



Waves, Electrons & Sounds

Izad Khormaei, November 4, 2006
Engineering Department
Clark College

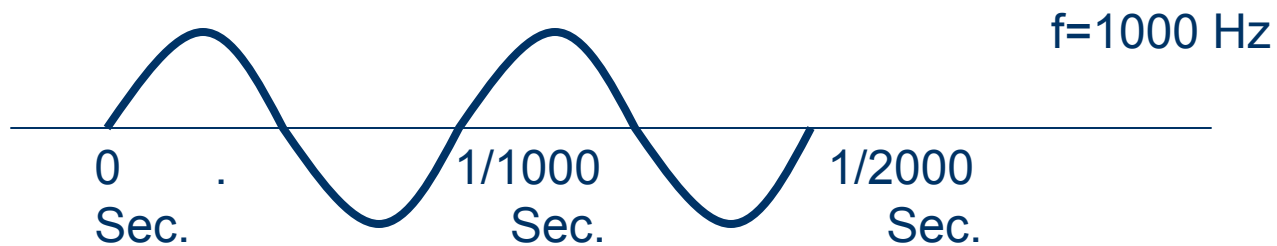
Topics

- Wave Characteristics
- Frequency Spectrum
- Application example(s)

Wave Characteristics

- Frequency in Hertz, f
 f = number of times a repeats in one second.

Example:

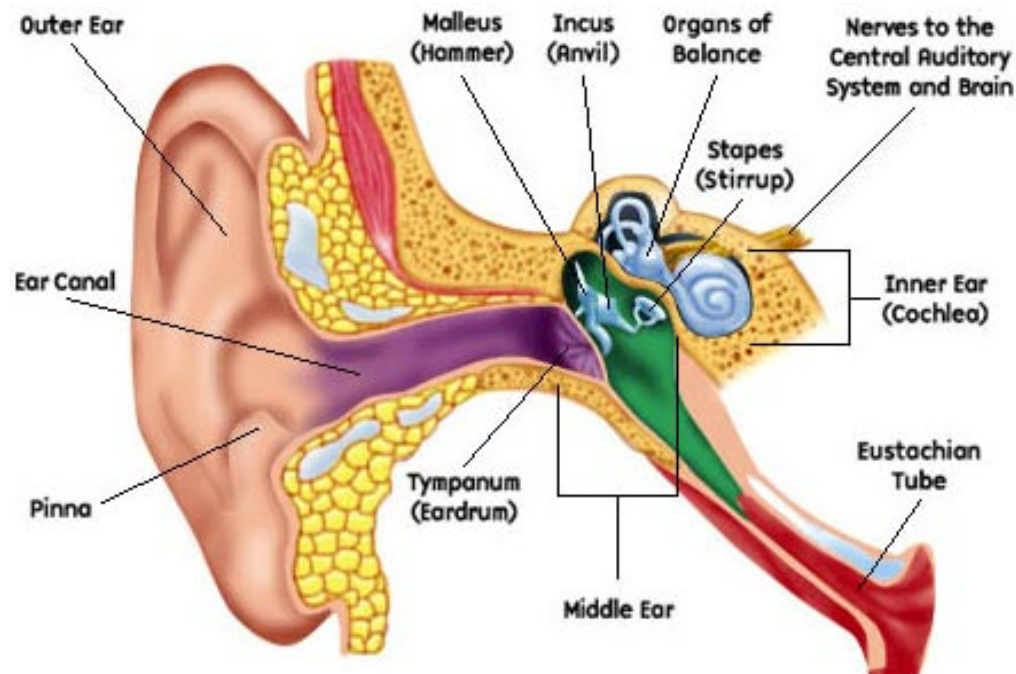


- Wave length $\lambda = \text{“speed of light”} / f$

Example: $\lambda = 300,000,000 / 1000 = 300,000$ meters

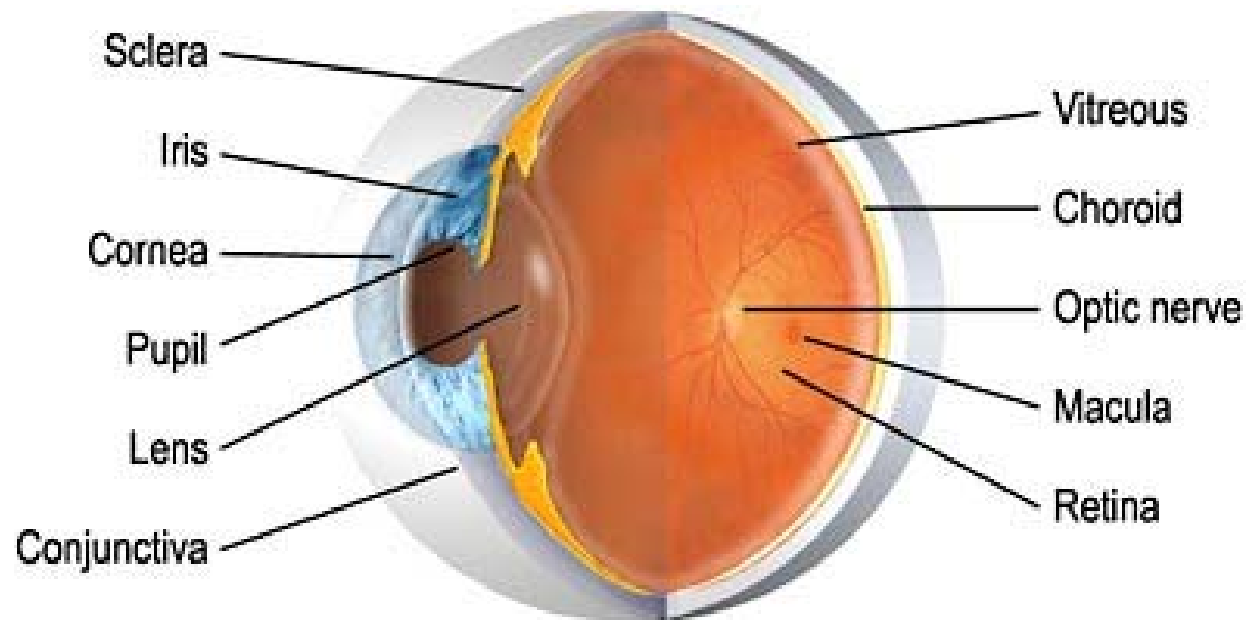
What can we hear?

- Perfect hearing range: 20 – 20,000 Hertz
- Typical hearing range: 100 -15,000 Hertz



What can we see?

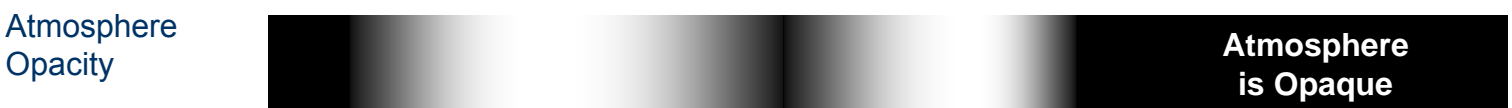
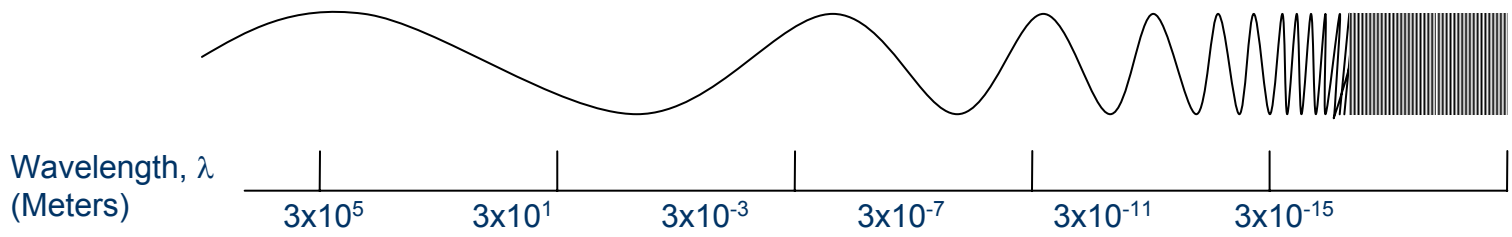
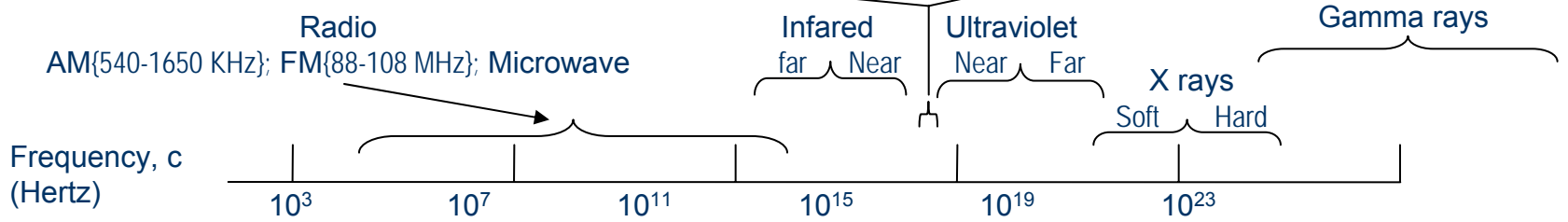
- Range for visible light: 3×10^{14} - 7.5×10^{14} Hz



Frequency Spectrum



Visible {Freq : $3 - 7.5 \times 10^{14}$ Hz; Wavelength: 700 – 400 nanoMeter}



Radio Window
f: 2×10^7 to 2×10^{10} Hz
λ: 20 to 2×10^{-2} Meters

Optical Window
c: 3×10^{13} to 3×10^{15} Hz
λ: 10^{-5} to 10^{-7} Meters

Atmosphere is Opaque

Experiment

“Paper Cup Speaker”

Experiment: Paper Cup Speaker



Sound Generation

1. The alternating current from the source flows through the wire in a circular pattern.
2. This creates an alternating magnetic field through the center of the coil.
3. As the magnetic field through the loop of wire changes, the permanent magnet repels and attracts the coil of wire.
4. This action causes the bottom of the cup to vibrate.
5. The vibration in the bottom cup causes the air pressure to change through the body of the cup, creating sound waves.



Experiment: Hear & See Sound Waves

- Turn on the signal generator (1 Volt, 1000 Hertz) and connect the Ogden speaker.
“What are you hearing?”
- Connect the oscilloscope to the signal generator.
“What are you seeing?”

Generate Sine Waves

- Start up MATLAB Program and type the following text in the command window:

```
>> t=[0:1:2000];  
>> plot (t, sin(2*pi*t/1000))
```

- Compare what you see on the screen with the sound you heard from the speaker and the sound that you saw on the oscilloscope.

Experiment

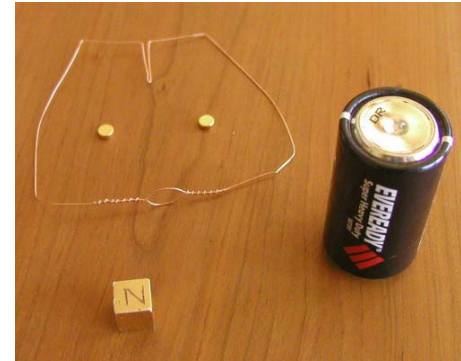
“Self-Contained Motor”

Experiment: Self-Contained Motor

Build a motor using:

- Three magnets
- A 20" piece of copper wire
- A D-cell battery

Components

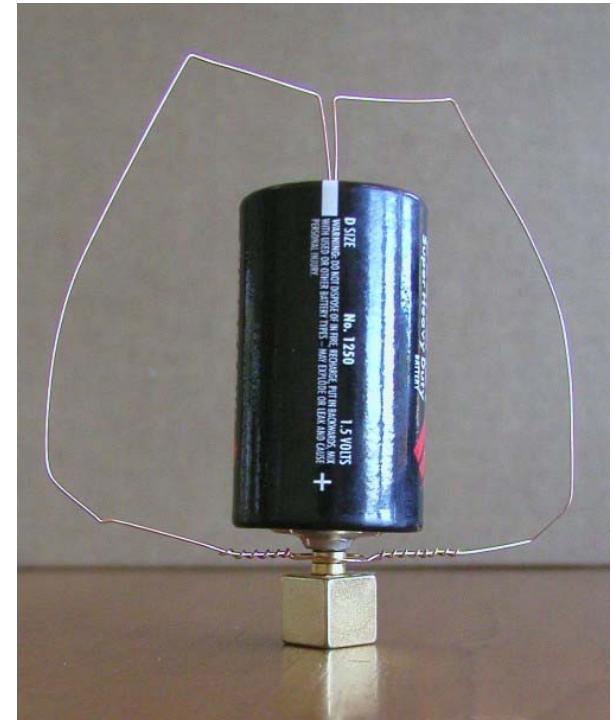


These VERY powerful magnets are made from an alloy of the rare earth element Neodymium, along with Iron and Boron. This is the most powerful permanent magnet alloy known.

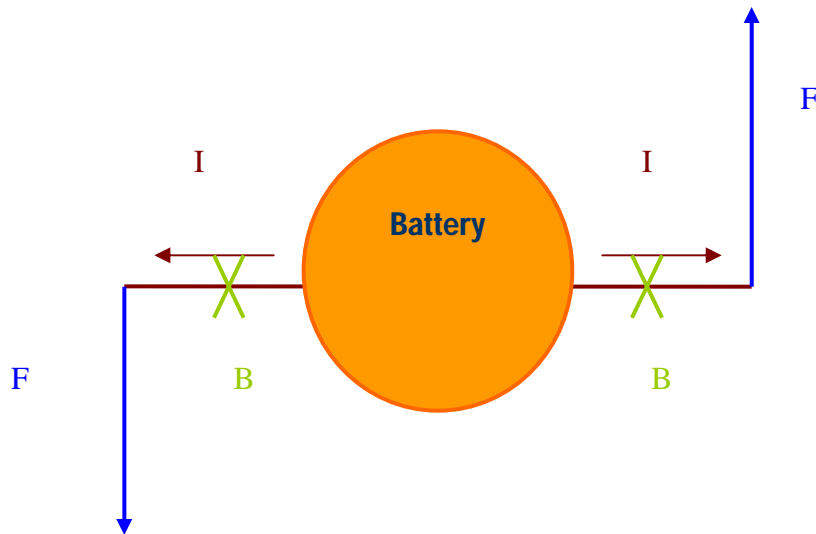
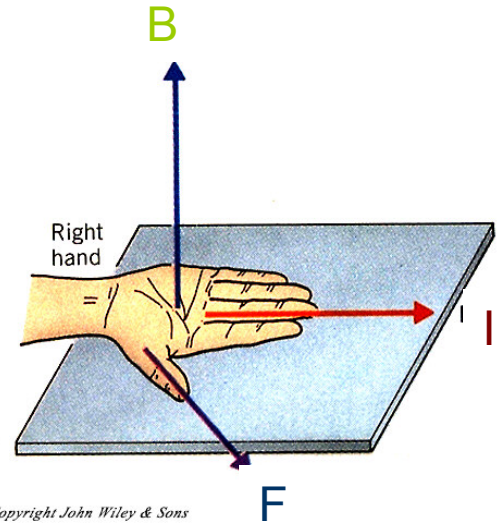
Instructions

1. Place the two small disk magnets together.
2. Place the two disks on top of the north pole of the cube magnet.
3. The loop in the bottom of the wire form is then placed on top of the two disks. The loop is just barely larger than the disks.
4. Place the positive pole of the battery on top of the disk magnets.
5. Place the pointed end of the wire form in the dimple at the top of the battery. Be careful, wire may be hot!
6. When the whole structure is balanced on the cube magnet, the wire begins spinning around the battery as is shown in the picture.

Hint: Forces generated are small, so make sure that the wire can turn freely.



How does it work?



F=Force

B=Magnetic Field

I= Current

Bottom view of battery without magnets

Theory in Words

1. The current from the battery is flowing outwards from both sides of the wire.
2. This creates a magnetic field around the wire. This field interacts with the field from the cube magnet and the disks.
3. The wire's field creates a force at right angles to the field from the magnets. This causes the right side of the wire to be pushed towards you, and the left side to be pulled away from you.
4. This action continues until the battery runs down.