Physical Science – Grade 4
Electricity

Standards:

- Recognizes and identifies properties of magnetic energy
- Recognizes and identifies properties of electrical energy
- Identifies how energy can be transferred from one form to another

Teacher Background

**Electric current** is the moving of electrons from one atom to another, down a long chain of atoms. The energy needed to push the electrons from one point to another point is called **voltage or volts**. The total amount of electrons flowing through a wire is called current and is measured in **amperes or amps**. It is similar to the amount of water flowing through a hose. Bigger hoses can move more water, and bigger wires can move more electrons. The more current (amps), the more force, just like the hose.

Certain materials allow electrons to move or can carry electrical current. They are called **conductors**. Other materials do not allow electrons to move easily and they are called **insulators**. With enough push, anything can conduct electricity (think lightening) but if it does not easily conduct electricity it is considered an insulator.

Examples:
Conductors- metals, salt water, carbon (graphite)
Insulators – glass, plastic, rubber, air

**Batteries** are measured in volts because they “push” electrons out into the wire. Lights, motors, buzzers etc. all use the energy of the moving electrons and convert them into another form of energy. In the case of a light, the electrons have a hard time traveling through the wire in the light bulb and cause it to get warm and glow. In a buzzer, the electricity causes something to vibrate, producing a sound. Each time the electricity is converted into something else, there is less electricity (energy) left in the wire, so that if you put 3 light bulbs on a circuit in a row, the 1st one will be brightest, 2nd less so and the 3rd may not even be lit at all.

In order to avoid this problem, people have come up with different ways to connect wires and objects in a **circuit**.
A **series circuit** means that everything is in a single path. One way in and one way out.

![Series Circuit Diagram](scienceprojectideasforkids.com)

A **parallel circuit** means that there are two or more ways for the electricity to go. The red path or the blue path.

![Parallel Circuit Diagram](iss.cet.edu/electricity/)

Electricity can also be converted into magnetism. If a wire is wrapped around a conductor, usually a piece of soft iron, and electricity is passed through the wire, it will create a magnetic field of force around the metal. This is called an **electromagnet**. It is very useful because it can be turned off and on.

**Building an Electromagnet**

![Electromagnet Diagram](daymix.com)

(Picture from daymix.com)
Lesson 1 – What is Electricity?

Materials: paper circles (enough for each student to have 2)

Procedure:

Suggestion: This lesson would be a good time to read “Switch on, Switch off” with your class.

1. Tap into students’ prior knowledge and list all the terms they can think of that have to do with electricity. List them for all to see. Keep this list posted in your classroom. Tell them you are going to study electricity and find out how all many of these words relate to each other.

2. Have the students form a line. Give everyone in the line 2 paper circles, one for each hand. Tell them the paper represents electrons and that they are atoms. They all have all the electrons they can hold. Now, you “push” another electron into the hand of the first student in line. (tell them they can’t drop electrons) What is that student going to do with the extra electron? Give it to the person beside them, of course

3. This continues until the last person in line has three “electrons”. They have nowhere to put it, but if you make the line into a circle, with the teacher as the empty hand, then they can continue to pass it along. (In this activity, the teacher is the battery and the students are the atoms in the wire. The battery has extra electrons on one end and room to store electrons on the other.

Once this game has been played, explain to students that this is how electricity flows in a wire.
Lesson 2 - Circuits

Materials:

- Wire
- Light bulbs
- Battery holders
- Switches
- Batteries

1. Begin by reminding the students of the electricity game that was played in the previous lesson. Ask students to retell how electricity works. What happened when the atom had too many electrons? What happened when the teacher moved the line into a circle?

2. Explain that now they are going to create a circuit using wire, light bulbs, switches and batteries. Break students into small groups (3 or 4) and give them 2 wires, light bulb, battery holder and switch. **DO NOT give them the battery at this time. They could create a situation where the wire gets hot. For example, if one wire goes from one end of the battery to the other, it could get overheated.**

Once the groups have their materials, ask them to make a circuit. Tell them a circuit is a circular path that goes around from the beginning and back again. One end of the battery holder can be the beginning and the other end is the finish line. This is called a closed circuit. If the student cannot follow the wire all the way back to the finish line, it is an open circuit. Open circuits do not allow electricity to flow.

3. Let student groups explore how to make a closed circuit. Once some groups figure it out, you can build a circuit on the wall and hold it in place with Velcro or tape. There are many correct answers to this, as long as a student can trace a path from the beginning and get back to the end without lifting their finger off the wire. You can now give them a battery and see if the bulb lights.

4. Student groups should share their circuits with other groups, since there may be more than one way of building the circuit in the class. The groups should explain to the class why their circuit lights the bulb, and is therefore a closed circuit.
Lesson 3 - Parts and Types of Circuits

Materials:  
- battery holders
- Batteries
- Wire
- motors
- switches

Procedure:
1. Begin by reviewing orally how to build a closed circuit. Have students explain how to build a circuit and what is the difference between a closed and open circuit.

2. Have students build a circuit with battery holder, 2 wires, motor and switch and once they have a working circuit, give them a battery and see if the motor works. You may then ask them to add more bulbs or motors or anything else to their series circuit. Also, help them identify the following parts of a circuit.

   - Battery
   - Conductor
   - Insulator
   - Switch

3. After students have discovered how to set up a series circuit, ask groups to demonstrate how to do it.

4. If any groups have discovered how to set up a parallel circuit, ask groups to demonstrate. If not, give students time to discover this. Tell them to try to make 2 bulbs light so that both bulbs are getting the same amount of electricity.

5. Finally, you can teach them how to rearrange the items in their circuit so that there is more than one path for the electricity to go, a parallel circuit. This allows all items on the circuit to get equal amounts of electricity.
Grade 4 Physical Science - Magnetism

MAGNET OBSERVATIONS

Materials Needed

2 bar magnets
1 compass

Procedure

Investigate your magnet. Try different things and write down five observations that you make.

1. ________________________________________________________________
2. ________________________________________________________________
3. ________________________________________________________________
4. ________________________________________________________________
5. ________________________________________________________________
MAGNETIC POLES (or Opposites attract)

Materials Needed

1 compass
donut magnets
assorted magnets
2 round pens or pencils

Procedure

1. Take 4 round magnets and put them on a pencil. See if you can make the magnets attract and repel by flipping them over on the pencil. Record your findings.

__________________________________________________________________
__________________________________________________________________
__________________________________________________________________

2. Move all of the magnets away from one bar magnet. Put the compass at the end of the magnet marked "N". Draw an arrow on the diagram below showing what direction the painted end of the compass needle points. Then repeat for the end marked "S".

3. Use a ruler and put one donut magnet at 0 inches. Place the South Pole of another magnet at 5 inches so that they face each other. Move the South pole slowly to the other magnet until you feel them pull on each other. How close do they have to be?

Questions

1. What would happen if you put one magnet on a pencil?

2. How close do the magnets have to be to each other to be attracted?

3. The compass needle is a magnet. Why does a compass work on earth? What does this tell you about the earth?
MAGNETIC INSULATORS

Background

Let's see if there are magnetic insulators that are similar to electrical insulators.

Materials Needed

1 round magnet 1 compass notebook paper
brown paper aluminum foil plastic cup
other classroom items paper clip

Procedure

1. Place a paper clip near your magnet. Will it pick it up? __________________

2. Now place the paper clip under a piece of paper. Can the magnet pick up the clip through the paper or does the paper stop the magnetism? __________________

_____________________________________________________________________

3. Put the paper clip in the following situations and see if the magnet can move the clip. Record your answer below

   Paper cup ___________________________________________________________

   Paper cup with water ________________________________________________

   Plastic cup _________________________________________________________

   Piece of wood ______________________________________________________

5. Place a paper clip on 0 inches and place the magnet at 5 inches. Slowly move the magnet close until the paper clip moves. How close can you get? ____________

What would happen with a stronger magnet? ______________________________

_____________________________________________________________________

Journal Question:

How are magnetic insulators different from electrical insulators?
ELECTROMAGNET

Background

Here's an example of how electrical energy can be transformed into magnetic energy.

Materials Needed

1 three foot long wire  1 Steel Rivet or nail  2 batteries in holders
paper clips

Procedure

1. Wrap the wire tightly around the whole length of the nail. Wrap all of the wire but about 6 inches at each end. Try not to overlap the wire

2. Try to pick up the paper clips by touching them with the nail. What happens?

______________________________________________________________________
______________________________________________________________________
______________________________________________________________________

3. Hook up the batteries so that electricity is running through the wire.

4. Try again to pick up the paper clips. What happens? Why?

______________________________________________________________________
______________________________________________________________________
______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________
5. Now disconnect the battery and try the paper clips again. Does the same thing happen as in step 2? What has happened to the nail?

______________________________________________________________________
______________________________________________________________________
______________________________________________________________________

6. How many paper clips can your electromagnet pick up? ___________________
How could you make it stronger?
_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________

7. In this experiment, we transferred magnetic energy into electrical energy. What other forms of energy can electricity change into?

______________________________________________________________________
______________________________________________________________________
______________________________________________________________________

How strong is your magnet?
Grade 4 Physical Science Project

ALARMIN G SCIENCE!

Objective:
For students to design, create and test an electrical alarm that goes off when the
door is opened. The alarm must be hidden from the outside. Upon completion,
points will be earned for the alarms that are best hidden, most easily operated
and uses the least amount of materials.

GOAL:
To engineer a hidden alarm system on a cardboard box door that is well hidden,
easily operated and uses the least amount of materials.

RULES AND REGULATIONS:

1. Students will begin with the following materials.

   - cardboard boxes
   - copper wire
   - batteries
   - buzzers/electric bell
   - string
   - aluminum foil
   - paper clips
   - markers
   - masking tape
   - electrical tape
   - scissors
   - battery holder

2. Design an electrical circuit that will operate when the door is opened.

3. Trace the flow of electricity through your alarm circuit. Did you build a complete
circuit into your design? In a complete circuit, the electricity from the battery flows
along one wire to the buzzer, along the other wire and then back to the battery. The
moving electricity makes the buzzer sound. If you disconnect one wire, the electricity
stops moving because you broke the circuit. How does your switch interrupt the flow of
energy to stop the alarm?

4. Students will work in small groups on the design, building and testing of this project.
Lesson 1

Procedure:

1. Introduce the steps of the design process to students.

Teams will follow the Engineering Design Process.

1. Identify the Problem
2. Research the Problem
3. Develop possible solutions
4. Select the best possible solutions
5. Construct a prototype
6. Test and Evaluate the solution
7. Communicate the solution
8. Redesign

2. Explain to students that for this lesson, you will be working on steps 1 – 3 of the design process. Each design team needs to consider the following when creating their design

   A. How to make an electrical circuit with a buzzer
   B. How to make a switch that will go on when the door is opened
   C. How to hide the wires from being seen outside of the box.

In teams, students will create a minimum of two possible solutions. They will eventually need to choose one.

3. Each team will draw the electrical circuit they think will work, labeling all the parts. Enter thoughts and observations about the team’s design into their engineering journal.

**Lesson 2**

**Procedure:**

1. Review step 4 of the design process with students and explain that they will be working on selecting the best solution for their alarm.

2. Groups work together to select their final choice for the team’s design.

3. Students record the following in their journal:
   - A. How the electricity will flow through the circuit
   - B. How the switch will work

**Lesson 3**

**Procedure:**

1. Review steps 5 and 6 of the design process and explain to students that they will be receiving materials to create their circuit and building a prototype of the circuit.
   - Each team will receive materials to create their circuit
   - Build a prototype of your circuit outside of the box. Test it.
   - Mark the box where the circuit will be placed
   - Build the prototype in the box.
   - Test the prototype until it works (Testing can take place without everyone watching.)

2. Students record their observations about how the prototype was built and compare it to their original design. They will also record the results of tests.

**Lesson 4**

**Procedure:**

1. Review the previous steps in the engineering design process and remind students about steps 7 & 8.

2. Students will then create a poster that depicts the following:
   - A. A diagram of their circuit
B. A diagram of their switch and how the door operates it
C. A diagram of where the circuit will be placed.

All drawings must show measurements of the alarm circuit (some or much of this can be done as homework if class time is limited)

Lesson 5

Procedure:

1. Student teams use their poster to present their design idea and take questions from the audience.

2. Students record in their journal who did what for the team in making and presenting the poster. How did you decide who would do which part?

Lesson 6

Procedure:

1. Testing Day !!! Teams test their alarms to see if their circuit works and makes the alarm sound.