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# IMH TEP'S

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## LEGACY ACADEMY

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### **9.6 Inducing Current & Making a Telephone**

Grade 9 Activity Plan

# Reviews and Updates

## 9.6 Inducing a Current and Making a Telephone

### Objectives:

1. To understand electromagnetism and electromagnetic fields.
2. To understand the properties of magnets.
3. To know how electrical energy is generated in equipment such as dams and windmills.
4. To know how telephones work.

**Key words/concepts:** magnets, magnetization, temporary and permanent magnets, magnetic fields, domains, poles, electromagnetism, electromagnetic induction.

**Take-home product:** a set of headphones.

Segment	Details
African Proverb and Cultural Relevance. (5mins)	The cattle is as good as the pasture in which it grazes. <b>Ethiopia</b>
Pre-test (10mins)	Assess students' understanding of magnetism through brainstorming. Ask thought provoking questions on magnets and magnetic fields.
Background (10 min.)	Introduce magnets and their special properties that allow them to conduct currents. Demonstrate properties of magnets. Introduce Electromagnetic induction.
Activity 1 (10mins)	Use two Styrofoam cups and a string create a simple telephone speak into one end and listen for the sound on the opposite end.
Activity 2 (10mins)	Use a coil connected to a multi-meter and a magnet; to create and measure the voltage created by moving the magnet across the coil at different speeds.
Activity 3 (10mins)	Connecting both ends of a coil to the ends of different voltage batteries and placing the different poles of a large magnet and observe.
Activity 4 (15mins)	Make a set of headphones using magnets, coat hanger and tuna fish cans.
Follow-up (10 min.)	Re-assemble and discuss the findings.
Post-test (10 min.)	Magnet Tag

**Suggested interpretation of proverb:** one is only as good as the kind of information one acquires. Garbage in—garbage out.  
Also, as observed in this activity, the strength of an induced magnet field is a function of the potential difference in the circuit.

Find out some useful information by following these links:

<http://www.youtube.com/watch?v=uDbO4DNy1vE>

<http://www.youtube.com/watch?v=2leLwaQ9ueA>

## **Background Information**

See Activity 6.5 for background information on magnets, permanent magnet and electromagnets.

### **Electromagnetic Induction**

When a conductor (e.g. a wire) moves through a magnetic field, it causes voltage to be produced along the conductor, causing electrical current.

### **Additional Information**

<http://www.explainthatstuff.com/magnetism.html>

Explains magnetism, magnetic fields, types of magnets, and domain theory

<https://www.thoughtco.com/electromagnetic-induction-2699202>

Explains electromagnetic induction and the history of its discovery

<http://www.antiquetelephonehistory.com/telworks.php>

Link helps to explain how telephones work and how they use sound waves, electrical current and electromagnets

## Activity 1: The String Telephone

*Suggested format: make students form groups of two.*

*Purpose: to understand the simple principles upon which telephones work*

Item	Quantity (for 10 students)
341ml Styrofoam Cup	12
String	1 spool
Toothpicks	12

### Procedure:

1. Using a toothpick, make a **small** hole at the bottom of two cups and tie the end of a string through the holes such that the knots could be seen looking into the cup. Tie a big knot to ensure the string does not drop out of the cups.
2. Speak into one cup and listen through the other cup to observe the sound.

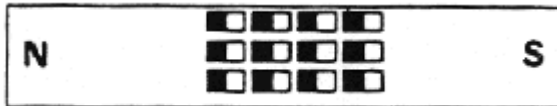
**Describe how the string telephone works; stating that the vibration in the string that is what enables the sound to travel from one end to the other.**

## Activity 2: Induced Electromagnetic Fields

### Before magnetization



### After magnetization



By using this simple principle of electromagnetic induction, you can create all sorts of things, including motors, solenoids, read/write heads for hard disks and tape drives, speakers.

*Suggested format: the number of groups formed should be equivalent to the number of multimeters available, e.g. if there are 2 multimeters and 10 students, make the students form two groups of five each.*

*Note: mentor should endeavour to make coils beforehand and multimeter should be adjusted to measure **millivolts**.*

*Purpose: to demonstrate electromagnetic induction.*

Item	Quantity (mentor only)
Magnet wire	1 roll
Bar magnet	1
Multi-meter	1
Crocodile clips	2

### Procedure:

1. Using about 1 meter of magnet wire, make coil the diameter of a D size battery.
2. Connect both ends of the coil to a multi-meter
3. Turn the multi-meter on.
4. Move the magnet slowly through the coil and record the maximum voltage reading from the multimeter
5. Move the magnet fast through the coil and record the maximum voltage reading from the multimeter.

Note: make the students write up a summary of their observations.

## Activity 3: Generating a Field from a Potential Difference

*Suggested format: the number of groups formed should be equivalent to the available multimeters e.g. if there are 2 multimeters and 10 students, make the students form two groups of five each.*

*Purpose: to generate a field using a battery.*

Item	Quantity (for mentor only)
Magnet wire	1 roll
AA battery	2
9V battery	At least 2
Crocodile clips	2
Bar magnet	1

### Procedure

1. Connect both ends of a large coil to a 1.5V battery. Place a large magnet into the centre of the coil.  
**Observation: a weak force of attraction or repulsion depending on the direction of the current from the battery and the pole of the magnet.**
2. Turn the magnet around and place the other pole of the magnet into the coil.  
**Observation: a weak force of attraction or repulsion depending on the direction of the current from the battery and the pole of the magnet.**
3. Using a 9V battery, repeat steps 1 and 2.  
**Observation: a strong force of attraction or repulsion depending on the direction of the current from the battery and the pole of the magnet.**
4. Swap the battery terminals (Changing the direction of current through the coil) Place the magnet in the coil.  
**Observation: attractive forces now become repulsive.**

### Question: Why do we have an attractive or repulsive force?

When current is passed through a coil, there will be a magnetic field across the coil. The pole of the magnetic field is dependent on the direction of the current.

**Use the procedures and observations from Activities 2 and 3 to help the students understand how the string telephone works.**



## Activity 4: Making a Set of Head Phones

This activity was culled from <http://www.johnchilds.net/tunaheadphones.htm>

*Suggested format: every student should have their own set-up, as this will be the take home product for the after school session.*

*Purpose: to know how speakers are made.*

Item	Quantity (for 10 students)
Tuna fish cans	20
Ring-magnets (Radio Shack)	20
Copper wire	1 spool
3.5mm mini phone plug (Radio Shack)	10
String	1 spool
Coat hanger	10
Bristol board	2
Vinyl ring binder (optional)	10

**Note: be sure to do all coiling and cutting before activity.**



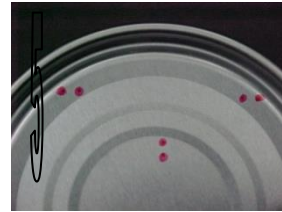
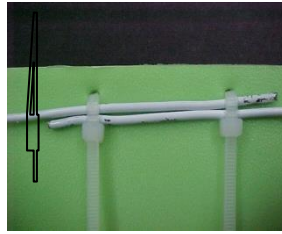
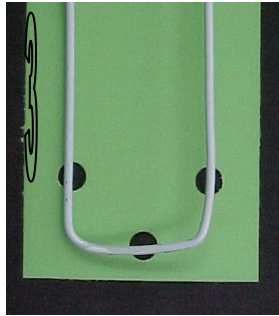
1. Cut some plastic into strips 5 cm wide and 42 cm long. Cheap flexible vinyl 3 ring binders are a good source of plastic. To get a strip 42 cm long, you need to carefully remove the plastic from the rivets that hold the metal rings in place, so you have the entire width of the notebook. Or you can cut the strips from the height of the binder and staple two shorter pieces together. A heavy paper will also work, such as poster board. The main function of the plastic is

cosmetic.

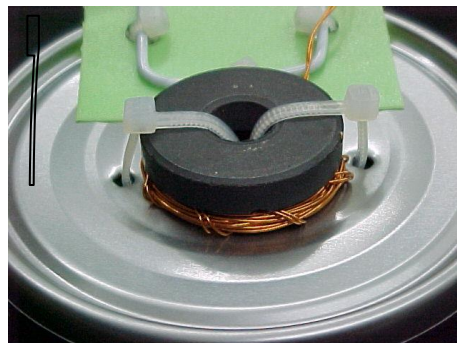


2. Remove the hook from a wire coat hanger by bending each wire repeatedly with a pair of pliers until it breaks. (Be careful as the wire gets quite hot!) Bend and form the coat hanger so it fits on top of the plastic strip. Wire coat hangers come in different thicknesses of wire. You want

the thinnest wire. The thicker wire coat hangers are much too hard to work with and adjust.



3. Punch three holes in each end of the plastic strip using a hole punch. Use a nail or awl to punch four small holes where the two ends of the coat hanger meet.
4. Use two cable ties or strings to secure the two loose ends of the coat hanger together, and at the same time fasten the coat hanger to the plastic strip.
5. Use the three holes in the end of the plastic strip as a template to mark the location for six small holes in the tuna can.



6. Use a hammer and nail to punch the six small holes marked in step 5, in each can. These holes must be big enough for a cable tie to go through them. Also punch three more holes to secure the coils and magnets. The centre hole should be a little larger to accommodate two cable ties.
7. Fasten the plastic strip and coat hanger to the cans using cable ties. Don't fasten them too tightly; you want them to be able to vibrate! (That's the name of the game, right?)
8. Fasten a magnet with a coil of wire under it to each can.  
**Do NOT hold on to the cans for this next step.**
9. With both cans fastened to the wire and plastic, bend the wire in an arc that fits over your head. Do not hold on to the cans, as the small gauge cable ties will SNAP! They are not strong enough to transfer the leverage for bending the wires. Use pliers if necessary, to hold onto the wires.

10. Bring the long leads from one coil over the top of the headphones to the other coil. (Twist them around the coat hanger wires to keep them secure.) Tie a knot in the black wire (the wire with the mini phone plug on one end) and secure it to the coat hanger with a cable tie.
11. Carefully scrape the lacquer insulation off about 1 cm of each lead from each coil. (Four ends.) Removing the dull orange lacquer insulation should reveal a shiny copper colour. Use a knife edge, scissors edge, or piece of sandpaper.
12. Join the two coils and the black wire into a series connection. (Parallel will also work.) Insulate the connections with some kind of tape. (Electrical tape is nice, but masking tape is fine, and in a pinch, scotch tape will also work.)

### Observation Tables

Experiment 2 (Small Coil, Small Magnet)	
Max Voltage (Slow)	
Max Voltage (Fast)	
Conclusion	

Experiment 2 (Small Coil, Small Magnet)	
Max Voltage (Slow)	
Max Voltage (Fast)	
Conclusion	

Experiment 2 (Small Coil, Small Magnet)	
Max Voltage (Slow)	
Max Voltage (Fast)	
Conclusion	

\*Use Large Magnet

Experiment 3 (1.5V to induce voltage)	
Small coil	
Large coil	
Conclusion	

\*Use Large Magnet

Experiment 3 (Large coil)	
1.5V	
9V	
Conclusion	

## **Post-test Game:**

### **Magnet Tag (Similar to Amoeba Tag)**

It is best to play outside on a nice day. Assign each student a ticket that either has "South" or "North" written on it. Tell them not to show anybody else what they have been assigned. Choose one of the students to be the "catcher" and tell them to count to 20 while the other students (magnets) scatter. The goal of the game is the catcher to catch as many people (magnets) as they can by tagging them. There is one catch; if a person is tagged they must reveal their "ticket" identity. The only way that the catcher can officially capture a person is if their ticket identity is opposite from theirs. For example, if the catcher is "north" then they can only capture "south" and vice versa. If they succeed in capturing a magnet opposite from them, then they latch arms and both become the catchers. They continue the game trying to catch the rest of the students (students). The rule remains the same "opposites attract, likes repel" so if one person from the now linked "catcher" team tags somebody who does not attract to them they do not have to join the chain. Once a chain has four people on it, they have the choice of splitting up into groups of 2. Continue the game until every student has been tagged.