(1) $V_D = \sqrt{\frac{F_D}{\mu_D}}$ $\quad V_E = \sqrt{\frac{F_E}{\mu_E}}$

$$\frac{V_D}{V_E} = \frac{\sqrt{\frac{F_D}{\mu_D}}}{\sqrt{\frac{F_E}{\mu_E}}} = \sqrt{\frac{F_D}{F_E}} \cdot \sqrt{\frac{\mu_E}{\mu_D}} = \sqrt{\frac{F_D}{F_E}} \cdot \frac{d_E}{d_D}$$

but $\frac{\mu_E}{\mu_D} = \frac{\pi\left(\frac{d_E}{2}\right)^2 \rho}{\pi\left(\frac{d_D}{2}\right)^2 \cdot \rho} = \frac{d_E^2}{d_D^2}$

so $$\boxed{\frac{V_D}{V_E} = \sqrt{\frac{F_D}{F_E}} \cdot \frac{d_E}{d_D} = \sqrt{\frac{150}{96}} \cdot \frac{0.3}{0.9} = \sqrt{\frac{25}{16}} \cdot \frac{1}{3} = \frac{5}{4 \cdot 3} = \frac{5}{12}}$$

(2) $f_n = \frac{nV}{4L}$ $\quad n = 1, 3, 5, \ldots$

$$\boxed{\frac{nV}{4L} = 375\ \text{Hz}}$$

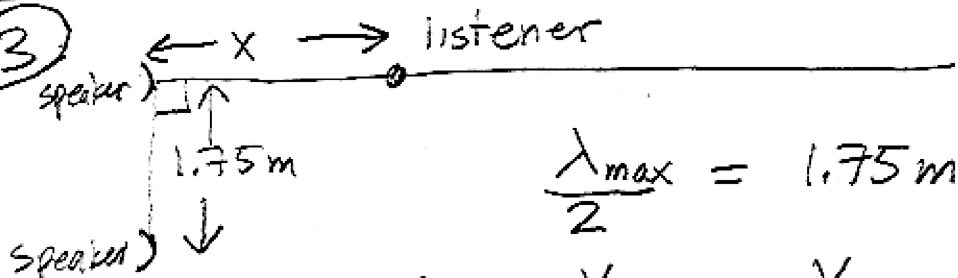
$V = 350$ m/s
$L = 0.7$ m

$$n = \frac{4 \times 0.7 \times 375}{350} \qquad \frac{0.7}{350} = \frac{1}{500}$$

$$\boxed{n = 4 \times \frac{375}{500} = 4 \times \frac{3}{4} = 3}$$

$\boxed{\text{this is the \underline{second} harmonic}}$

(3)



$$\frac{\lambda_{max}}{2} = 1.75\,m$$

$$f_{min} = \frac{V}{\lambda_{max}} = \frac{V}{2 \cdot 1.75\,m} = \frac{350\,m/s}{3.5\,m}$$

$$\boxed{f_{min} = 100\ Hz}$$

(4) Moving source: $f = \dfrac{1}{1 - \frac{V_r}{V}} f_o$ $\left(\begin{array}{l} V_r = \text{running speed} \\ V = \text{speed of sound} \end{array}\right)$

After reflection, moving listener hears $f' = \left(1 + \frac{V_r}{V}\right) f$

so $$f' = \frac{1 + \frac{V_r}{V}}{1 - \frac{V_r}{V}} f_o$$

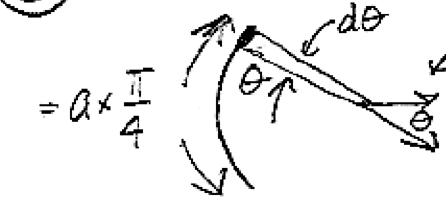
beats at frequency $|\Delta f| = |f_o - f'|$

$$= \left| f_o \left(1 - \frac{1 + \frac{V_r}{V}}{1 - \frac{V_r}{V}} \right) \right| = \left| f_o \left(\frac{1 - \frac{V_r}{V} - 1 - \frac{V_r}{V}}{1 - \frac{V_r}{V}} \right) \right|$$

$$|\Delta f| = \frac{2V_r}{V - V_r} \times f_o = \frac{2 \cdot 5}{350 - 5} \times 345$$

$$\boxed{|\Delta f| = 10\ Hz}$$

⑤ First do:



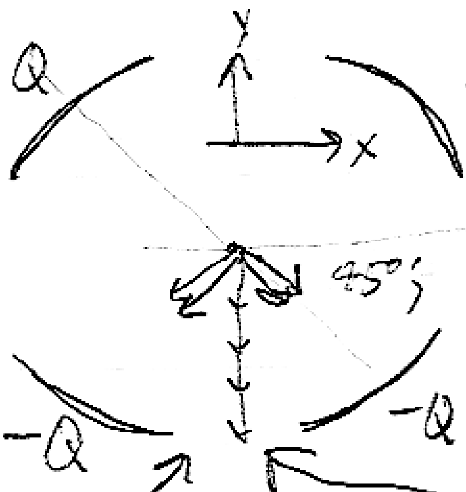
$$dE_x = dE\cos\theta = k\frac{dQ}{a^2}\cos\theta = k\frac{\lambda a\,d\theta}{a^2}\cos\theta$$

$$dE_x = k\cdot\frac{4Q}{\pi a}\cdot\frac{1}{a}\cos\theta\,d\theta$$

$$\lambda = \frac{Q}{\frac{\pi a}{4}} = \frac{4Q}{\pi a}$$

$$E_x = k\cdot\frac{4}{\pi}\frac{Q}{a^2}\int_{-\pi/8}^{\pi/8}\cos\theta\,d\theta$$

$$\underline{\underline{E_x = k\cdot\frac{Q}{a^2}\cdot\frac{8}{\pi}\cdot\sin\left(\frac{\pi}{8}\right)}}$$



$\sin 45° = \frac{1}{\sqrt{2}}$

total E will be in $-y$ direction, magnitude

symmetry; $E_x = 0$

$$= 4\cdot\frac{1}{\sqrt{2}}\times E_x$$

$$\boxed{E_{tot} = 4\cdot\frac{1}{\sqrt{2}}\times\frac{Q}{a^2}\cdot\frac{8}{\pi}\sin\left(\frac{\pi}{8}\right)}$$

in $-y$ direction.