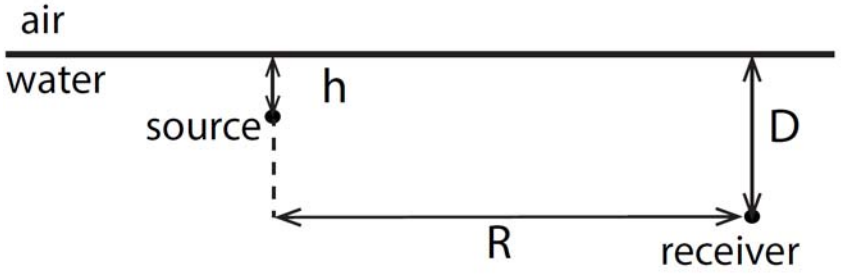
PhD Qualifying Examination in Acoustics

Two-hours, closed-book

Examinees are permitted a one page crib sheet

Answer all parts of all three questions

1) Consider a time-harmonic monopole of frequency ω and source strength Q located underwater at a distance h from the surface. A receiver is located at distance D from the surface. The horizontal separation between the receiver and the source is R.

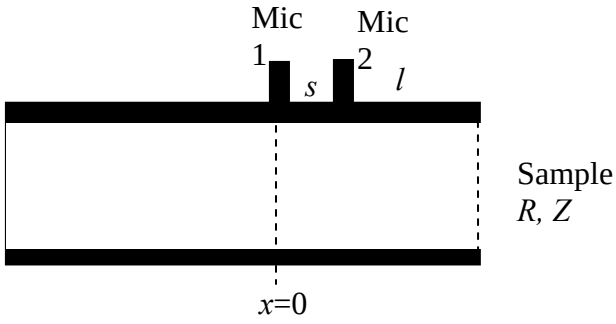


1. (1 points) What is expression for the pressure at the receiver if $kD \gg 1$ and $kh \gg 1$
2. (3 points) Determine a general expression for the pressure at the receiver, for arbitrary values of *D*, *h*, and *R*.
3. (4 points) Assume now that $R \gg h$. Derive a simplified expression for the pressure at the receiver
4. (2 points) Demonstrate that if $R \gg h$ and $R \gg D$, the amplitude of the pressure at the receiver is inversely proportional to R^2 .

2) A simple sound source radiates harmonic diverging *spherical waves* into air at 20°C with 10 watts of acoustic power at a frequency of 500 Hz. Determine the following at a distance from the source of 1 m. In the following, please ensure to specify appropriate units

a) Average intensity
b) Pressure amplitude
c) Particle velocity amplitude
d) Particle displacement amplitude
e) Energy density
f) Condensation
g) Sound Pressure Level

3) Consider the two-microphone impedance tube method for determination of the complex reflection coefficient and acoustic impedance of a material. The method employs two microphones spaced a distance *s* apart, and with *l* the distance from the material to the closest mic.



1) Considering plane waves of frequency ω incident from the left, derive an expression for the complex reflection coefficient of the sample in terms of the transfer function between the two microphones,

$$H_{12} = \frac{P_2}{P_1}$$

Hint: In this problem, you "know" identically the reflection coefficient of the termination. Therefore you know identically the pressure distribution that *should* exist in the tube. Hence, you know the pressure at each individual mic, and can analytically calculate the transfer function that *should* have been measured.

2) What is the relationship between the reflection coefficient and the impedance at the termination of the tube?