

Module on Sound: A Draft Outline

Soumya Chakravarti (schakravarti@gmail.com)
March 2010

1. This draft outline is presented for critical and constructive input from readers who will eventually be the contributors to this module. Please feel free to add your signed comments, corrections and criticisms BELOW each original text.

That way all readers may see the inputs of all contributors.

2. The way I view it, the topic of Sound is best introduced to a student by first discussing naturally occurring phenomena involving sound. This the student can relate to most easily. After this introductory discussion we will introduce the concepts and the language that physicists use to describe sound.

3. The module may be divided into submodules in the introductory discussion:

- (a) The source of sound.
- (b) The propagation of sound.
- (c) The role of the medium in the propagation of sound.
- (d) The reception of sound.

4. The Source:

How do you make sound? 5 ways come to mind :

- Speak/sing
- Strike
- Stroke
- Bow
- Blow

Note: All of these are components of music and the underlying basis is vibration. A discussion of vibration on each of the 5 points above with reference to musical instruments (including voice) can be introduced here.

A discussion of the vocal cords also naturally belongs here. (Biology)

5. The Propagation:

How does sound travel? Can we 'see' sound travel?

Examples of

- Lightning and thunder (A cute way to measure the speed of sound from thunder needs to be placed somewhere below)

- Echoes

Waves travel: water waves in a pond or in the ocean are 'seen'.

(Will help later connect to the idea that sound is a wave.)

6. The medium:

- Air (the most common medium). Common property shared by gases.

- Water (Shared all liquids). (Discussion of whale communication?)

- Solids (strike at one point of a rail line or long metal bar and hear the sound at a distant point by putting the ear against the bar)

Doesn't work equally well for metals and non-metals.

>> Question: Can we find appropriate do-yourself examples for students for each of these discussion points?<<

7. The reception

- The ear (natural). Discussion on the biological aspects here.

- The microphone (human-made) Discussion on the technology of the microphone here.

Common property: Mechanical response to vibration. The underlying theme is Energy and its transformation from one form to another.

Points to ponder: Sound is a good candidate to be described as a wave. Sound is transfer of energy across space. Sound needs a medium.

8. At this point we can begin the physical description of waves. The usual point at which textbooks begin.

9. Describing waves:

First, qualitative: Loudness, pitch, quality of sound (pure versus mixed)

Next, quantitative: Speed, Wavelength, Frequency, Amplitude. Requires discussions of a periodic wave, a pure wave (single frequency).

Relation between Speed, Wavelength, Frequency.

What do we mean by sonic, subsonic, ultrasonic sound? What are their applications (sonar etc)?

Further: Superposition of waves. Independence of waves (Superposition Principle). Consequences of superposition.

Connection between qualitative concepts of loudness, pitch, quality and quantitative concepts of frequency, amplitude, superposition. (decibels here? probably later - under 11 below)

Transverse and Longitudinal waves - The latter is a point of abstraction and hence confusion.

Which class of waves is sound, T or L? How do we know? A physical model of a pressure wave here.

Connection between a wave and the vibration of particles in the path of the wave. (Necessarily involves math - belongs under 11?)

10. Other features of sound:

- Diffraction (bending around corners: "I can hear you talk in the next room but I cannot see you!" - an interesting discussion about the comparative size of wavelength of a wave and the size of the gap through which it passes.)

- Doppler Effect. (Discussion on the general property of Doppler effect - implications for light and astronomy.)

- Resonance (A vast territory. Will have to be selective in picking and presenting)

- Connection between speed and property of the medium.

11. The math of sound waves. I am leaving this open because I don't know at this time how much mathematical manipulation is included the syllabus.

12. I must have overlooked other important topics. Please fill in. Thank you.