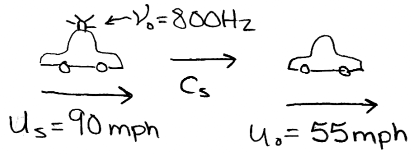
#4 Ch8 #1

a)



$C_s = 90mph = 90\cancel{mph}\left(\frac{1610m}{1\ mile}\right)\left(\frac{1hour}{3600s}\right)$

$= 40.3\ m/s$

$u_o = 55\ miles/hour\left(\frac{1610m}{1mile}\right)\left(\frac{1hour}{3600s}\right) =$

$= 24.6\ m/s$

both source and observer are moving, use (8.7)

$$\nu' = \frac{C_s - u_o}{C_s - u_s}\nu_0$$

← speed of observer

← unshifted frequency

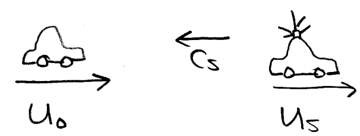
↑ speed of sound

↑ speed of source

315.4

$$= \frac{340\ m/s - 24.6\ m/s}{340\ m/s - 40.3\ m/s}(800\ Hz) = 842Hz$$

b)

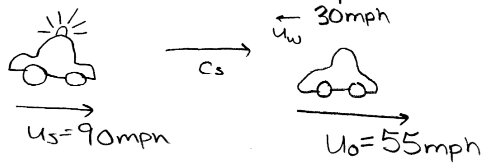


now the source is getting further away instead of approaching. The velocity of the two cars is opposite the direction of the two cars. Thus the signs in Eq (8.7) must be flipped.

$$\nu' = \frac{C_s + u_o}{C_s + u_s}\nu_0 = \frac{340\ m/s + 24.6\ m/s}{340\ m/s + 40.3\ m/s}(800Hz) = 767\ Hz$$

#5 Ch8 #2

situation a) police car approaching observer



$$30\text{ mph} = 30\,\text{mi/hr}\left(\frac{1610\text{m}}{1\text{miles}}\right)\left(\frac{1\text{hr}}{3600\text{s}}\right)$$
$$= 13.4\text{ m/s}$$

In this case, the wind is opposing the direction of propogation of the sound, effectively decreasing the sound velocity

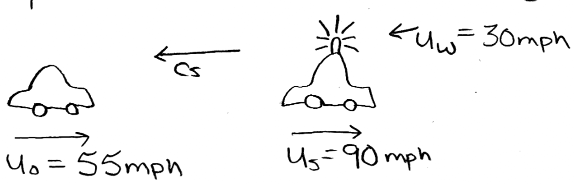
326.6 302

$$\nu' = \frac{C_s + (-u_w) - u_o}{C_s + (-u_w) - u_s}\,\nu_o = \frac{340\text{m/s} - 13.4\text{m/s} - 24.6\text{m/s}}{340\text{m/s} - 13.4\text{m/s} - 40.3\text{m/s}}(800\text{Hz})$$

negative because it opposes the sound velocity

$$= 844\text{ Hz}$$

situation b) police car moves away from observer



now, the wind is moving in the same direction as the sound, so the wind makes the sound carry the sound faster because the wind velocities and the sound velocities add.

378

$$\nu' = \frac{C_s + U_s + U_o}{C_s + U_s + U_s} = \frac{340\text{m/s} + 13.4\text{ m/s} + 24.6\text{m/s}}{340\text{m/s} + 13.4\text{ m/s} + 40.3\text{m/s}}(800\text{Hz})$$

$$= 768\text{ Hz}$$

8-4. $\nu = \frac{C_w + V}{C_w - V} \nu_0$

$$\Delta\nu = \nu - \nu_0 = \frac{2V}{C_w - V} \nu_0$$

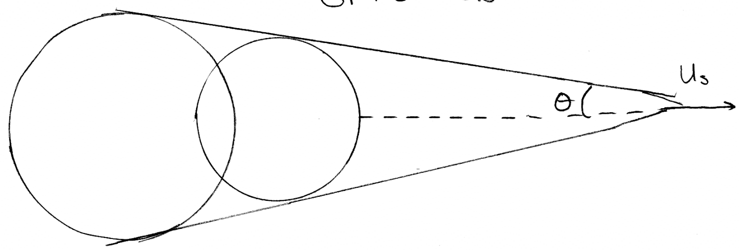
$$\Rightarrow V = \frac{\Delta\nu \, C_w}{2\nu_0 + \Delta\nu} = \frac{3 \times 340}{2 \times 800 + 3} \doteq 0.64 \ (m/s)$$

#6 Chap. 8 #5

$u_s = 500\,m/s$

$c_s = 340\,m/s$

$\sin\theta = \frac{c_s}{u_s}$



$\theta = \sin^{-1}\left(\frac{340}{500}\right)$

$= 42.8°$

#7 Chap 8 #8

a) $\nu' = \frac{1+\beta}{\sqrt{1-\beta^2}}\nu_0 \qquad \beta = \frac{u}{c}$

$c = \lambda_0\nu_0 \qquad c = \lambda'\nu'$

$\frac{c}{\lambda'} = \frac{1+\beta}{\sqrt{1-\beta^2}}\frac{c}{\lambda^0} \qquad \frac{\lambda^0}{\lambda'} = \frac{1+\beta}{\sqrt{1-\beta^2}} \qquad \left(\frac{\lambda_0}{\lambda'}\right)^2 = \frac{(1+\beta)^2}{1-\beta^2} = \frac{(1+\beta)^2}{(1+\beta)(1-\beta)}$

$\left(\frac{\lambda_0}{\lambda'}\right)^2(1-\beta) = 1+\beta \qquad \left(\frac{\lambda_0}{\lambda'}\right)^2 - 1 = \beta\left[1+\left(\frac{\lambda_0}{\lambda'}\right)^2\right]$

.7159

$\beta = \frac{\left(\frac{\lambda_0}{\lambda'}\right)^2 - 1}{\left(\frac{\lambda_0}{\lambda'}\right)^2 + 1} = \frac{\left(\frac{5500}{6500}\right)^2 - 1}{\left(\frac{5500}{6500}\right)^2 + 1} = -\frac{0.284}{1.716} = -0.166$

$u = \beta c \Rightarrow u = 0.166c$

b) The negative sign tells us it's receeding. Intuitively, if something is moving away, the peaks would appear to be moving apart to an observer, which means the frequency is getting lower. Looking at a diagram of the em spectrum lowering the frequency makes visible light more red.