Name: Key

Physics 4C Spring 2020 Test 5 (Waves)

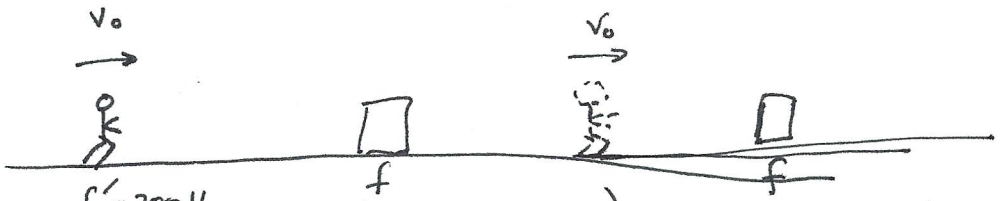
1. A jogger runs at a constant pace down a straight road towards a city block where technicians are testing sound equipment for an outdoor music festival. Two speakers are set up along the road, one at each end of the block, playing the same sine wave tone, and as she jogs towards them she hears a frequency of exactly 200 Hz. She runs past the first speaker and hears 3.00 beats per second as she continues to approach the second speaker. How fast is the jogger running? $V_0 = ?$

   Take the speed of sound in air to be 343 m/s.

Doppler: speed of observer

$$f' = \left(\frac{V \pm V_0}{V \mp V_s}\right) f$$

(V: wave speed; V_s: speed of source)



actual speaker frequency

$$f' = \left(\frac{V+V_0}{V}\right) f$$

$$f = \frac{V f'}{V+V_0}$$

$$f_b = |f_1 - f_2|$$

Higher freq. from speaker on right: $= f' = 200$ Hz

Lower freq. from speaker on ~~right~~ left

$$f_b = \left(\frac{V+V_0}{V}\right) f - \left(\frac{V-V_0}{V}\right) f$$

$$= \left(\cancel{V} + V_0 - \cancel{V} + V_0\right) \frac{f}{V}$$

$$f_b = \frac{2V_0 f}{V}$$

$$f_b = \frac{2V_0}{\cancel{V}} \left(\frac{\cancel{V} f'}{V+V_0}\right)$$

$$f_b = \frac{2V_0 f'}{V+V_0}$$

$$2V_0 f' = (V+V_0) f_b$$

$$V_0 (2f' - f_b) = V f_b$$

$$V_0 = \frac{V f_b}{(2f' - f_b)}$$

$$V_0 = \frac{(343 \text{ m/s})(3 \text{ Hz})}{(2(200 \text{ Hz}) - (3 \text{ Hz}))}$$

$$V_0 = 2.59 \text{ m/s}$$