

**Title: Magnetic Car STEM Challenge**

**Estimated Time: 1-2 periods**

**Core Ideas (GSE Standard and elements):**

**S1P2. Obtain, evaluate, and communicate information to demonstrate the effects of magnets on other magnets and other objects.**

- b. Plan and carry out an investigation to demonstrate how magnets attract and repel each other and the effect of magnets on common objects.

**S2P2. Obtain, evaluate, and communicate information to explain the effect of a force (a push or a pull) in the movement of an object (changes in speed and direction).**

- a. Plan and carry out an investigation to demonstrate how pushing and pulling on an object affects the motion of the object.
- b. Design a device to change the speed or direction of an object.
- c. Record and analyze data to decide if a design solution works as intended to change the speed or direction of an object with a force (a push or a pull).

**S4P3. Obtain, evaluate, and communicate information about the relationship between balanced and unbalanced forces.**

- a. Plan and carry out an investigation on the effects of balanced and unbalanced forces on an object and communicate the results.
- b. Construct an argument to support the claim that gravitational force affects the motion of an object.

**S8P3. Obtain, evaluate, and communicate information about cause and effect relationships between force, mass, and the motion of objects.**

- b. Construct an explanation using Newton's Laws of Motion to describe the effects of balanced and unbalanced forces on the motion of an object.

**Science and Engineering Practices:**

**Planning and Carrying Out Investigations:**

Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation.

**Constructing Explanations and Designing Solutions:**

Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process or system.

**Crosscutting Concepts:**

**Structure and Function:**

The way an object is structured/designed determines many of its properties and functions.

**Stability and Change:**

For designed systems, conditions that affect stability and factors that control rates of change are critical to consider and understand.

**STEM Challenge Overview:**

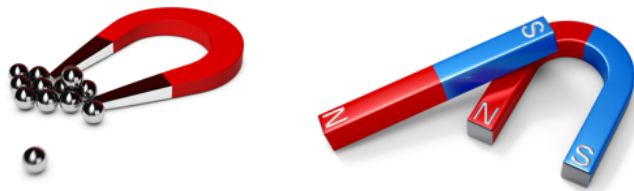
In this STEM Challenge, the student's task is to build a car that is powered only by the force (push or pull) of a pair of magnets.

|                           |   |
|---------------------------|---|
| <b>Ask</b>                | Ask students to describe the unusual property that magnets have that most objects don't. Using a pair of magnets show them how a pair of magnets can attract and repel each other. Ask them to consider how this attraction or repulsion could be used in a helpful manner. If time permits, show them this 4 minute YouTube Video that shows the fastest train in the world (MAGLEV train in China) zipping along at 430 km/hr (270 miles/hr).<br><a href="https://www.youtube.com/watch?v=PTo-krTSZBA">https://www.youtube.com/watch?v=PTo-krTSZBA</a>  |
| <b>Imagine/Brainstorm</b> | Students <b>brainstorm</b> ideas for how they could design and construct their own vehicle that uses only the repulsion or attraction of a pair of magnets to move. After brainstorming, they should consider the strengths and weaknesses of each idea.  |
| <b>Plan/Design</b>        | In order to learn more about topic, have them read the <i>Marvelous Magnets</i> article and discuss how magnets are used to do a variety of useful things. It is a good idea to briefly discuss how the attractive pulls and repulsive pushes of magnets can be used effectively. After learning about magnets, students <b>plan</b> and <b>design</b> a simple vehicle that use a pair of magnets to move it from place to place.<br>Depending on the level of your students and the time you have for this challenge, you can make this open-ended or more of a guided inquiry for your students. If you take a more open-ended approach, provide a greater variety of materials that can be used to construct the vehicle and encourage more out of the box designs. |
| <b>Create/Test</b>        | Students follow their plan, and <b>create</b> their model car. Once it is created, students <b>test</b> their car in a measureable way to evaluate the effectiveness of their solution. In this case, they test to see if their car can effectively move from one place to another using only the power of the magnets. Their results should be recorded, organized, and analyzed.  |
| <b>Improve</b>            | After discussing and evaluating their results, students improve their solution and re-test if possible.   |

## Teacher Notes:

This STEM Challenge is great because it is super versatile and can be used to teach about magnetism, forces, and even modes of transportation. At our school, we typically use it as a first grade activity when students are learning about magnets and magnetism. This [YouTube Video](#) is a great way to launch the lesson because it gives kids a chance to see what 430 km/hr looks (and sorta feels) like as the MAGLEV train cruises down the track.

**Magnets** are objects that have an unusual ability to attract and repel certain materials. They are quite unique and amazing. Magnets have two poles that are called the north pole and the south pole. The **poles** are areas near the opposite ends of a magnet where the magnetic force is the strongest.



Magnets are useful in lots of ways. Their attractive properties are used to stick things on other objects like refrigerators. They are also used to help power speakers in stereos and store data in computers.

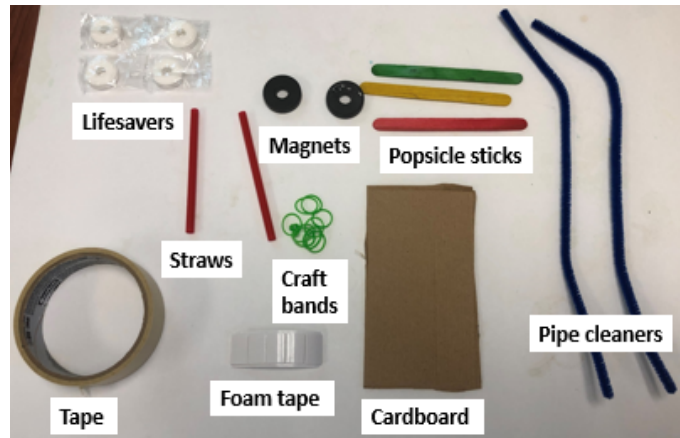


If you are using this lesson to build understanding of forces, spend some additional time discussing the nature of forces. At the elementary level, forces are interactions between objects that cause a push or a pull between them. Forces can move objects that are at rest or stop objects that are moving. At the middle school level, you can discuss how Newton's Laws of Motion can be used to more specifically describe the effects of the forces that act on the vehicle that they build. For example, instructional focus could be placed on how the vehicle at rest will stay at rest until the unbalanced force supplied by the magnets acts on it to compel its movement (1<sup>st</sup> Law).

In this STEM Challenge, the students' task is to build a vehicle powered only by the attractive pull or repulsive push of a pair of magnets. While we encourage our students to be super creative in the type of car that they create, we normally encourage them to use a combination of lifesavers, straws and craft bands to create a pair of wheel and axels that turn effectively. If time permits, they can add things like seats, bumpers, hoods, and trunks. Finally, make sure that they make at least one or two improvements to their original car as you emphasize the cyclical nature of the engineering design process.

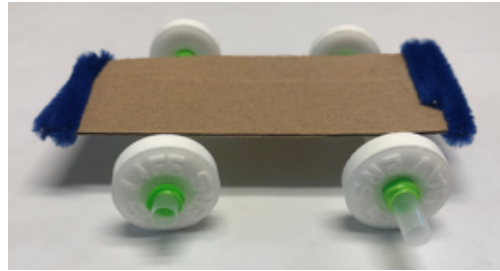
**Suggested materials for student use:**

A pair of ring or bar magnets, 4 large Lifesavers, 1-2 straws (slightly smaller than the holes in the Lifesavers), 3-4 pieces of foam mounting tape (Dollar Store), 8-10 craft rubber bands, piece of cardboard, scotch or masking tape, 3-4 popsicle sticks (optional), 1-2 pipecleaners (optional).



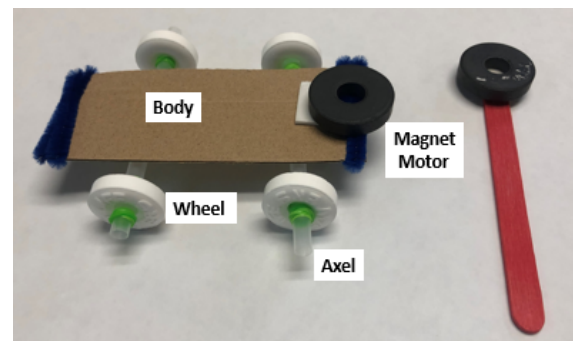
## Magnetic Car STEM Challenge:

Can you design, build, and test a car that is powered only by the force of a pair of magnets?



### Designing and constructing your car:

1. After learning about force and magnets, **plan** and **design** a simple magnetic car that uses the force of magnets to move.
2. Using the materials provided and your plan, **construct** your magnetic car. Your car should include 4 wheels, 2 axels, 1 body, and a magnet motor.
3. If time permits, add other parts to your car such as bumpers, seats, a hood, a trunk.
4. **Test** your car and see how well it moves.



### Evaluating and Improving:

1. As a group, discuss how you were able to construct your car and explain how the car used the magnets to make it move.
2. As a group, **evaluate** the effectiveness of your design and discuss how you would change your design moving forward to **improve** the performance of your car. If time permits, make these improvements and re-test.