

Period 18 Activity Sheet Solutions: Information Transfer

Activity 18.1: Information Transfer Using Electrical Energy

a) Loudspeakers

- 1) Briefly connect the loudspeaker on your table to a 1.5 volt battery. Place your hand on the speaker as someone quickly connects and disconnects the battery. What do you feel? What happens to the loudspeaker cone as you connect and disconnect the battery?

The loudspeaker cone moves as you connect and disconnect the battery.

- 2) What makes the loudspeaker cone move?

A current flows through a coil of wire, which is connected to the cone of the speaker. A permanent magnet in the loudspeaker exerts a force on the current in the coil. The current thus experiences a force, whose strength is proportional to the amount of current. The coil moves in a pattern, which is the same as the pattern of the current in the coil.

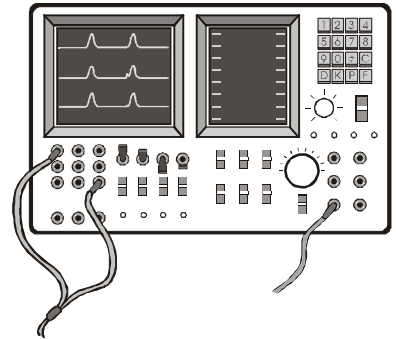
b) Microphones

- 1) Your instructor will demonstrate a microphone connected to an oscilloscope. Draw or describe the pattern you see on the oscilloscope screen when the microphone is not in use.

The pattern is basically a flat line with some interruptions from background noise in the room

- 2) What happens to the pattern on the screen when someone speaks into the microphone?

The pattern changes as the person speaks. The changing pattern on the oscilloscope screen shows the electric current produced by the microphone.



- 3) How is sound transferred by a microphone?

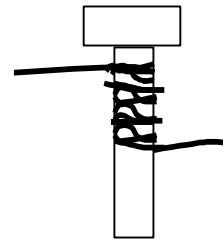
Pressure waves from sound cause a coil of wire to move near an electromagnet. The motion of the coil in the magnetic field of the magnet induces a changing current in the coil of wire. Information from the pattern of sounds moving the magnet is turned into a changing electric current. You see the results of these patterns on the oscilloscope screen.

- 4) How is a microphone similar to loudspeaker? How do they differ?

Both microphones and loudspeakers use induced current and magnetic fields to make energy conversions between sound waves and a changing current. They both use coils of wire in a magnetic field and permanent magnets to do so. However, a microphone converts sounds waves into a changing current, while a loudspeaker converts a changing current into sound waves.

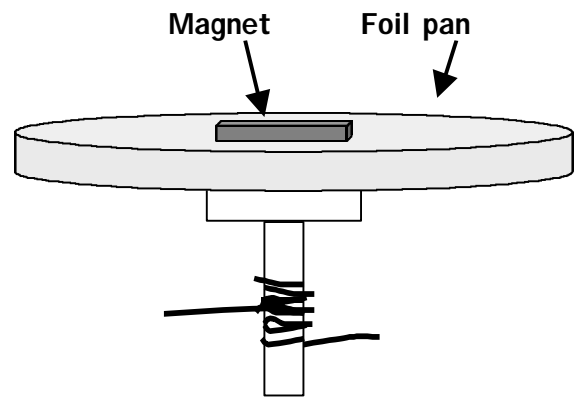
c) **Building a loudspeaker**

- 1) Cut a piece of wire about 3 meters long. Wrap the wire around the top half of the bolt, leaving about 10 cm of each end of the wire free.



- 2) Using sandpaper, scrape the insulating coating off of about 5 cm of each end of the wire.

- 3) Place the head of the bolt against the bottom of a foil pan.
- 4) Place a magnet on the other side of the pan so that the magnetic attraction between the bolt and the magnet holds the pan in place.



- 5) Attach the ends of the radio leads to the ends of the wire wrapped around the bolt.

- 6) What do you hear when you turn on the radio?

You should hear sound from the radio coming from your speaker.

- 7) Explain how your loudspeaker works.

A changing current from the radio flows through the connecting wire from the radio to the wire wrapped around the bolt. The wire and bolt form an electromagnet with a changing magnetic field. This changing magnetic field exerts a force on the permanent magnet, attracting and repelling it. The movements of the permanent magnet vibrate the foil pan, producing sound waves.

- 8) How is the loudspeaker similar to the buzzer you built in Period 16?

The buzzer has a similar electromagnet made from a nail wrapped in wire. The changing magnetic field from this electromagnet exerts a force on a nonmagnetic wire, alternately attracting and repelling the wire. The wire's vibrations open and close the circuit, producing a changing current. In the loudspeaker, a changing magnetic field in an electromagnet attracts and repels the permanent magnet on the pan, causing it to vibrate and produce sound waves.

d) **Telephone Pickups (Optional Activity)**

- 1) Place the two telephone pickups several centimeters apart. Be sure that one pick up is connected to the oscilloscope and the other is connected to the generator. What happens when the pickups are moved near one another?

When the pickups are placed close together, a wave pattern appears on the oscilloscope screen. The wave results from the changing current in the "receiving" pickup.

- 2) When held close together, the two pick ups act like a transformer. Explain how information could be transferred from one pick up to the other.

A changing current in the "sending" pickup's wire induces a magnetic field in the space around it. That magnetic field exerts a force on the magnetic field surrounding the "receiving" pickup's current-carrying wire. This magnetic force modulates (changes) the current in the receiving pickup's wire.

e) **Carbon Telephone (Optional Activity)**

- 1) Try the Styrofoam cup "telephones." Turn on the amplifier that is connected between the cup and the loudspeaker. Have one person speak into the cup while someone else listens at the speaker. Describe what happens.

If you put your ear close to the speaker, you can hear the person's voice coming from the speaker.

- 2) Use an analog multimeter to measure the resistance of the cup. Connect the meter leads to the terminals at the bottom of the cup. What happens to the resistance as you speak into the cup?

The resistance changes as the pressure waves from your voice cause the carbon granules in the cup to move.

- 3) How could a change in resistance of the carbon in the cup affect the loudspeaker?

The amount of current flowing through a circuit depends on the voltage and the resistance. In this circuit the voltage is constant. As you speak into the cup, the resistance changes, so the amount of current flowing through the circuit, and thus through the speaker, changes.

Activity 18.2: Information Transfer Using Radiant Energy

a) **Free play radio**

- 1) Examine the free play radio. List the energy conversions that take place when the radio is operated from its solar cell.

Radiant energy (from the floodlight) to electrical energy (in the solar cell) to sound energy (in the radio's loudspeaker)

- 2) List the energy conversions that take place when the radio is operated by turning the crank.

Chemical potential energy to kinetic energy of motion to strain energy to kinetic energy to electrical energy to sound energy

- 3) What type of energy transfers information from a radio station transmitter to the radio?
__electromagnetic energy (radio waves)__

b) Energy transfer with beams of radiant energy

Your instructor will demonstrate energy and information transfer with a laser beam.

- 1) How is energy transferred from the radio to the loudspeaker?

A changing current from the radio changes the intensity of the LED flashlight beam. A changing current from the radio flows through connecting wires to a small plate in the laser, which changes the intensity of the laser beam.

- 2) How is the laser beam's energy modulated to transfer information from the radio?

The changing beam of radiant energy from the laser or the LED flashlight strikes a photocell connected to the loudspeaker on the other side of the room. The changing radiant energy from the beam is converted into a changing electric current in the photocell. This changing current drives the loudspeaker.

- 3) Connect a solar cell to the white amplifier/loudspeaker. What happens when an LED flashlight connected to a radio shines on the solar cell? What type of radiant energy transfers information?

A modulated (changing) current from the radio transfers information by modulating the beam of visible light from the LED flashlight. The energy from the LED flashlight produces a changing electric current in the solar cell. This changing current produces sound waves in the amplifier's loudspeaker.

- 4) Point a TV remote control at the solar cell connected to the amplifier/loudspeaker. Describe what happens. What type of radiant energy transfers information?

The TV remote control uses infrared radiation to produce a changing current in the solar cell. This changing current produces a changing magnetic field, which moves the loudspeaker's cone, producing sound.