**Homework 3 due 2/5**

**Problem 1.** Suppose you’re biking down the street with speed 10m/s. An ambulance is approaching you from behind at a speed of 30m/s blaring its siren at a frequency of 400Hz. You can take vsound = 343m/s.

(a) What frequency do you hear as it’s approaching?

(b) What frequency do you hear when it passes you?

**Problem 2.** The ambulance is back. You’re doing 10m/s down the road again, and it’s doing 30m/s. This time it’s in front of you, coming towards you. When the ambulance passes you, your hear a frequency drop of 150Hz. What is the source frequency of the ambulance’s siren? Again, presume vsound = 343m/s.

**Problem 3.**  Suppose you’re a bat chasing an insect in front of you. You’re traveling to the right at a speed of 7m/s. You send out an ultrasonic ping of frequency 5000Hz. It comes back 0.06s later, at a frequency of 4890Hz.

(a) How far away from you is the insect?

(b) What is its velocity? We’ll assume for the sake of discussion that the insect and you flying along a straight line?

**Problem 4.** In all of our problems so far, we’ve assumed that the source and observer are moving along the same line. But now let’s consider a different scenario, which is still broadly amenable to same analysis we did in class (that of using kinematics). Suppose you’re standing on the street ‘y-axis’ at coordinate (+y). And a car is driving along the street ‘x-axis’ with a speed (+vs). When it gets to coordinate (+x), it honks at a slow driver (probably on Broad street in my experience) with frequency fs. Letting this instant be t = 0….

(a) Write a symbolic expression in terms of x, y, v for when this wavefront reaches you.

(b) Write a symbolic expression in terms of x, y, v, vs, and Ts for when the second wavefront reaches you.

(c) Write down a symbolic expression for the observed period in terms of all these variables. Don’t try to simplify it.

(d) Using Taylor series we can make the following approximation, valid for when λ is small. Using this approximation, simplify your expression for To and get an expression for fo,



(e) Evaluate it for y = 50m, x = 50m, car speed 20m/s, and sound speed 343m/s, and car horn frequency 600Hz.

**Problem 5.** A fighter jet is passing by directly overhead. You hear it 10s later, when it makes an angle of 30 degrees w/r to the horizon. Assuming vsound = 343m/s….

(a) What is its speed?

(b) What is its altitude?