Problems Done in Class

Chp. 24/25

- Electric Field and potential from a uniformly charged long cylinder, see below pages (1), (2)

Ch 18,

P. 63 (3+4), P. 61 see page (9)

Ch. 16

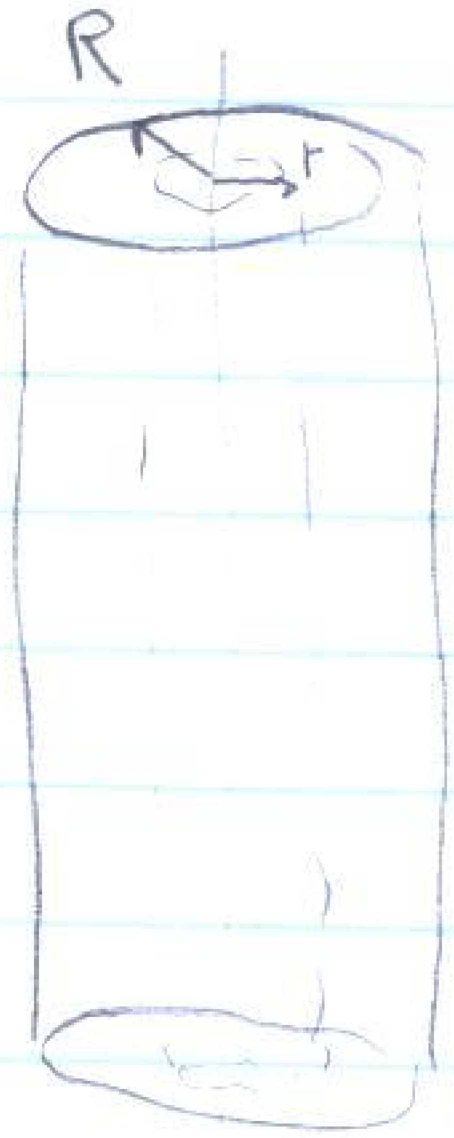
P. 56, Variant of P. 3

Ch. 17

P. 40

(1)

Solid Cylinder



$$\Phi_E = \int E \cdot dA = 4\pi k_e Q_{in}$$

$$\Phi_E = E \cdot A = 4\pi k_e Q_{in}$$

$$A = 2\pi r \cdot L \qquad Q_{in} = \rho \pi r^2 L$$

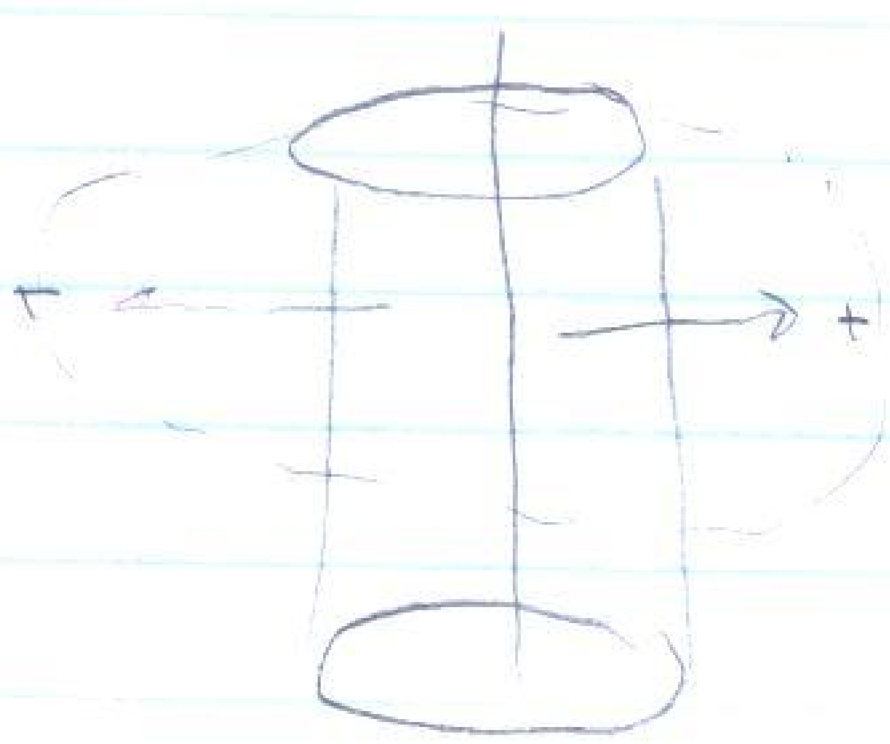
$$E \cdot 2\pi r L = 4\pi k_e \rho \pi r^2 L$$

$$\pi R^2 \cdot \rho = \lambda \qquad E = 2\pi k_e \rho r$$

$$E = 2\pi k_e \lambda \frac{r}{\pi R^2}$$

$$E = 2 k_e \lambda \frac{r}{R^2}$$

Outside

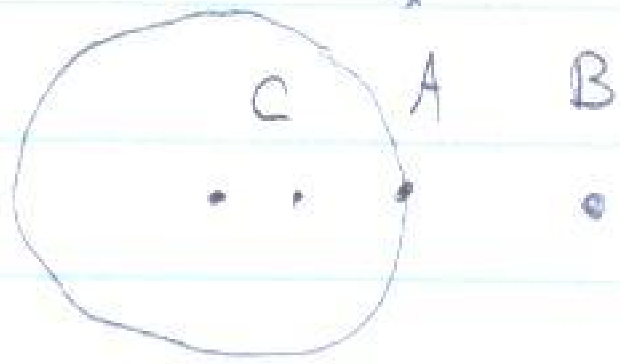


$$\Phi_E = \int E \cdot dA = 4\pi k_e Q_{in}$$

$$E_r = \frac{2 k_e \lambda}{r}$$

(2) Find the Potential Difference Between A and B For solid cylinder

$$E_r = \begin{cases} 2k_eQ \dfrac{r}{R^2} & r < R \\[2ex] \dfrac{2k_eQ}{r} & r > R \end{cases}$$



$$V_B - V_A = -\int_{r_A}^{r_B} E_r \, dr$$

$$V_B - V_A = -\int_{r_A}^{r_B} \frac{2k_eQ}{r} dr = -2k_eQ \ln \frac{r_B}{r_A}$$

For C and A

$$V_c - V_A = -\int_{r_A}^{r_c} \frac{2k_eQ}{R^2} r\,dr$$

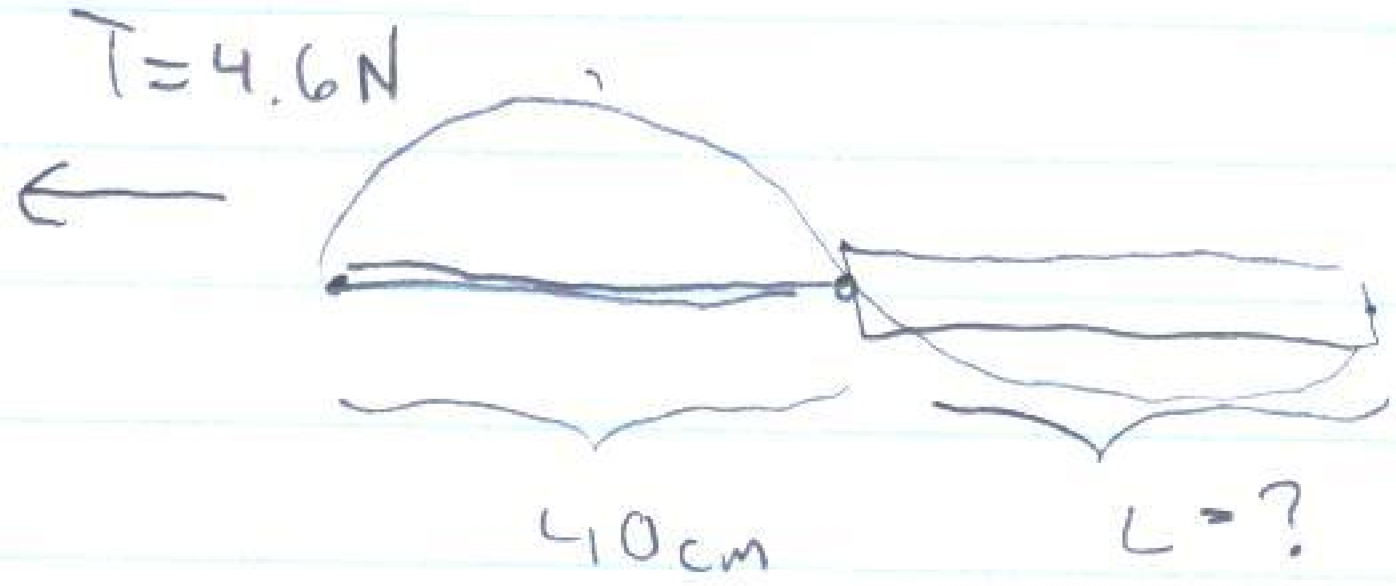
$$= -\frac{2k_eQ}{R^2} \frac{1}{2} r^2 \Big|_{r_A}^{r_c}$$

$$\boxed{V_C - V_A = +\frac{2k_eQ}{R^2} \frac{1}{2}(r_A^2 - r_c^2)}$$

③ Ch 18

Superposition & Standing waves

p63



$\mu_1 = 2\frac{g}{m}$ $\mu_2 = ?$

First Find the density:

$\mu_1 = 2\frac{g}{m}$ $\mu_2 = \left(\frac{d_2}{d_1}\right)^2 \mu_1$

$\mu_2 = 4\mu_1 = 8\frac{g}{m}$

① f is constant

② $\frac{V_1}{\lambda_1} = f = \frac{V_2}{\lambda_2}$ $V_2 = \sqrt{\frac{T}{\mu_2}}$

$\frac{V_2}{V_1} = \sqrt{\frac{\mu_1}{\mu_2}} = \sqrt{\frac{1}{4}} = \frac{1}{2}$

④

Then

$V_1 = \lambda_1 f$

- $V_1 = \sqrt{\frac{T}{\mu_1}} = \sqrt{\frac{4.6N}{2 \times 10^{-3} \frac{kg}{m}}} = 47.95 m/s$

- $V_2 = 24\ m/s$

- $V_1 / \lambda_1 = f$

$48\ m/s \,/\, .8\ m = f = \underline{60\ Hz}$

- $\frac{V_2}{f} = \lambda_2$ $\qquad \lambda \propto V$

$\frac{V_2}{V_1} = \frac{\lambda_2}{\lambda_1} = \frac{1}{2}$ $\qquad \lambda_2 = \frac{\lambda_1}{2} = \underline{40 cm}$ $\qquad \underline{L = 20cm}$

(5)

Variant of Ch 16 P. 3

At time $t=0$ there are two pulses on a string

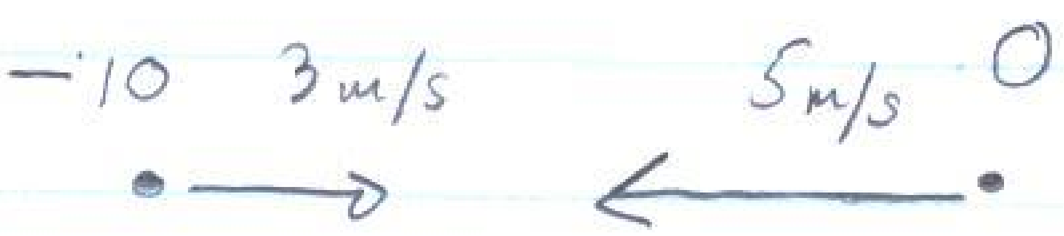
$y_1 = 5e^{-(x+5t)^2}$ and $y_2 = 2e^{-(x-3t+10)^2}$

Describe what happens, when and where is the pulse height maximum

y_1 is a left mover

y_2 is a right mover

at $t=0$



They meet when:

$$\Delta t = \frac{d}{V_{rel}} = \frac{10\text{ m}}{8\text{ m/s}} = 1.25\text{ s}$$

$\Delta x = -6.25\text{ m}$

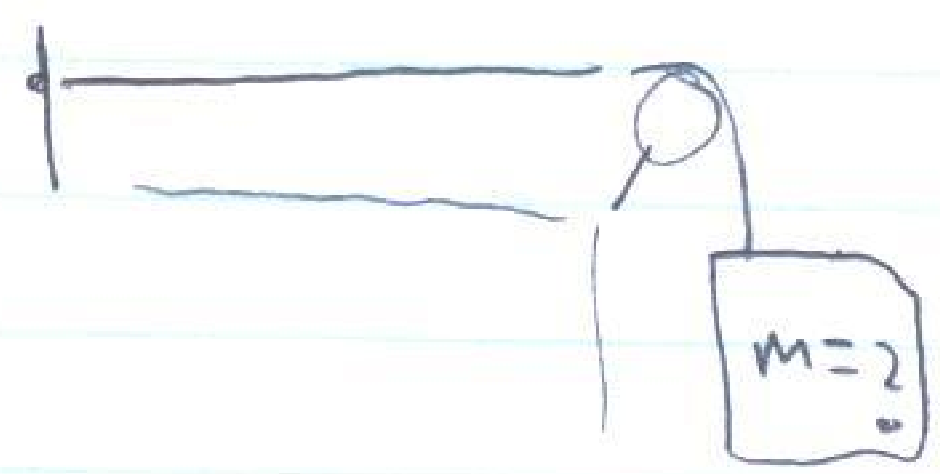
max height $= 5 + 2 = 7$

(6)

Problem 56   Ch 16

$y = 0.2m \sin(0.75\pi x + 18\pi t)$

$\mu = 0.250 \frac{kg}{m}$



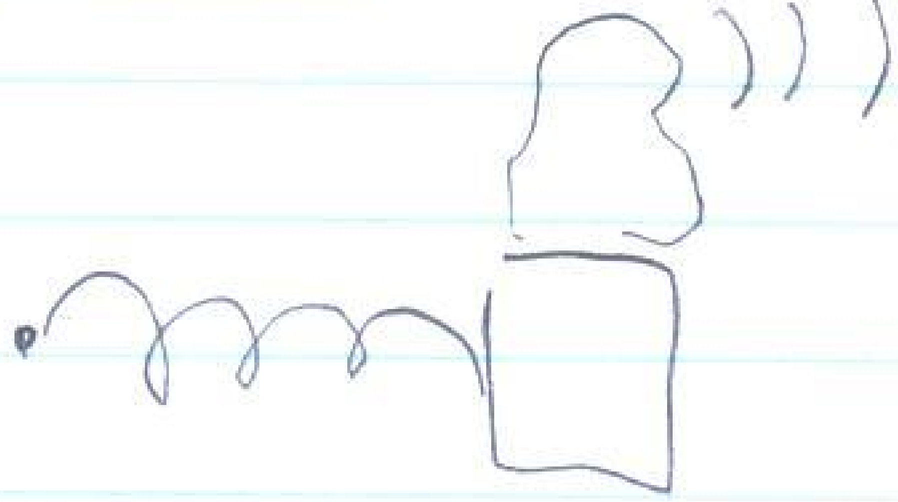
$k = \frac{3}{4}\pi \frac{1}{m}$ $\omega = 18\pi \frac{1}{s}$ $c_s = \frac{\omega}{k} = \frac{18\pi}{\frac{3}{4}\pi} = 24 m/s$

$v = \sqrt{\frac{T}{\mu}}$

$\mu v^2 = mg$

$\frac{\mu v^2}{g} = m \longrightarrow$ $\boxed{m = 14.68 \text{ kg}}$

(7) Ch 17 p 40



$k = 20.0 \frac{N}{m}$

$m = 5.0 kg$

$A = 0.5 m$

$$f' = \left(\frac{c_s + v_0}{c_s - v_s} \right) f$$

$$x = A \sin(\omega t) \qquad \omega = \sqrt{\frac{k}{m}}$$

$$v = + A\omega \cos(\omega t)$$

$$|v_{max}| = A\omega$$

$$|v_{max}| = 0.5 m \sqrt{\frac{20 N/m}{5.0 kg}} = 1.0 m/s$$

$$f' = \left(\frac{c_s + 0}{c_s \pm v_s} \right) f = \frac{343}{343 \pm 1 m} (440 Hz)$$

$$f' = 440 \pm 1.28 Hz$$

(8)

Minimum Sound Level

$$I = \frac{P}{4\pi r^2}$$

$$\beta_{max} = 10 \log_{10} \frac{I}{1 \times 10^{-13}\ W/m^2}$$

$$6\!\!\!/0\ dB = 1\!\!\!/0 \log_{10} \frac{I}{I_0}$$

$$10^6 = \frac{I}{I_0} \Rightarrow I_{max} = 1 \times 10^7 \frac{W}{m^2}$$

So

$$I_{max} = 1 \times 10^7 \frac{W}{m^2} = \frac{P}{4\pi r^2}$$

$$\frac{I_{max}}{I_{min}} = \frac{r_{min}^2}{r_{max}^2} = \frac{2^2}{1^2} = \frac{4}{1}$$

$$I_{min} = \frac{I_{max}}{4}$$

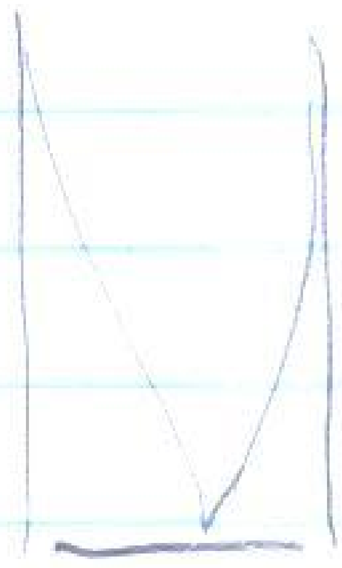
$$\beta_{min} = 10 \log_{10} \frac{I_{max}}{4\ I_0}$$

$$\beta_{min} = \beta_{max} - 10 \log_{10} 4$$

$$\beta_{min} = 60 - 16.6 = 43.4\ dB$$

(9)

P61 - Well - Chp 18



$$\lambda_n = \frac{4L}{n}$$

$$v = \lambda f$$

$$n \frac{v}{4L} = \frac{v}{\lambda} = f$$

$$n \frac{v}{4L} = f_1$$

$$(n+2) \frac{v}{4L} = f_2$$

$$\left(\frac{f_1}{\frac{v}{4L}} + 2 \right) \frac{v}{4L} = f_2$$

$$f_1 + \frac{v}{2L} = f_2 \implies \frac{v}{2L} = f_2 - f_1 = 8.5 \frac{1}{s}$$

$$\frac{340 m/s}{2 \cdot 8.5 \frac{1}{s}} = L = 20 m$$

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Ch 18,

P. 63, P. 61 see page ⑨
③+④

Ch. 16

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