Physics for future Presidents

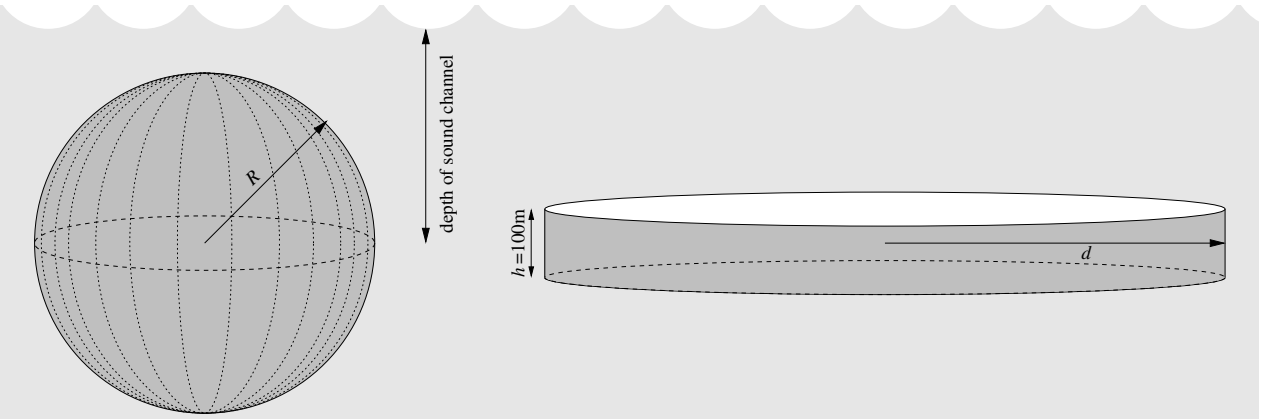
Department of Physics, Carnegie Mellon, Deserno

Homework 11, due in recitation on Thursday, October 24th

The deep ocean sound channel

In class we have learned that Maurice Ewing used the physics of the deep ocean sound channel to located pilots who were shot down over the pacific during WWII. If they dropped a SOFAR sphere, which imploded in the sound channel and thus sent of a loud "ping!", this sound could be heard much farther than if the sound channel didn't exist. In this problem we will convince ourselves that this is actually true.

Assume first of all that the navy built an underwater microphone which could hear a distant "ping!" up to a distance of 10 kilometers *in the absence of any channeling effect*. In other words, if the waves spread out *spherically*, you can hear the "ping!" for 10 kilometers. Now, if we create the sound in the middle of the sound channel, the waves will spread out essentially along a circle, but let's be a little bit more precise. Say that the sound channel is about 100 meters wide (in vertical extent) and that the waves spread vertically for these 100 meters, and of course also radially for as far as they go. At what radial distance from the "ping!" has the wave energy dropped down to the threshold value which the navy's microphone, also placed into the sound channel, can just about pick up?



Spreading of sound in the *absence* of a sound channel

Spreading of sound in the *presence* of a sound channel

Hints:

- *You don't know the energy released by the "ping!". It will turn out that at the end of the day you don't need that information, but if you feel you need it along the way, just call it "E".*
- *The energy picked up by the microphone is only that fraction of the initial ping-energy that hits the area of the microphone, compared to the area over which the ping-wave has diluted. You don't know the area of the detecting microphone, and again you won't need it. But if you feel you might need it in order to reason out your answer, just call it "A_{mic}".*
- *You're looking for the maximal distance that you can hear in the sound channel. Call it "d".*