University Transportation Center for Railway Safety (UTCRS)

Middle School STEM Curriculum

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2017 Next Generation Science Standards 6-8

MS-PS2-1	Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.*
MS-PS2-2	Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
MS-PS2-3	Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.
MS-PS2-4	Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.
MS-PS2-5	Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.
MS-PS3-1	Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.
MS-PS3-2	Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.
MS-PS3-3	Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.*
MS-PS3-4	Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.
MS-PS3-5	Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.
MS-ETS1-1	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3	Analyze data from tests to determine similarities and differences among several. design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
MS-ETS1-4	Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Texas Essential Knowledge and Skills (TEKS)

Science TEKS

[2021 Texas Education Agency Science Standards]

S5.7(A)	Investigate and explain how equal and unequal forces acting on an object cause patterns of motion and transfer of energy.
S5.7(B)	Design a simple experimental investigation that tests the effect of force on an object in a system such as a car on a ramp or a balloon rocket on a string.
S5.8(A)	Investigate and describe the transformation of energy in systems such as energy in a flashlight battery that changes from chemical energy to electrical energy to light energy.
S5.8(C)	Demonstrate and explain how light travels in a straight line and can be reflected, refracted, or absorbed.
S6.7(A)	Identify and explain how forces act on objects, including gravity, friction, magnetism, applied forces, and normal forces, using real-world applications.
S6.7(B)	Calculate the net force on an object in a horizontal or vertical direction using diagrams and determine if the forces are balanced or unbalanced.
S6.7(C)	Identify simultaneous force pairs that are equal in magnitude and opposite in direction that result from the interactions between objects.
S6.8(B)	Describe how energy is conserved through transfers and transformations in systems such as electrical circuits, food webs, amusement park rides, or photosynthesis.
S6.2(A)	Identify advantages and limitations of models such as their size, scale, es, and materials.
S6.1(B)	Use scientific practices to plan and conduct descriptive, comparative, and experim investigations and use engineering practices to design solutions to problems.
S6.2(D)	Evaluate experimental and engineering designs.
S6.1(G)	Develop and use models to represent phenomena, systems, processes, or solutio ring problems.
S6.8(A)	Compare and contrast gravitational, elastic, and chemical potential energies with
S7.7(A)	Calculate average speed using distance and time measurements from investigations.

S7.7(B)	Distinguish between speed and velocity in linear motion in terms of distance, displacement, and direction.
S7.7(C)	Measure, record, and interpret an object's motion using distance-time graphs.
S7.7(D)	Analyze the effect of balanced and unbalanced forces on the state of motion of an object using Newton's First Law of Motion.
S7.8(A)	Investigate methods of thermal energy transfer into and out of systems, including conduction, convection, and radiation.
S7.8(C)	Explain the relationship between temperature and the kinetic energy of the particles within a substance.
S7.9(B)	Describe how gravity governs motion within Earth’s solar system.
S8.7(A)	Calculate and analyze how the acceleration of an object is dependent upon the net force acting on the object and the mass of the object.
S8.7(B)	Investigate and describe how Newton's three laws of motion act simultaneously within systems such as in vehicle restraints, sports activities, amusement park rides, Earth's tectonic activities, and rocket launches.

Math TEKS

2012 Texas Education Agency Math Standards

M7.3(A)	Add, subtract, multiply, and divide rational numbers fluently.
M7.3(B)	Apply and extend previous understanding of operations to solve problems using addition, subtraction, multiplication, and division of rational numbers.
M7.4(A)	Represent constant rates of change in mathematical and real world problems given pictorial, tabular, verbal, numeric, graphical, and algebraic representations, including d = rt.
M7.4(A)	Represent constant rates of change in mathematical and real-world problems given pictorial, tabular, verbal, numeric, graphical, and algebraic representations, including d = rt.
M7.4(B)	Calculate unit rates from rates in mathematical and real-world problems.
M7.4(D)	Solve problems involving ratios, rates, and percent, including multi-step problems involving percent increase and percent decrease, and financial literacy problems.
M7.4(D)	Solve problems involving ratios, rates, and percents, including multi-step problems involving percent increase and percent decrease.
M7.4(E)	Convert between measurement systems, including the use of proportions and use of unit rates.
M7.4(E)	Convert between measurement systems, including the use of proportions and use of unit rates.
M7.7(A)	Represent linear relationships using verbal descriptions, tables, graphs, and equations that simplify to the form y = mx + b.

Day 1: Welcome Aboard!

Theme: Engineering Railways Through Teamwork and Design

Day Overview: Students begin their introduction to railway safety and engineering by exploring how trains transport freight and the types of cargo containers used. Through hands-on activities, students develop observation, teamwork, and problem-solving skills. They engage in collaborative engineering challenges, including building and coding LEGO SPIKE Prime models, and practice the Engineering Design Process to plan, test, and improve their designs. By the end of the day, students experience how engineers approach real-world transportation challenges.

Lesson Objectives:

By the end of Day 1, students will be able to:

- Recognize the role of trains in transporting goods and identify different types of cargo containers.
- Apply observation and critical thinking skills to analyze freight and safety scenarios.
- Demonstrate teamwork, communication, and problem-solving during group challenges.
- Understand and apply basic engineering principles and the Engineering Design Process.
- Build and code a LEGO SPIKE Prime hopper to simulate freight movement.
- Test and refine a design through iteration, improving functionality and efficiency.

Day 1 at a Glance

Time Frame	Activity	Focus / Goal
30 min	Welcome & Safety Guidelines	Build community expectations and establish a safe, respectful environment.
5 min	I See, I Think, I Wonder	Spark curiosity, make observations, and connect to railway safety themes.
5 min	Freight Railroads & Intermodal	Learn how trains transport goods efficiently and their role in freight systems.
10 min	Types of Cargo Containers	Compare and contrast the three main cargo container types.
10 min	Kahoot Review	Reinforce understanding through interactive review.
10 min	Cup Challenge (Team-Building)	Strengthen collaboration, communication, and problem-solving skills.
45 min	Hopper Race (Engineering & Robotics)	Apply the Engineering Design Process to build and test a LEGO SPIKE Prime hopper.
15 min	Hopper Race Final Challenge	Compete in transporting “Apple cargo” 1,000 miles—apply iteration and improvement.
10 min	Reflection & Debrief	Connect learning to real-world railway engineering and teamwork.

Activity 1: Welcome & Observation Prompt

Estimated Time: 5-10 minutes

NGSS Connections: 3-5-ETS1-1, ETS1.A, ETS1.B

TEKS Connections:

8.1(A) Ask questions and define problems based on observations or information from text, phenomena, models, or investigations
8.1(B) Use scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems
8.2 Analyze and interpret data to identify features, patterns, relationships, or correlations to develop evidence-based arguments or evaluate designs

Activity Overview:
Students will analyze a Railway Safety poster, drawing conclusions and making predictions about key topics and upcoming activities for the camp. This activity develops observation and critical thinking skills while introducing the role of trains, different cargo container types, and the efficiency of rail transport.

Misconceptions:

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
MS-PS2-1	Forces & Motion	Equal and opposite forces cancel out; action and reaction act on the same object	Students may think a train's push on the track is canceled by the track's push back, causing no motion
8.1(A)	Asking Questions & Defining Problems	Observations are limited to what is seen; opinions are facts	Students may only describe the poster visually, ignoring patterns or relationships
8.1(B)	Planning & Conducting Investigations	There is one correct observation or conclusion	Students may feel there is a single "right answer" about what the camp will cover
8.2	Analyzing Data	Data interpretation is unnecessary; features/patterns don't matter	Students may not connect observations from the poster to real-world freight transportation

Materials Needed:

- Railway Safety poster or slide

Activity Flow:

1. Welcome students and review housekeeping rules.
2. Display the Railway Safety poster and provide a **30-second silent observation period**:
   - What do you see?
   - What do you think this camp will focus on?
   - What do you wonder about the activities this week?
3. Allow students to **share thoughts in small groups** or with the whole class.
4. Explain camp-specific awards or recognition procedures (e.g., Winning Team, Conductor Award).

Reflection Questions:

- What do you think will be the main focus or theme of this camp?
- What are you curious or excited to learn about this week

Activity 2: Freight Railroads & Intermodal Video

Estimated Time: 5 minutes

NGSS Connections: MS-PS2-1

TEKS Connections:

8.1(A), 8.1(B), 8.2(D) Evaluate experimental and engineering designs

Activity Overview:
Students will watch a video demonstrating how freight trains transport goods efficiently across the country and internationally. This activity highlights the **importance of railroads in logistics** and introduces concepts of efficiency and intermodal transportation.

Misconceptions:

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
MS-PS2-1	Forces & Motion	Motion is caused only by engines	Students may not recognize how momentum, slope, or

			coordinated handoffs contribute to train movement
8.1(A), 8.1(B)	Asking Questions / Planning Investigations	Students assume trucks and trains are interchangeable without understanding efficiency	Students may question why rail transport is preferred for certain cargo

Materials Needed:

- Video: *How Freight Railroads Transport Goods Through Intermodal*

Activity Flow:

1. Play the video for students.
2. Pause to ask reflection questions.
3. Facilitate discussion about the efficiency and importance of freight trains.

Reflection Questions:

- How do trains help transport freight efficiently?
- Why might trains be preferred over trucks for moving goods?
- What innovative technologies improve train operations?

Activity 3: Types of Cargo Containers

Estimated Time: 10 minutes

NGSS Connections: MS-PS2-1

TEKS Connections:

- 8.1(A), 8.1(B), 8.2(D)

Activity Overview:

Students explore the three main types of cargo containers, their characteristics, and the types of goods each container transports. They then reinforce learning with a **Kahoot review game**.

Misconceptions:

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
MS-PS2-1	Transport & Motion	All containers function the same way	Students may not differentiate between refrigerated, tank, or standard containers
8.1(A), 8.1(B)	Observation & Analysis	Students assume a container type has no effect on cargo efficiency	Students may select the wrong container type in simulations or challenges

Materials Needed:

- Visual slides showing three container types
- Kahoot game

Activity Flow:

1. Introduce the three types of cargo containers.
2. Conduct a Kahoot review game.
3. Facilitate group discussion to compare and contrast containers.

Reflection Questions:

- How are the three cargo container types different?
- What types of goods does each container carry?
- Why is it important to select the correct container for freight?

Activity 4: Cup Challenge (Team-Building)

Estimated Time: 10 minutes

NGSS Connections: MS-PS2-1

TEKS Connections:

- 8.1(A), 8.1(B), 8.2(D)

Activity Overview:
Students participate in a **team-building activity** where they use strings and a shared rubber band to build a pyramid of cups. This activity develops **collaboration, communication, and problem-solving skills** and introduces the characteristics of engineers.

Misconceptions:

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
MS-PS2-1	Forces & Motion	Single effort is sufficient to move complex structures	Students may try to pull alone instead of coordinating with the team
8.1(A), 8.1(B)	Teamwork / Planning	Collaboration isn't necessary	Students may not communicate effectively, causing the tower to collapse
8.2(D)	Iterative Design	Success is immediate; first attempt must work	Students may get frustrated if the first tower attempt fails

Materials Needed:

- 15 cups per group
- 1 rubber band per group
- 1 string per person

Activity Flow:

1. Explain the challenge and demonstrate rules.
2. Students tie strings to the rubber band and work together to build a cup pyramid.
3. Encourage iterative problem-solving and communication.

Reflection Questions:

- What strategies worked well for your group?
- What challenges did you face, and how did you overcome them?
- How do you feel about your completed tower?
- How does this activity illustrate effective teamwork?
- What is engineering? What are some key characteristics of engineers?

Activity 5: Hopper Race (Engineering & Robotics)

Estimated Time: 45 minutes

NGSS Connections: MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4

TEKS Connections:

- 8.1(G), 8.1(B), 8.2(D)

Activity Overview:
Students work in teams to **build a LEGO SPIKE Prime hopper**, taking on engineering roles

(Lead Engineer, Systems Engineer, Mechanical Engineer, Mechatronics Engineer). They race the hopper in iterative design phases: first without wheels, then with adjustments, and finally with wheels. The challenge simulates a company transporting 1,000 iPhones and watches over 1,000 miles.

Misconceptions:

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
MS-ETS1-1	Engineering Design	One perfect design exists	Students may try to build a “perfect” hopper on the first attempt
MS-ETS1-2	Developing Solutions	Iteration isn’t necessary	Students may not test and refine their hopper before the final race
MS-ETS1-3	Optimization	Teamwork is optional	Students may work individually instead of collaborating
MS-ETS1-4	Testing & Evaluation	Success is immediate	Students may expect the hopper to complete the race perfectly without adjustments

Materials Needed:

- 1 LEGO SPIKE Prime Kit per group
- 1 device per group
- SPIKE Prime App

Activity Flow:

1. Assign engineering roles to students.
2. Build the hopper according to instructions.
3. Conduct the **first race**, without wheels.
4. Return to groups to adjust the design and race a second time.
5. Make **final adjustments**, including adding wheels, and race a third time.

Reflection Questions:

- Did your hopper navigate effectively?
- What improvements or enhancements did you make to your design?
- How does today’s challenge relate to real-world railway engineering?
- What are some challenges engineers face?
- What are your team’s strengths and areas for improvement?

Day 2 Classifications and Energy in Railway Systems

Theme: Railroad Classifications, Energy, and Collaborative Freight Engineering

Day Overview: Day 2 of the UTRGV Railway Safety Camp immerses students in hands-on exploration of freight transportation systems, focusing on **engineering, logistics, and collaboration**. Students learn about the three classes of railroads—Class 1, 2, and 3—and investigate how these systems work together to transport goods efficiently. Through ramp modeling and LEGO Spike Prime robotics activities, students explore **potential and kinetic energy**, coding, and the Engineering Design Process, culminating in a freight delivery design challenge that mimics real-world railroad logistics.

Lesson Objectives:

By the end of Day 2, students will be able to:

- Identify and explain the three classes of railroads and their characteristics.
- Understand the types of freight transported and the efficiency of rail logistics.
- Apply concepts of potential and kinetic energy using ramp and robotic models.
- Program robots to simulate freight transport across different railroad classes.
- Practice teamwork, problem-solving, and engineering design principles in real-world contexts.

Day 2 at a Glance

Time Frame	Activity	Focus / Goal
5 min	Mapping Class 1 Railways	Students examine Class 1 railway networks, analyze patterns, and discuss coverage across the U.S. and Canada.
15 min	How Freight Trains Connect the World	Students explore types of goods transported, efficiency of rail transport, and collaboration between railroad companies.
10 min	Classes of Railways	Students learn about Class 1, 2, and 3 railroads, compare differences, and complete a Quizizz to check understanding.
20 min	Ramp Railways: Modeling Train Speed by Class	Students model Class 1, 2, and 3 railroads with toy cars and tracks to explore speed differences and compare potential and kinetic energy.
1 hr	This is Uphill – LEGO Spike Prime Ramp Challenge	Students build and program a LEGO bike to travel up/down a ramp, applying potential and kinetic energy concepts and practicing the Engineering Design Process.
1 hr 30 min	Training Camp 2 – Robotic Freight Challenge	Students code LEGO Spike Prime robots to simulate freight movement across Class 1, 2, and 3 railways, including stops and cargo handoffs, practicing teamwork and engineering design skills.

Activity 1: Mapping Class 1 Railways

Estimated Time: 5 minutes

NGSS Connections: MS-PS3-2, MS-PS3-4

TEKS Connections:

- Science 8.7(B)
- Math 8.10(C)

Activity Overview:
Students examine a map of six Class 1 railway companies across the U.S. and parts of Canada, analyzing patterns of tracks and network coverage. Students discuss observations in groups and share findings with the class.

Misconceptions:

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
MS-PS3-2	Energy & Motion	Energy is “used up” or disappears	Students may think that once a balloon rocket is launched or a LEGO robot moves, the energy is gone and cannot be reused.
MS-PS3-4	Energy Transfer	Energy is only transferred by visible movement	Students may not recognize invisible forms of energy transfer, such as forces through air or sensors in robotics.
Science 8.7(B)	Newton’s Laws & Motion	Laws act independently	Students may not understand that multiple laws of motion (e.g., action-reaction, inertia, friction) can act simultaneously within a system.
Math 8.10(C)	Proportionality & Ratios	Ratios only apply to direct scaling	Students may incorrectly assume changes in size or distance are linear, not considering proportional reasoning when scaling experiments or robot movement.

Materials Needed:

- Visual slides of Class 1 railways map

Activity Flow:

1. Display the map for **1 minute** for silent observation.
2. Students discuss observations in **2-minute groups**.
3. Each group shares key points with the class.

Reflection Questions:

- What patterns or features did you notice about the lines on the map?
- Which countries are covered by these rail networks?
- Do any tracks overlap or intersect?

Activity 2: How Freight Trains Connect the World

Estimated Time: 15 minutes

NGSS Connections: MS-PS2-1

TEKS Connections: 8.1(A), 8.1(B)

Activity Overview:
Students watch a video demonstrating how freight trains transport goods nationally and internationally. They discuss types of goods moved, efficiency of rail transport, and collaboration between railroads.

Misconceptions:

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
MS-PS2-1	Forces & Motion	Forces cancel out	Students may think that because action and reaction forces are equal and opposite, they cancel each other out and no motion occurs (e.g., in balloon rockets or train wheels).
MS-PS2-1	Forces & Motion	Forces act on the same object	Students may incorrectly assume that action and reaction forces act on the same object, rather than on two different objects interacting.
8.1(A)	Scientific Inquiry	Observation is optional	Students may not notice all aspects of an experiment, such as motion, distance, or team interactions, focusing only on obvious effects.
8.1(B)	Engineering Design	Problem-solving and planning are optional	Students may attempt tasks without defining the problem, considering constraints, or collaborating with teammates.

Materials Needed:

- Video: *How Freight Trains Connect the World*

Activity Flow:

1. Watch the video.
2. Discuss reflection questions as a class.

Reflection Questions:

- What types of goods are commonly transported by freight trains, and why are trains efficient?
- How do different railroad companies collaborate nationally and internationally?
- What role do freight trains play in connecting ports, warehouses, and consumers globally?

Activity 3: Classes of Railways

Estimated Time: 10 minutes

NGSS Connections: MS-PS2-1

TEKS Connections: 8.1(A), 8.1(B)

Activity Overview:
Students learn about the **three classes of railroads**—Class 1, 2, and 3—discuss differences, and complete a **Quizizz** activity to check understanding.

Misconceptions:

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
MS-PS2-1	Forces & Motion	Forces cancel out	Students may think that because action and reaction forces are equal and opposite, they cancel each other out, resulting in no motion (e.g., in balloon rockets or moving LEGO robots).
MS-PS2-1	Forces & Motion	Forces act on the same object	Students may incorrectly assume that action and reaction forces act on the same object rather than on two different objects interacting.
8.1(A)	Scientific Inquiry	Observation is optional	Students may focus only on what they see and ignore measurements, distances, or effects of sensors during experiments.

8.1(B)	Engineering Design	Problem-solving and planning are optional	Students may attempt tasks without defining the problem, considering constraints, or collaborating with teammates.

Materials Needed:

- Quizizz (checking for understanding)

Activity Flow:

1. Teacher introduces Class 1, 2, 3 railroads.
2. Students discuss differences.
3. Complete Quizizz assessment.

Reflection Questions:

- How many Class 1 railways exist?
- What distinguishes a Class 1 from a Class 2 railway?
- How does Class 2 differ from Class 3?
- Which class is near your city?
- Which class would you likely encounter on a road trip?

Activity 4: Ramp Railways – Modeling Train Speed by Class

Estimated Time: 20 minutes

NGSS Connections: MS-PS3-1

TEKS Connections: 8.7(B), 8.1(A), 8.1(G)

Activity Overview:
Students design **toy car track models** to represent Class 1, 2, and 3 railways. They explore speed differences and compare **potential vs. kinetic energy**, adding a loop to the track to observe motion dynamics.

Misconceptions:

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
MS-PS3-1	Energy & Motion	Energy is "used up" or disappears	Students may think that energy applied to a balloon rocket or LEGO robot is gone once motion occurs, ignoring energy transfer and storage.

8.7(B)	Newton's Laws & Motion	Laws act independently	Students may not realize that multiple forces and motion laws (action-reaction, friction, inertia) can act simultaneously in experiments or robot movement.
8.1(A)	Scientific Inquiry	Observation is optional	Students may overlook measurements, distances, or sensor data, focusing only on visible motion.
8.1(G)	Scientific Problem Solving	Only one solution exists	Students may think there is a single correct way to design or code a robot, ignoring iterative testing and refinement.

Materials Needed:

- 15 toy car tracks per group (5 short, 5 medium, 5 long)
- 1 toy car per group

Activity Flow:

1. Model Class 3 railway: 5 tracks.
2. Model Class 2 railway: 10 tracks.
3. Model Class 1 railway: all 15 tracks.
4. Add a loop to observe energy dynamics.

Reflection Questions:

- Which track class was fastest/smoothest?
- Why are Class 3 trains slower in real life?
- What risks exist traveling too fast on lower-quality tracks?
- How does infrastructure investment affect safety and shipping times?
- Where is potential energy highest? Where is kinetic energy greatest?
- Why must the car have enough potential energy before entering the loop?

Activity 5: This is Uphill – LEGO Spike Prime Ramp Challenge

Estimated Time: 1 hour

NGSS Connections: MS-PS3-1, MS-ETS1-1 through 1-4

TEKS Connections: 8.1(A), 8.7(B), 8.1(G), 8.4(C)

Activity Overview:

Students use LEGO Spike Prime kits to **build and program a bike** traveling up and down a ramp. They apply the **Engineering Design Process** and explore potential and kinetic energy.

Misconceptions:

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
MS-PS3-1	Energy & Motion	Energy is “used up” or disappears	Students may think that energy applied to a robot or balloon is gone once the motion occurs, ignoring energy transfer and storage.
MS-ETS1-1	Engineering Design	Only coding matters	Students may focus on programming a robot without considering mechanical design, constraints, or stability.
MS-ETS1-2	Analyzing Data	Testing is unnecessary	Students may not test or iterate their designs before final implementation.
MS-ETS1-3	Iterative Design	First attempt is final	Students may assume initial designs are correct and skip troubleshooting or refinement.
MS-ETS1-4	Optimizing Solutions	Teamwork is optional	Students may attempt tasks individually rather than collaborating and assigning roles.
8.1(A)	Scientific Inquiry	Observation is optional	Students may overlook details such as measurements, sensor data, or system behavior.
8.7(B)	Newton’s Laws & Motion	Laws act independently	Students may not recognize that multiple forces and motion laws act simultaneously in systems like robots or balloon rockets.
8.1(G)	Scientific Problem Solving	Only one solution exists	Students may think there is a single correct way to build or code a robot instead of testing multiple solutions.
8.4(C)	Safety & Practices	Safety is optional	Students may ignore proper safety procedures when using LEGO SPIKE Prime kits, sensors, or classroom materials.

Materials Needed:

- LEGO Spike Prime Kit (1 per group)
- iPad (1 per group)

Activity Flow:

1. Build "This is Uphill" model.
2. Program bike to travel up/down ramp.
3. Assign engineering roles: Lead, Systems, Mechanical, Mechatronics.

Reflection Questions:

- Where is the bike's highest potential energy?
- Where is its greatest kinetic energy?
- Which type of energy increases as the bike moves down the ramp?

Activity 6: Training Camp 2 – Robotic Freight Challenge

Estimated Time: 1 hour 30 minutes

NGSS Connections: MS-ETS1-1 through 1-4

TEKS Connections: 8.1(A), 8.7(B), 8.1(G), 6.4(H)

Activity Overview:
Students program LEGO Spike Prime robots to **simulate freight movement across Class 1, 2, and 3 railways**, including stops and handoffs. They apply **engineering design principles, coding, and teamwork**.

Misconceptions:

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
MS-ETS1-1	Engineering Design: Defining Problems	Only coding matters	Students may focus on programming a robot without considering mechanical design, constraints, or stability.
MS-ETS1-2	Analyzing Data	Testing is unnecessary	Students may not test or iterate their designs before final implementation.
MS-ETS1-3	Iterative Design	First attempt is final	Students may assume initial designs are correct and skip troubleshooting or refinement.

MS-ETS1-4	Optimizing Solutions	Teamwork is optional	Students may attempt tasks individually rather than collaborating and assigning roles.
8.1(A)	Scientific Inquiry	Observation is optional	Students may overlook measurements, distances, or sensor data, focusing only on visible motion.
8.7(B)	Newton’s Laws & Motion	Laws act independently	Students may not realize that multiple forces and motion laws (action-reaction, friction, inertia) can act simultaneously in experiments or robot movement.
8.1(G)	Scientific Problem Solving	Only one solution exists	Students may think there is a single correct way to design or code a robot, ignoring iterative testing and refinement.
6.4(H)	Measurement & Data	Units and precision don’t matter	Students may ignore accuracy when measuring distances or timing robot movements, affecting performance and results.

Materials Needed:

- LEGO Spike Prime Kit (1 per group)
- iPad (1 per group)

Activity Flow:

1. Build and program robots per instructions.
2. Navigate a teacher-designed track simulating cargo transport.
3. Assign roles: Lead, Systems, Mechanical, Mechatronics.

Reflection Questions:

- How did the robot simulate real freight operations?
- Why are speed and track quality important?
- What challenges do rail companies face in coordinating freight movement?

Day 3: Derailments and Obstructions

Theme: Navigating Challenges: Preventing Derailments Through Engineering and Sensors

Day Overview: Students explore the causes of train derailments and reflect on the consequences of even a single cart going off track. Using the Engineering Design Process, they design, build, and program LEGO Spike Prime robots to navigate complex tracks, detect obstacles, and remove them. Through hands-on problem solving, coding, and collaboration, students apply engineering thinking while considering real-world applications for train safety.

Lesson Objectives:

By the end of Day 3, students will be able to:

- Identify six common causes of train derailments.
- Understand how forces and track design impact train movement.
- Apply the Engineering Design Process to design, code, and test a robot.
- Collaborate effectively to solve complex robotics and obstacle challenges.
- Reflect on how sensor systems and design decisions support real-world railway engineers.

Day 3 at a Glance

Time	Activity	Focus / Goal
15 min	What Could Go Wrong?	Watch a video on train derailments, take notes, and participate in discussion. Identify six common causes of derailments.
10 min	Balloon Sensor Activity	Team challenge to keep a balloon in the air, fostering communication, focus, and coordination; simulate sensor responses and teamwork.
20 min	Train Wheel Design	Explore how train wheels interact with tracks. Build cup-based wheel models and test designs to prevent derailments.
45 min	Training Camp-2: Playing With Objects	Build and code LEGO Spike Prime robots to navigate a course, detect objects, and respond with precise movements. Apply EDP and troubleshoot sensors.
45 min	Remove and Relocate an Obstruction	Apply coding and robotics to guide a robot, remove an obstruction, and test sensor systems on a more complex track. Practice teamwork and engineering precision.
10–15 min	Reflection & Clean-Up	Discuss sensor applications, collaboration, design challenges, and potential real-world solutions. Disassemble robots and clean up.

Activity 1: What Could Go Wrong?

Estimated Time: 15 minutes

NGSS Connections: MS-PS2-2

TEKS Connections: 8.1A, 8.4C, 6.7A

Activity Overview:
Students will identify six common causes of train derailments and participate in a guided discussion. They will take notes while watching a video and reflect on what causes derailments, where these issues typically occur, and the potential consequences of a single cart derailing. This activity builds foundational understanding of forces, track systems, and real-world safety considerations for trains.

Misconceptions:

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
MS-PS2-2	Forces and Motion	Gravity and friction are not significant in real-world train systems	Students may think a train can derailed without friction or gravity affecting it
8.1A	Scientific Inquiry	Asking questions or investigating is unnecessary; the teacher provides all answers	Students may expect the instructor to give a full list of derailment causes without observation or discussion
8.4C	Safety Practices	Laboratory and field safety rules are optional	Students may ignore safety when simulating derailments with models
6.7A	Forces Acting on Objects	All forces are obvious and act the same on every object	Students may think applied force alone will prevent derailments, ignoring friction, weight distribution, or track design

Materials Needed:

- Train Derailments and Mistakes Caught On Camera video
- Notebook or recording sheet for notes

Activity Flow:

1. Welcome students and introduce the activity purpose.
2. Show the video on train derailments.
3. Instruct students to take notes on causes, locations, and consequences of derailments.
4. Facilitate a guided discussion using reflection questions:
    - What are six common causes of train derailments?

- Where do derailments most frequently occur?
- What can happen if a single cart derails?

5. Encourage students to share observations in pairs or small groups.
6. Summarize key concepts and connect to upcoming activities involving engineering and sensor systems.

Activity 2: Balloon Sensor Activity

Estimated Time: 10 minutes

NGSS Connections: MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4

TEKS Connections: 8.1(A), 8.1(B)

Activity Overview:
Students work in teams to keep a balloon in the air without letting it touch the ground. This activity simulates sensor systems and encourages teamwork, communication, focus, coordination, and shared responsibility. Students learn how objects can react to forces and how collaborative problem solving improves outcomes.

Misconceptions:

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
MS-ETS1-1	Engineering Design	Teamwork is optional; only individual solutions matter	Students may try to keep the balloon up alone instead of coordinating with teammates
MS-ETS1-2	Analyzing Data	Observations are not essential for improvement	Students may not reflect on which strategies worked or failed
MS-ETS1-3	Optimizing Solutions	One attempt is enough; the first solution is final	Students may give up after failing to keep the balloon up once
MS-ETS1-4	Iterative Design	Design does not need testing	Students may ignore the value of practice rounds or adjustments

Materials Needed:

- Balloons

Activity Flow:

1. Introduce the activity and explain that the balloon represents a sensor reacting to team movements.
2. Review rules: no hitting the balloon twice in a row, team members must stay connected.
3. Practice round: 30 seconds to get a feel for the activity.
4. Round 1 – No hazards: 1 minute to keep the balloon in the air.
5. Round 2 – Hazard 1 (No talking): 1 minute without speaking.
6. Round 3 – Hazard 2 (Two balloons): keep both balloons in the air.
7. Optional challenges: additional hazards or time limits to increase difficulty.

Reflection questions:

- What made it easier or harder to keep the balloon in the air?
- How did your team work together to achieve the goal?
- What strategies would you try differently next time?

Activity 3: Train Wheel Design

Estimated Time: 20 minutes

NGSS Connections: MS-PS2-2

TEKS Connections: 8.1(A), 8.1(B), 8.2(D)

Activity Overview:
Students explore how train wheels interact with tracks. They build two different wheel models using cups and meter sticks to test which design stays on the track without derailing. This activity demonstrates forces, motion, and design effectiveness.

Misconceptions:

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
MS-PS2-2	Forces and Motion	Wheels will stay on tracks regardless of design	Students may assume all wheel shapes perform the same on a track
8.1(A)	Scientific Inquiry	One correct solution exists	Students may believe the first wheel model they build is “right”

8.1(B)	Experimental Design	No testing is needed	Students may not test both wheel designs or iterate
8.2(D)	Evaluate Designs	Trial and error is unnecessary	Students may ignore how adjustments improve stability

Materials Needed:

- 4 cups
- Tape
- 2 meter sticks
- 1 box or chair

Activity Flow:

1. Demonstrate how train wheels interact with tracks.
2. Students arrange meter sticks to simulate tracks.
3. Construct two wheel models using cups.
4. Test both models to determine which design stays on the track.
5. Facilitate reflection discussion:

Reflection Questions

- What design changes helped your train stay on the tracks?
- How did your team collaborate to solve problems?
- What surprised you about wheel behavior on the tracks?

Activity 4: Training Camp-2 – Playing With Objects

Estimated Time: 45 minutes

NGSS Connections: MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4

TEKS Connections: 8.1(A), 8.1(B), 8.2(D)

Activity Overview:
Students build and code LEGO Spike Prime robots to navigate a teacher-designed course. Robots must detect objects using sensors and perform specific movements. This hands-on challenge applies the Engineering Design Process, coding skills, and problem-solving.

Misconceptions:

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
MS-ETS1-1	Engineering Design	Robots work perfectly the first time	Students may expect the robot to detect objects flawlessly without testing
MS-ETS1-2	Analyzing Data	Observing sensor feedback is unnecessary	Students may ignore sensor readings during trials
MS-ETS1-3	Iterative Testing	Coding does not need refinement	Students may stop after one failed attempt instead of debugging
MS-ETS1-4	Optimizing Solutions	Team collaboration is optional	Students may work individually rather than assigning roles and collaborating

Materials Needed:

- iPad
- LEGO Spike Prime Kit
- Spike Training 2 coding instructions

Activity Flow:

1. Guide students to launch LEGO Spike Prime on iPads.
2. Access Training 2: Playing With Objects and follow build instructions.
3. Code the robot to navigate the course and detect objects.
4. Test robot movements, troubleshoot sensor issues, and refine code.

Reflection Questions:

- How did your team collaborate to solve problems?
- Did you understand how the ultrasonic sensor works?
- How could these sensors improve real railway systems?

Activity 5: Remove and Relocate an Obstruction

Estimated Time: 45 minutes

NGSS Connections: MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4

TEKS Connections: 8.1(A), 8.1(B), 8.2(D)

Activity Overview:

Students apply the Engineering Design Process to a complex robotics challenge. Using LEGO Spike Prime, they design a driving base, develop code to maneuver objects, and collaborate to remove obstructions from a course. The activity emphasizes precision, teamwork, and real-world engineering applications.

Misconceptions:

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
MS-ETS1-1	Engineering Design	Only one student role matters	Students may focus on coding only, ignoring driving base or strategy tasks
MS-ETS1-2	Analyzing Data	Sensor placement is unimportant	Students may misplace sensors, leading to false readings
MS-ETS1-3	Iterative Testing	First code attempt is final	Students may not test or refine the robot before attempting the final challenge
MS-ETS1-4	Optimizing Solutions	Collaboration slows progress	Students may try to work individually instead of assigning roles and coordinating

Materials:

- iPad
- LEGO Spike Prime Kit
- Teacher-created track
- Wheel-Axle Assembly Replacement

Activity Flow:

1. Explain the final challenge and objectives.
2. Students design and build robot driving bases.
3. Code robots to detect obstructions, stop, and relocate objects.
4. Test, troubleshoot, and refine movements and sensor performance.
5. Facilitate reflection discussion:
    - What distance worked best for stopping the train?
    - How could this sensor system assist real train engineers?
    - How did your team address sensor placement or false detections?

Day 4 Smart Sensors and Safe Crossings

Theme: Safe Navigation: Sensors, Motion, and Teamwork

Day Overview:
Students explore rural railroad crossings, Newton's Third Law, and sensor-based engineering through hands-on experiments and robotics. They analyze hazards, perform balloon rocket experiments, and build and program LEGO Spike Prime forklifts to move wheel-and-axle replicas. The day emphasizes critical thinking, teamwork, and real-world applications of safety and engineering concepts.

Lesson Objectives:

By the end of Day 4, students will be able to:

- Identify characteristics, potential hazards, and safety procedures at rural railroad crossings.
- Apply Newton's Third Law of Motion through hands-on experiments and analyze action-reaction forces.
- Collaborate effectively in teams to complete balloon rocket and robotics challenges.
- Design, build, and program a LEGO SPIKE Prime forklift to pick up and transport a wheel-and-axle replica.
- Apply the Engineering Design Process to integrate sensors, mechanical design, and coding for precise movement.
- Connect STEM skills to real-world rail safety applications and problem-solving.

Day 4 at a Glance

Time	Activity	Focus / Goal
20–30 min	Rural Grade Crossings	Identify characteristics and hazards of rural crossings; analyze real-world scenarios and propose safety solutions
35–45 min	Balloon Race Activity	Explore Newton's Third Law of Motion; observe action-reaction forces; connect forces to train motion; develop teamwork
90–120 min	Rural Tracks Alert	Build and program LEGO SPIKE Prime forklifts; apply Engineering Design Process; integrate wheel-and-axle mechanics; practice coding and teamwork for safe object transport
10–15 min	Reflection & Clean-Up	Discuss lessons learned, team collaboration, and real-world applications; disassemble robots and clean up

Activity 1: Rural Grade Crossings

Estimated Time: 20–30 minutes

NGSS Connections: MS-PS2-1

TEKS Connections: 8.1(A), 8.1(B), 8.2(D)

Activity Overview:
Students work in groups to identify characteristics, potential hazards, and safety procedures at rural grade crossings. They analyze images and a video ("The Long Mile") to understand real-world scenarios, discuss safety measures, and propose solutions to improve safety.

Misconceptions:

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
MS-PS2-1	Forces & Motion	Forces cancel out	Students may think equal and opposite forces result in no motion at crossings
MS-PS2-1	Forces & Motion	Forces act on the same object	Students may assume action and reaction forces act on one object instead of two interacting objects
8.1(A)	Scientific Inquiry	Observing hazards is unnecessary	Students may not notice warning signs or environmental risks at rural crossings
8.1(B)	Engineering Design	Problem-solving is optional	Students may fail to propose solutions after analyzing images/video
8.2(D)	Evaluate Designs	Solutions do not need testing	Students may suggest ideas without considering feasibility or safety impact

Materials Needed:

- Images of rural grade crossings
- Video: "The Long Mile"

Activity Flow:

1. Divide students into groups of 3–4.
2. Show images of rural grade crossings and ask:
    - "Based on these images, what can you determine about rural grade crossings?"
3. Students discuss responses in groups.
4. Conduct the "Stop and Think" activity with follow-up questions.
5. Groups share answers with the class.
6. Watch "The Long Mile" video.
7. Respond to guided questions to check understanding and connect to safety procedures.

Reflection Questions:
Before the Video:

- What do you already know about railroad crossings in rural areas?
- Have you ever crossed train tracks without lights or gates? What did you do?
- Why might people ignore warning signs at train tracks? What could go wrong?

After the Video:

- What clues in the video indicate that something serious is about to happen?
- How did the characters' choices impact the outcome?
- What role do time and distance play in a train's ability to stop?
- What message was the video trying to convey?
- How could sensors or improved technology have helped prevent the incident?
- How could you help others understand the dangers of rural grade crossings?

Activity 2: Balloon Race Activity

Estimated Time: 35–45 minutes

NGSS Connections: MS-PS2-1, MS-PS2-2

TEKS Connections: 8.1(A), 8.1(B), 8.7(B)

Activity Overview:
Students explore Newton's Third Law of Motion through a balloon rocket experiment. Working in groups, they attach a balloon to a straw on a string track and observe how action-reaction forces propel the balloon. This hands-on activity demonstrates force and motion while encouraging teamwork and critical thinking.

Misconceptions:

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
MS-PS2-1	Forces & Motion	Forces cancel out	Students may think equal and opposite forces mean no movement in the balloon rocket
MS-PS2-1	Forces & Motion	Forces act on the same object	Students may assume action and reaction forces act on the balloon alone rather than balloon and air/string system
8.1(A)	Scientific Inquiry	Observation is optional	Students may not notice the balloon's motion or variations in force effects

8.1(B)	Engineering Design	Experiment does not require iteration	Students may fail to test different balloon sizes or string tensions
8.7(B)	Newton's Laws	Laws act independently	Students may not connect the experiment to real-world systems like train wheels or sensors

Materials Needed:

- 1 balloon per group
- String or fishing line
- 1 small straw per group
- Tape
- Video: "Action and Reaction: Newton's Third Law"

Activity Flow:

1. Watch the video explaining Newton's Third Law.
2. Anchor a fishing line with a threaded straw between two chairs.
3. Tape a small balloon to the straw.
4. Launch the balloon and observe its motion as force is applied.
5. Adjust balloon size or tension to test changes in potential energy.
6. Discuss how action and reaction forces are demonstrated in the balloon rocket.

Reflection Questions:

- What is Newton's Third Law of Motion?
- How was Newton's Third Law demonstrated in the balloon rocket experiment? How could you tell where the forces were applied?
- What would happen if you made your balloon bigger or smaller?
- How did you demonstrate teamwork during this activity?
- What was the action in the experiment? What was the reaction?
- How is this similar to a train using its wheels to push on the track?
- If a sensor tells the train to stop, what is the reaction?

Activity 3: Rural Tracks Alert

Estimated Time: 90–120 minutes

NGSS Connections: MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4

TEKS Connections: 8.1(A), 8.1(B), 8.2(D)

Activity Overview:

Students build and program a LEGO SPIKE Prime forklift to lift and move a wheel-and-axle replica. They apply the Engineering Design Process to design, code, and test the forklift, reinforcing teamwork, wheel-and-axle mechanics, and railway safety concepts. The activity integrates coding, engineering, and collaboration in a real-world-inspired challenge.

Misconceptions:

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
MS-ETS1-1	Engineering Design	Only coding matters	Students may focus on programming and neglect design or mechanical integration of the forklift
MS-ETS1-2	Analyzing Data	Testing is unnecessary	Students may not test the forklift's movement or color sensor functionality
MS-ETS1-3	Iterative Design	First attempt is final	Students may stop after one failed attempt rather than refining code or design
MS-ETS1-4	Optimizing Solutions	Team collaboration is optional	Students may work individually instead of delegating tasks and coordinating as a team

Materials Needed:

- iPad
- LEGO Spike Prime Kit
- Teacher-created track with pick-up and drop-off areas
- Spike Prime Forklift
- AMONG US Dance Battle 25-minute timer (music & alarm)

Activity Flow:

1. Students follow the Engineering Design Process to build a functioning forklift.
2. Code the forklift to stop using a color sensor, lift a wheel-and-axle replica, and transport it to the drop-off area.
3. Test and refine robot performance on the teacher-designed track.
4. Integrate the forklift into the LEGO Spike Prime driving base.
5. After completing the task, students park their robot in the UTRGV Railway Safety Parking zone.

Reflection Questions:

- What worked well for your group? What didn't work as expected?
- What challenges did you face, and how did you overcome them?

Day 5 Camp Review and Final Task

Theme: Applying STEM Skills: Engineering Solutions for Railway Safety

Day Overview: Students review key concepts from the camp—including railroad classifications, cargo containers, and derailment causes—through interactive activities. For the final challenge, they design, build, and program a LEGO SPIKE Prime forklift to lift and relocate a wheel-and-axle replica. This hands-on activity emphasizes engineering principles, sensor use, coding, teamwork, and real-world rail safety applications.

Lesson Objectives:

By the end of Day 5, students will be able to:

- Review and recall railroad classifications, cargo container types, and common causes of train derailments.
- Apply teamwork, planning, and problem-solving skills to complete a complex engineering challenge.
- Design, build, and program a LEGO SPIKE Prime forklift incorporating sensors for precise movement.
- Demonstrate understanding of wheel-and-axle mechanics through a hands-on, real-world task.
- Simulate railway engineering tasks by safely transporting a wheel-and-axle assembly using coding and mechanical design principles.

Day 5 at a Glance

Time	Activity	Focus / Goal
15 min	Camp Review	Review railroad classifications, cargo container types, and common causes of derailments via interactive Kahoot; reinforce prior learning
150 min	Final TASK	Apply Engineering Design Process to design, build, and program LEGO SPIKE Prime forklift; lift and transport wheel-and-axle assembly; integrate sensors and coding for real-world rail safety applications
10–15 min	Reflection & Clean-Up	Discuss lessons learned, team collaboration, and real-world applications; disassemble robots and clean up

Activity 1: Camp Review

Estimated Time: 15 minutes

NGSS Connections: MS-PS2-1

TEKS Connections: 8.1(A), 8.1(B), 8.2(D)

Activity Overview:
Students participate in a live Kahoot review to revisit railroad classifications, cargo container types, and common causes of derailments. Questions are interactive, encouraging discussion and reinforcement of key concepts.

Misconceptions:

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
MS-PS2-1	Forces & Motion	Students may forget prior concepts about derailments or cargo weight	Students might confuse derailment causes or cargo container types during review
8.1(A)	Scientific Inquiry	Reviewing prior learning is unnecessary	Students may rely on guessing rather than recalling information
8.1(B)	Engineering Design	Applying prior knowledge to new tasks is optional	Students may not connect review to the final robotics challenge
8.2(D)	Evaluate Designs	Repetition is unhelpful	Students may ignore analyzing patterns in past challenges

Materials Needed:

- Kahoot link: Camp Review
- iPads or smart devices
- Spike Prime Forklift

Activity Flow:

1. Launch the live Kahoot review.
2. Students answer and discuss each question interactively.
3. The instructor emphasizes correct answers and connects to real-world rail safety applications.

Reflection Questions:

- N/A

Activity 2: Final TASK

Estimated Time: 150 minutes

NGSS Connections: MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4

TEKS Connections: 8.1(A), 8.1(B), 8.2(D)

Activity Overview:
Students design, build, and program a LEGO SPIKE Prime forklift robot capable of lifting and relocating a wheel-and-axle assembly. They incorporate sensors into their code and apply prior lessons in coding, teamwork, and engineering to operate tools that simulate real railway safety tasks.

Misconceptions:

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
MS-ETS1-1	Engineering Design	Only coding matters	Students may focus on programming and overlook mechanical design or stability
MS-ETS1-2	Analyzing Data	Testing and refinement are unnecessary	Students may not iterate or test robot movements before completing the task
MS-ETS1-3	Iterative Design	First design is final	Students may assume initial forklift design is sufficient without troubleshooting
MS-ETS1-4	Optimizing Solutions	Teamwork is optional	Students may attempt to complete the challenge individually rather than assigning roles

Materials:

- LEGO SPIKE Prime Kit
- Smart device with SPIKE App
- Measuring stick
- Timer/stopwatch
- Premade track with pickup and drop-off zones

Activity Flow:

1. Students use the SPIKE Prime app or guided instructions to build a forklift robot with a color sensor, focusing on gears, arms, and stability.
2. Program the robot to:
   - Move forward to pick up an object
   - Lift the fork using a motor
   - Transport and lower the object into the delivery zone
3. Test and refine movements to ensure precision.
4. Apply all coding and engineering skills learned throughout camp to complete the track.

Reflection Questions:

- How does your robot system reflect what really happens when replacing a wheel and axle assembly?
- How was today's challenge applicable to Railway Engineering?
- What are some challenges engineers face?
- What are some of your team's strengths and weaknesses?

Appendices

Appendix A: Video Links

Day 1: Welcome Aboard!

Freight Railroads & Intermodal
Video: *How Freight Railroads Transport Goods Through Intermodal*
https://www.youtube.com/watch?v=UyscH3vx0LA

Day 2: Classifications and Energy in Railway Systems

How Freight Trains Connect the World
Video: *How Freight Trains Connect the World*
https://www.youtube.com/watch?v=1OuZPfLGMaQ

Day 3: Derailments and Obstructions

What Could Go Wrong? (Train Derailments)
Video: *Train Derailments and Mistakes Caught On Camera*
https://www.youtube.com/watch?v=XYZ_Derailments *(replace with actual link if available)*

Day 4: Smart Sensors and Safe Crossings

Rural Grade Crossings Video
Video: *The Long Mile*
https://www.youtube.com/watch?v=XYZ_LongMile *(replace with actual link if available)*

Balloon Race Activity
Video: *Action and Reaction: Newton's Third Law*
https://www.youtube.com/watch?v=XYZ_NewtonsLaw *(replace with actual link if available)*

Day 5: Camp Review and Final Task

No additional videos; all content is hands-on and review-based.

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*Some Pictures were taken by instructors (Wheel and Axle examples, ramp with metersticks example)