

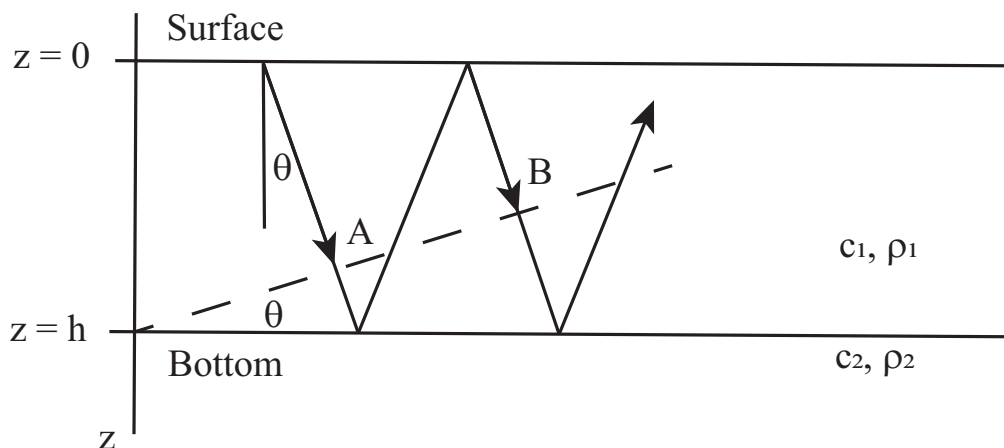
## P6317 Assignment III

Due, Friday, April 8, 2022

- 1) [5] You are calibrating a circular piston source of radius 20 cm over the frequency range from 5 kHz to 50 kHz. How far away from the source should the test hydrophone be placed in order to avoid near-field effects?
- 2) [5] A typical hydrophone has a sensitivity of about  $S = -170$  dB (re  $1 \text{ V}/\mu\text{Pa}$ ). You paid \$2000 for the preamplifier and it has a noise level of 20 nV (that means that if a signal is bigger than 20 nV you can see it). At what maximum range can you expect to detect a 100 dB (re  $1 \mu\text{Pa}$ ), 10 kHz source? (assume spherical spreading and use an absorption value of 0.001 dB/m).
- 3) [5] In class, we considered the problem of how the ray model could relate to the problem of sound trapped in a layer that is thin compared to the wavelength. With reference to the figure below, in order for a wave “mode” to lead to constructive interference, we require the phase of points A and B to be the same. Show that for this requirement to be met,

$$\Delta\phi = \frac{kh}{\cos\theta} + \frac{kh}{\cos\theta} \cos 2\theta - \epsilon - \pi = 2(n-1)\pi$$

where,  $k$  is the wavenumber,  $h$  is the bottom depth,  $\theta$  is the incidence angle, and  $\epsilon$  is the phase change occurring at the bottom, and “n” is some integer.



- 4a) [8] For the 200 kHz echosounding record shown on the following figure, label the bottom, the surface, the location of fish schools and individual fish. If the sound speed is 1475 m/s, what is the minimum depth shown in the echosounding. Explain the cause of the “multiple” bottom expressing where you would expect it in apparent distance (or time) compared to the real bottom. Comment on the accuracy of the depth given that the sound speed has been fixed at an arbitrary value. For a reasonable range of sound speeds, what uncertainty should be assigned to any given depth?
- 4b) [2] If the vessel making the echosounding is traveling at 3 m/s, what is the maximum bottom slope in this area. How does this slope compare with the apparent slope of the bottom in the echosounding?

