UNIVERSITY TRANSPORTATION CENTER FOR
RAILWAY SAFETY

University Transportation Center for Railway Safety (UTCRS)

Elementary School STEM Curriculum

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3-5-ETS1-1	Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success
3-5-ETS1-2	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3-5-ETS1-3	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.
3-PS2-1	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.
3-PS2-2	Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.
4-PS3-1	Use evidence to construct an explanation relating the speed of an object to the energy of that object.
4-PS3-3	Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion.
4-PS3-4	Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
4-PS4-3	Generate and compare multiple solutions that use patterns to transfer information.
5-PS1-3	Make observations and measurements to identify materials based on their properties.
5-PS2-1	Support an argument that the gravitational force exerted by Earth on objects is directed down

Texas Essential Knowledge and Skills (TEKS)

Science 5.1(A),	Ask questions and define problems based on observations or information from text, phenomena, models, or investigations
Science 5.3(B),	Communicate explanations and solutions individually and collaboratively in a variety of settings and formats
Science 5.3(C)	Listen actively to others' explanations to identify relevant evidence and engage respectfully in scientific discussion.
Science 5.5(B),	Identify and investigate cause-and-effect relationships to explain scientific phenomena or analyze problems
S.5.2.D,	The student is expected to evaluate experimental and engineering designs
Science 5.4(A)	Explain how scientific discoveries and innovative solutions to problems impact science and society
Science 5.3(A)	Develop explanations and propose solutions supported by data and models
Science 5.1(B)	The student is expected to use scientific practices to plan and conduct descriptive and simple experimental investigation and use engineering practices to design solutions to problems;
Science 5.2(C)	The student is expected to use mathematical calculation to compare patterns and relationships
Science 5.6(C)	The student is expected to compare the properties of substance before and after they are combined into a solution and demonstrate that matter is conserved in solutions
Science 5.2(D),	The student is expected to evaluate experimental and engineering designs.
Technology 5.4(C)	Design and create an outline collaboratively that documents a problem, possible solutions, and an expected timeline for the development of a coded solution.
Technology 5.6(A)	a specific educational standard focused on demonstrating understanding of technology concepts within the context of operating systems, network systems, virtual systems, and learning systems
Science 5.8(C),	The student is expected to demonstrate and explain how light travels in a straight line and can be reflected, refracted, or absorbed.
Science.5.7(C)	The student is expected to investigate and explain how equal and unequal forces acting on an object cause patterns of motion and transfer of energy; and

Science 5.1(A),	Ask questions and define problems based on observations or information from text, phenomena, models, or investigations
Science 5.6(B)	The student is expected to demonstrate and explain that some mixtures maintain physical properties of their substances such as iron filings and sand or sand and water;
Science 5.7(A)	The student is expected to investigate and explain how equal and unequal forces acting on an object cause patterns of motion and transfer of energy; and
Technology 5.4(D)	The student is expected to: compare multiple algorithms for the same task and determine which algorithm is the most appropriate for that task.
ELA.5.6.C	The student is expected to make and correct or confirm predictions using text features, characteristics of genre, and structures;
SEL 5.1	The student is expected to use scientific practices to plan and conduct descriptive and simple experimental investigation and use engineering practices to design solutions to problems;
Math 5.9(C)	solve one- and two-step problems using data from a frequency table, dot plot, bar graph, stem-and-leaf plot, or scatterplot.
Science 5.2(E)	The student analyzes and interprets data to derive meaning, identify features and patterns, and discover relationships or correlations to develop evidence-based arguments or evaluate designs.
ELA.5.6.C	The student is expected to make and correct or confirm predictions using text features, characteristics of genre, and structures.
Science 3.1(A)	The student is expected to ask questions and define problems based on observations or information from text, phenomena, models, or investigations
Science 4.3(A)	The student is expected to develop explanations and propose solutions supported by data and models
Science 4.8(A)	The student is expected to investigate and identify the transfer of energy by objects in motion, waves in water, and sound
Science 5.7(B)	The student is expected to 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

Day 1: Welcome Aboard!

Theme: Cargo Systems and Collaborative Engineering in Rail

Day Overview: Students begin their introduction to railway safety and engineering by exploring how trains transport different types of cargo. Working in teams, they will take on hands-on engineering challenges and use robotic kits to build simple moving models. Through the Engineering Design Process, students will test their ideas and start thinking and working like engineers.

Activity Objectives:

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

- Recognize different types of cargo containers used in railway shipping.
- Understand basic engineering concepts and how they help solve transportation challenges.
- Apply teamwork, planning, and design skills using the Engineering Design Process.
- Build and test a robotic model incorporating coding principles.
- Simulate real-world logistics through a hands-on cargo transport challenge.

Day 1 at a Glance

Time	Activity	Focus / Goal
5–10 min	Welcome & Observation Prompt	Review rules, spark curiosity with "I See, I Think, I Wonder"
10–15 min	Railway Systems 101	Learn Dry, Refrigerated, and Tank containers; explore cargo types
15–20 min	Conductors in Training – Team Challenge	Build cup towers to practice teamwork and collaboration
30 min	Trackside Theory 121 – Engineering Design Process	Learn steps of the EDP and apply to tower challenge
45–60 min	Signals & Systems 131 – Robotics & Code Lab	Build & program "hopper" robots; test movement
45–60 min	Innovation Depot 141 – Cargo Transport Challenge	Modify robots to transport cargo; apply 1 mm = 1 mile scale
10–15 min	Exit Ticket & Clean-Up	Reflect, disassemble robots, and clean up

Activity 1: Welcome & Observation Prompt

Estimated Time: 5-10 minutes

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

TEKS Connections: Science 5.1(A), Science 5.3(B), Science 5.3(C), Science 3.1(A)

Activity Overview:
Students are welcomed and review the housekeeping rules from the Day 1 presentation. They participate in an "I See, I Think, I Wonder" activity to spark curiosity about the Railway Safety Camp classroom. The instructor will also go over the Day 1 goals and objectives.

Misconceptions:

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
3-5-ETS1-1	Engineering Design: defining problems and developing solutions	There is only one correct solution; design is linear, not iterative	Students may think there's only one "right" way to build a train cargo model and may give up if it doesn't work the first time
ETS1.A	Defining and Delimiting Engineering Problems	Constraints and criteria are optional; problem definition is unnecessary	Students may want to design a train cargo system without considering size limits or weight constraints
ETS1.B	Developing Possible Solutions	Prototypes must be perfect; teamwork is optional	Students may try to build a perfect robotic model on the first attempt or work alone instead of collaborating
Science 5.1(A)	Scientific Investigation	Observations are only what is seen; opinions are facts	Students may only look at their robot moving and ignore measurements like distance or speed
Science 5.3(B)	Forces & Motion	Heavier objects always move faster/slower; materials behave the same in all conditions	Students may assume a heavier cargo container will always move slower on the train track

Science 5.3(C)	Energy & Motion	Energy is “used up”; only engines/motors cause motion	Students may think their LEGO train can’t move unless the motor is on, ignoring pushes, gravity, or slope
Science 3.1(A)	Scientific Investigation Process	There is always one right answer; following steps guarantees success	Students may expect their model to work perfectly if they follow instructions exactly, without testing and revising

Materials:

- Observation image or slide

Activity Flow:

1. Welcome students and review housekeeping rules.
2. Conduct a 30-second silent observation prompt:
   a. What do you see?
   b. What do you think this camp is about?
   c. What do you wonder?
3. Allow students to share their thoughts in small groups or as a whole class.
4. Explain the **Winning Team** and **Conductor Award** procedures.

Activity 2: Railway Systems 101 – Cargo Container Types

Estimated Time: 10-15 minutes

NGSS: 5-PS1-3, ETS1.B, ETS1.C

TEKS: Science 5.5(B), ELA.5.6.C , Science 5.1(A)

Activity Overview:
Students explore Dry, Refrigerated, and Tank containers and learn how various types of cargo are transported.

Misconceptions: Students might assume that all cargo trains carry the same type of container or only transport food.

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
5-PS1-3	Properties & Changes of Matter	Physical changes create or destroy matter; all materials behave the same under all conditions	Students may think a cargo container or LEGO part changes mass when heated or stressed
ETS1.B	Developing Possible Solutions	Only one correct solution exists; prototypes must be perfect initially	Students may stop iterating on robot or cargo delivery design after the first attempt succeeds
ETS1.C	Optimizing the Design Solution	Trade-offs don't matter; optimization only means bigger/faster	Students may try to make their robot "perfect" without considering speed, accuracy, or constraints like track quality
Science 5.5(B)	Properties of Matter	Materials react the same to heat, cooling, or mixing; matter can disappear	Students may assume all "cargo" objects behave the same way when loaded or moved
ELA.5.6.C	Listening & Speaking Skills	Sharing ideas isn't necessary if you "already know"; disagreements are bad	Students may not contribute to team discussions about robot design or cargo challenges
Science 5.1(A)	Scientific Investigation	Observations are only what is seen; following steps guarantees success	Students may ignore measurements, testing, or iteration when building or coding robots

Materials:

- 1 iPad/Laptop for Kahoot or Quizlet per group
- 1 journal or notebook (for notes) per group
- 1 pencil/pen per group

Activity Flow:

1. Show the video and review the three discussion questions with students.
2. Introduce the different container types and allow students to take notes as needed.
3. Present real-world examples of each container type.
4. Use Kahoot or Quizlet to assess students' understanding.
5. Optional: Have students sort classroom objects into the appropriate container types.

Activity 3: Conductors in Training – Team Building Challenge
Estimated Time: 15-20 minutes

NGSS: 3-5-ETS1-2, ETS1.C, ETS1.A

TEKS: S.5.2.D, Science 5.3(C), Science 4.3(A)

Activity Overview:
Students work in teams to build a 10- or 15-cup tower using only cups, string, and rubber bands, practicing collaboration and teamwork skills.

Misconceptions: Students may think engineering is done alone, rather than through teamwork and collaboration.

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
3-5-ETS1-2	Generating and Comparing Solutions	Only one “right” solution exists; comparing multiple ideas isn’t necessary	Students may choose the first robot design that works and not explore alternatives for better accuracy or efficiency
ETS1.C	Optimizing the Design Solution	Trade-offs are unnecessary; improvements only matter if something breaks	Students may ignore adjusting robot designs for better cargo delivery speed or distance
ETS1.A	Defining & Delimiting Engineering Problems	Engineers can design without considering constraints; problem definition is unimportant	Students may attempt to build a robot without considering track limitations or cargo size
S.5.2.D	Forces & Motion	Heavier objects always move faster/slower; friction is ignored	Students may assume a heavier cargo block always slows the robot, regardless of push or slope
Science 5.3(C)	Energy & Motion	Energy is “used up”; only motors/engines cause motion	Students may think the robot cannot move cargo unless the motor is active, ignoring pushes or track slope
Science 4.3(A)	Force, Motion, & Energy	Forces act in isolation; motion only applies to visible movement	Students may not account for multiple forces affecting robot motion or subtle energy transfers

Materials:

- 10–15 cups per group
- 1 rubber band per group
- 4–6 pieces of string per group

Activity Flow:

1. Explain the rules: use only one hand and the tool solely to stack cups.
2. Build towers for 10–15 minutes.
3. Debrief with questions: What strategies worked? What challenges did you face? How does this activity relate to teamwork?
4. Introduce the terms **Engineering** and **Engineers.**

Activity 4: Trackside Theory 121 – Intro to Engineering Design Process

Estimated Time: 30 minutes

NGSS: 3-5-ETS1-1, ETS1.B, ETS1.C

TEKS: Science 5.4(A), Science 5.3(A), Science 5.1(B)

Activity Overview:
Students explore each step of the Engineering Design Process (EDP) and apply it to real-world railway challenges.

Misconceptions: Some students may believe that once a design is complete, it cannot or should not be modified.

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
3-5-ETS1-1	Defining Problems & Developing Solutions	Only one correct solution exists; engineering is linear, not iterative	Students may stop iterating on a robot or tower design once it works the first time
ETS1.B	Developing Possible Solutions	Prototypes must be perfect on the first try; teamwork isn't necessary	Students may try to build a robot alone or expect it to function perfectly initially

ETS1.C	Optimizing the Design Solution	Trade-offs aren't necessary; optimization only means bigger/faster	Students may ignore adjusting designs for efficiency, accuracy, or safety
Science 5.4(A)	Engineering Design Process	Once a design is finished, it can't/shouldn't be changed; testing isn't important	Students may not revise robot or tower designs after initial success
Science 5.3(A)	Matter, Energy & Motion	Energy is "used up"; only motors/engines can cause motion	Students may not account for pushes, pulls, friction, or slopes affecting robot motion
Science 5.1(B)	Scientific Investigation	Following steps guarantees success; observations are only what is seen	Students may ignore measurements or iterative testing during robot or tower challenges

Materials:

- Engineering Design Process posters or slides

Activity Flow:

1. Define the steps of the Engineering Design Process: **Frame, Investigate, Brainstorm, Plan, Create, Test, Evaluate, Iterate**.
2. Provide real-world examples for each step.
3. Connect the steps back to the tower-building challenge to reinforce understanding.

Activity 5: Signals and Systems 131 – Robotics & Code Lab

Estimated Time: 45-60 minutes

NGSS: 3-5-ETS1-3, ETS1.C, 4-PS3-4

TEKS: Technology 5.4(C), Science 5.2(C), Science 5.1(B)

Activity Overview:
Students build a simple "hopper" robot and use the Spike Prime app to test its movement.

Misconceptions: Students may believe that robots will always work perfectly on the first try, without the need for testing or debugging.

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
3-5-ETS1-3	Optimizing a Design Solution	Once a solution works, it doesn't need improvement; optimization is only making things faster/stronger	Students may stop adjusting their robot after it moves the cargo successfully, ignoring timing or accuracy improvements
ETS1.C	Optimizing the Design Solution	Trade-offs are bad/unnecessary; constraints don't matter	Students may try to make their robot perfect in all ways at once, ignoring battery, track, or material limits
4-PS3-4	Energy Transfer and Conservation	Energy is "used up"; only engines/motors transfer energy	Students may think their robot can't move the cargo without the motor or ignore friction affecting distance
Technology 5.4(C)	Problem-solving & Design with Technology	Technology automatically solves problems; coding/robotics is one-step	Students may expect their robot to function perfectly on the first attempt without testing or iteration
Science 5.2(C)	Force, Motion, Energy	Heavier objects always move slower; energy only exists with visible motion	Students may assume a heavier cargo item will always travel slower than a lighter one, ignoring slope, friction, or push
Science 5.1(B)	Scientific Investigation	Following steps guarantees success; observation = opinion	Students may think following coding instructions exactly guarantees perfect robot performance or confuse guesswork with data

Materials:

- 1 Spike Prime Robot kit per group
- 1 iPad or laptop per group
- Table space & floor area
- Masking Tape
- 1 Meter Stick per group (If needed)

Activity Flow:

1. Assign team roles as outlined in the presentation.
2. Build the robot following the Spike Prime app instructions.
3. Review coding blocks (Yellow, Magenta, Blue).
4. Code the robot, test it, and make modifications as needed.
5. Discuss possible improvements and design modifications.

Activity 6: Innovation Depot 141 – Cargo Transport Challenge

Estimated Time: 45–60 minutes

NGSS: ETS1.B, 5-PS2-1, 3-PS2-2

TEKS: Science 5.6(C), Science 5.2(D),

Activity Overview:
Teams modify their robots to transport "cargo" a set distance, using the scale of 1 mm = 1 mile.

Misconceptions: Students may think that heavier cargo will always move more slowly, without considering factors like friction or energy.

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
ETS1.B	Developing Possible Solutions	Only one correct solution exists; prototypes must be perfect initially	Students may stop iterating on a robot or cargo delivery design after the first attempt succeeds
5-PS2-1	Forces & Motion	Students may think heavier objects always move faster or slower; friction is ignored	Students may assume a heavier cargo item always travels slower, regardless of slope or push
3-PS2-2	Motion & Interaction of Forces	Only engines/motors can cause motion; forces act in isolation	Students may not account for pushes, pulls, or multiple forces acting on a robot
Science 5.6(C)	Force, Motion & Energy	Energy is "used up" rather than transformed; motion only occurs with visible energy	Students may not consider how energy transfers through pushes, slopes, or friction in the robot challenge
Science 5.2(D)	Forces & Motion	Motion happens automatically without applying a force; heavier objects always behave differently	Students may assume a robot or cargo moves without sufficient push or that heavier cargo always slows it down

Materials:

- 1 Spike Prime kit per group
- 1 Meter stick per group
- 10 Cargo items per group (flat washers, blocks)

Activity Flow:

1. Present the Apple iPhone scenario.
2. Explain the 1 mm = 1 mile scale rule.
3. Teams modify their Hopper robots (e.g., add wheels) and test their performance.
4. Record and compare the distances traveled by each robot.

Final Activity: Exit Ticket & Clean-Up

Estimated Time: 10–15 minutes

Activity Overview:
Students reflect on their work, disassemble their Hopper robots, participate in a debrief discussion, and clean up their workspace.

Materials:

- Exit slips (if a physical copy is desired)
- Inventory checklist

Activity Flow:

1. **Exit Question:** "What surprised you about trains?"
2. Disassemble robots and check inventory.
3. Assist classmates with cleanup.

Day 1 Reflection Questions:

1. In what ways did today's activities mirror real engineering work?
2. What challenges did you encounter, and how did you solve them?
3. How did working as a team help you achieve your goals?
4. What new things did you learn about how cargo is transported?
5. Which skills or strategies from today will help you in tomorrow's activities?

Day 2: Vaquero Station

Theme: Learning Freight Rail Systems Through Hands-On Engineering and Coding

Day Overview: Students explore how train systems operate and the role of freight logistics. They learn the differences between Class 1, 2, and 3 railroads and investigate how track quality and energy influence movement. Using coding and robotics, teams simulate cargo delivery across rail systems, emphasizing accuracy, timing, and teamwork.

Lesson Objectives:

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

- Identify and compare the characteristics of Class 1, 2, and 3 railroads.
- Explain how track quality influences motion and energy transfer.
- Apply the Engineering Design Process to simulate rail conditions.
- Use block coding to control robot movement.
- Discuss the importance of coordinated freight logistics.

Day 2 at a Glance

Time	Activity	Focus / Goal
20 min	Railway Systems 101 – Intro to Locomotive Science	Explore differences between Class 1, 2, and 3 railroads; map activity; anchor charts; Quizizz check-in
30–45 min	Trackside Theory 121 – Engineering Energy on the Tracks	Model rail conditions with Hot Wheels; explore potential & kinetic energy; predict, test, and analyze energy transfer
45 min	Signals & Systems 131 – Robotics & Code Lab	Block-code “bike” robots to move up an incline; practice trial-and-error and logic sequencing
60 min	Innovation Depot 141 – Freight Coordination Challenge	Program robots to simulate freight transport across Classes 1–3; plan stops, speed, and handoffs; test and revise; discuss real-world logistics
10–15 min	Exit Ticket & Clean-Up	Reflect on coordination, disassemble robots, check inventory, and team cleanup

Activity 1: Railway Systems 101 – Intro to Locomotive Science

Estimated Time: 20 minutes

NGSS: 3-5-ETS1-1, ESS3.A, ETS1.B

TEKS: Science 5.6(A), Science 5.8(C), Science.5.7(C)

Activity Overview:
Students explore the differences between Class 1, 2, and 3 railroads using visual examples.

Misconceptions: Students may assume that all trains travel at the same speed and have the same pulling power, regardless of their class.

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
NGSS: 3-5-ETS1-1	Define a problem and identify solutions	Students may think there is only one correct solution rather than multiple possible solutions	When designing a robot to deliver cargo safely, some students may assume there is only one "right" way to build or code it
NGSS: ESS3.A	Human impacts on natural systems	Students may believe human activity has little or no effect on natural systems	Students might not recognize how poorly maintained tracks or crossings could create hazards that need engineering solutions
NGSS: ETS1.B	Designing solutions requires iteration	Students may assume the first design will work perfectly without testing or adjustment	Students building wheel-and-axle assemblies may think their first try won't need tweaking to prevent derailments
TEKS: Science 5.6(A)	Cause and effect in systems	Students may think changes in one part of a system don't affect the whole	Students may not realize that changing the ramp angle or track quality affects robot or train performance
TEKS: Science 5.8(C)	Engineering solutions must consider impacts	Students may think safety or environmental factors aren't important	Students may initially ignore the importance of signals, sensors, or safe stops when programming robots
TEKS: Science 5.7(C)	Observations and measurements require precision and repetition	Students may think measurements are exact and don't need refinement	Students may record distances for robot tests once, without repeating trials to ensure accuracy

Materials:

- 1 iPad/Laptop per group
- 1 chart paper sheet per group
- 1-3 Markers per group

Activity Flow:

1. Review housekeeping rules and Day 2 goals/objectives.
2. Conduct the class railroads map activity: *I see, I think, I wonder*.
3. Show a freight train video and discuss guided questions.
4. Explain the differences between Class 1, 2, and 3 railroads using real-world examples (e.g., BNSF, FEC, Hondo).
5. Allow students to create an anchor chart or take notes.
6. Assess understanding with a Quizizz check-in on rail classes.

Activity 2: Trackside Theory 121 – Engineering Energy on the Tracks

Estimated Time: 30-45 minutes

NGSS: 3-PS2-2, 4-PS3-1, ETS1.A

TEKS: Science 5.6(B), Science 5.7(A), Science.5.7(C), Science 4.8(A)

Activity Overview:
Students use Hot Wheels cars and ramps to model and explore different rail conditions.

Misconceptions: Students may confuse potential and kinetic energy or assume that a steeper ramp always makes objects move faster.

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
NGSS 3-PS2-2	Motion and forces	Students may think a steeper ramp or stronger push always makes objects go faster, ignoring friction, surface type, or energy transfer	Hot Wheels cars on different ramps: students predict which will go farthest without considering friction or ramp material
NGSS 4-PS3-1	Energy transfer	Students may believe energy is "used up" rather than transferred or conserved	Observing Hot Wheels cars converting potential energy at the top of the ramp into kinetic energy as they move

NGSS ETS1.A	Engineering design	Students may assume once a design works, it cannot or should not be modified	Adjusting car ramp design after test runs to improve distance or speed
TEKS Science 5.6(B)	Force & motion	Students may confuse potential vs. kinetic energy or assume force always equals motion	Hot Wheels ramp tests: predicting motion without calculating height or angle
TEKS Science 5.7(A)	Energy conservation	Students may not recognize that energy is stored or transformed in different ways	Comparing ramps of different heights and observing differences in car motion
TEKS Science 5.7(C)	Engineering design & iteration	Students may think trial-and-error is "wrong" and only final designs matter	Students iteratively adjust ramps or car placement to achieve better performance
TEKS Science 4.8(A)	Measurement & data	Students may ignore repeated trials or fail to record data accurately	Measuring distance traveled by Hot Wheels cars with inconsistent methods across trials

Materials:

- 2 Hot Wheels cars per group
- 10 large tracks per group
- 5 small tracks per group
- 14 connectors per group
- Masking tape (If needed)
- Sticky notes, rulers, stopwatches, and recording sheets

Activity Flow:

1. Assign team roles: **Lead, Systems, Mechanical, Mechatronics**.
2. Introduce concepts of **potential and kinetic energy** and the **law of conservation of energy**.
3. Predict which ramp or railroad class will allow the car to travel farthest.
4. Test each scenario three times, measuring distance and time.
5. Analyze results: Where is energy stored? How does track quality affect motion?

Activity 3: Signals and Systems 131 – Robotics & Code Lab

Estimated Time: 45 minutes

NGSS: 3-5-ETS1-2, 4-PS3-4, ETS1.C

TEKS: Technology 5.6(A), Science 5.3(C), Science 5.1(B)

Activity Overview:
Students use block coding to program a "bike" robot to move up an incline.

Misconceptions: Students may believe that coding is simply dragging blocks, without understanding the logic or sequence behind the program.

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
NGSS 3-5-ETS1-2	Engineering design: Developing solutions	Students may think engineering is done individually rather than collaboratively	Tower-building challenge with cups, string, and rubber bands
NGSS 4-PS3-4	Energy transfer & work	Students may assume energy is automatically "used up" instead of converted between potential and kinetic	Predicting which ramp or railroad class will allow a Hot Wheels car to travel farthest
NGSS ETS1.C	Optimizing design solutions	Students may think a first attempt is final and does not need iteration	Adjusting robot Hopper design after testing to carry cargo farther
TEKS Technology 5.6(A)	Problem-solving with technology	Students may think coding is simply dragging blocks without logical sequencing	Block-coding a robot to move up an incline or transport cargo
TEKS Science 5.3(C)	Forces & energy in real-world contexts	Students may assume heavier objects always move slower without considering friction or applied force	Hopper robot carrying different cargo weights over a set distance
TEKS Science 5.1(B)	Scientific investigation & testing	Students may believe one trial is sufficient and fail to record repeated data for accuracy	Testing robot movement multiple times to measure distance and evaluate design improvements

Materials:

- 1 iPad/Laptop per group
- 1 Spike Prime Robot Kit per group
- Color-coded blocks or markers
- Materials to build ramp (Tri-Folds, Wood planks, etc..)

Activity Flow:

1. Demonstrate key code blocks: **move, pause, loop**.
2. Challenge students to make the robot climb the ramp using only code.
3. Review the role of **trial and error**, using real-world examples.
4. Discuss: Which blocks or sequences improved efficiency?

Activity 4: Innovation Depot 141 – Freight Coordination Challenge

Estimated Time: 60 minutes

NGSS: 3-5-ETS1-3, 5-PS2-1, ETS1.B

TEKS: Science 5.6(C), Technology 5.4(D), Science 5.2(C)

Activity Overview:
Students program robots to simulate freight transport across Class 1, 2, and 3 railroads.

Misconceptions: Students may assume freight trains move randomly, rather than following planned routes.

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
NGSS 3-5-ETS1-3	Communicating solutions & testing	Students may think testing is just about seeing if it works once, without analyzing results for improvement	Testing Hopper robot cargo delivery and comparing distances traveled
NGSS 5-PS2-1	Forces & motion	Students may assume heavier cargo always moves slower regardless of design or friction	Modifying Hopper robot to carry different cargo weights over a measured distance

NGSS ETS1.B	Designing solutions to meet criteria	Students may believe one design can't be improved or that the first solution is always the best	Iterating Hopper robot modifications to maximize efficiency and distance
TEKS Science 5.6(C)	Force & motion relationships	Students may not consider factors like friction, energy transfer, or design efficiency	Testing robot movement on different ramp surfaces or with added wheels
TEKS Technology 5.4(D)	Using technology to solve problems	Students may think coding alone guarantees success without trial and error	Programming the Hopper robot and adjusting code based on test results
TEKS Science 5.2(C)	Scientific investigation & evaluation	Students may assume a single observation is enough or fail to record data systematically	Measuring Hopper distance multiple times to evaluate modifications and improvements

Materials:

- 1 Spike Prime Robot Kit per group
- 1 iPad/Laptop per group
- 1 Timer/Stopwatch per group
- Labeled stations on the floor (using colored electrical tape)

Activity Flow:

1. Introduce the scenario: **Ship cargo from the coast to the yard**.
2. Design planned stops, speed, and cargo handoffs.
3. Program the robot using **loops** and **color detection**.
4. Test the program, revise as needed, and run multiple trials.
5. Discuss: How does this simulation reflect real-world freight logistics?

Final Activity: **Exit Ticket & Clean-Up**

Estimated Time: 10-15 minutes

Activity Overview:
Students reflect on their work, disassemble their robots, and clean up their workspace.

Materials:

- Exit slips (if a physical copy is desired)
- Inventory checklist

Activity Flow:

1. **Reflection Question:** Why is coordination important between rail companies?
2. Disassemble robots and check inventory/parts.
3. Work as a team to clean up the workspace.

Day 2 Reflection Questions:

1. What was most surprising about how railroads are organized?
2. How does the class of a track affect cargo movement and efficiency?
3. Where did you observe energy transforming in today's activities?
4. Why is coding important for controlling freight trains?
5. How do engineers use planning to ensure trains travel safely and efficiently?

Day 3: Future Vaquero Engineers

Theme: Engineering Rail Safety: Understanding Design and System Risks

Day Overview: Safety is the focus of the day as students investigate the causes of train derailments and how engineers design solutions to prevent them. They will simulate fragile railway signals, explore how wheel-and-axle systems function, and apply Newton's Third Law. Students will also use sensors and coding to detect hazards and protect the tracks.

Lesson Objectives:

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

- Identify common causes of train derailments.
- Simulate fragile signal systems and practice teamwork.
- Apply Newton's Third Law to wheel-and-axle design.
- Use coding to simulate inspection and hazard detection.
- Explain how safety engineering prevents accidents.

Day 3 at a Glance

Time	Activity	Focus / Goal
25 min	Railway Systems 101 – What Can Go Wrong?	Investigate causes of train derailments using articles and visuals; discuss the importance of quick detection
20–25 min	Conductors in Training – Signal Simulation Challenge	Simulate fragile railway signals with balloons; practice teamwork and hazard adaptation
25–35 min	Trackside Theory 121 – Wheel and Axle Challenge	Build and test cup-and-dowel train axles; explore derailments and the importance of alignment
15–20 min	Signals and Systems 131 – Understanding Code Flow	Read block code like a story to understand navigation logic and obstacle detection
45–60 min	Innovation Depot 141 – Inspection Detection Challenge	Program robots to detect obstacles, stop or clear tracks, test, debug, and present solutions
10–15 min	Exit Ticket & Clean-Up	Reflect on rail safety, disassemble robots, check inventory, and clean up workspace

Activity 1: Railway Systems 101 – What Can Go Wrong?

Estimated Time: 25 minutes

NGSS: ETS1.A, ESS3.B, 3-5-ETS1-1

TEKS: Science 5.1(B), Science 5.3(A),

Activity Overview:
Students investigate real train derailment causes using articles and visual aids.

Misconceptions: Students may assume that derailments occur only because trains are speeding.

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
NGSS ETS1.A	Defining and solving problems	Students may think problems have only one correct solution	Analyzing causes of train derailments and brainstorming multiple safety solutions
NGSS ESS3.B	Natural hazards and human impact	Students may assume derailments happen only due to human error or speeding	Investigating real derailment scenarios and identifying various contributing factors
NGSS 3-5-ETS1-1	Engineering design process	Students may believe once a design is built it doesn't need testing or improvement	Designing a signal or balloon rocket system, testing, and refining based on observations
TEKS Science 5.1(B)	Scientific investigation	Students may think observation alone is enough to understand complex systems	Observing derailment simulations and noting multiple causal factors
TEKS Science 5.3(A)	Critical thinking & problem solving	Students may assume solutions are obvious or require no teamwork	Collaborating to plan and prototype a derailment prevention system

Materials:

- Article snippet
- Chart paper or board

Activity Flow:

1. Show the video *“What Can Go Wrong?”* highlighting train derailments.
2. Read or summarize real derailment examples.
3. List the causes of derailments on the board.
4. Discuss: Why is quick detection critical for preventing accidents?

Activity 2: Conductors in Training – Signal Simulation Challenge

Estimated Time: 20-25 minutes

NGSS: ETS1.B, 3-PS2-1, 3-PS2-2

TEKS: Science 5.6(C), PE 5.7(B), SEL 5.1

Activity Overview:
Teams use balloons to model fragile railway signals under hazardous conditions.

Misconceptions: Students may believe train signals operate like traffic lights, rather than responding to sensors or control commands.

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
NGSS ETS1.B	Developing and evaluating solutions	Students may think one solution is always the best or that no changes are needed once a design is made	Teams adjusting balloon signal systems to withstand “hazards”
NGSS 3-PS2-1	Forces and motion	Students may assume objects always move the same way regardless of applied force	Predicting how a balloon rocket will move along a string track
NGSS 3-PS2-2	Types of interactions	Students may believe objects only interact when touching	Observing how air escaping from a balloon propels the straw along the string
TEKS Science 5.6(C)	Force and motion relationships	Students may think steeper or stronger forces always produce faster or farther motion	Testing balloon rockets or Hot Wheels cars on ramps

TEKS PE 5.7(B)	Teamwork and cooperation	Students may assume working together isn't necessary or that one person can control success	Coordinating as a team to keep the balloon afloat during the signal challenge
TEKS SEL 5.1	Self-management and responsible decision-making	Students may believe safety decisions are automatic or not influenced by planning	Reacting appropriately to signal cards along the taped track activity

Materials:

- 1- 9in Balloon per group
- Hazard prompt cards

Activity Flow:

1. Review the rules and objectives of the balloon activity.
2. Work as a team to keep the balloon in the air without touching it directly or letting go of each other.
3. Respond to hazards announced by the teacher (e.g., spin, freeze, duck).
4. If the balloon drops, the signal "fails."
5. Debrief: How did your team adapt to the hazards?

Activity 3: Trackside Theory 121 – Wheel and Axle Challenge

Estimated Time: 25-35 minutes

NGSS: ETS1.C, 3-PS2-2, 4-PS3-1

TEKS: Science 5.6(A), Science 5.2(D), Science 5.3(B)

Activity Overview:
Students construct a cup-and-dowel train axle and test it to observe potential derailments.

Misconceptions: Students may assume that round objects will always roll properly, regardless of how the axle is aligned.

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
NGSS ETS1.C	Optimizing solutions through testing and iteration	Students may think the first design will always work perfectly and that testing isn't necessary	Building cup-and-dowel wheel and axle assemblies for trains and adjusting after derailments
NGSS 3-PS2-2	Types of interactions	Students may believe round objects always roll correctly regardless of alignment or track quality	Observing how wheels behave on different track setups
NGSS 4-PS3-1	Energy transfer	Students may think energy is "used up" or doesn't transfer between potential and kinetic forms	Using ramps to test Hot Wheels motion and predicting distance traveled
TEKS Science 5.6(A)	Motion and force	Students may assume steeper ramps always make objects move faster	Testing ramp angles with toy cars or robots
TEKS Science 5.2(D)	Energy and motion	Students may not recognize how energy is stored and transformed	Discussing energy storage in raised objects or compressed mechanisms
TEKS Science 5.3(B)	Scientific investigation	Students may assume one trial is enough for reliable results	Running 2–3 trials for each wheel, axle, or ramp test to gather accurate data

Materials:

- 2 foam cups per group
- 1 dowel or pencil
- Masking Tape
- 2 meter sticks or 2–4 ft wooden dowels (to serve as tracks) per group

Activity Flow:

1. Build the wheel-and-axle assembly and track, then test by rolling.
2. Adjust spacing or balance if derailments occur.
3. Create a second wheel-and-axle model for additional testing.
4. Conduct 2–3 trials.
5. Present a final demo for the class.
6. Debrief: Which design worked best? What failed? What surprised you the most?

Activity 4: Signals and Systems 131 – Understanding Code Flow

Estimated Time: 15-20 minutes

NGSS: ETS1.B, 4-PS3-4, 3-5-ETS1-2

TEKS: Technology 5.4(C), Science 5.2(C), Science 5.3(A)

Activity Overview:
Students read block code like a story to understand the sequence and logic of coding for navigation.

Misconceptions: Students may believe a robot will always execute code correctly, even if the instructions are incorrect or illogical.

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
NGSS ETS1.B	Developing possible solutions	Students may think a solution should work perfectly on the first attempt, without iteration	Programming robots to climb ramps or transport cargo without testing and refining code
NGSS 4-PS3-4	Energy transfer and conversion	Students may believe coding a robot automatically ensures correct motion without considering forces, friction, or sequence	Coding a "bike" robot to move up a ramp and adjusting for performance after testing
NGSS 3-5-ETS1-2	Planning and carrying out investigations	Students may assume one trial or code run is sufficient for evaluation	Performing multiple test runs to see how different code blocks affect robot movement
TEKS Technology 5.4(C)	Using technology to solve problems	Students may think using coding blocks is purely visual, without logical sequencing	Designing block code sequences for robots to complete tasks accurately
TEKS Science 5.2(C)	Motion and forces	Students may think robots move exactly as expected without needing adjustments	Observing robot behavior on inclines and modifying code or setup
TEKS Science 5.3(A)	Scientific inquiry	Students may think that outcomes are obvious and don't need testing or reflection	Running multiple trials to refine robot performance and improve understanding

Materials:

- 1 iPad/Laptop with code sample

Activity Flow:

1. Demonstrate and discuss key code blocks.
2. Have students predict how the robot will behave.
3. Discuss: How can this coding approach be used to detect obstacles?

Activity 5: Innovation Depot 141 – Inspection Detection Challenge

Estimated Time: 45–60 minutes

NGSS: ETS1.B, 5-PS2-1, 3-5-ETS1-3

TEKS: Science 5.2(D), Technology 5.6(A), Science 5.1(B)

Activity Overview:
Teams program a robot to detect obstacles and stop or clear the track.

Misconceptions: Students may assume that robots can detect obstacles without using sensors.

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
NGSS ETS1.B	Developing possible solutions	Students may think a single design will always work without testing or iteration	Programming robots to transport cargo without testing for obstacles or errors
NGSS 5-PS2-1	Forces and motion	Students may believe objects move randomly or without applied forces	Observing robot motion along planned paths and realizing planned forces are needed for accurate movement

NGSS 3-5-ETS1-3	Evaluating solutions	Students may think the first solution is automatically the best	Testing multiple robot configurations to determine the most efficient freight delivery solution
TEKS Science 5.2(D)	Force, motion, and interactions	Students may assume heavier or lighter objects behave predictably without considering friction or surface	Testing robot movement with different “cargo” weights on the track
TEKS Technology 5.6(A)	Using technology to solve problems	Students may think programming alone guarantees success	Iteratively coding, testing, and refining robots to complete safe delivery challenges
TEKS Science 5.1(B)	Scientific investigation and reasoning	Students may believe experiments don’t require observation, measurement, or adjustment	Observing robot trials, recording outcomes, and making improvements

Materials:

- 1 Spike Prime Robot Kit per group
- 1 iPad/Laptop per group
- Obstacle items
- Sensors, sound blocks
- Safe zone markers

Activity Flow:

1. Introduce the scenario: test that your robot’s detection system works.
2. Program the robot to stop, signal, clear the obstacle, and resume movement.
3. Test and debug the program as needed.
4. Present the final solution to the class.

Final Activity: Exit Ticket & Clean-Up

Estimated Time: 10-15 minutes

Activity Flow:

1. **Exit Question:** How can you contribute to keeping trains safe?
2. Disassemble robots and check all parts.
3. Work as a team to clean up the workspace.

Day 3 Reflection Questions:

1. What surprised you most about how train wheels and axles work?
2. How did teamwork help you succeed in the signal activities?
3. How do sensors help prevent train accidents?
4. What new insights did you gain about derailments?
5. Which parts of today's activities felt most like real engineering work?

Day 4: Smart Sensors, Safe Crossings

Theme: Preventing Railway Accidents Through Motion, Force, and Technology

Day Overview: Students investigate rural rail crossings and the risks where tracks intersect with roads. Through hands-on activities and robotics, they simulate signals, use logical thinking to respond to hazards, and explore action-reaction forces with balloon rockets. They will also code robots to act as emergency responders and clear obstructions from the tracks.

Lesson Objectives:

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

- Explain what rural grade crossings are and identify associated risks.
- Apply Newton's Third Law through investigations and relate it to braking and motion.
- Simulate live railway signals and practice safety logic.
- Code a robot to detect and clear track obstructions.

Day 4 at a Glance

Time	Activity	Focus / Goal
25 min	Railway Systems 101 – What Can Go Wrong?	Investigate causes of train derailments and understand why quick detection is critical.
20–25 min	Conductors in Training – Signal Simulation Challenge	Simulate fragile signals under hazards and practice teamwork and logical responses.
25–35 min	Trackside Theory 121 – Wheel and Axle Challenge	Build and test wheel-and-axle systems; explore design, motion, and derailment prevention.
15–20 min	Signals and Systems 131 – Understanding Code Flow	Read and interpret block code to understand logic for robot navigation.
45–60 min	Innovation Depot 141 – Inspection Detection Challenge	Program robots to detect and clear track obstacles, simulating automated safety systems.
10–15 min	Exit Ticket & Clean-Up	Reflect on safety engineering, disassemble robots, and clean workspace.

Activity 1: Railway Systems 101 – Rural Grade Crossings

Estimated Time: 25 minutes

NGSS: 3-5-ETS1-1, ETS1.B, ESS3.C

TEKS: Science 5.1(A), Science 5.3(A)

Activity Overview:
Students examine rural rail crossings and discuss the associated risk factors.

Misconceptions: Students may believe that all railroad crossings are equally safe or that trains always stop for vehicles, not recognizing the specific risks at rural crossings.

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
NGSS 3-5-ETS1-1	Defining problems	Students may think there is only one "correct" solution to a problem	Understanding rural rail crossing hazards and thinking only one robot design could address them
NGSS ETS1.B	Developing possible solutions	Students may assume the first idea will automatically work	Brainstorming robot designs without considering testing or iteration
NGSS ESS3.C	Human impacts on Earth systems	Students may believe rail safety is not affected by human decisions or environmental factors	Discussing risks at rural grade crossings and the need for safety measures
TEKS Science 5.1(A)	Scientific investigation	Students may think observation and questioning are unnecessary	Examining images and videos of rural crossings without considering risk factors
TEKS Science 5.3(A)	Scientific reasoning	Students may believe solutions are obvious and don't require analysis	Predicting safety issues without testing or evaluating different robot or signal designs

Materials:

- 1 iPad/Laptop per group
- Images and video clips
- Kahoot review

Activity Flow:

1. Display images of rural rail crossings.
2. Discuss: *"What could go wrong here?"*
3. Watch a short video or scenario illustrating crossing hazards.
4. Play a Kahoot game to check students' understanding.

Activity 2: Conductors in Training – Signal or Stall

Estimated Time: 30 minutes

NGSS: ETS1.C, 4-PS3-3, 3-PS2-1

TEKS: Science 5.6(B), Science 5.3(C)

Activity Overview:
Teams navigate a taped track while drawing signal cards, responding logically to simulate real-time railway hazards.

Misconceptions: Students may assume that responding to signals is simple or automatic, not realizing it requires careful observation, timing, and logical decision-making.

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
NGSS ETS1.C	Optimizing solutions	Students may assume their first design is perfect and needs no improvement	Teams testing balloon rockets or robot movements without adjusting for performance
NGSS 4-PS3-3	Energy transfer	Students may think energy is "used up" instead of transferred	Observing how motion is affected when balloon rockets or ramps are launched
NGSS 3-PS2-1	Forces and motion	Students may believe heavier objects always move slower or that all forces result in straight motion	Predicting how objects move along tracks or balloon rockets without considering direction, friction, or launch angle
TEKS Science 5.6(B)	Forces and energy	Students may think only speed affects motion	Balloon rocket experiments may show inconsistent motion, leading to misinterpretation
TEKS Science 5.3(C)	Scientific reasoning	Students may think trial-and-error is not part of engineering	Teams may avoid iterating on robot code or balloon launcher adjustments

Materials:

- Floor track tape
- Signal cards (Green, Yellow, Red, Obstacle)

Activity Flow:

1. Explain "IF–THEN" logic and its role in safety decisions.
2. Teams walk the taped track.
3. Draw a signal card and react accordingly:
4. IF Yellow → slow down
5. IF Obstacle → reroute
6. Debrief: How did this activity demonstrate teamwork and logical decision-making?

Activity 3: Trackside Theory 121 – Newton's Third Law Balloon Racers

Estimated Time: 45 minutes

NGSS: 3-PS2-1, 4-PS3-1, ETS1.A

TEKS: Science 5.6(A), Science 5.7(C), Math 5.9(C), Science 5.7(B)

Activity Overview:
Students explore action and reaction forces by launching balloon rockets to simulate motion.

Misconceptions: Students may think that the balloon will always travel straight or predictably, not realizing that direction and motion depend on the forces and angle of release.

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
NGSS 3-PS2-1	Forces and motion	Students may believe objects always move in the direction of the applied force without considering friction or obstacles	Balloon rockets on strings may veer or stop unexpectedly
NGSS 4-PS3-1	Energy transfer	Students may think energy is lost rather than transformed	Launching balloon rockets or rolling cars along ramps, not recognizing potential ↔ kinetic energy conversion

NGSS ETS1.A	Defining and solving problems	Students may assume the first solution is automatically correct	Predicting which ramp or track design will allow a car or robot to move farthest without testing or iterating
TEKS Science 5.6(A)	Motion and forces	Students may think only weight affects motion	Observing Hot Wheels cars or balloon rockets and misattributing speed changes solely to mass
TEKS Science 5.7(C)	Investigation & analysis	Students may think measuring once is sufficient for conclusions	Measuring distance or time of runs without repeating trials
TEKS Math 5.9(C)	Data analysis	Students may misinterpret graphs or tables	Recording ramp distances or robot test times and drawing incorrect conclusions
TEKS Science 5.7(B)	Scientific reasoning	Students may think predictions do not need to be tested	Assuming their predicted winner ramp or track class will perform as expected without experimentation

Materials:

- 1 9in-balloon per group
- Straw, string, tape
- Chairs for anchor

Activity Flow:

1. Thread a straw onto a string.
2. Tape a balloon to the straw.
3. Inflate the balloon and launch it along the string.
4. Observe the forces in action and the resulting motion.
5. Test again and make adjustments as needed.
6. Discuss: How does this experiment help us understand how trains start, stop, and move?

Activity 4: Signals & Systems 131 – Robotics Forklift Build

Estimated Time: 45–60 minutes

NGSS: ETS1.B, 4-PS4-3, ETS1.C

TEKS: Technology 5.4(D), Science 5.2(E), Science 5.3(B)

Activity Overview:
Students build and program a robot forklift to safely transport a wheel along a designated path.

Misconceptions: Students may assume that the robot will automatically move the wheel safely without considering speed, alignment, or obstacles, not realizing careful coding and control are required.

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
NGSS ETS1.B	Developing possible solutions	Students may assume coding alone guarantees success without testing or iteration	Programming robots to climb ramps or move cargo without debugging
NGSS 4-PS4-3	Information technology & signals	Students may think robots always follow instructions perfectly	Using block code to navigate robots; students may not anticipate sensor limitations or errors
NGSS ETS1.C	Optimizing solutions	Students may think the first design is always the best	Iterating robot design to improve speed, accuracy, or obstacle handling without testing variations
TEKS Technology 5.4(D)	Design and problem-solving	Students may believe coding is only dragging blocks, ignoring logic	Programming robots without planning loops, conditions, or sensor responses
TEKS Science 5.2(E)	Scientific investigation	Students may think testing once is enough to confirm results	Testing robot movement once and assuming the solution is perfect
TEKS Science 5.3(B)	Data analysis & reasoning	Students may misinterpret results or ignore errors	Recording robot performance and drawing conclusions without comparing multiple trials

Materials:

- 1 LEGO Spike Prime kit per group
- 1 iPad/Laptop per group
- Mock wheel & axle
- Safe zone marker

Activity Flow:

1. Build the robot forklift model.
2. Program the robot to pick up the wheel, sound an alarm, transport it, and park safely.
3. Test the program and make improvements as needed.
4. Optional: Add a timed or scored challenge for engagement and fun.

Activity 5: Innovation Depot 141 – Rural Track Alert Challenge

Estimated Time: 45–60 minutes

NGSS: ETS1.B, 3-5-ETS1-3, ESS3.B

TEKS: Science 5.6(C), Science 5.1(B), Technology 5.6(A)

Activity Overview:
Teams program a robot to detect obstacles on the track and safely remove them.

Misconceptions: Students may believe that robots cannot prevent accidents or that real railway safety systems are not automated.

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
NGSS ETS1.B	Developing and evaluating solutions	Students may think a single design or approach is always correct	Designing robots for freight delivery without considering alternative designs or iterative improvements
NGSS 3-5-ETS1-3	Testing and refining solutions	Students may assume the robot will work perfectly without testing or adjustments	Running the robot once and assuming it can handle obstacles accurately
NGSS ESS3.B	Human impacts on natural systems	Students may think technology has no limitations in real-world safety scenarios	Programming robots to remove track obstacles without considering real-world constraints like sensor range or timing
TEKS Science 5.6(C)	Forces and motion	Students may confuse cause and effect of motion	Robot collisions or stopping distances may be misinterpreted as coding errors rather than force interactions

TEKS Science 5.1(B)	Scientific investigation	Students may assume one trial is sufficient to draw conclusions	Testing robot safety once and not analyzing multiple runs for accuracy and reliability
TEKS Technology 5.6(A)	Application of technology to solve problems	Students may believe coding or robots automatically prevent accidents	Students may overestimate how sensors and automation ensure real-world safety without iterative testing

Materials:

- 1 Spike Prime-Robot kit per group
- 1 obstacle for practice (On Floor)
  Safe zone marker
- 1 iPad/Laptop per group

Activity Flow:

1. Present the scenario: Your train must avoid a collision.
2. Program the robot to detect obstacles, stop, signal, clear the obstruction, and continue moving.
3. Test the robot and explain your design choices.

Final Activity: Exit Ticket & Clean-Up

Estimated Time: 15 minutes

Activity Flow:

1. **Exit Prompt:** "How do sensors help trains and people stay safe?"
2. Disassemble robots and check all parts in the kits.
3. Work as a team to clean up the workspace.

Day 4 Reflection Questions:

1. What factors make rural rail crossings especially dangerous?
2. How did Newton's Third Law appear in your balloon rocket experiment?
3. How did your team respond when signals or hazards changed?
4. How does detection technology help prevent accidents?
5. If you could invent a new safety device, what would it be and why?

Day 5: Full STEAM Ahead

Theme: Culminating Challenge, Showcase, and Celebration

Day Overview: On the final challenge day, students put their knowledge into action by designing, building, and programming a robot to solve a real-world railway safety problem. They will plan, prototype, test, and present their solutions to classmates. The day concludes with reflection, celebration, and recognition of their growth as emerging engineers.

Lesson Objectives:

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

- Integrate all camp skills to design and program a final robot project.
- Present their solutions confidently to peers.
- Reflect on their growth in engineering, problem-solving, and teamwork.
- Celebrate accomplishments and receive recognition for their efforts.

Day 5 at a Glance

Time	Activity	Focus / Goal
20 min	Railway Systems 101 – Review and Challenge Reveal	Review key concepts from the week; introduce the final challenge; brainstorm multiple possible solutions.
45–60 min	Conductors in Training – Plan & Prototype	Sketch and plan robot design; begin building the base and installing sensors; understand the importance of iteration and testing.
45–60 min	Trackside Theory 121 – Code, Test, Improve	Program robot movement, alerts, and stops; test with obstacles; debug and refine design and code; conduct final timed or scored run.
45 min	Innovation Depot 141 – Present and Celebrate	Present robot design and coding logic; demonstrate robot in action; answer questions; receive peer and teacher feedback.
20 min	Celebration and Awards	Reflect on the week; celebrate accomplishments; announce award winners; distribute certificates/prizes; take group photos.

Activity 1: Railway Systems 101 – Review and Challenge Reveal

Estimated Time: 20 minutes

NGSS: 3-5-ETS1-1, ETS1.C, 3-PS2-1

TEKS: Science 5.1(A), Science 5.3(C), Science 5.6(A)

Activity Overview:
Students review key concepts from the week and are introduced to the final challenge.

Misconceptions: Students may think they already know the "best" solution or that there is only one correct way to solve the final challenge, rather than understanding that multiple designs and approaches can work.

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
NGSS 3-5-ETS1-1	Defining problems and constraints	Students may think there is only one correct solution	Interpreting the final robot challenge as requiring a single "right" design rather than exploring multiple approaches
NGSS ETS1.C	Optimizing solutions	Students may assume their first design will work perfectly without testing	Building the robot base and expecting it to deliver cargo without iteration or troubleshooting
NGSS 3-PS2-1	Forces and motion	Students may confuse the effect of force and direction on movement	Observing robot or balloon motion and assuming it will always move straight without considering push/pull forces or friction
TEKS Science 5.1(A)	Scientific investigation	Students may believe one trial provides enough evidence	Testing robot function only once and concluding it works perfectly
TEKS Science 5.3(C)	Force, motion, and energy	Students may think heavier objects always move faster	Predicting that a heavier LEGO robot moves faster or farther on a ramp without accounting for friction and slope
TEKS Science 5.6(A)	Simple machines and motion	Students may assume all mechanical assemblies work automatically	Building wheel-and-axle or forklift models without checking alignment, balance, or connections

Materials:

- Slide or poster with challenge goals

Activity Flow:

1. **Quick team review:** Reflect on the skills and concepts learned throughout the week.
2. **Introduce final challenge:** Design, build, and program a robot for safe freight delivery.
3. **Team brainstorming:** Groups generate and discuss potential solutions.

Activity 2: Conductors in Training – Plan & Prototype

Estimated Time: 45–60 minutes

NGSS: 3-5-ETS1-2, ETS1.B, ETS1.C

TEKS: Science 5.4(A), Technology 5.4(D), Science 5.2.D

Activity Overview:
Teams develop a plan, create sketches, and begin constructing their final robot design.

Misconceptions: Students may think that their first design will work perfectly without testing or iteration, not realizing that trial, error, and refinement are essential parts of the engineering process.

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
NGSS 3-5-ETS1-2	Developing and using models	Students may think their first model is always correct	Creating a robot prototype and expecting it to work perfectly without testing or iteration
NGSS ETS1.B	Designing solutions	Students may assume there is only one correct design	Planning a robot to deliver cargo safely but believing only one approach will succeed
NGSS ETS1.C	Optimizing solutions	Students may think coding alone ensures success	Programming robot movement without testing for obstacles or adjusting for real-world conditions
TEKS Science 5.4(A)	Forces and motion	Students may confuse cause and effect	Predicting robot motion without considering friction, ramp slope, or force direction

TEKS Technology 5.4(D)	Problem-solving with technology	Students may think technology works automatically	Expecting robot sensors to detect obstacles correctly without coding logic or calibration
TEKS Science 5.2.D	Scientific investigation	Students may think one trial is sufficient	Testing robot performance only once and assuming it's fully functional

Materials:

- 1 LEGO Spike Prime kit per group
- Papers/Journal for sketches
- Pencils

Activity Flow:

1. Teams create a detailed sketch of their design.
2. Collect the necessary robot components.
3. Start constructing the robot base and installing sensors.
4. The teacher monitors progress and provides guidance to each group.

Activity 3: Trackside Theory 121 – Code, Test, Improve

Estimated Time: 45–60 minutes

NGSS: ETS1.C, 4-PS4-3, 3-PS2-2

TEKS: Technology 5.6(A), Science 5.2(D), Science 5.3(B)

Activity Overview:
Teams program, test, and adjust their robots to ensure successful and safe freight delivery.

Misconceptions: Students may think that coding alone guarantees the robot will work perfectly, without needing adjustments or troubleshooting based on real-world testing.

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
NGSS ETS1.C	Optimizing solutions	Students may think coding alone guarantees a perfect solution	Programming a robot to climb a ramp and assuming it will always succeed without testing and adjusting
NGSS 4-PS4-3	Information can be encoded for transmission	Students may think robots or signals transmit information automatically	Using robot sensors to detect a signal or obstacle without understanding coding logic or sequence
NGSS 3-PS2-2	Forces and interactions	Students may think objects always move as expected	Predicting robot motion up a ramp without considering friction, incline, or force magnitude
TEKS Technology 5.6(A)	Problem-solving with technology	Students may assume technology works without planning or iteration	Expecting robots to complete a task perfectly on the first try without debugging
TEKS Science 5.2(D)	Scientific investigation	Students may think one test or trial is enough	Testing robot performance once and assuming it's fully functional
TEKS Science 5.3(B)	Forces and motion	Students may confuse action-reaction or cause-effect relationships	Launching a robot or balloon and expecting straight motion without considering opposing forces

Materials:

- 1 iPad/Laptop per group
- 1 LEGO Spike Prime robot kit per group
- Obstacles, safe zones ror practice

Activity Flow:

1. Teams program the robot's movement, stopping points, and alert signals.
2. Conduct test runs with obstacles in place.
3. Debug and refine the code and robot design.
4. Perform a final timed or scored test run.

Activity 4: Innovation Depot 141 – Present and Celebrate

Estimated Time: 45 minutes

NGSS: ETS1.B, ETS1.C, 3-5-ETS1-3

TEKS: Science 5.3(C), Technology 5.4(D), Science 5.1(B)

Activity Overview:
Teams showcase their robot's design, explain its features, and perform a live demonstration.

Misconceptions: Students may think the presentation only requires showing the robot working, rather than explaining their design process, coding choices, and problem-solving strategies.

Strand / Standard	Key Concept	Common Student Misconceptions	Camp Context Example
NGSS ETS1.B	Developing and using models	Students may think their first design is always correct	Building a robot for freight delivery and assuming it will work perfectly without testing or iteration
NGSS ETS1.C	Optimizing solutions	Students may assume that coding alone guarantees success	Programming a robot to navigate obstacles without debugging or adjusting code
NGSS 3-5-ETS1-3	Evaluating solutions	Students may believe there is only one correct solution	Designing a robot for the final challenge and thinking only one design can solve the problem
TEKS Science 5.3(C)	Forces and motion	Students may think that robots or objects will move as expected without accounting for real-world forces	Robot stops or fails when encountering unexpected friction or ramp angles
TEKS Technology 5.4(D)	Problem-solving with technology	Students may think technology works perfectly without planning	Expecting the robot to complete delivery tasks without testing and refining
TEKS Science 5.1(B)	Scientific investigation	Students may think one trial is sufficient to evaluate a design	Running the robot once and assuming the program and build are fully effective

Materials:

- Finished robots (LEGO Spike Prime Robot Kit)
- Presentation cards (optional)

Activity Flow:

1. Each team presents their design, coding logic, and any refinements made.
2. Conduct a live demonstration of the robot in action.
3. Answer questions from peers and the audience.
4. The teacher provides constructive feedback and guidance.

Final Activity: Celebration and Awards

Estimated Time: 20 minutes

Activity Flow:

1. Review key highlights and accomplishments from the week.
2. Announce the Winning Team and Conductor Award recipients.
3. Distribute certificates or small prizes.
4. Take a group photo and conclude with a thank-you celebration.

Day 5 Reflection Questions:

1. What achievement or moment from this week are you most proud of?
2. How did you approach and solve problems like an engineer?
3. In what ways did your teamwork grow or improve throughout the week?
4. What advice or tips would you share with next year's campers?
5. What activity or experience did you enjoy the most at Railway Safety Camp?

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