Passage 7 - Data on the physics of hearing (physics)

Overall:
-'human threshold of hearing' defined - <u>minimum*</u> intensity at a certain frequency that is required for hearing
-'human threshold of pain' defined - <u>maximum*</u> intensity at each frequency that we can hear without pain
-both are about intensities, which are plotted on the x-axis below

-'S' defined - the percent increase in air density and water density… etc at given intensities

-sound intensity, decibels, dB
-frequencies, Hertz, Hz, 1Hz = 1cycle/sec

Figure:
-There are multiple lines and axes showing different things on the same figure

-x-axis label, intensity (db), from -20 - 240
-y-axis label, frequency (Hz).
-in the y-axis, the numbers ('scale') are complicated, using scientific notation and some kind of shorthand. 2, 4, 6, 8, then the number $1x10^1$, which is 10. The next set of numbers use the same format - $2x10^1$ (20), $3x10^1$ (30), etc. Then $1x10^2$ (100), which is followed by 2, 4, 6, 8. We have to assume this is an abbreviation for $2x10^2$ (200), 300, 400, 600, 800. Then 10^3 (1000), 2 again for 2000, and on and on.
Note: take the time to look at the axes and, if they are confusing like this one, pause as long as necessary to decipher what they mean. If it isn't straightforward, you can guarantee there will be a questions about it!

-at the top of the figure there is a third 'axis' with the labels $S=10^{-8}$ %, $S=10^{-2}$ %, $S=10^{-1}$ % and S=100%
-this third axis refers to the vertical dotted lines, labeled in the key as 'in air' and 'in water', meaning the S (% increase in density) in air and the S in water.
-for a given S, the S in water is at a slightly higher intensity than in air.
-as the intensity <u>increases</u>, the S <u>increases</u> (from .0000001% to 100%)

-the threshold of hearing is a curve with two endpoints.
-humans cannot hear below 20Hz or above ~25000Hz (this is where the curve 'threshold of hearing' has endpoints)
-humans are able to hear frequencies in the middle of our range even when they are quiet (low intensity) but high and low frequency sounds must be loud (have a high intensity) in order to be heard

-the threshold of pain is virtually vertical.
-because the threshold of pain is vertical, it is not dependent on frequency. At nearly all frequencies, humans feel pain if the sound has an intensity greater than approx. 120dB.

Notes:
-This is a challenging figure to interpret, especially for students who are unfamiliar with sound waves and the concepts of intensity and frequency.
-Curves are difficult to interpret. Here, try tracing the 'threshold of hearing' with your finger from the bottom to the top. Pause every couple of points to think about how your finger has moved as you go along the curve. As you go up the curve (increasing frequency), the curve goes to the left (decreasing intensity), then straight up (constant intensity), then curves back to the right (increasing intensity).
*- 'threshold' may be an unfamiliar word, and it may be difficult to know if the part that humans can hear is to the left or to the right of the curves. In the introductory material, it says the threshold of hearing is the minimum (so humans can hear to the right of this curve) and the threshold of pain is the maximum (so humans can hear to the left of this curve.
Therefore, humans can hear without pain the range of sounds in between the two solid lines