INVESTIGATION

3-A

GUIDED AND OPEN INQUIRY

Investigating Generators and Turbines

Skills and Strategies

- Questioning and Predicting
- Planning and Conducting
- Processing and Analyzing
- Evaluating
- Communicating

Safety

- Handle the meter with care.
- Use construction tools carefully.

What You Need

- 5 m of insulated copper wire (about 26 gauge)
- 2 alligator clips
- cardboard tube
- powerful bar magnets
- galvanometer
- other materials as determined by your design
- access to information resources (for example: online, in-print, interviews)

PART A: BUILD AND TEST A SIMPLE GENERATOR—GUIDED INQUIRY

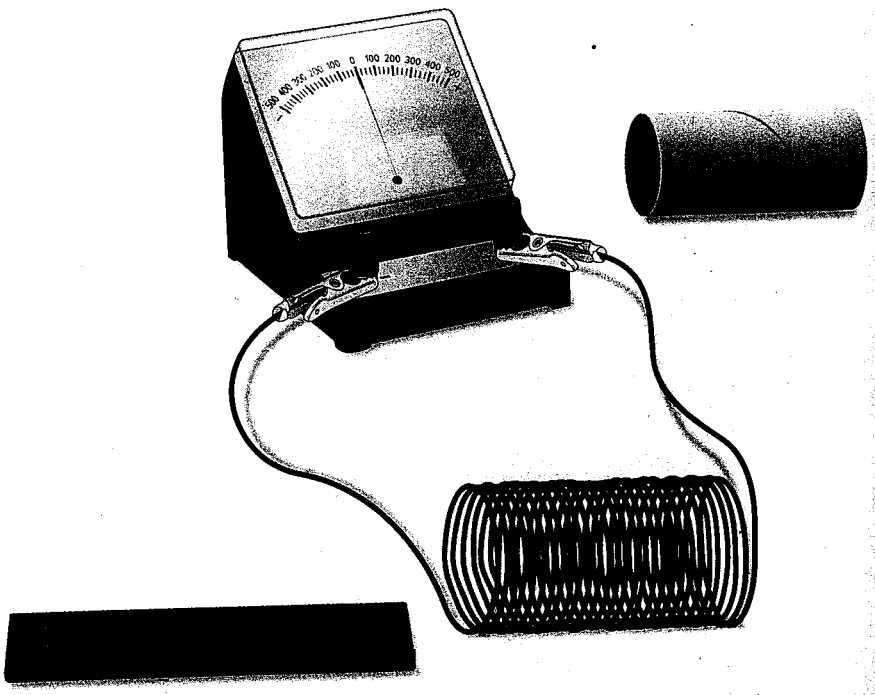
A generator uses a magnet and a coil of wire to transform kinetic energy into electrical energy.

Question

How can you investigate which factors affect the amount of electrical energy produced by a simple generator?

Procedure

1. Leaving about 15 cm for a lead at both ends of the wire, make a coil of about 25 turns by wrapping the wire around a cardboard tube. Remove the tube from the coil.
2. Strip the insulation off each end of the wire. Then connect the ends to the galvanometer with alligators clips. The galvanometer measures electrical activity.



3. While closely monitoring the meter, insert one end of the magnet into the coil and then pull it out. Record any movement you observe on the meter.
4. With your partner, brainstorm how you could increase the reading on the meter. Record your ideas. For each variable you decide to test, write a hypothesis to predict which possible outcome you think will occur.
5. Test your ideas and record your results.

Process and Analyze

1. Which condition or combination of conditions that you tested recorded the most electrical activity? Why do you think this was the case?

Evaluate

2. Were you surprised by your results? Explain.

PART B: DESIGN AND BUILD A TURBINE OR GENERATOR—OPEN INQUIRY

In Part B, your team will create a working turbine or generator based on your own design. If you build a generator, you can use the simple generator you built in Part A as a springboard, but your design must be your own. Think wind, water, human-generated energy, or any other source available to you.

Question

Read the Procedure. Determine the question that you will investigate.

Procedure

1. What questions do you have about how you could design, build, and test a turbine or generator? Brainstorm and record your ideas.
2. Use information resources to investigate answers to your questions.
3. Based on your research, develop a materials list, safety guidelines, and procedure for a specific turbine or generator that you will build. Your teacher must approve your plan before you build your device.
4. Once approved, build your device.
5. Test your device. Troubleshoot any problems that arise.

Evaluate

1. Did your device work as you expected? Why or why not?
2. If you were to repeat this investigation, what would you do differently? Explain why.

3. Bring the negatively charged strip near the top of the electroscope and allow it to touch the metal ball of the electroscope.
4. Neutralize, or ground, the electroscope by touching it with your finger. Record your observations about what happens to the leaves of the electroscope.
5. Rub an acetate strip or a glass rod with silk to give it a positive charge. Bring the acetate strip or glass rod near, without touching, the metal ball. Record what happens to the leaves. Then touch the metal ball with the positively charged strip or rod. Record what happens to the leaves. Remove the positively charged strip or rod, and record what happens to the leaves.
6. Ground the electroscope by touching the ball with your finger. Bring a negatively charged vinyl strip rod near, without touching, the neutral electroscope. With the strip held near the electroscope, touch the top of the electroscope with your finger to ground it. Then take your finger off. After your finger is no longer touching the electroscope, move the negative strip away from the electroscope. Record your observations.

Analysis

(a) In step 2, when the leaves spread out indicating that they were charged, was this because of conduction or induction of electric charge? How do you know?

(b) Draw a diagram that shows what happens when a negative strip is brought near the metal ball. Show the position of the leaves, and the areas of negative and positive charges. What happened when the strip was taken away? How could you explain this in terms of electron movement?

(c) Draw diagrams to show what happens when the negative strip touches the metal ball, and what happens to the electroscope after the negative strip has been taken away.

(d) Is an electric force acting on the leaves in step 3? How do you know?

(e) Did the electroscope become charged in step 3? How do you know?

(f) Why was it necessary to ground the electroscope in step 4 before proceeding to step 5? What happened to the leaves of the electroscope when you grounded it? What does this indicate about the electroscope?

(g) Draw diagrams to show the position of the leaves of the electroscope and charges for steps 5 and 6.

(h) In steps 2 and 6, the electroscope is charged by induction. Explain what this means. How does charging the electroscope by induction compare with charging by conduction?

(i) Explain how you could use a positively charged acetate strip to give an electroscope a positive charge or a negative charge.

Evaluation

(j) Some electroscopes are made with gold leaves. Would this have been a benefit in your investigation?

(k) What is the advantage of using an electroscope, rather than simply using a hanging pith ball?

Synthesis

(l) Would it have made any difference to our understanding of electricity if electrons had been called positive and protons had been called negative? Explain your answer.

9B Investigation

The Electroscope

William Gilbert, physician to Queen Elizabeth I, was the first person to create an electroscope around 1600. He was also the first person to use the term "electricity." Electroscopes have not significantly changed since the 1600s. For example, Figure 1 shows an electroscope from the late 1800s. Compare it with the electroscope that you will use in this Investigation.

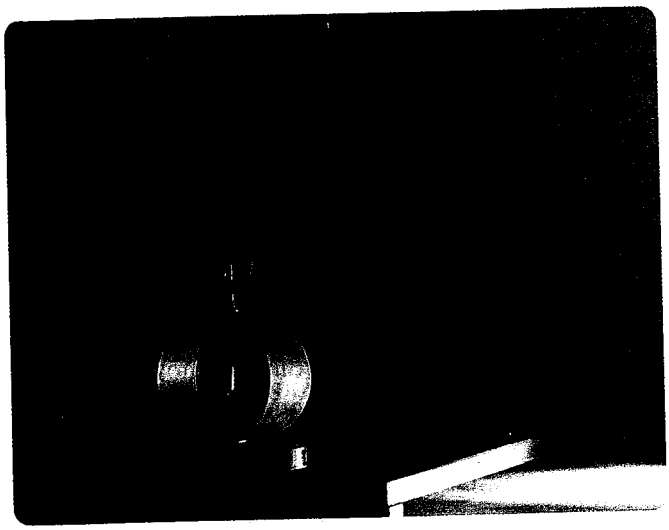


Figure 1

In this Investigation, you will use an electroscope to investigate how different materials are charged by conduction and induction.

Question

How can an electroscope be charged by induction and by conduction?

Experimental Design

You will use an electroscope to determine the charges on different objects.

Materials

- metal-leaf electroscope
- vinyl strip
- paper towel
- acetate strip or glass rod
- piece of silk

INQUIRY SKILLS

○ Questioning	● Conducting	● Evaluating
○ Hypothesizing	● Recording	● Synthesizing
○ Predicting	● Analyzing	● Communicating
○ Planning		

Procedure

1. Copy Figure 2, which shows a diagram of a neutral electroscope, into your notebook.

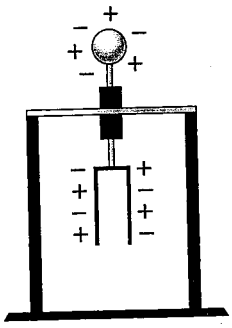


Figure 2 A neutral electroscope

2. Negatively charge a vinyl strip using a paper towel. Bring the strip near, without touching, the sides and then the ball on top of the electroscope (Figure 3). Draw a sketch of the electroscope and strip in the position where the leaves were spread out the most.

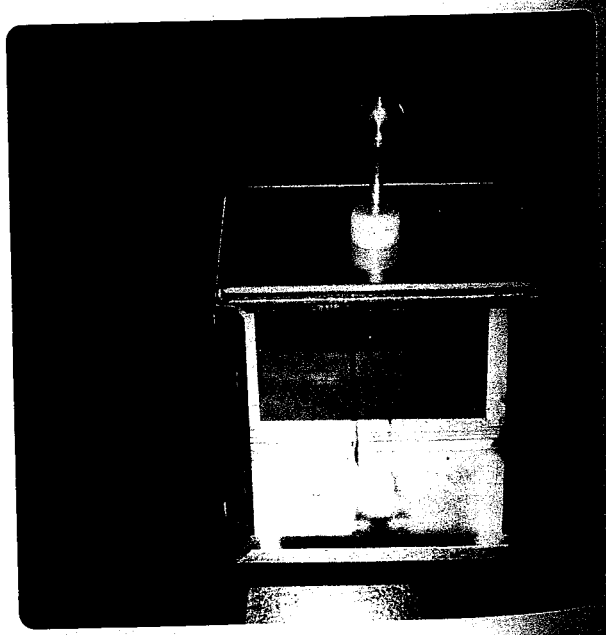


Figure 3 Step 2