

Physics 23 Practice Midterm

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Closed Book; 1 page of notes allowed; no calculators. For full credit, make your reasoning clear, show your work, arrive at clear symbolic answers, and when a numerical answer is required, put it in scientific notation and include units, like $\sqrt{5} \times 10^{12}$ C.

Please box your final answers; otherwise we won't know which among multiple answers is the one you intend.

For all problems, take the ideal gas constant to be $R = 8$ Joules/mole and the speed of sound in air to be $v = 350$ m/s.

Note, there are two pages.

- (15 pts) The D-string and the high E-string on a guitar are both made of the same material. The D-string is strung at a tension of 150 N, and has a diameter of 0.9 mm, while the high E-string has a tension of 96 N, and a diameter of 0.3 mm. Call the speed of wave propagation on the D-string v_D , and that on the high E-string v_E . Determine the ratio v_D/v_E .
 - (15 pts) A novel musical instrument is made by stringing a guitar string inside a 0.7 meter length of bamboo pipe. It is not easy to pluck the string... ignore that. One end of the bamboo pipe is closed, the other open (the string is attached to a narrow strut across the open end). The string is tensioned to 100 N, and its fundamental frequency is the note F_4^\sharp at 375 Hz. When the string is plucked, it excites a resonance in the bamboo tube. Which harmonic of the pipe does this resonance correspond to?
 - (20 pts) Two identical speakers are a distance of 1.75 meters apart. A listener can move along a line in front of one speaker; the line is perpendicular to a line that joins the two speakers. The listener can vary the distance to the nearest speaker from 0 and ∞ meters. The speakers emit identical tones, and the frequency can be changed. For most frequencies, the listener finds maximum destructive interference sometimes occurs when the nearest speaker is certain distances away. However, when the frequency falls below f_{\min} , the listener never perceives maximum destructive interference. Find f_{\min} .
 - (20 pts) You run directly toward a wall, carrying a tuning fork that emits, in its rest frame, a frequency of $f_0 = 345$ Hz. You are running at 5 m/s. At what frequency do you hear beats between the direct sound from the fork and the sound reflected from the wall?
 - (30 pts) Four line charges are arranged symmetrically in arcs as shown in Fig. 1. Each subtends 45° , and on each the linear charge density is constant, adding up to the total charge shown. Find the electric field at the center of the circle.
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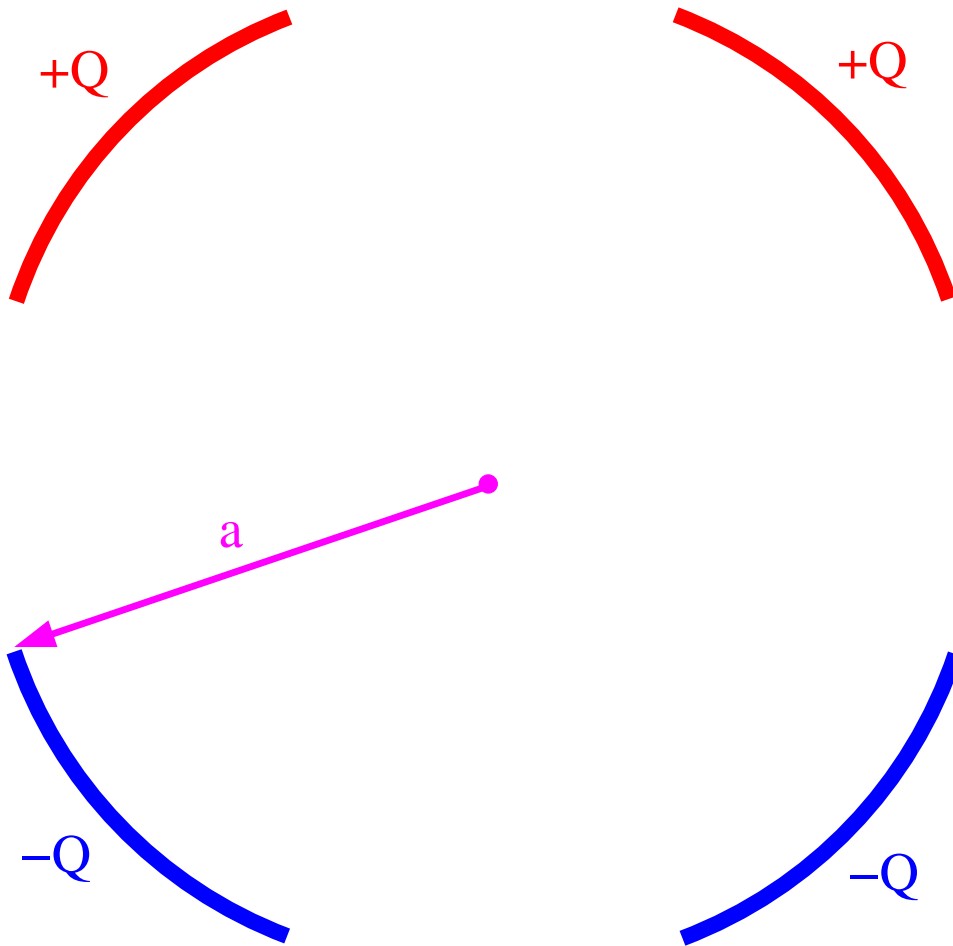


Figure 1: Figure for Problem 5.