**Problem 4:** (20 pts.) You and your roommate have decided to measure the speed of one of the Lafayette carts using the Doppler shift. You have two identical sirens that broadcast a sound at exactly 550 Hz. Your roommate hops in the cart and turns the siren on while driving directly at you. You turn on your siren and observe that the combined signal has beats with frequency 7.30 Hz.

a. (5 pts.) What is the frequency you hear from the moving siren?

b. (15 pts.) What is the speed of the cart?

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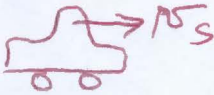
$f_L - f_S = 7.30 \, Hz.$ But $f_S = 550 \, Hz.$

$$\therefore \boxed{f_L = 557.3 \, Hz}$$

b. (15 pts.) What is the speed of the cart?

$$f_L = f_S \left(\frac{v}{v - v_S} \right)$$

($v_L = 0$ here. pick $-$ sign because $f_L > f_S$ since cart is approaching.)

$$v - v_S = \frac{f_S}{f_L} \cdot v$$

$$v_S = v \left(1 - \frac{f_S}{f_L} \right) = 343 \frac{m}{s} \left(1 - \frac{550}{557.3} \right) =$$

$$\boxed{v_S = 4.49 \, m/s}$$ (about 10 mph).