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# Magnetic Marvels: The Maglev Inventor's Workshop

## Materials Needed

- A variety of magnets (e.g., strong neodymium disc magnets, ring magnets, bar magnets)
- Cardboard or foam board for building a base/track
- Lightweight objects to levitate (e.g., a small piece of balsa wood, a pencil, a piece of foam)
- Craft supplies (hot glue gun, tape, scissors, ruler, markers)
- A "Design Journal" (notebook and pencil) for sketching ideas and recording observations
- Optional: Paper clips, iron filings in a sealed container, a compass

## Learning Objective

The student will apply their understanding of magnetic polarity and forces to design, construct, and test a simple prototype that uses magnetic repulsion to achieve levitation.

## Learning Outcomes

By the end of this lesson, the student will be able to:

- Demonstrate and explain the concepts of magnetic attraction and repulsion.
- Predict how magnets will interact based on their orientation (poles).
- Use the engineering design process (imagine, plan, create, test, improve) to solve a challenge.
- Explain how the principle of magnetic levitation works in their own prototype and in real-world technologies like Maglev trains.

## Teacher Methodology

This lesson uses a **Project-Based Learning (PBL)** and **Guided Inquiry** approach. The teacher acts as a facilitator or "senior engineer" rather than a lecturer. The process encourages the student to ask questions, experiment independently, and learn from both successes and failures. The structure follows the 5E Model (Engage, Explore, Explain, Elaborate, Evaluate) to build understanding through hands-on discovery.

## Activity: The Maglev Challenge

### Part 1: Engage - The Mission (10 minutes)

**Teacher's Role:** Spark curiosity and present the challenge.

**Instructions:** Start with a compelling question: "Have you ever seen something float in mid-air without strings? Today, your mission is to become an inventor and build a device that makes an object levitate using only the invisible power of magnets. Think about super-fast trains that don't touch the tracks or floating vehicles of the future. How could we make that happen?"

Show a short video clip of a real Maglev train in action to provide context and inspiration.
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Part 2: Explore - Magnet Bootcamp (20 minutes)

Teacher's Role: Provide materials and encourage free-form experimentation.

Instructions: Give the student the magnets and other small items (paper clips, compass). Don't give instructions yet. Let them simply play and discover. Ask guiding questions to prompt observation:

- "What happens when you bring two magnets close together?"
- "Can you make one magnet push another away without touching it? How do you have to turn it?"
- "Which parts of the magnet are the strongest?"
- "What happens to the compass needle when you bring a magnet near?"

This "bootcamp" allows the student to intuitively grasp the concepts of poles, attraction, and repulsion before being formally taught.

Part 3: Explain & Design - Blueprinting Your Device (15 minutes)

Teacher's Role: Help the student articulate their discoveries and plan their creation.

Instructions: Open the Design Journal. Together, establish the key principle discovered in Part 2: **Like poles repel, and opposite poles attract.** Explain that this "pushing" force (repulsion) is the secret to levitation.

Challenge the student to sketch at least two different ideas for their levitation device. How will they arrange the magnets on a base (the "track") and on the object to be levitated (the "vehicle") to create a stable pushing force? Remind them to think about keeping the vehicle from flipping over or sliding off the side.

Part 4: Elaborate - The Build (45-60 minutes)

Teacher's Role: Facilitate the building process, offer support, and encourage problem-solving.

Instructions: Using the cardboard, craft supplies, and magnets, the student brings their design to life. This phase is all about trial and error. The teacher should resist giving answers and instead ask questions to help the student overcome challenges:

- **If it's not levitating:** "Are the magnetic poles lined up correctly to repel each other? Are the magnets strong enough for the weight of the vehicle?"
- **If the vehicle flips over:** "Is the magnetic force unstable? How could we add 'guide rails' to the track or change the shape of the vehicle to keep it balanced?"
- **If it slides off:** "What could you add to the sides of the track to keep the vehicle centered?"

Encourage the student to record changes and improvements in their Design Journal. This is the core of the engineering process.

Part 5: Evaluate - The Showcase (15 minutes)

Teacher's Role: Assess understanding through demonstration and explanation.

Instructions: The student presents their final prototype. The assessment is not on how "perfect" the device is, but on their ability to explain it. Ask the student to:

1. Demonstrate how their device works.
2. Explain *why* it works, using the terms "attraction," "repulsion," and "magnetic poles."
3. Share one challenge they faced during the build and how they solved it.

4. Suggest one improvement they would make if they had more time or different materials.

Differentiation & Extension

- **For Support:** If the student is struggling, work together to build a simple, pre-designed levitator first (e.g., floating a ring magnet over another ring magnet on a pencil). This provides a foundational success before they tackle their own design.
- **For a Challenge (Extension):** Challenge the student to build a longer track. Can they make their vehicle travel from one end to the other using magnetic forces? Or, can they design a simple magnetic switch that "turns off" the levitation?

Sustainable Development Goal (SDG) Connection

SDG 9: Industry, Innovation, and Infrastructure.

Discuss how this small-scale experiment connects to a huge global goal. Magnetic levitation is an innovative technology used to build resilient and sustainable infrastructure. Maglev trains use less energy, create less friction (meaning less wear and tear), and can travel at higher speeds than traditional trains, making them a cleaner and more efficient mode of transportation for the future.

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