(10) A rocket moves at a speed of 242 m/s directly toward a stationary pole (through stationary air) while emitting sound waves at frequency $f = 1250$ Hz.

(a) What frequency f' is measured by a detector that is attached to the pole?

(b) Some of the sound reaching the pole reflects back to the rocket as an echo. What frequency f'' does a detector on the rocket detect for the echo?

(c) If the air in this problem is moving toward the pole at speed 20 m/s (i) what value for the source speed v_s should be used in the solution of part (a), and what value for the detector speed v_D should be used in the solution of part (b)?

(11) Two sinusoidal waves, identical except for phase, travel in the same direction along the string and interfere to produce a resultant wave given by; $y'(x,t) = (3.0\text{ mm}) \sin(20x - 4.0t + 0.820\text{ rad})$ with x in metres and t in seconds. What are (a) the wavelength λ of the two waves, (b) the phase difference between them, and (c) their amplitude y_m?

(12) The wavefunctions for two transverse waves on a string are

$$y_1 = 0.03 \cos(6.0x - 18t + 1.5)$$

$$y_2 = 0.03 \cos(6.0x - 18t - 2.3)$$

where y and x are measured in metres and t in seconds.

(a) What is the phase difference between these waves?

[Hint: if $y(x,t) = y_m \cos(kx - \omega t + \phi)$ then $\theta = (kx - \omega t + \phi)$ is the phase of the wave at position x & time t]

(b) What is the amplitude and the phase constant of the resultant wave?

(c) What is the transverse displacement of the string at $x = 0$ at $t = 0$?

(13) A string has a length of 3.0 m and a mass of 12 g. If this string is subjected to a tension of 250 N, what is the speed of transverse waves?

(14) A string of length L is plucked at a distance d from one end. Find the smallest value of d in terms of L if the string vibrates only at the second harmonic.

If the string has a mass m and a tension T, what is the frequency of the second harmonic?