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- **Threshold of pain is 120 – 130 dB**
- **The dynamic range of human hearing extends from zero dB to the threshold of pain.**
- **Example: Problem 43P, Chapter 18, Halliday/Resnick/Walker, 5th edition (the subsonic jet)**

	Intensity level (dB)
Ear drum rupture	160
Pain threshold	120-130
Shotgun blast	100
Car horn (6 m distance)	90
City street	75
Typical room	40
Open country	10
Threshold of hearing	0

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- **The audible sound:** a pressure wave with frequency between 20 Hz and 20,000 Hz and with an intensity above the standard threshold of hearing:

- Frequency: 20 Hz - 20,000 Hz (corresponds with pitch)
- Wavelength (at 20°C in air): 0.0172m – 17.2 m
- Intensity: 10^{-12} - 10 W/m^2 (0 to 130 dB)
- Pressure: (2 x 10^{-5} – 60) N/m^2; (2 x 10^{-10} - 0.0006) atm
- **Sounds may be generally characterized by:**
  - **Pitch (frequency)**
  - **Loudness (is NOT simply the intensity level)**
  - **Quality (timbre – determined by the harmonic content of the sound)**

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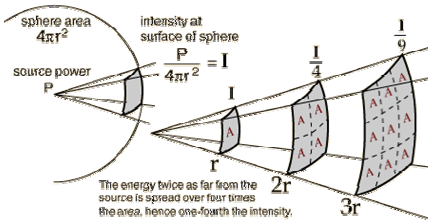
- **Variation of sound intensity with distance: the inverse square law:**



The wave form of a spherical sound wave is: $s(r,t) = \frac{b}{r}\sin(kx - \omega t)$

(see example used in Lecture 12: Problem 38P, Halliday/Resnick/Walker, 5th edition)

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- **Structure of the human ear**