

## Answer on Question #72986, Physics / Mechanics | Relativity

An ambulance siren has frequency 250 Hz. The ambulance is headed towards an accident site with a speed of 90 km/h. Two police officers on separate motor cycles head for the same accident site: one follows the ambulance with a speed of 80 km/h. and the other approaches the accident site from the other direction with a speed of 80 km/h. What frequency does ambulance siren has for each of the police officers? Take the speed of sound equal to 340 m/s.

### Solution:

We use the equation for the Doppler Effect:

$$f = \left( \frac{c + v_r}{c + v_s} \right) f_0$$

where  $c$  is the velocity of waves in the medium;  $v_r$  is the velocity of the receiver relative to the medium; positive if the receiver is moving towards the source (and negative in the other direction);  $v_s$  is the velocity of the source relative to the medium; positive if the source is moving away from the receiver (and negative in the other direction).

If the speeds  $v_s$  and  $v_r$  are small compared to the speed of the wave, the relationship between observed frequency  $f$  and emitted frequency  $f_0$  is approximately

$$f = \left( 1 + \frac{\Delta v}{c} \right) f_0$$

Police officer follows the ambulance

$$f = \left( 1 + \frac{22.2 \text{ m/s} - 25 \text{ m/s}}{340 \text{ m/s}} \right) \times 250 \text{ Hz} = 247.9 \text{ Hz}$$

Police officer moving towards the ambulance

$$f = \left( 1 + \frac{25 \text{ m/s} - 22.2 \text{ m/s}}{340 \text{ m/s}} \right) \times 250 \text{ Hz} = 252 \text{ Hz}$$

**Answer: 247.9 Hz and 252 Hz**

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