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**In-Class Field Trip:**

**Gravity Railroad**

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| **Estimated Time: 45 minutes to 1 hour** | |
| **Core Ideas (GSE Standards and elements):**  **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. | |
| **Science and Engineering Practices**  Planning and Carrying Out Investigations  Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. | **Disciplinary Core Ideas**  PS2.A Forces and Motion  Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object’s speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.)  PS2.B Types of Interactions  Objects in contact exert forces on each other. |
| **Crosscutting Concepts**  Cause and Effect  Cause and effect relationships are routinely identified. |
| **Authentic Scenario (Phenomena):**  Show students a video of a Long, Fast-Moving CSX Intermodal Train:  <https://www.youtube.com/watch?v=5gryuPZ7He8>  Ask the students, “What do you observe about the train in this video? How is the train able to move so fast with those heavy cars?” | **Vocabulary:**   * balanced * unbalanced * force * gravity * friction * drag |
| **Guiding Questions:**  What effect do balanced and unbalanced forces have on objects?  How does gravity affect the motion of an object?  How does the height of a ramp affect the distance a toy train will roll? |
| **Materials Needed:**  For each group of students:   * A toy train (must have moving wheels) * A flat piece of cardboard * 3 stackable items of the same size (i.e., blocks, books, etc.) * Meter stick * Masking tape * Recording sheet | **Safety Considerations:**   * N/A |
| **Technology Integration:**   * Device with Internet access |
| **Literacy Connections:**  Force & Motion:   * *Motion* by Debra J. Housel   Trains:   * *How Does it Work?: Trains* by Nikole Brooks Bethea   All texts are available on [www.getepic.com](http://www.getepic.com) | |

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| **5E Stage** | **Student Activities**  How will students engage actively in the three dimensions throughout the lesson?    **Teacher Activities**  How will the teacher facilitate and monitor student learning? |
| **Engage** | Show students a video of a Long, Fast-Moving CSX Intermodal Train:  <https://www.youtube.com/watch?v=5gryuPZ7He8>  Ask the students, “What do you observe about the train in this video? How is the train able to move so fast with those heavy cars?”  Ask, “What do you know about forces?” When an object is at rest, it means the forces acting on the object are balanced. For example, a book sitting on a desk has an equal amount of gravity pushing down on it as the amount of force of the desk pushing up on it. The same goes for an object in motion – if no other forces interfere, the object would keep moving forever.  Motion is caused by unbalanced forces. For example, when you arm wrestle with someone if you are both exerting the same amount of force, your arms don’t move. When someone exerts more force, the stronger arm will overtake the weaker arm and push it down.  Say, “Today, you are going to observe the effects of balanced and unbalanced forces on an object.” |
| **Explore** | Give each group of students a toy train (must have moving wheels), a flat piece of cardboard, three stackable items of the same size (i.e., blocks, books, etc.), a meter stick, and a recording sheet.  Instruct the students to set the toy train on the ground. Ask, “Why isn’t the train moving? How could we make the train move?”  Have students use a piece of masking tape to mark a starting point for the train. Next, have a student place the train on the starting point and give it a gentle push. Have them measure how far the train traveled.  Ask, “How could we get the train to go further?” Instruct the students to build a ramp one object tall. Make sure the top of the ramp is at the starting point. Students should place the train at the top of the ramp and let go. Have them measure how far the train traveled.  Let students explore and observe with a ramp two and three objects tall.  After the students have had time to explore, ask, “Which ramp made the train go the furthest distance? Which ramp created the most unbalanced force?” |
| **Explain** | To learn more about the ways objects move, read aloud *Motion*. Discuss how motion is movement. Motion can be slowed or stopped through friction and drag. Friction is a force that slows or stops motion. Drag is water or air resistance. An unbalance in forces causes motion. Gravity is an unseen force that pulls us toward the Earth.  The teacher will also introduce the STEM Career of Systems Management Analyst. Systems Management Analysts use data to understand patterns and trends for a business. They work with platform users and platforms to gauge issues. To become a Systems Management Analyst, you will need a bachelor's degree in computer science or a related field. You will also need good communication, critical thinking, and interpersonal skills.  Time permitting, show the video Meet Jenica: CSX Technology Employee: <https://www.youtube.com/watch?v=RhKA9RQyd5E> (51 seconds) |
| **Elaborate** | Add more weight to the train in some way and retest. Do you get the same results? |
| **Evaluate** | Using the C-E-R model, explain how gravitational force affects the motion of an object. |

**Notes:**

Teachers, live feed from the Waycross, Georgia Train Depot is available here: <https://www.youtube.com/watch?v=p0MiR5gPJLk>

Name:

**Gravity Railroad Recording Sheet**

Part 1:

1. Set the toy train on the ground.
2. Why isn’t the train moving?
3. How could we make the train move?

Part 2:

1. Using a piece of masking tape, mark a starting point for the train.
2. Place the train on the starting point and give it a gentle push.
3. How far did the train travel?
4. Why do you think this happened?

Part 3:

1. Build a ramp one object tall (make sure the top of the ramp is at the starting point).
2. Place the train at the top of the ramp and let go.
3. How far did the train travel?
4. Why do you think this happened?

Part 4:

1. Build a ramp two and three objects tall.
2. Place the train at the top of the ramp and let go.
3. How far did the train travel with
   1. Two objects:
   2. Three objects:
4. Why do you think this happened?

Questions:

1. Which ramp made the train go the furthest distance?
2. Which ramp created the most unbalanced force?