Non-Contact Force

ELECTRICIAN (CONCEPT)

PIPE TRADES (MATERIALS)

GRADES	LEARNING OBJECTIVE	CONCEPTS
• Grade 4	Students will learn about non-contact forces and how they impact everyday life. Students will also graph data collected from the exercise.	• Magnetism • Gravity • Electricity

Curriculum connections

GRADE 4 SCIENCE

- Organizing idea – Energy: Understanding of the physical world is deepened by investigating matter and energy.
- Guiding question: How can forces affect objects from a distance?
- Learning outcome: Students investigate how forces can act on objects without contact.
- Skills and procedures:
    - Describe how non-contact forces interact with objects
    - Demonstrate the effect of gravity on an object
    - Conduct investigations regarding the push and pull of magnetism on objects

GRADE 4 MATH

- Organizing idea – Statistics: The science of collecting, analyzing, visualizing, and interpreting data can inform understanding and decision making.
- Guiding question: In what ways can communication be shaped by the choice of representation?
- Learning outcome: Students evaluate the use of scale in graphical representations of data.
- Skills and procedures:
    - Select an appropriate scale to represent data
    - Represent data in a graph using many-to-one correspondence
    - Describe the effect of scale on representation
    - Justify the choice of graph used to represent certain data
    - Compare different graphs of the same data
    - Interpret data represented in various graphs

Description

Students will experiment with two non-contact forces: gravity and magnetism. Students will learn about gravity and magnetism as well as magnetic and non-magnetic influences. Students will also explore the relationship between magnetism and electricity. Challenge students to identify which non-contact force is at play and why the magnet acts the way it does.

Electricians must be aware of non-contact forces for many reasons. Electricians use aluminum conduits to run wires. When a magnet moves through a conductive, non-magnetic metal tube or pipe (like copper or aluminum), an electrical current is produced. In simple terms, this is Faraday's law in action. When the magnet moves through a conductive, non-magnetic metal pipe, it descends due to gravity but at a slower rate due to the electrical current acting in the opposite direction of gravity. In simple terms, this is Lenz's law in action.

Some real-world applications that utilize Lenz's Law include electromagnetic brakes, induction cooktops, electric generators, Eddy Current balances and brakes, metal detectors, braking system on trains, levitating trains (Maglev trains), card readers, microphones, motors, inductors, and transformers. Electricians deal with many of these applications.

Both electricians and pipe trade technicians work with various types of pipe. Aluminum pipe is used by electricians because it's lightweight and resists corrosion. Copper pipe is used by plumbers in commercial and industrial plumbing because it's a strong, tried and tested material. ABS pipe is used by plumbers in draining, waste, and venting applications. ABS is cheaper than copper and is faster and easier to install.

TIME

- 20–50 minutes

MATERIALS

- 1 magnet
- 3 aluminum pipes
- 2 copper pipes
- 1 ABS pipe
- 1 steel pipe
- 1 roll of electrical tape
- 1 stopwatch

Procedure

PREPARATION

- Lay materials out on a table or desk to ensure all materials are accounted for. Run the task prior to instruction.

STEPS

1. Introduce students to the different materials by putting them on display. Tell students what each item is and how plumbers and electricians use these materials in their work. Introduce the non-contact forces of gravity and magnetism.
2. Ask students what will happen if they drop the magnet 2 feet from the ground. What non-contact force will be acting on the magnet? Drop the magnet but make sure the magnet is caught before it hits the ground. Students will see that the magnet falls unimpeded onto the cloth. NOTE: If the magnet hits the ground, the impact will damage the magnet.
3. Ask students what will happen if they drop the magnet through the narrow 2-foot ABS pipe. What non-contact force will be acting on the magnet? Drop the magnet through the ABS pipe. Students will see that the magnet drops through the pipe at around the same speed as it did when it was free-falling.
4. Ask students what will happen if they drop the magnet through the narrow 2-foot steel pipe. What non-contact force will be acting on the magnet? Drop the magnet. Students will see that the magnet will not fall. Ask students why the magnet didn't fall. Explain that when a magnet is dropped in a steel tube, it's affected by both magnetism and gravity. However, because the magnetic force is stronger than the force of gravity, the magnet sticks to the pipe.
5. Ask students what will happen if they drop the magnet through the narrow 2-foot copper pipe. What non-contact force will be acting on the magnet? Drop the magnet through the copper pipe. Note that the magnet will move through the copper pipe at a slower rate than it did during the free fall and through the ABS pipe, but that it will not stick to the side of the pipe.
6. Ask students what will happen if they drop the magnet through the narrow 2-foot aluminum pipe. What non-contact force will be acting on the magnet? Drop the magnet through the aluminum pipe. Note that the magnet will move through the aluminum pipe at a slower rate than it did during the free fall and through the ABS pipe, but that it will fall at about the same rate as it did through the copper pipe and will not stick to the side of the pipe like it did in the copper pipe. Why is this? Discuss magnetic and non-magnetic materials. Point out in as much detail as desired that the magnet slows down in the non-magnetic metal pipes due to an induced electrical current acting in the opposite direction of the falling magnet as the magnet moves down the copper and aluminum pipes. This is known as Lenz's law.
7. These pipes fit inside one another. Challenge students to create a thicker pipe and notice what happens to the magnet. Secure the pipes with the electrical tape provided.

Assessment suggestions

WRITTEN

Have students record their findings in a scribbler or booklet or on an exit slip.

DISCUSSION

As a class, discuss students' observations.

TABLE OF VALUES AND GRAPH (MATH CONNECTION)

Students can record each drop in a table. Students can then generate a graph based on their recorded data and compare their graph with that of other groups.

Extension

- This activity can be used to explain the scientific method. Students can list the different variables associated with the task.

Contributors

Mira Vanhala, Mark Iwaasa, Josh Hill, Warren Anderson, Colton Garner