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Problem 20.67 (RHK)

An acoustic burglar alarm consists of a source emitting waves of frequency 28.3 kHz. *We have to find beat frequencies of waves reflected from an intruder walking at* 0.95 m s^{-1} *directly away from the alarm.*

Solution:

Frequency of the burglar alarm, $f = 28.3 \times 10^3$ kHz.

Speed of the burglar walking away from the alarm, $v = 0.95$ m s^{-1}.

Using the Doppler shift relation frequency of the signal as detected by the burglar,

$$f_{burglar} = 28.3 \times 10^3 \frac{(343 - 0.95)}{343} \text{ Hz} = 28.22 \times 10^3 \text{ Hz}.$$

Frequency of the reflected signal at the source will be further Doppler shifted as the burglar is moving away from the siren. It will be

$$f_r = 28.22\times10^3 \times \frac{343}{(343+0.95)}\ \text{Hz} = 28.14\times10^3\ \text{Hz}.$$

The beat frequency will be

$$f_{beat} = f - f_r = (28{,}300 - 28{,}140)\ \text{Hz} = 160\ \text{Hz}.$$