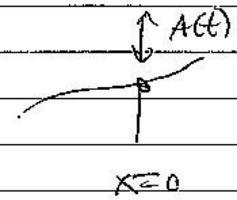
## G 8.1




$$A(t) = D\cos\omega t$$

$$\omega^2 = \frac{T}{\rho} k^2$$

Force of plunger on string

$$F = -2T \frac{\partial\psi}{\partial x}\bigg|_{x=0}$$

$\phi$ STRING EXTENDS LEFT & STRING

$$\psi = D\cos(kx - \omega t) \qquad x>0$$

$$= D\cos(-kx - \omega t) \qquad x<0$$

$$\Rightarrow \boxed{F = +2TDk\sin\omega t}$$

Now,

$$P(t) = -2T \frac{\partial\psi}{\partial x}\bigg|_{x=0} \frac{\partial\psi}{\partial t}\bigg|_{x=0}$$

$$= -2T\left(\frac{-k}{\omega}\right)\left[\frac{\partial\psi}{\partial t}\bigg|_{x=0}\right]^2$$

$$P(t) = +2T\sqrt{\rho/T}\, D^2\omega^2 \sin\omega t$$

$$\Rightarrow \boxed{\langle P(t)\rangle = \sqrt{T\rho}\; D^2\omega^2}$$

Q 9.4 CONT.

AND,

$$F_{\phi R} \propto k'(\psi_-(0,t) - \psi_+(a,t)), \quad (2$$

USING EQ (Ø).

NOW DEAL W/ LHS OF BLK ①.
THE FORCE ON BCK ① FROM LHS:

$$F_{1L} \propto k'(\psi(0,t) - \psi(a,t)) \quad (3)$$

MOCK-UP LHS OF ① SO THAT

$$F_{1L} \propto k(\psi_+(0,t) - \psi_+(a,t)) \quad (4)$$

$$\propto k'(\psi_-(0,t) - \psi_+(a,t)), \quad (5$$

USING EQ (7).

MOCK-UPS ARE JUST A SEMI-INFINI
SERIES OF BLOCKS JOINED BY SPRING
OF SAME K. A GIVEN BLOCK ONLY
KNOWS WHAT HAPPENS TO THE
SPRINGS ATTACHED TO IT.
SUPPORTED NORMAL MODES IN
EACH SECTION OF SPRING DEPEND
ON LOCAL INTERACTIONS & TRANSLATION
INVARIANCE.

G 8.2.

$I(t) = Z\dot{\psi}^2$  w/ $[I]$ = ENERGY / AREA-TIME

w/ $\psi \sim \cos(kx-\omega t)$

NEED TO FIND $Z$. BACK TO CHAP 7.

$v^2_{SOUND} = \gamma P_0/\rho$

$V^2_{STRING} = T/\rho_L$

$Z_{STRING} = \sqrt{T\rho_L}$

BY ANALOGY, $Z_{SOUND} = \sqrt{\gamma P_0 \rho}$  w/ $\gamma = 1.3$

FROM ABOVE

$I(t) = Z A^2 \omega^2 \sin^2(kz-\omega t)$, w/ A = AMP.

$\langle I\rangle = \frac{1}{2} Z A^2 (2\pi f)^2$

$\Rightarrow A = \left[\dfrac{2\langle I\rangle}{4\pi^2 f^2 Z}\right]^{1/2}$

$\langle I\rangle = 1\times10^{-3}\times10^{7}$ ergs/cm$^2$-sec $= 10^4$ ergs/cm$^2$-s

$f = 440$ Hz

$Z = \left[1.3 * 1.01\times10^6 * 1.29\times10^{-3}\right]^{1/2}$ cgs $= 41.2$ cgs

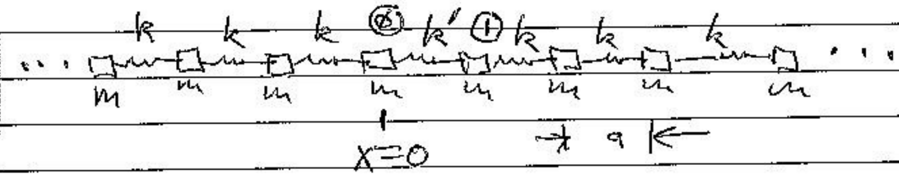
G 8.2

HENCE

$$\boxed{A = 8\times10^{-3}\ cm = 80\,\mu m}$$

G 9.4 MASSLESS BLOCK @ X=0

(a) COMBINE 2 SPRINGS INTO 1
AND REDRAW SYSTEM:




$k' = k/2$ (ADD SPRINGS, k DECREASES)

(b) TO LEFT OF X=0:

$$\psi_- \equiv \psi = A e^{ikx - i\omega t} + RA e^{-ikx - i\omega t}$$

TO RIGHT OF X=a:

$$\psi_+ \equiv \psi = T A e^{ikx - i\omega t}$$

FORCE ON BLOCK $\phi$ FROM RIGHT:

$$F_{\phi R} \propto k' \left( \psi(0,t) - \psi(a,t) \right) \qquad (\phi)$$

MOCK-UP SPRING TO RIGHT OF BLK $\phi$
W/ VIRTUAL SPRING SO THAT FORCE
ON RHS OF BLK $\phi$:

$$F_{\phi R} \propto k \left( \psi_-(0,t) - \psi_-(a,t) \right) \qquad (1)$$

## G 9.4 CONT.

NOW EQS (1) & (2) $\Rightarrow$

$$k\left(\psi_-(0,t) - \psi_-(a,t)\right) = k'\left(\psi_+(0,t) - \psi_+(a,t)\right)$$

$$k\left[(1+R) - (e^{ika} + R e^{-ika})\right]$$
$$= k'\left[(1+R) - T e^{ika}\right] \qquad (6)$$

EQNS (4) + (5) $\Rightarrow$

$$k\left[T - T e^{ika}\right] = k'\left[(1+R) - T e^{ika}\right] \qquad (7)$$

COMBINE/MANIPULATE (6) & (7) AND USE $k' = k/2$:

$$\boxed{R = \frac{1 - e^{ika}}{2 e^{-ika}} \qquad T = \frac{1 + e^{ika}}{2}}$$

NOTE THAT $\left\{\begin{array}{l} R \to 0 \\ T \to 1 \end{array}\right\}$ AS $k' \to k$

FROM (6) & (7).