Physics 6B Review for Midterm 1 2008 Oct 22

13.39

$f_s = 900\ Hz$

$v_w = 15.0\ m/s$

$v_m = 343\ m/s$

a) $\lambda_{upwind} \equiv \lambda_u$?

Wrt ground, the wave velocity is $v_u = v_m - v_w$.
If you stand downwind, you'll hear the same frequency f_s, just as ambulance chasers that keep pace hear the true siren frequency.

$$v_u = f_s \lambda_u \rightarrow \lambda_u = \frac{v_u}{f_s} = \frac{v_m - v_w}{f_s} = \frac{(343\ m/s - 15.0\ m/s)}{(900\ Hz)}$$

$$= 0.36\bar{4}\ m = \boxed{36.4\ cm}$$

b) $\lambda_{downwind} \equiv \lambda_d$?

$v_d = v_m + v_w$

$v_d = f_s \lambda_d$ by the same reasoning.

$$\lambda_d = \frac{v_d}{f_s} = \frac{v_m + v_w}{f_s} = \frac{(343\ m/s + 15.0\ m/s)}{(900\ Hz)}$$

$$= 0.39\bar{7}\ m = \boxed{39.8\ cm}$$

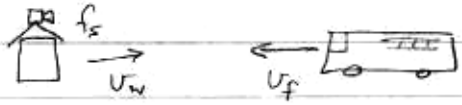
c) $f_{o,upwind} \equiv f_u$?

$v_f = 15.0\ m/s$

$f_u = f_s\left(\frac{v_m + v_o}{v_m - v_s}\right)$, v_o & v_s are wrt medium at rest

$$= f_s\left(\frac{v_m + (v_f - v_w)}{v_m - (v_w)}\right) = f_s\left(\frac{v_m}{v_m - v_w}\right) = (900\ Hz)\left(\frac{343}{343 - 15}\right) = \boxed{941\ Hz}$$

d) $f_{o,\text{downwind}} = f_d$?



$$f_d = f_s\left(\frac{v_m + v_o}{v_m - v_s}\right) = f_s\left(\frac{v_m + (v_f + v_w)}{v_m - (-v_w)}\right)$$

$$= f_s\left(\frac{v_m + v_f + v_w}{v_m + v_w}\right) = (900\ \text{Hz})\left(\frac{343 + 15.0 + 15.0}{343 + 15.0}\right)$$

$$= \boxed{938\ \text{Hz}}$$