ITQ ARTS AND SCIENCE INTEGRATION
GRADE 4
DANCE AND PHYSICAL SCIENCE

It's Electrifying! Electromagnets
Lesson 3

CONTENT STANDARDS

Dance

1.4 Explain the principles of variety, contrast, and unity, and apply to a dance sequence.

Physical Science

PS1c Students know electric currents produce magnetic fields and know how to build a simple electromagnet.

ESSENTIAL QUESTIONS *(Questions that students might ask about the topic)*

- What is an electromagnet and how does it work?
- How can I use contrast to show the structure and function of an electromagnet?

OBJECTIVES & STUDENT OUTCOMES *(Students will be able to…..)*

- make movement choices as they explore the structure and function of electromagnets, including the telegraph.

ASSESSMENT *(Various strategies to evaluate effectiveness of instruction and student learning)*

- **Feedback for Teacher**
  - Student response to inquiry
  - Student performance
- **Feedback for Student**
  - Teacher feedback
  - Peer feedback
  - Videotape feedback

WORDS TO KNOW

Dance

- **Contrast**: To set side-by-side to emphasize differences. In dance this could be represented as opposites such as high/low, fast/slow or heavy/light, sharp/smooth, etc.

Science

- **Coil:** Wire wound repeatedly around a central core.
- **Core:** The material around which a coil is wound.
- **Current:** The flow of electricity through a conductor.
- **Electromagnet:** A piece of iron that becomes a temporary magnet when electricity flows through an insulated wire wrapped around it.
- **Magnetic field**: The area of magnetic force surrounding a magnet.
- **Switch:** A device used to open and close circuits.
- **Telegraph:** A device for sending coded messages by signals produced by closing and opening an electric circuit.

MATERIALS

- Large piece of yarn or ribbon 50 feet long
- two pieces of 8" x 10" paper, one labeled "positive pole" and one labeled "negative pole."

- Note cards
- Schematic of Electromagnet (pg. 212 in the FOSS Teacher Guide)
- Electromagnet Exercise - Set up Diagram (attached)
- Movement Problem Handout (attached)
- Two hanging labels: one labeled metal, one labeled plastic
- Music – *Flight of the Bumblebee,* by Nikolai Rimsky-Korsakov
- CD Player
- Video camera and monitor
- Science notebooks (one per student)

RESOURCES

- *FOSS Kit Grade 4*, "Physical Science: Magnetism and Electricity," Investigation 4, Parts 1, 3, and 5; Investigation 5, Part 1
- *Music for Creative Dance* by Eric Chappelle

PREPARATION

- Pre-set a table (large enough to crawl under) labeled D-cell and positive and negative poles, one large piece of fabric labeled insulated wire tied at the "negative pole" of the table
- Schematic of Electromagnet (attached)
- Electromagnet Exercise - Set up Diagram (attached)
- Movement Problem Handout (one copy per group or post)
- Two hanging labels: one labeled metal, one labeled plastic
- Two pieces of 8" x 10" paper, one labeled "positive pole" and one labeled "negative pole."
- CD player, music and video camera
- Ample room to move freely

WARM UP *(Engage students, access prior learning, review, hook or activity to focus the student for learning)*

(5 minutes)

- Review the electric current through a D-cell doing the bump.
- Review Magnets.
- *Ask:*
  - *What do magnets do?* [Magnets attract metal objects that have steel or iron in them.]
  - *Once metal objects are stuck to a magnet, how do we remove them?* [We have to physically pull the metal object off the magnet.]
  - Arrange in pairs.
  - *Say*: *One of you will be the north pole and the other the south pole.*
  - *Ask: What will happen when these two magnets meet?* [The magnets will attract.]
  - *Say: Show me attracting by pulling toward each other with your hands, elbows, knees, heads, shoulders, etc. Show me how you would pull these two magnets apart.*
    - Note: Students will move slowly toward each other using resistance and then quickly connect and press strongly the two body parts. When pulling apart, students should use a strong pulling force to resist, then quickly separate.
  -

MODELING *(Presentation of new material, demonstration of the process, direct instruction)*

(15 minutes)

- Introduce **Electromagnets**.
- *Ask/Say:*
  - *Now you have reviewed magnets, what do you think an **electromagnet** could be?* [Students may guess it is a compound word and think electro would mean electricity and magnet would mean an object that attracts metal objects.]
  - *Electromagnets are temporary magnets that use electricity to become magnetized.*
  - *Can we turn a regular magnet on an off?* [No. A regular magnet is always magnetized.]

- *That is what makes **electromagnets** so special. We can make a temporary magnet by taking a simple iron rivet (or large iron nail called the **core**), wrapping it in a wire **coil** and connecting it to a source of electricity.*

- Post a schematic of an electromagnet and review its parts: **core**, insulated wire (called the **coil**), a D-cell, and a **switch**.
- *Ask/Say:*
  - *What is the role of the **switch**?* [To control the flow of electricity. It opens and closes the circuit.]
  - *When the circuit is closed the electricity flows through the **coil** and around the iron **core**. This creates a **magnetic field** that causes the **core** to become **magnetized** and attracts metal objects.*
  - *What do you think will happen when the **switch** opens the circuit?* [The electricity stops, the **magnetic field** disappears, and the objects fall away from the **core**.]
  - *The iron **core** becomes a simple piece of metal once again that is no longer magnetized.*
- Select one student to be the **core** and wrap him/her one time with a piece of yarn or ribbon.
  - *Say: How strong do you think the **magnetic field** will be if I wrap the **core** one time?* [The **magnetic field** will be weak.]
  - Have the rest of the class sit on the floor.
  - *Say: You will be metal objects attract to the core when I close the circuit. Move slowly toward the **core** by crawling or scooting. When I open the circuit you will fall away safely showing that the **magnetic field** has disappeared.*
  - *Chant: Circuit is closed, electricity flows.*
  - Students attract slowly and weakly to the **core**.
  - *Chant: Circuit is open, electricity stops.*
  - Students fall away from the core safely.
  - Wrap the student representing the **core** ten times. Have the rest of the class back up and sit on the floor.
  - *Ask: What do you think will happen to the **magnetic field** if I wrap the **core** tightly ten times?* [The **magnetic field** will become stronger.]
  - Repeat exercise showing stronger and quicker attraction.
- Create movement for the parts of the **electromagnet** (allow five minutes to create).
  Note: Each part of the **electromagnet** will be performing at a specific level. Using levels in this way will show **contrast** and will be easily seen by an audience. Using levels in this way also creates **variety** and interest in a dance.
- Divide the class into two equal groups. In each group divide as follows:
- *Say:*
  1. *One student will create the iron **core**.*
     - Solve the problem: *How will you make your body look like an iron core that is tall, solid, rigid, and strong? How can you show being magnetized?*
  2. *One student will create the **switch**.*
     - Solve the problem: *How can you create, at a medium level, two contrasting shapes to show an open and closed **circuit**?*
  3. *Two students: one of you will create and move like a metal object and the other will create and move like a plastic object.*
     - Solve the problem: *If you are a metal object, how will you show starting on a low level, being attracted to the **core** at a high level when the circuit is closed? How will you show loss of attraction to the **core** when the circuit is opened?*
     - *If you are a plastic object, how will you show no attraction at a low level?*
  4. *Remainder of the group will represent the insulated wire: one long wire from the positive pole, wrapping around the core to the **switch** and one short wire from the switch to the negative pole.*
     - Solve the problem: *How can you show, at low level, the electric current flowing out and the negative pole of the D-cell, around the **core**, and back to the positive pole of the D-cell. (Hint: Use the bump from lesson #2.)*

GUIDED PRACTICE *(Application of knowledge, problem solving, corrective feedback)*
(20 minutes)

- Have the video camera ready.
- Post the following steps and diagram for the set up and demonstration of the electromagnet exercise.
  1. Place the opposite poles of the D-cell downstage (toward the audience) about six feet apart.
  2. The student representing the **core** will position him/herself in center of the space.
  3. The students representing the insulated wire will connect the two poles and circling around (**coil**ing) the **core** one time.
  4. The two students as the metal or plastic will position themselves apart form the **core**.
  5. The person representing the **switch** will stand next to the positive pole.
  6. Construct and rehearse five minutes.

- Procedure for performing the dance (post before performance):
  - The **switch** performs the chant, closes the circuit and the music starts.
  - The **electric current** flows along the pathway of the wire and once around the **core** using the bump.
  - The **core** moves shows it is magnetized (allow vocals if desired).
  - The **switch** performs the chant, opens the circuit, the music stops. Everyone is still.
- Repeat the exercise with for group two.
- *Ask* (the observers after each demonstration)*:*
  - *What happened when the **circuit** was open?* [Everyone stopped moving. Electric **current** stopped flowing and magnetism disappeared. The metal object dropped slowly to the floor. The plastic object didn't attract at all but just laid there.]
- Select one of the groups to demonstrate the next exercise.
- *Ask: What will happen if I wrap the **core** two more times?* [The **magnetic field** will be stronger.]
- *Ask: How will the dance be changed?*
  - Allow the class to think about the changes and give the demonstration group 30 seconds to discuss (allow coaching from the observers).
  - If necessary, review and coach the changes: the **magnetic field** will get stronger, the flow of electricity will circle around the **core** three times**,** the **core** will pull on the objects strongly and the metal object will attract faster and stronger when the **switch** is closed. When the **switch** is opened the metal object will (safely) collapse to the ground. The plastic object will not move.
  - Perform and videotape.
- Review the **contrast** between performance #1 and performance #2.
  - *Ask:*
    - *What differences did we notice between the two performances?* [The first performance used weaker and slower movement because the **core was** wrapped one time. The second performance showed stronger and faster movement because the **core** was wrapped three times.]
    - *What would happen if I used thicker wire or made the coil very tight?* [When using thicker wire, the **magnetic field** gets stronger. The thicker the wire and the tighter the coils the stronger the **magnetic field**.]

- The **Telegraph** Demonstration
- Define **telegraph**: a **telegraph** is a device that uses electrical signals, usually sent through telecommunication lines or radio. The **electromagnetic telegraph** is a device in which people can send coded text messages. To send a message, an operator pressed a switch, sending a signal, which sent an electric current along a wire to the receiving machine.
- *Say: Let's simulate an **electromagnetic telegraph** with our arms.*
  - *Say:*
    - *I am the operator of this **telegraph**. My right arm represents the **key** or the switch of*

*the **telegraph**. The **key** opens and closes the circuit that makes the **core** an **electromagnet**. The **electromagnet** attracts a steel strip and makes a click. When my arm (which is the **key**) is up, the circuit is open and no messages can be sent. When I drop my right arm onto my left arm, the circuit is closed. When I drop my arm I want you to say the word click. Let's practice* (do this several times).

- *Now you try it.*
  - In a seated position, have students practice with you. Have each student place one arm on top of another, across chest. Raise the right arm so that the elbow of the right arm is on top of the left hand (right hand and forearm is perpendicular to left arm).
- *Say: circuit open*. Students should raise their right arm.
- *Say: circuit closed.* Students should drop their right arm and say "click".
- Repeat this several times.

- If time permits, select three students: one person will represent the **key** (the switch), one the steep strip, and one will represent the electromagnet.
  - Position the **electromagnet** in a standing position with their right hand extended to the side, palm up.
  - Position the steel strip on the right of the first student.
  - The student who represents the **key** will gently touch the shoulder of the steel strip.
  - The student who represents the steel strip will gently slap the student who represents the electromagnet's outstretched hand (to close the circuit) and then immediately raise their hand to open the circuit.
  - The observers will respond "click" when they see the action of the steel strip contact the **electromagnet**.
  - Think of a secret word that will be written on the board in the **telegraph** exercise. Place dashes on the board to represent the number of letters in the word.
  - Select one student to write the code (you will say a letter) each time the **key** touches the **electromagnet** and the click is heard.
  - *Say: A message will be written on the board in a code we will all understand. Each time you hear the click, I will say a letter and* _____ (the student's name) *will write it on the board.*
- Each time the **key** closes the **circuit**, the **electric current** flows, the **core** is magnetized, the clickers say "click" in a strong, sharp voice (no shouting) and the metal strip attracts strongly to the **core**, the code is printed, the **key** opens the **circuit**, and the metal strip is released springing back (have the "metal strip" student show this action) to its original position.
- Repeat until the word is spelled out on the board. As a group, everyone says the word.
- Videotape demonstrations.

DEBRIEF AND EVALUATE *(Identify problems encountered, ask and answer questions, discuss solutions and learning that took place. Did students meet expected outcomes?)*
(10 minutes)

- *Ask:*
  - *What are three ways we can strengthen the **magnetic field** of an **electromagnet**?* [Thicker wire, more **coils**, tight wrapping]
  - *How does the **telegraph** work?* [Each time the **circuit** is closed, the **electric current** flows magnetizing the **core**, which attracts the steel strip making a loud click, then the **key** opens the **circuit** the steel strip is released and springs back into place.]
  - *How does the **telegraph** deliver messages?* [The clicks made by the **telegraph** produce a code.]
- Have students respond to the following exit questions in their science notebooks: (Students may work independently, in pairs or small groups.)
  - *What is an **electromagnet** and how does it work?*
  - *How did we use **contrast** in movement to show the different parts of the **electromagnet**?*

EXTENSION *(Expectations created by the teacher that encourages students to participate in*

further research, make connections and apply understanding and skills previously learned to personal experiences.)

- Write a story about **electromagnets**, narrate and perform the dance to music.
- Create body percussion to send messages in Morse Code.

Movement Problems - Electromagnets

1. *One student will create the iron **core**.*
   - Solve the problem: *How will you make your body look like an iron core that is tall, solid, rigid, and strong? How can you show being magnetized?*

2. *One student will create the **switch**.*
   - Solve the problem: *How can you create, at a medium level, two contrasting shapes to show an open and closed **circuit**?*

3. *Two students: one of you will create and move like a metal object and the other will create and move like a plastic object.*
   - Solve the problem: *If you are a metal object, how will you show starting on a low level, being attracted to the **core** at a high level when the circuit is closed? How will you show loss of attraction to the **core** when the circuit is opened?*
   - *If you are a plastic object, how will you show no attraction at a low level?*

4. *Remainder of the group will represent the insulated wire: one long wire from the positive pole, wrapping around the core to the **switch** and one short wire from the switch to the negative pole.*
   - Solve the problem: *How can you show, at low level, the electric current flowing out and the negative pole of the D-cell, around the **core**, and back to the positive pole of the D-cell. (Hint: Use the bump from lesson #2.)*