Forces of Attraction

Overview:

Magnets attract each other by exerting a magnetic force, but what makes an object a magnet? In this lesson, Dash will help students conduct a scientific experiment to find out which objects are more magnetic than others and how magnets interact with each other.

Curriculum: Science, ELA

Group Size: 2 per Dash	Target Grades: 3 - 5	Time Required: 1.5 - 2 hours

Content Standards:

NGSS:

- 3-PS2-3: Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.
- 5-PS1-3: Make observations and measurements to identify materials based on their properties.

ELA:

- W.3.2: Write informative/explanatory texts to examine a topic and convey ideas and information clearly.
- W.3.8: Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.

Materials Needed:

- 1 Dash per group of 2 students
- One Blockly compatible device per group
- 1 magnet per group, as strong as possible
- Glass plate
- Small amount of iron filings
- Xylophone Mallet or lego built arm
- Tape or string
- Collection of objects (some magnetic and some not, such as wood, plastic, metal office supplies, different types of wire, nails and other building supplies)
- Experiment Recording Table

Lesson Objectives:

- Develop hypotheses about the magnetism of different objects.
- Test hypotheses by running an experiment.
- Write a conclusion to support experimental data.
- Learn about the reactions of everyday objects to a magnet and the reaction between two magnets.

Lesson Procedure:

This lesson can be broken into four classes or sections.

Class 1: Introduction to Magnetism (30 minutes)
Class 2: Gathering Data with Dash (30 minutes)
Class 3: Gathering Data with Two Dashes (20 minutes)
Class 4: Writing Conclusions (30 minutes)

Class 1: Introduction to Magnetism

Ask students to think about why some things stick together without glue and others don't.

- Your pictures don't stick to the fridge on their own, so how do you get them to stay up?
- Do the magnets that you use stick to all parts your house, like walls and windows?
- Can you think of anything special about these objects that might make them magnetic?

Open the following video and watch it up to 1:15. It provides an introduction to magnetism. https://www.youtube.com/watch?v=tdBpokG4wLM

Vocabulary

- Magnetism is an electric current generated by an object that causes attractive and repulsive forces between objects. In certain minerals, the clusters of atoms within the mineral are aligned, which causes the object to be magnetic.
- Magnetic objects generate a magnetic field to attract or repel other magnetic objects. This field is produced by a magnetic object and acts on all objects, but its effects are only seen on other magnetic objects.
- Level of magnetism is a property of these minerals, just like their color, hardness, or flexibility: you can test it, but you can't make an object become magnetic.
- Magnetism is a force that acts on other magnetic objects.
    - Brainstorm other forces that students can feel or observe the effects of, but cannot see directly (e.g. gravity, wind, sound).

Unplugged activity - Magnetic Fields

This activity will help students visualize the effects of magnetism by creating a visual magnetic field.

1. Place a magnet on a table below a glass plate.
2. Spread iron filings onto the plate.
3. Shake the plate slightly and watch what happens to the filings.
    a. The filings will rearrange into rings around the magnet.
    b. Talk to students about why they couldn't see the rings around the magnet before. Were they always there?
    c. Do students observe any other patterns in the rings? They should notice that the rings go around both poles, and the rings become farther apart as they are further from the magnet. The magnet's force is weaker as the filings get farther away.
4. Notice that if you move the magnet around, the filings also move.

Review with students the effects of magnetism:

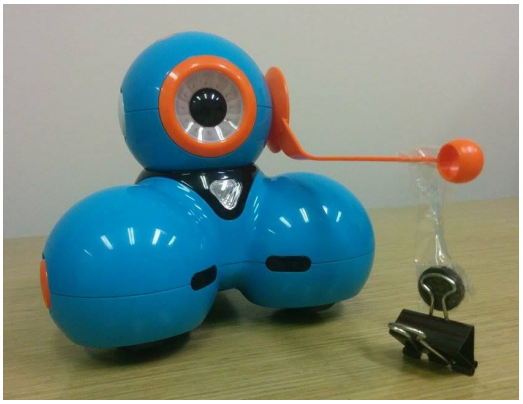
- Objects that contain certain minerals exert a magnetic force, which attracts other objects containing those minerals.

- The magnetic force is invisible, but its effects can be seen by bringing magnets close together or by placing iron filings above a magnet.

Now pull out the objects that the students will experiment on. You should include objects that are magnetic (e.g. nails, paper clips, other magnets, and iron wire) and objects that are not magnetic (e.g. wood, plastic, paper, fabric, copper wire).

Ask students to write a hypothesis about each of the objects, on their Experiment Recording Table. They should consider whether the object is magnetic, and whether a magnet will have any effect on it.

Class 2: Gathering Data with Dash



Place the objects around the classroom. For very small objects, make sure they are in front of an obstacle like a wall or block, so Dash doesn't miss them.

Attach a magnet to Dash using the Xylophone Mallet (or an arm built with Lego, or bunny ears) and tape or string. The magnet should be on the bottom of the mallet or hanging from the arm or ears.

Students will use Blockly to program Dash to move around the room. If necessary, review the following Blockly commands with students:

- **Start** blocks determine when the program will begin running. For example, when Dash's top button is pushed. Everything students want to be included in the program is attached below the **Start** block.
- **Drive** blocks to make Dash can move forwards or backwards, or turn.
- **Control** blocks allow students to repeat an action until something happens (Repeat Until), or perform an action if a condition is met (If), or pause and.
- **Sound** blocks make Dash or Dot play a **sound.**
- **Light** blocks change the color of lights on the robots.
- **Look** blocks cause Dash to look down or around.

An example program is shown here.

Dash starts when the button is pressed.	
Dash continues until it comes to an obstacle, the object to be tested.	
Dash moves forward.	
Dash stops and makes a sound or lights up to alert the student.	
Then Dash looks down to attempt to grab the object with a magnet.	
Dash moves backward until it comes to an obstacle, the student.	
Dash stops. At this point, the student can remove the object if Dash picked it up.	

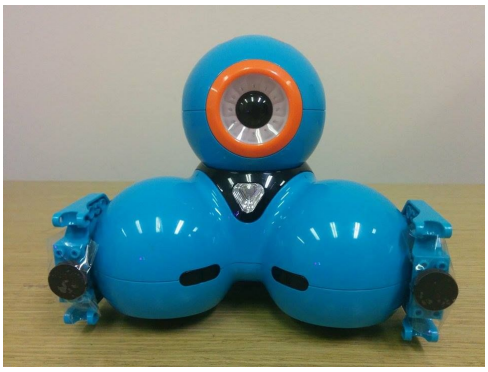
Extension: Older students could try to develop a pattern that will take Dash to each object exactly once, with pauses to allow them to remove an object that Dash picked up.

Students record the results of each interaction that the magnet has with an object. They should note whether the object is picked up, moved a little but not be picked up, or unaffected by the magnet.

Class 3: Gathering Data with Two Dashes

The groups of students should now combine into groups of 4, with 2 Dashes per group. The students will try another experiment with 2 magnets. Students should record the results of each experiment on their Experiment Recording Table.

1. Move the magnets so they are attached in front of the Dashes. This is easy using the building brick connectors. Make sure that the magnets on the Dashes are perfectly lined up with each other and are opposite of each other (opposite poles lined up).



2. Place the 2 Dashes facing each other. Move one Dash toward the other, slowly.
    - Students should pay close attention to see when the magnets start to pull the Dashes closer: at some point, the magnets should snap together.

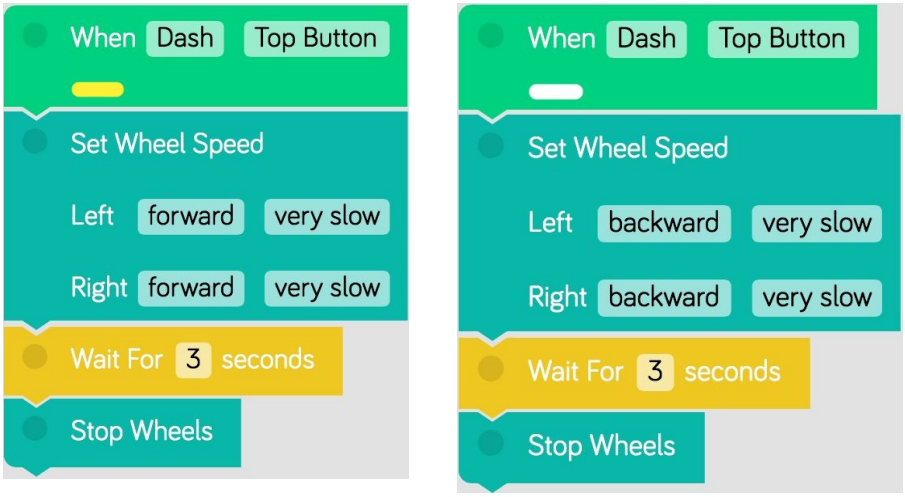
3. Then try to move one of the Dashes backward. At first, use the very slowest setting, to see the effects of the magnets. If the magnets are strong enough, one Dash will pull the other! The stronger the magnets, the faster the speed one Dash will be able to pull the other.

4. Reset the robots and try again, this time with the magnets offset so that the opposite poles don't meet perfectly. It should be easier for them to pull apart.

5. Reset the robots one more time, with the magnets rotated so that the like poles face each other.

6. Move the Dashes toward each other, slowly. When they get close, the magnets should repel each other, so the Dashes do not want to meet. If the magnets are strong enough, one Dash will push the other backward without touching.

Some example code:



Extension: Older students could program the Dashes to perform the experiments automatically. For example, the Dashes move toward each other, meet, and back up slowly then more quickly to try to pull the magnets apart.

Class 4: Writing Conclusions

Have students write a report with their findings. Prompt them to include:

- A categorization of which types of objects are magnetic
- Conclusions about why those types are magnetic or not
- Ideas for why the magnets were easier to pull apart when they were turned
- Ideas for why the magnets repelled each other when their poles were reversed

Have students take turns explaining their findings to the class. They should talk about any differences in the data between groups, and think about why those occurred.

Explain which basic minerals are magnetic (iron, nickel, and cobalt), and show students that those minerals are in each of the magnetic objects.

For the second experiment, discuss the strengths of magnetic fields. When they are not aligned, there is less force between the two magnets, so the robots were easier to move apart.

wonder workshop

Experiment Recording Table

List the objects in this table. Start by making a hypothesis about what will happen when Dash's magnet gets close to the object: will it be picked up, attracted but not picked up, or not affected? Then write down what happens as Dash runs through the experiment.

Object	Hypothesis	Result

For the second experiment, think about what will happen when 2 magnets interact. Write your hypotheses and the results here.

Experiment	Hypothesis	Result
Magnets aligned		
Magnets offset		
Magnets reversed		

wonder workshop

Evaluation Rubric

	Excellent	Competent	Needs work
Participation and Teamwork	The student actively participates in classroom discussions, answering questions and cooperating with group member(s) during the activity.	The student occasionally participates in classroom discussions and cooperates somewhat with group member(s).	The student does not participate in classroom discussion. The student does not cooperate with their group member(s) during the activity.
Programming	The student correctly applies a variety of commands to complete the task. The program responds to input and completes the experiment.	The student correctly applies commands, but their program is limited.	The student applies commands only with consistent help from the teacher or groupmates.
Scientific Method	The student writes complete and well-reasoned hypotheses. They make detailed notes during the experiment.	The student writes basic hypotheses. They make notes during or after the experiment.	The student writes incomplete hypotheses, and does not take complete notes during the experiment.
Conclusion	The student writes a full conclusion that compares their hypotheses to the experimental results. They draw reasonable conclusions.	The student writes a conclusion that includes the experimental results. It does not draw complete conclusions from the results.	The student does not write a complete conclusion, or the conclusion does not take all of the results into account.