

Activity 3 – Jump Rope Generator

TEACHER'S GUIDE

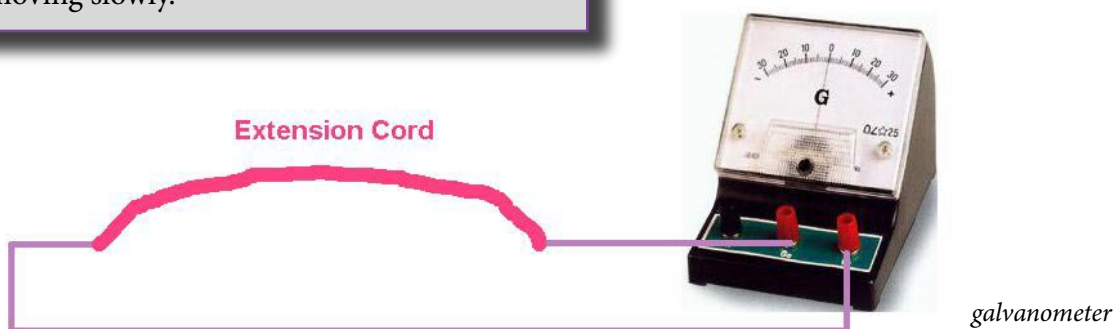
Your class will demonstrate the generator effect, which is due to electromagnetic induction when a conductor (a long metal wire) moves through a magnetic field. In this activity, the magnetic field your students work with is Earth's magnetic field and the long wire is an extension cord. The cord is part of a loop of wire that closes through a galvanometer. This loop is important since electrical current must flow in a loop. When the wire is aligned east to west and rotated clockwise or counter-clockwise, it moves across Earth's magnetic field (which points north and downward) allowing the maximum current to flow. (See the photograph of the teachers on page 8). This current can be detected using the galvanometer. This occurs because when a magnetic field is changed in a loop of wire, a voltage, and hence a current, is induced in the loop. This is what happens when the armature of a generator is rotated, when an iron car drives over a loop of wire imbedded in the roadway to activate a traffic light, or when a piece of wire is twirled like a jump rope in Earth's magnetic field. When the wire is aligned north to south, it is aligned with Earth's magnetic field and moves across Earth's magnetic field only slightly up and down. Moving the wire almost parallel to Earth's magnetic field means that only a small amount of electrical current will flow through the wire.

GOALS

- 1) Students will know that Earth has a magnetic field.
- 2) Students will observe the deflection of a galvanometer needle when an electrical cord crosses Earth's magnetic field.
- 3) Students will record how much the galvanometer needle is deflected when the electrical cord is rotated when aligned east to west versus north to south, and also when the cord is rotated while moving quickly versus moving slowly.

MATERIALS

- 100-foot extension cord with ground prong
- Current or voltage galvanometer (micro-Ammeter if using a current galvanometer)
- Two lead wires with alligator clips on at least one end
- One compass



Understanding that Earth has a magnetic field is important to many of NASA's science missions, including THEMIS.

PROCEDURE

1. Attach the alligator clip at the end of one wire to the ground prong of the extension cord. Attach this wire's other end to the galvanometer. Take the second wire, and keeping its alligator clip closed, push the clip into the ground receptacle on the other end of the extension cord. Attach the other end of this second wire to the other contact on the galvanometer.
2. Use a compass to align the extension cord in the east-west direction. Leave both ends of the extension cord on the ground. It helps to have two students stand on the cords, near the end, to make sure the galvanometer stays connected to the cord. Have two additional students pick up the middle half of the cord and twirl it like a jump rope. (See the picture below.) It doesn't matter whether it rotates clockwise or counterclockwise. Have the students observe the galvanometer and record their observations on the worksheet.
3. Have the students twirl the cord faster and observe the galvanometer and record their observations.
4. Repeat step 2, but align the extension cord in the north-west direction again, using a compass. Have the students observe the galvanometer and record their observations.



TEACHER ANSWER KEY

1) higher speed means a larger deflection; 2) The maximum voltage (or current) should occur east-west and fast; 3) The minimum voltage (or current) should occur north-south and slow; 4) the explanation is given above. We recommend you use Question 4 to determine how much more discussion or explanation you need to provide the class before moving to another topic.

Student Name _____ *Date* _____

Jump Rope Generator: Observations

Fill out the table with your measurements of greatest deflection on the galvanometer in each of the four cases. Then answer the questions below the table.

	Cord aligned east-west	Cord aligned north-south
Slow		
Fast		

1. What effect does the rotational speed of the cord have on the deflection of the galvanometer?
2. Describe the conditions in which you had the maximum voltage (or current) through the galvanometer.
3. Describe the conditions in which you had the minimum voltage (or current) through the galvanometer.
4. Explain why the galvanometer needle moves when you play jump-rope with the extension cord.
5. Explain why the the orientation of the jump rope to Earth's magnetic field effects the galvanometer reading.