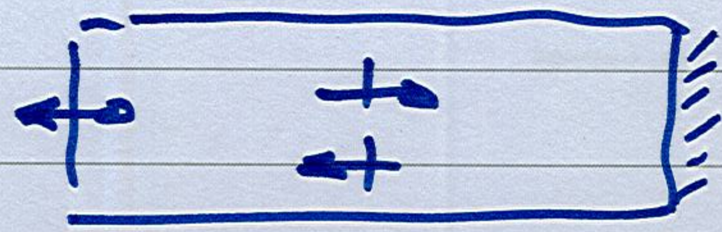
Homework Hints

1.



$x = -1\,m$ $\qquad$ $x = 0$

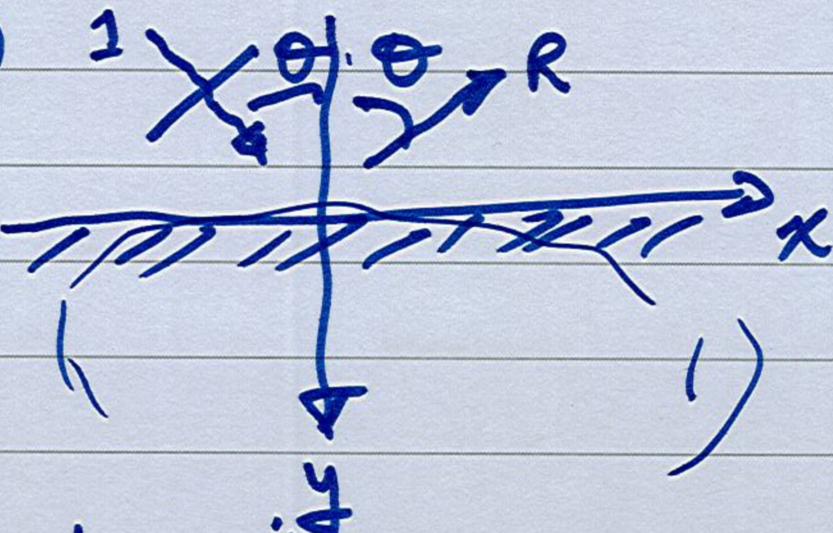
$$\hat{p} = e^{-ikx} \underbrace{+0.8e^{+ikx}}$$

$$\hat{u}_x = -\frac{1}{j\omega\rho_0}\frac{d\hat{p}}{dx}$$

$$I_x = \frac{1}{2}\mathrm{Re}\{\hat{p}\,\hat{u}_x^*\} \qquad \tilde{z} = \frac{\hat{p}(x)}{\hat{u}_x(x)}$$

$$W = I_x S$$

2.

① 

$$p_1 = e^{-jk_x x} e^{-jk_y y} + R\text{~~~~}$$

$$\hat{u}_{y_1} = -\frac{1}{j\omega\rho}\frac{d\hat{p}}{dy}$$

$$I_y = \frac{1}{2}\,\mathrm{Re}\{\hat{p}_1\,\hat{u}_{y_1}^{*}\} \qquad y = 0$$

3. $$\tilde{p}(x,t) = A\underline{e^{-\alpha x}}\, e^{-j\beta x}\, e^{i\omega t}$$

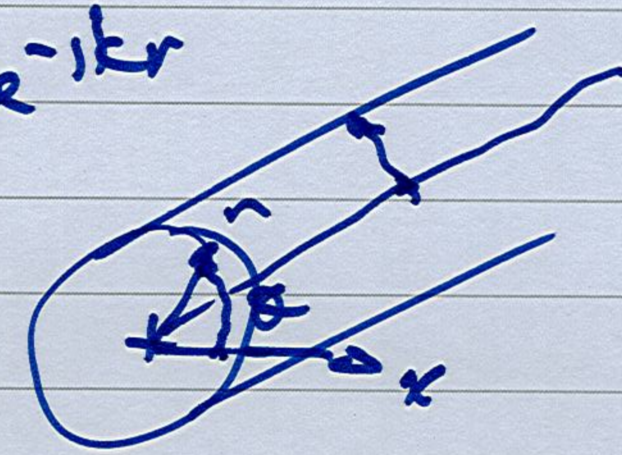
$$= A\, e^{-jkx} e^{i\omega t}$$

$$k = \beta - j\alpha$$

$$\hat{\tilde{u}}_x = -\frac{1}{j\omega\rho}\frac{d\tilde{p}}{dx} \qquad \neq \frac{\tilde{p}}{\rho c}$$

$$I_x = \frac{1}{2}\mathrm{Re}\{\tilde{p}\,\hat{\tilde{u}}_x^*\}$$

4. $\tilde{p}(r,\theta) = \dfrac{A}{r^{1/2}} \sin\theta \, e^{-jkr}$



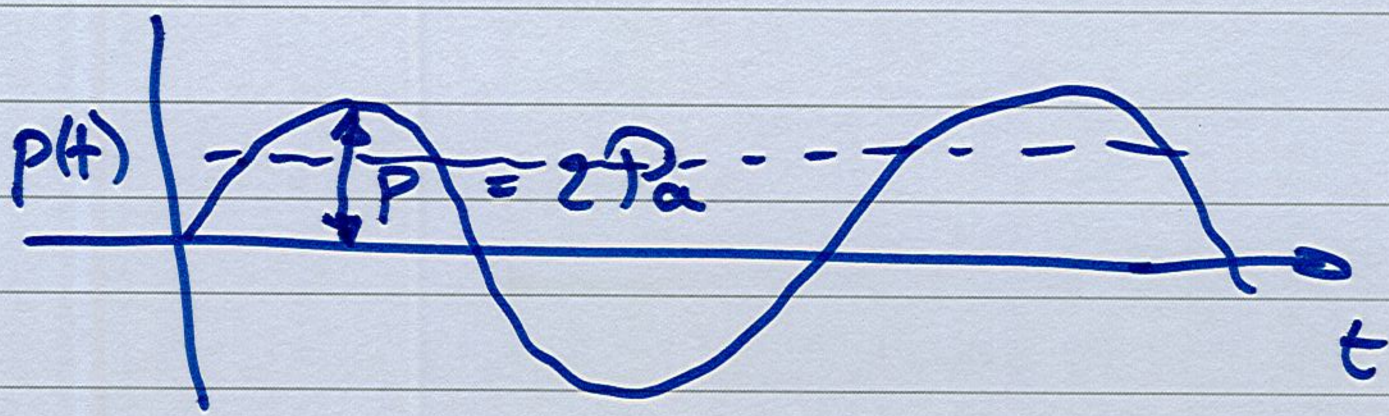
$\bar{u} = -\dfrac{1}{j\omega\rho} \nabla \tilde{p}$

see page 520

$I_r = \frac{1}{2} \mathrm{Re}\left\{ \tilde{p}(r,\theta)\, \tilde{u}_r^{*}(r,\theta) \right\}$

$\tilde{Z}_r = \dfrac{\tilde{p}(r)}{\tilde{u}_r(r)}$ find limit as $kr \to \infty$

5.12.3



$$p_{rms}^2 = \frac{|P|^2}{2}$$

$$L_p = 10 \log_{10} \frac{p_{rms}^2}{p_{ref}^2}$$

"particle speed"

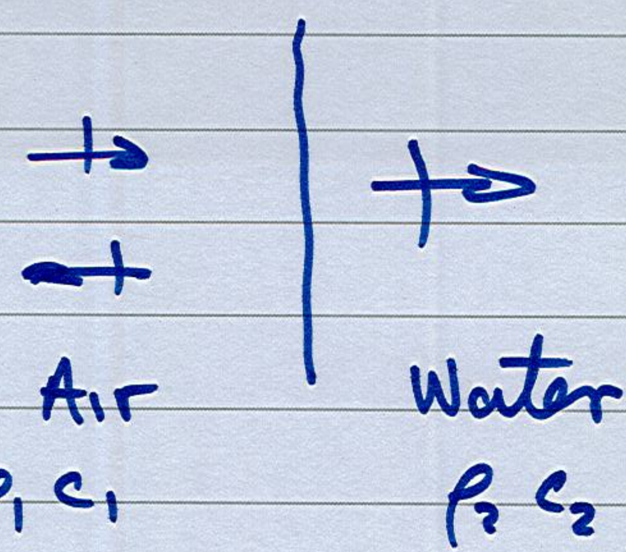
particle velocity

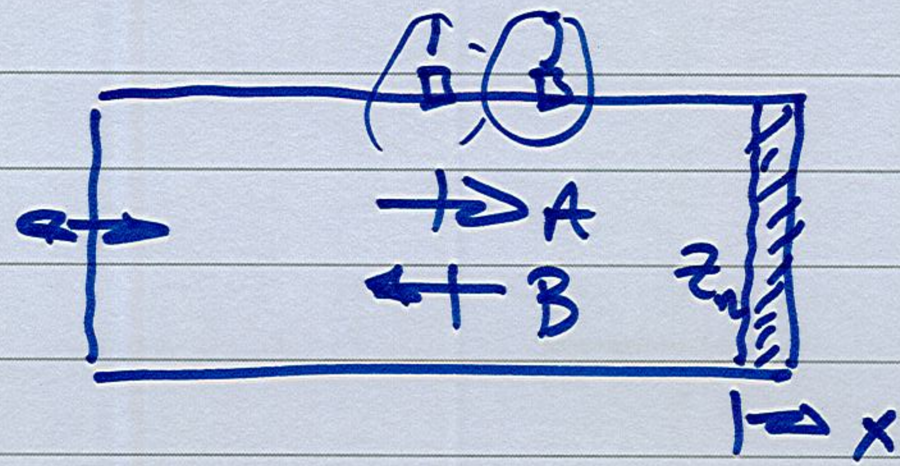
4.0 Fundamentals of Reflection & Transmission

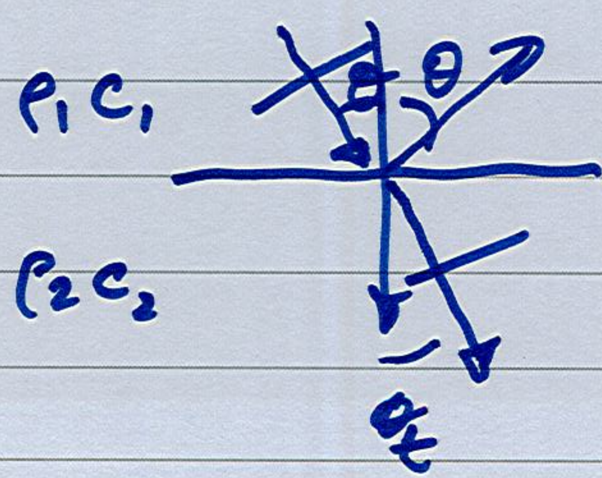
Chapter 6

4.1 Introduction

Two fluid




A
B
Z_n
x


$\rho_1 c_1$
θ
$\rho_2 c_2$
θ_t

<u>Cases:</u>

① Sound in a semi-infinite medium hitting a second ~~sem~~ semi-infinite medium

$\rho_1 c_1 \mid \rho_2 c_2$

(1a) finite depth intermediate layer

$\rho_1 c_1 \;\big|\; \rho_2 c_2 \;\big|\; \rho_3 c_3$

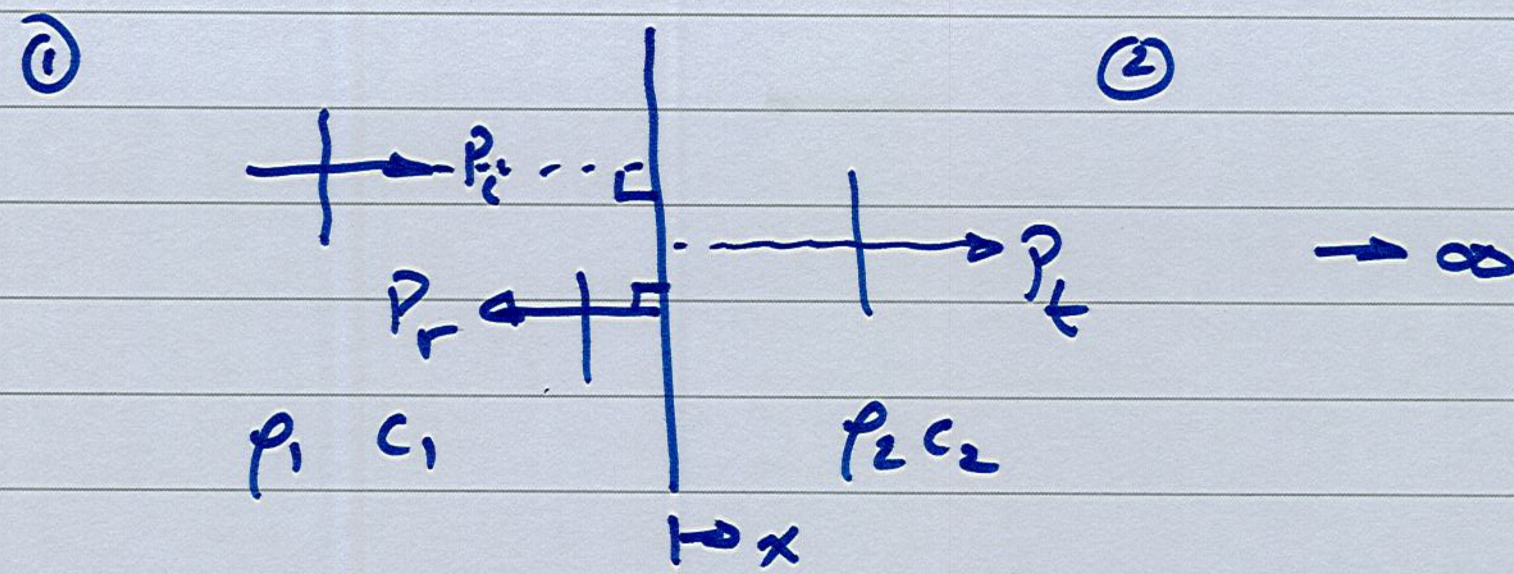
② Sound transmission through a <u>limp</u> barrier

③ Reflection from an <u>impedance</u> surface.

Application

- predict sound transmission
  - walls
  - aircraft fuselage
  - ships
- absorption & reflection from interior & exterior surfaces.

4.2 Normal Incidence Reflection and Transmission (two fluid)



$$\nabla^2 \hat{p}_1 + k_1^2 \hat{p}_1 = 0 \qquad \nabla^2 \hat{p}_2 + k_2^2 \hat{p}_2 = 0$$

$$k_1 = \frac{\omega}{c_1} \qquad k_2 = \frac{\omega}{c_2}$$

$$\hat{p}_1 = P_i e^{-ik_1 x} + P_r e^{+ik_1 x}$$

$$\hat{p}_2 = P_t e^{-ik_2 x}$$

$$\hat{u}_1 = \frac{P_i}{\rho_1 c_1} e^{-ik_1 x} - \frac{P_r}{\rho_1 c_1} e^{+ik_1 x}$$

$$\hat{u}_2 = \frac{P_t}{\rho_2 c_2} e^{-ik_2 x}$$

3 constants P_i, P_r, P_t

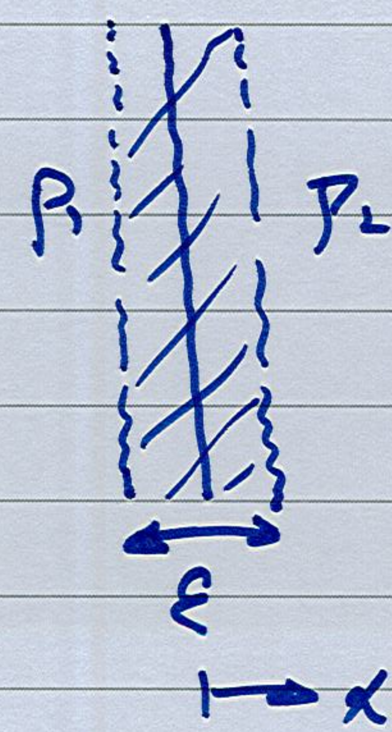
usually normalize wrt. P_i

2 b.c.'s

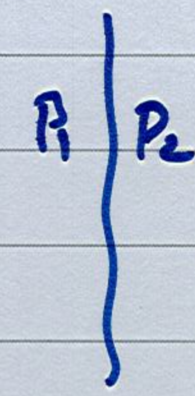
2 unknowns

$$\frac{P_r}{P_i} = R \qquad \frac{P_t}{P_i} = T$$

(i) Pressure Continuity Eqn.

① 

②



$$\tilde{p}_1 - \tilde{p}_2 = \underbrace{m_s}_{\text{mass/unit area of layer Thickness } \varepsilon} \tilde{a}$$

b.c. ①

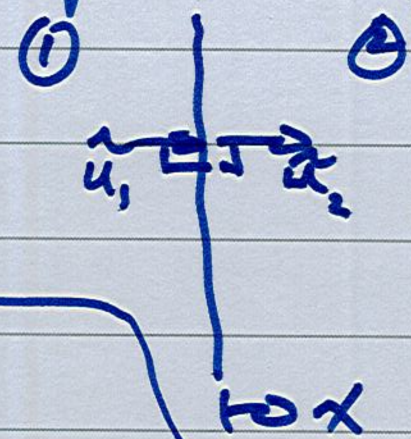
$$\boxed{\tilde{p}_1(0) = \tilde{p}_2(0)}$$

$$\tilde{a} = \frac{\tilde{p}_1 - \tilde{p}_2}{m_s}$$

when $\varepsilon \to 0$ $\quad m_s \to 0$

$\tilde{a} \to \infty$ if $\tilde{p}_1 \neq \tilde{p}_2$

(ii) Velocity Continuity B.C.



$$\boxed{\hat{u}_{1_n}(0) = \hat{u}_{2_n}(0)}$$

for the two fluids to remain in contact

B.C. 2

harmonic

$$\cancel{j\omega}\,\hat{\xi}_{1_n}(0) = \cancel{j\omega}\,\hat{\xi}_{2_n}(0)$$

$\therefore$ displacements are also continuous

Notes:

1. since $\dfrac{\hat{p}_1(0)}{\tilde{u}_{1n}(0)} = \dfrac{\hat{p}_2(0)}{\tilde{u}_{2n}(0)}$

$$\left.\frac{\hat{p}_1}{\tilde{u}_{1n}}\right|_{x=0} = \left.\frac{\hat{p}_2}{\tilde{u}_{2n}}\right|_{x=0} = \left.\tilde{z}_1\right|_{x=0} = \left.\tilde{z}_2\right|_{x=0}$$

normal specific acoustic impedance is continuous