

29:029 Physics III

Exam I

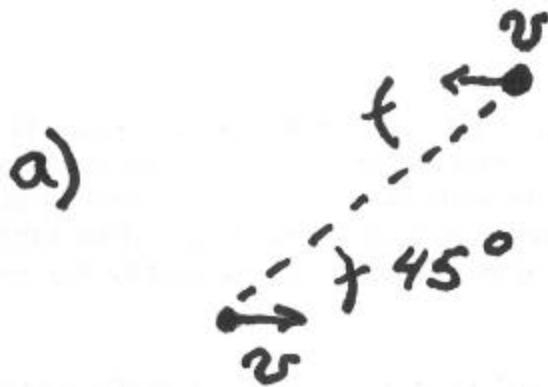
September 22, 2000

Closed book exam. Please show all work to get full credit. Point values for each problem are indicated. Please ask questions if you need clarification. If you don't show your work, or make written comments, then there is no way for me to give partial credit.

- 1) (12 points) Consider waves on a string that has tension T , mass density μ , and length L . One end of the string is fixed, but the other end is free to move vertically.
 - a) What is the frequency of the lowest frequency standing wave on the string?
 - b) What is the total energy in the standing wave in a) if the amplitude of the oscillation is D ?

- 2) (12 points) Sound source A is located at $x=0, y=0$, and sound source B is placed at $x=0, y=2.4\text{m}$. The two sources radiate coherently in phase. An observer at $x=40\text{m}, y=0$ notes that as she walks along in either the positive or negative y direction away from $y=0$, the sound intensity diminishes. What is the lowest and the next higher frequency of the sources that can account for that observation?

- 3) (12 points) A string of Tension T and mass density μ is terminated on a spring that resists vertical motion according to the force law $F = -Ky$. Assume that the spring has neither mass nor friction.
- Write down the equations that you need in order to determine the reflected wave amplitude given an incident wave amplitude ($=1$).
 - What condition must be satisfied in order for the reflected wave to be shifted by $\pi/4$ (45 degrees) from the incident wave?
- 4) (12 points) Doppler Shift.
- What is the Doppler shift of a frequency f when both the transmitter and the receiver are moving with equal and opposite velocities V which are at a 45 degree angle with respect to a line that joins the transmitter and receiver (see the figure)?
 - If both are made to be transmitters and one is not moving and has frequency f and the moving transmitter (frequency $f/2$) moves directly toward the fixed transmitter. What velocity is required in order to produce waves with the same frequency in the frame of the fixed source? In this situation, will the interference nodes of the two waves be moving (explain briefly)?



b)

f

$f/2$