

57. We use Eq. 18-47 with $f = 500$ Hz and $v = 343$ m/s. We choose signs to produce $f' > f$.

(a) The frequency heard in still air is

$$f' = 500 \left(\frac{343 + 30.5}{343 - 30.5} \right) = 598 \text{ Hz} .$$

(b) In a frame of reference where the air seems still, the velocity of the detector is $30.5 - 30.5 = 0$, and that of the source is $2(30.5)$. Therefore,

$$f' = 500 \left(\frac{343 + 0}{343 - 2(30.5)} \right) = 608 \text{ Hz} .$$

(c) We again pick a frame of reference where the air seems still. Now, the velocity of the source is $30.5 - 30.5 = 0$, and that of the detector is $2(30.5)$. Consequently,

$$f' = 500 \left(\frac{343 + 2(30.5)}{343 - 0} \right) = 589 \text{ Hz} .$$