

- An ambulance siren is heard by a stationary person at 1100 Hz when the ambulance is approaching with speed v.
- The ambulance makes a U turn and speeds away with v. The stationary person hears it at 950 Hz now.
- What is the speed with which the ambulance is getting away?

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- For a source moving away there is a frequency decrease.
- In both cases the change depends on the ratio of the source speed to the speed of sound.

Equations associated with ideas:

Approaching source: $f_{obs}^{(+)} = \dfrac{f_{src}}{1 - \frac{v_{src}}{v_s}}$

Receding source: $f_{obs}^{(-)} = \dfrac{f_{src}}{1 + \frac{v_{src}}{v_s}}$

At $t = 20°C$: $v_s = 343 \ \frac{m}{s}$

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- A second information comes from the knowledge of the observed frequency when the source moves away.
- Two pieces of information should be sufficient to determine two unknowns: speed v, and frequency f_{src} - as emitted by the source.
- Eliminate f_{src}.

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- $v = 343 \frac{150}{2050} \frac{\text{m}}{\text{s}} = 25.1 \frac{\text{m}}{\text{s}} = 90\ \text{km/h}$ ← possible

$f_{src} = f^{(+)}(1 - v/v_s) = 1020\ \text{Hz}$