PROJECT LEAD THE WAY PLTW

Curriculum Framework
PLTW Launch – 4th Grade – Energy: Collisions

This module begins with three fictional characters at an amusement park observing bumper cars. Through the example of the bumper cars, students are introduced to energy transfer and conversion in collisions. The students apply new skills and knowledge to solve a design problem where they are asked to design and build a restraint system to protect a passenger in a vehicle collision. The passenger is represented by an egg. The vehicle rolls down an inclined plane and collides with a solid object such as a wall.
Students explore how mechanisms change energy by transferring direction, speed, type of movement, and force. Students discover a variety of ways that potential energy can be stored and released as kinetic energy. Citing evidence, students explain the relationship between the speed of an object and the energy of that object. They also predict the transfer of energy as a result of a collision between two objects. As students solve the problem for this module, they will apply their knowledge and skills related to energy transfer in collisions to develop a vehicle restraint system.

<table>
<tr><th colspan="3">Desired Results (stage 1)</th></tr>
<tr><td rowspan="4">Standards
Next Generation Science Standards
4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object.
4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide.
PS2.A: Forces and Motion - Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion.
The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it.
PS2.B: Types of Interactions - Objects in contact exert forces on each other.
3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.</td><th colspan="2">Transfer</th></tr>
<tr><td colspan="2">Students will be able to independently use their learning to …
T1 – Evaluate a problem in a new and novel situation.
T2 – Apply a step by step design process to solve a problem.
T3 – Predict the effects of a collision.</td></tr>
<tr><th colspan="2">Meaning</th></tr>
<tr><td>UNDERSTANDINGS:
Students will understand that …
U1 – Engineers have a step by step approach for looking at and solving a problem called the design process.
U2 – Engineers and designers create new products and technology to meet a need or want that meets specific criteria for success, including constraints on materials, time, and cost.</td><td>ESSENTIAL QUESTIONS:
Students will keep considering …
Q1 – How are potential and kinetic energy related?
Q2 – What happens to energy during a collision?</td></tr>
</table>

• 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 carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. • ETS1.A Defining and Delimiting Engineering Problems – Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into accounts. • ETS1.B Developing Possible Solutions – Research on a problem should be carried out before beginning to design a solution. At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. • Science and Engineering Practices – Asking Questions and Defining Problems – Asking questions and Builds on K-2 experiences and progresses to specifying qualitative relationships. • Science and Engineering Practices – Developing and Using Models – Builds on K-2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. • Science and Engineering Practices – Planning and Carrying Out Investigations – Builds on K-2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. • Science and Engineering Practices – Analyzing and Interpreting Data – Builds on K-2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used.	• U3 – Engineers 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. • U4 – Engineers propose a solution to develop for a design problem after evaluating multiple possible designs. • U5 – Prototypes can be evaluated and improved upon by a series of fair and controlled tests to identify a product's strengths and limitations. • U6 – Engineers write down everything they do to document their work, organize their thoughts, and show their steps in an engineering notebook. • U7 – Engineers share their work with and get feedback from others at many points throughout the design process. • U8 – Energy is the ability to do work. • U9 – Engineers design mechanisms to change energy by transferring direction, speed, type of movement, and force. • U10 – Potential energy can be stored in many ways and is released as kinetic energy. • U11 – The faster a given object is moving, the more energy it possesses. • U12 – Contact forces transfer energy during a collision, resulting in a change in the object's motion.	

- Science and Engineering Practices – Using Mathematics and Computational Thinking – Builds on K-2 experiences and progresses to extending quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions.
- Science and Engineering Practices – Constructing Explanations and Designing Solutions – Builds on K-2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.
- Science and Engineering Practices – Obtaining, Evaluating, and Communicating Information – Builds on K-2 experiences and progresses to evaluating the merit and accuracy of ideas and methods.
- Crosscutting Concept – Scale, Proportion, and Quantity – Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long periods of time. Standards units are used to measure and describe physical quantities such as weight, time, temperature, and volume.
- Crosscutting Concept – Systems and System Models – A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.
- Crosscutting Concept – Systems and System Models – A system can be described in terms of its components and their interactions.
- Crosscutting Concept – Energy and Matter – Energy can be transferred in various ways and between objects.
- Crosscutting Concept – Structure and Function – Different materials have substructures, which can sometimes be observed.
- Crosscutting Concept – Structure and Function – Substructures have shapes and parts that serve functions.

Acquisition

KNOWLEDGE: Students will…

- K1 – Explain what happens at each step of the design process. U1
- K2 – State questions that engineers may ask when gathering information about a situation people want to change. U2
- K3 – Identify the differences between invention and innovation. U2
- K4 – List ways in which energy can be transferred. U8, U9

SKILLS: Students will…

- S1 – Follow a step by step approach to solving a problem. U1
- S2 – Identify specific constraints such as materials, time, or cost that engineers and designers must take into account given a specific design problem. U2
- S3 – Brainstorm and evaluate existing solutions to a design problem.U2, U3
- S4 – Generate multiple solutions to a design problem while taking into account criteria and constraints. U2, U3
- S5 – Use a decision matrix to compare multiple possible solutions to a design problem and select one to develop, taking into account how well each solution meets the criteria and constraints of the problem. U3, U4
- S6 – Plan fair tests in which variables are controlled to identify a product's strengths and limitations. U5
- S7 – Perform fair tests in which variables are controlled to identify a product's strengths and limitations. U5
- S8 – Organize and maintain an engineering notebook to document work. U6
- S9 – Share findings and conclusions with an audience. U7

• Crosscutting Concept - Patterns – Patterns of change can be used to make predictions. • Crosscutting Concept - Cause and Effect – Cause and effect relationships are routinely identified, tested, and used to explain change. • Crosscutting Concept – Influence of Science, Engineering, and Technology on Society and the Natural World - People's needs and wants change over time, as do their demands for new and improved technologies. • Crosscutting Concept – Influence of Science, Engineering, and Technology on Society and the Natural World - Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. *Common Core ELA* • RI.4.1 Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text. • RI.4.3 Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text. • RI.4.9 Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably. • W.4.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly. • W.4.7 Conduct short research projects that build knowledge through investigation of different aspects of a topic. • W.4.8 Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources. • W.4.9 Draw evidence from literary or informational texts to support analysis, reflection, and research. *Common Core Math* • 4.OA.A.3 Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a		• S10 – Classify energy in a system as potential or kinetic energy. U8, U10 • S11 – Explain, citing evidence, the relationship between the speed of an object and the energy of that object. U9, U11 • S12 – Predict the transfer of energy as a result of a collision between two objects. U11, U12 • S13 – Solve a simple design problem involving the transfer of energy and collisions between two objects. U10, U11, U12

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letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding. • MP.4 Model with mathematics. • MP.5 Use appropriate tools strategically.		

Evidence *(stage 2)*		
Activities (A) Projects (P) Problems (B) (Module level)	Assessments FOR Learning	Assessments OF Learning
Activity 1: Energy	• Essential questions • Discussion questions after demonstration • Launch Log Ask section responses • Discussion of characters in story of bumper cars • Discussion of seat belt article related to egg car design problem	• Launch Log Ask • Conclusion questions
Activity 2: Potential and Kinetic Energy	• Essential questions • Discussion of the change from potential to kinetic energy after Skateboard Simulation and physical demonstration • Student completion of the teacher chosen app	• Student completion of the teacher chosen app (optional) • Conclusion questions
Activity 3: Speed and Energy	• Essential questions • Answer to the question in procedure part 1 • Data recording in part 2	• Video of pendulum swing and collision car (optional) • Answer to the question in procedure part 1

Learning Plan *(stage 3)*	
Activities (A), Projects (P), and Problems(B)	Knowledge and Skills
Activity 1: Energy • In this activity the students read an article on seatbelt safety and discuss the reading with a classmate.	K2, K4
Activity 2: Potential and Kinetic Energy • In this activity students will observe real world applications of potential and kinetic energy and classify energy in a system as either potential or kinetic.	K1, K2, K3, K4, S10
Activity 3: Speed and Energy • In this activity students explore the relationship between speed and energy of an object by assembling a simple model of a pendulum and vehicle and documenting the changes to the system that can increase or decrease the speed of the objects. Changes to the system will include	S10, S11

	• Prediction of distance that car will travel at each height in part 2 • Answer to the question in procedure part 2	• Prediction of distance that car will travel at each height in part 2 • Answer to the question in procedure part 2 • Conclusion questions
Project: Energy Transfer in Collisions	• Essential questions • Discussion of sound created by a car accident • Slow motion analysis of collision video (optional) • Data recording and sketch of each collision in Launch Log • Discussion of Potential and Kinetic Energy simulation demonstration	• Discussion of Potential and Kinetic Energy simulation demonstration • Conclusion questions
Problem: Vehicle Restraint Design	• Essential questions • Documentation in the Launch Log of each of the design process steps • Physical construction of the prototype • Communication of the design solution	• Documentation in the Launch Log of each of the design process steps • Physical construction of the prototype • Results of the prototype testing • Communication of the design solution • Conclusion questions

varying the amount of potential energy by altering the mass or initial height of the objects.	
Project: Energy Transfer in Collisions • In this project students will describe elastic and inelastic collisions in systems they construct using VEX IQ equipment. Students will also describe how energy is conserved and transferred in a collision, including changes in motion and the production of heat and sound.	S11, S12
Problem: Vehicle Restraint Design • In this design challenge, students will design a restraint system or alter the vehicle design to protect a passenger in a car during a collision. Students will prototype their design using the VEX IQ vehicle they constructed in Activity 3 and an egg as a passenger. The solution will be tested by rolling the vehicle down an inclined plane at varying slopes to evaluate the effectiveness of the design. Students will use technology to present their design solution, test outcomes, and provide suggestions for improvement.	K1, K2, S1, S2, S3, S4, S5, S6, S7, S8, S9 S11, S12, S13

Energy: Collisions Check for Understanding		Check for Understanding Summative Assessment

Energy: Collisions Check for Understanding	K4, S10, S11, S12

- **WE ARE ALL RESPONSIBLE**
- **A HEALTHY AND SUSTAINABLE FUTURE IS POSSIBLE**
- **IT ALL BEGINS WITH A CHANGE IN THINKING**
- **HEALTHY SYSTEMS HAVE LIMITS**
- **CREATE CHANGE AT THE SOURCE NOT THE SYMPTOM**
- **THINK 1000 YEARS**
- **READ THE FEEDBACK**
- **A HEALTHY AND SUSTAINABLE FUTURE IS POSSIBLE**

<table>
<tr><th colspan="3">Desired Results (stage 1)</th></tr>
<tr><td rowspan="4">Standards
Next Generation Science Standards
• 4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
• 4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
• PS2.A: Forces and Motion – Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion.
• PS2.A: Forces and Motion – The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it.</td><th colspan="2">Transfer</th></tr>
<tr><td colspan="2">Students will be able to independently use their learning to …
T1 – Evaluate a problem in a new and novel situation.
T2 – Apply a step by step design process to solve a problem.
T3 – Identify energy conversion in everyday situations.</td></tr>
<tr><th colspan="2">Meaning</th></tr>
<tr><td>UNDERSTANDINGS:
Students will understand that …
• U1 – Engineers have a step by step approach for looking at and solving a problem called the design process.
• U2 – Engineers and designers create new products and technology to meet a need or want that meets specific criteria for success,</td><td>ESSENTIAL QUESTIONS:
Students will keep considering …
• Q1 – How are energy conversion and transfer related?
• Q2 – How can humans use energy conversion and transfer to meet needs and wants?
• Q3 – How is usable energy converted from resources in your area?</td></tr>
</table>

• PS2.B: Types of Interactions – Objects in contact exert forces on each other. • PS2.B: Types of Interactions – Electric, and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other. • 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. • 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 carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. • ETS1.A Defining and Delimiting Engineering Problems – Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into accounts. • ETS1.B Developing Possible Solutions – Research on a problem should be carried out before beginning to design a solution. At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. • Science and Engineering Practices – Asking Questions and Defining Problems – Asking questions and Builds on K-2 experiences and progresses to specifying qualitative relationships.	including constraints on materials, time, and cost. • U3 – Engineers 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. • U4 – Engineers propose a solution to develop for a design problem after evaluating multiple possible designs. • U5 – Prototypes can be evaluated and improved upon by a series of fair and controlled tests to identify a product's strengths and limitations. • U6 – Engineers write down everything they do to document their work, organize their thoughts, and show their steps in an engineering notebook. • U7 – Engineers share their work with and get feedback from others at many points throughout the design process. • U8 – Energy is the capacity to do work. • Energy has the ability to cause motion or create change. • U9 – Two types of energy exist: potential (stored energy) and kinetic (energy in motion). • U10 – Six main forms of energy include light, thermal, electrical, mechanical, chemical, and nuclear. • U11 – Energy can be converted from one form to another to meet a human need or want.	• Q4 – What are some energy conversions that take place to create usable energy in a community?

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<td rowspan="3">
• Science and Engineering Practices – Developing and Using Models – Builds on K-2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.
• Science and Engineering Practices – Planning and Carrying Out Investigations – Builds on K-2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.
• Science and Engineering Practices – Analyzing and Interpreting Data – Builds on K-2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used.
• Science and Engineering Practices – Using Mathematics and Computational Thinking – Builds on K-2 experiences and progresses to extending quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions.
• Science and Engineering Practices – Constructing Explanations and Designing Solutions – Builds on K-2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.
• Science and Engineering Practices – Obtaining, Evaluating, and Communicating Information – Builds on K-2 experiences and progresses to evaluating the merit and accuracy of ideas and methods.
• Crosscutting Concept – Patterns – Patterns can be used as evidence to support an explanation.
• Crosscutting Concept – Cause and Effect – Case and effect relationships are routinely identified, tested, and used to explain change.
</td>
<td>• U12 – Energy can be transferred from place to place by sound, light, heat, and electric current.</td>
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<tr>
<td colspan="2">Acquisition</td>
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<td>
KNOWLEDGE: Students will…
• K1 – Explain what happens at each step of the design process. U1
• K2 – State questions that engineers may ask when gathering information about a situation people want to change. U2
• K3 – Identify the differences between invention and innovation. U2
• K4 – List examples in which energy is converted between potential and kinetic energy. U9, U10
• K5 – Describe six main forms of energy, including light, thermal, electrical, mechanical, chemical, and nuclear. U11
• K6 – List ways in which energy may be converted from one form to another. U12
• K7 – Describe how sound, light, heat, and electric current can transfer energy. U13
</td>
<td>
SKILLS: Students will…
• S1 – Follow a step by step approach to solving a problem. U1
• S2 – Identify specific constraints such as materials, time, or cost that engineers and designers must take into account given a specific design problem. U2
• S3 – Brainstorm and evaluate existing solutions to a design problem.U2, U3
• S4 – Generate multiple solutions to a design problem while taking into account criteria and constraints. U2, U3
• S5 – Use a decision matrix to compare multiple possible solutions to a design problem and select one to develop, taking into account how well each solution meets the criteria and constraints of the problem. U3, U4
• S6 – Plan fair tests in which variables are controlled to identify a product's strengths and limitations. U5
• S7 – Perform fair tests in which variables are controlled to identify a product's strengths and limitations. U5
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• Crosscutting Concept – Influence of Science, Engineering, and Technology on Society and the Natural World - People's needs and wants change over time, as do their demands for new and improved technologies. • Crosscutting Concept – Influence of Science, Engineering, and Technology on Society and the Natural World - Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. *Common Core ELA* • RI.4.1 Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text. • RI.4.3 Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text. • RI.4.9 Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably. • RI.4.10 By the end of year, read and comprehend informational texts, including history/social studies, science, and technical texts, in the grades 4-5 text complexity band proficiently, with scaffolding as needed at the high end of the range. • W.4.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly. • W.4.7 Conduct short research projects that build knowledge through investigation of different aspects of a topic. • W.4.8 Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories. • SL.4.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 4 topics and texts*, building on others' ideas and expressing their own clearly. • SL.4.3 Identify the reasons and evidence a speaker provides to support particular points. *Common Core Math*		• S8 – Organize and maintain an engineering notebook to document work. U6 • S9 – Share findings and conclusions with an audience. U7 • S10 – Differentiate between potential and kinetic energy. U8, U9 • S11 – Explain how energy can be converted to meet a human need or want. U9, U10 • S12 – Compare and contrast the transfer and conversion of energy. U10, U11, U12, U13 • S13 – Apply scientific ideas about the conversion of energy to solve a simple design problem. U10, U11, U12 • S14 – Design a system that is able to store energy and then convert the energy to a usable form as it is released. U10, U11, U12, U13

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• MP.4 Model with mathematics. • MP.5 Use appropriate tools strategically.		

Evidence *(stage 2)*		
Activities (A) Projects (P) Problems (B) (Module level)	Assessments FOR Learning	Assessments OF Learning
Activity 1: What is Energy Conversion?	• Essential questions • Discussion of three fictional characters and the food pantry unloading problem • Student documentation and presentation of potential and kinetic energy classroom examples • Responses to Part 2 Observing a KinetiCan • Responses to Part 4 Converting Chemical to Mechanical Energy	• Popplet presentation of potential and kinetic energy classroom examples • Student documentation and presentation of potential and kinetic energy classroom examples • Responses to Part 2 Observing a KinetiCan • Responses to Part 4 Converting Chemical to Mechanical Energy • Conclusion questions
Activity 2: Energy Conversion in Action	• Essential questions • Observation documentation of each station in Launch Log • Recording image of each station in Launch Log • Responses to the three prompts presented in Step Part 1 #3.	• Observation documentation of each station in Launch Log • Responses to the three prompts presented in Step Part 1 #3. • Labels of part 1 documentation completed in step Part 2 #5

Learning Plan *(stage 3)*	
Activities (A), Projects (P), and Problems(B)	Knowledge and Skills
Activity 1: What is Energy Conversion? • In this activity students review potential and kinetic energy and create a model to demonstrate the conversion between kinetic energy to potential energy and back. Finally, students reflect on human energy sources and how energy from food is converted to usable energy.	K1, K2, K3, K4
Activity 2: Energy Conversion in Action • In this activity students experience several types of energy conversion. As they work through the activity, they will be exposed to vocabulary that can be used in the final part of the activity in which the students create a digital presentation detailing one example of energy conversion.	K5, K6, S9, S10, S11

	• Labels of part 1 documentation completed in step Part 2 #5	• Digital presentation of one observed energy conversion • Conclusion questions		
Activity 3: Light Up Your World	• Essential questions • Educreations app document prediction of how energy is converted between forms using a coin battery and LED • Documented plan with updates to dismantle the flashlight • Documentation of Research on one energy source • Popplet presentation of one energy source	• Educreations app document prediction of how energy is converted between forms using a coin battery and LED • Popplet presentation of one energy source • Conclusion questions	Activity 3: Light Up Your World • This activity is designed to provide context for students learning about the sources of energy, its conversion into electrical energy, transporting energy to our homes and industry, and ultimately its conversion into forms of energy that benefit us, including light, thermal, and mechanical energy.	K6, K7, S11, S12
Project: Harnessing Energy	• Essential questions • Documentation in the Launch Log of each of the design process steps • Popplet presentation of the design solution	• Popplet presentation of the design solution • Conclusion questions	Project: Harnessing Energy • In this project students will use two devices built with VEX IQ® equipment to work toward a solution to a fictional problem involving lifting objects into a tree house.	K1, K2, K3, K4, S10, S11, S13
Problem: Food Pantry Design Problem	• Essential questions • Documentation in the Launch Log of each of the design process steps	• Documentation in the Launch Log of each of the design process steps	Problem: Food Pantry Design Problem • In this problem students will design and model a system to unload boxes of food at a community food pantry.	K1-7, S1-14

	• Physical construction of the prototype • Communication of the design solution	• Physical construction of the prototype • Results of the prototype testing • Communication of the design solution • Conclusion questions
Energy: Conversion Check for Understanding		Check for Understanding Summative Assessment

Energy: Conversion Check for Understanding	K4, K5, K6, K7, S10, S11, S12

- **WE ARE ALL RESPONSIBLE**
- **A HEALTHY AND SUSTAINABLE FUTURE IS POSSIBLE**
- **IT ALL BEGINS WITH A CHANGE IN THINKING**

PREFACE

This module introduces students to computer systems infrastructure including basic computer hardware and digital data representation. Students start by comparing the computer system to a human brain, focusing on input, processing, and output. Students move on to learning about how data is stored in a computer.

Students learn about collecting data and representing it visually using programming. Students also create a reaction timer concussion diagnosis tool. The module culminates in a problem that challenges students to create a program that measures baseline brain fitness. Along the way, students practice breaking down problems into smaller tasks and using variables, events, and control flow structures.

With these new understandings, students will come to appreciate how computer programs can help people solve real-life problems. This module ties well with the Biomedical Science Launch module, "Input/Output: Human Brain". Students will discover how similar a computer system and the human brain can be.

<table>
<tr><th colspan="3">Desired Results (stage 1)</th></tr>
<tr><td rowspan="4">Standards
Computer Science Teachers Association K-12 CS Standards
• 1B-CS-01 Describe how internal and external parts of computing devices function to form a system.
• 1B-CS-02 Model how computer hardware and software work together as a system to accomplish tasks.
• 1B-NI-04 Model how information is broken down into smaller pieces, transmitted as packets through multiple devices over networks and the Internet, and reassembled at the destination.
• 1B-NI-05 Discuss real-world cybersecurity problems and how personal information can be protected.
• 1B-DA-06 Organize and present collected data visually to highlight relationships and support a claim.
• 1B-DA-07 Use data to highlight or propose cause-and-effect relationships, predict outcomes, or communicate an idea.
• 1B-AP-09 Create programs that use variables to store and modify data.</td><th colspan="2">Transfer</th></tr>
<tr><td colspan="2">Students will be able to independently use their learning to…
T1 – Apply general understanding of computer systems to make sense of human-made machines.
T2 – Apply technology to solve age-appropriate challenges by creating digital artifacts such as games or tools.
T3 – Develop efficient solutions to computational problems by breaking into subproblems and identifying parts that can be abstracted and modularized.</td></tr>
<tr><th colspan="2">Meaning</th></tr>
<tr><td>UNDERSTANDINGS: Students will understand that…
• U1 – Computers are systems of inputs, outputs, and processors that can perform many tasks very quickly.
• U2 – Computing is a collaborative activity that fosters creativity, communication, and teamwork.
• U3 – People use technology to create useful tools that make our lives easier.
• U4 – Data can be collected and organized to represent meaningful information using digital tools.
• U5 – The Internet is a resource for research and collaboration that must be used in a safe and responsible way.
• U6 – The display on a digital screen corresponds to an x-y coordinate system.</td><td>ESSENTIAL QUESTIONS: Students will keep considering…
• Q1 – How does a computer system work?
• Q2 – How do humans translate a problem so that a computer can operate on it?
• Q3 – What are the advantages that technology offers to humans that allow us to accomplish things we couldn't do without technology?</td></tr>
</table>

- 1B-AP-10 Create programs that include sequences, events, loops, and conditionals.
- 1B-AP-11 Decompose (break down) problems into smaller, manageable subproblems to facilitate the program development process.
- 1B-AP-13 Use an iterative process to plan the development of a program by including others' perspectives and considering user preferences.
- 1B-AP-15 Test and debug (identify and fix) a program or algorithm to ensure it runs as intended.
- 1B-AP-16 Take on varying roles, with teacher guidance, when collaborating with peers during the design, implementation, and review stages of program development.
- 1B-IC-19 Brainstorm ways to improve the accessibility and usability of technology products for the diverse needs and wants of users.

Next Generation Science Standards

- 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- 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 carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
- ETS1.A Defining and Delimiting Engineering Problems—Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different

- U7 – Modularization, breaking problems into subproblems, and abstraction, ignoring details while focusing on common properties, are important steps to take when developing solutions with technology.
- U8 – Computer programs do not need to be right the first time. Testing and fixing things is normal when programming.

Acquisition

KNOWLEDGE: Students will…

- K1 – Explain why computer scientists break big problem into subproblems. U7
- K2 – Identify parts of a computational solution that can be abstracted and modularized in order to make the solution efficient and generalizable. U7
- K3 – Identify basic input and output devices in computer systems. U1
- K4 – Give examples of real-life applications of computer systems. U2, U3, U4, U5
- K5 – Give examples of how collaboration can lead to better solution design. U2, U3, U8
- K6 – Recognize that a data set can be represented in various ways to convey different information. U4
- K7 – Explain safe and responsible use of the Internet. U5
- K8 – Identify events that drive a program's behavior such as external user interaction and internal variable counters. U1, U3, U4, U6

SKILLS: Students will…

- S1 – Organize and collaborate with group members by assigning roles and taking turns. U2
- S2 – Use technology to express ideas. U1, U2, U3, U4, U5, U6, U7, U8
- S3 – Decompose a problem and use a predefined set of commands to write an algorithm that will solve the problem. U1, U7
- S4 – Demonstrate the correct use of the x-y coordinate system when manipulating object positions and movement on a screen during an animated solution. U6, U7
- S5 – Use functions to modularize repetitive tasks, break a program down into smaller pieces, and to make the program more efficient. U7
- S6 – Use variables appropriately as part of a computational solution to store and manipulate values that may change as the program runs. U7
- S7 – Implement a loop when appropriate to make a program repeat a section of code until an ending condition is reached. U7

proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into accounts. • ETS1.B Developing Possible Solutions—Research on a problem should be carried out before beginning to design a solution. At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. *Common Core ELA* • CCSS.ELA-LITERACY.L.3.1 Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. • CCSS.ELA-Literacy.3.RI.3 Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect. • CCSS.ELA-Literacy.3.SL.1 Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion). *Common Core Math* • CCSS.Math.Practice.MP1 Make sense of problems and persevere in solving them. • CCSS.Math.Practice.MP2 Reason abstractly and quantitatively. • CCSS.Math.Practice.MP4 Model with Mathematics.		• S8 – Use a conditional statement in a program as a true/false test to make the program follow a specified sequence of steps depending on the state of the condition. U7 • S9 – Program characters in an animation or game to respond to event triggers. U1, U2, U3, U6, U7, U8 • S10 – Demonstrate persistence in the cycle of testing, finding, and fixing problems in computer programs. U2, U7, U8 • S11 – Identify similarities between a computer system and a human body (input, processing, output). U1 • S12 – Explain how text and image data can be represented by strings of 1s and 0s. U1, U4

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• CCSS.Math.Practice.MP5 Use appropriate tools strategically.		

Evidence *(stage 2)*			Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems (B) (Module level)	Assessments FOR Learning	Assessments OF Learning	Activities (A), Projects (P), and Problems(B)	Knowledge and Skills
Activity 1 Input, Processing, and Output	Teacher will observe students as they participate in the role-playing activity. Teacher will answer questions during the activity.	Launch Logs will display students' understanding of the parallels between human body systems and computer systems. Students will demonstrate knowledge of inputs, processors, supporting structures, and outputs in both systems. Conclusion questions can be discussed to help assess student understanding.	4_3_1A Input, Processing, and Output • In this activity students learn about the anatomy of a computer system and its similarities to a human body, including input, processing, and output. Students learn the roles of basic computer hardware components and how they compare to the functions of human organs. • Students watch a video presentation that corresponds to the Biomedical Science Launch module 4_4. Students map the similar functions of parts of the human body to those of the computer: eyes/ears, sense/nerves (input), brain (processor), nerves/muscles (output), mouth (output). • Input, Output, Reaction Time. Students play a game where they measure reaction time as a group by passing a signal around a circle—first from hand to shoulder and then from hand to ankle. This will allow them to see the difference in reaction time when the pathway from shoulder to brain to hand is shorter than the pathway from ankle to brain to hand.	K3, S1, S11
Activity 2 Information Highway	Teacher will discuss content with students and answer their questions. Teacher will check student worksheets. Teacher will observe students' participation in group activity.	Launch Logs will show students' knowledge of data translation into bits and will demonstrate that they can transfer this to similar situations. Conclusion questions can be discussed to help assess student understanding.	4_3_2A Information Highway • In this activity students are introduced to the concept of abstraction and data representation in a computer system. Students learn that all electronic information must be translated to bits of data to be understood by the computer. • Basic information about the Internet is addressed, including privacy, safety, and appropriate behavior.	K1, K4, K7, S12

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Activity 3 Data Collection and Display	Teacher will discuss with students, answer questions, and observe students' participation in group programming.	Teacher will evaluate the end product (Collect-Count-Display program) from each team of students. Launch Log entries will demonstrate students' understanding of the system they built. Conclusion questions can be discussed to help assess student understanding.	4_3_3A Data Collection and Display • In this activity students begin by looking at data sets and considering how the data can be represented in different ways. • Students are introduced to programming using Tynker. Students learn basic programming concepts, including sequencing, repetitions, conditionals, events, functions, and using variables. • Students program an interactive game that collects data and then displays the collected data in a visual representation. • Students learn to break a problem down into subproblems and understand what data needs to be stored so it can be operated on later.	K1, K6, K8, S4, S5, S6, S7, S8, S10
Project 4 Reaction Test	Teacher will discuss with students, answer questions, and observe students' participation in group programming.	Teacher will evaluate the end product (Reaction Test program) from each team of students. Launch Log entries will demonstrate students' understanding of the system they built. Conclusion questions can be discussed to help assess student understanding.	4_3_4P Reaction Test • In this project students will create an interactive app to test the user's alertness, which can help diagnose a concussion. The app specifications are explicitly defined to the students. • Students will use knowledge and skills learned in the previous activities to process events, use variables, functions, repetitions, and conditionals. • Students will walk through the five steps of the design process as they work through their project. • Students will work in groups and collaborate as they brainstorm ideas and plan their designs in their Launch Logs. • The app that the students create in this project can be used to relate to the Biomedical Science Launch module 4_4.	K2, K4, K5, S1, S2, S3, S9, S10

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Problem 5 Brain Fitness	Teacher will discuss with students, answer questions, and observe students' participation in group programming.	Student groups will present their end product (Brain Fitness program). Launch Log entries will demonstrate students' understanding of the system they built. Conclusion questions can be discussed to help assess student understanding.	4_3_5B Brain Fitness • In this problem students will create an interactive app to assess the user's brain function, which can serve as a baseline for concussion testing. There are suggested ideas for the app. However, students choose whether they will use any of the suggestions or create their own idea for the game. • Students will use knowledge and skills learned in the previous activities to process events, use variables, functions, repetitions, and conditionals. • Students will walk through the five steps of the design process as they work through their problem. • Students will work in groups and collaborate as they brainstorm ideas and plan their designs in their Launch Logs. • The app that the students create in this project can be used to relate to the Biomedical Science Launch module 4_4.	K1 , K2, K3, K4, K5, K8, S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11
I/O: Computer Systems Check for Understanding	Teacher reviews the CFU with the students after they have answered the questions.	Check for Understanding Summative Assessment: –Data representation –Computer input, processing, output –Modularization: functions, variables –Control Flow: repetitions, conditionals, events	I/O: Computer Systems Check for Understanding	K3, K6, K8, S5, S6, S7, S8, S9, S12

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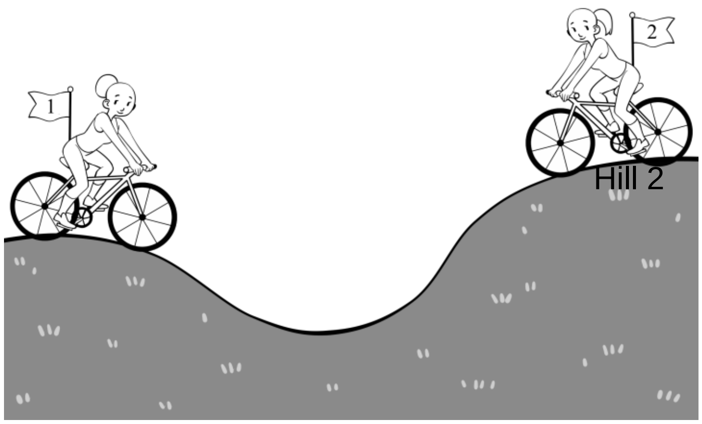
Energy: Collisions
Check for Understanding

1. Use the picture below to help you answer the questions about Maria.

Hill 1



Maria starts at the top of Hill 1 and rolls down it. She then decides to roll down Hill 2, from the top. From which hill will she make it to the bottom with a greater speed—Hill 1 or Hill 2? Circle the answer below.

Hill 1 Hill 2 She will gain the same speed from both hills.

Use your knowledge of energy to explain why Maria will arrive at the bottom with the greater speed from Hill 1 or Hill 2. Make sure to discuss both potential and kinetic energy in your answer.

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2. Which of these pictures show potential energy that can be converted to kinetic energy? Circle all of the examples that apply.

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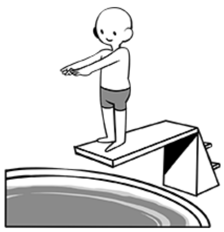
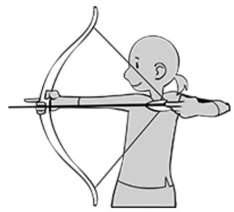
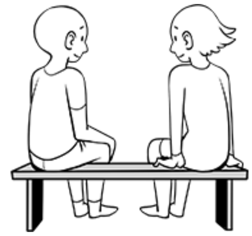


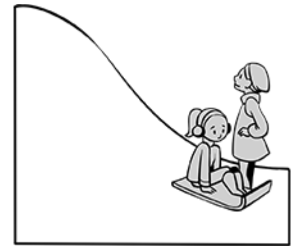
Boy on diving board



Bow and arrow with arrow pulled



People on a bench



Children at the bottom of a sled hill

Choose one picture you circled. Explain how potential energy is shown in the picture and how it will be converted to kinetic energy in that picture.

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3. Draw an arrow that points to where the potential energy is in this picture.

Describe what your arrow is pointing to and how potential energy will be converted to kinetic energy.

4. Explain why a drum gets louder when hit harder. Use the words **<u>collision</u>** and **<u>kinetic energy</u>** in your answer.

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Input/Output: Computer Systems
Check for Understanding

1. Angelina is playing a game on her tablet.
   - She tilts the tablet left and right to move her player on the screen.
   - She taps the player to make it jump and collect coins.
   - Whenever the player collects a coin, the tablet vibrates.
   - When time is up, the tablet makes a buzzer sound.

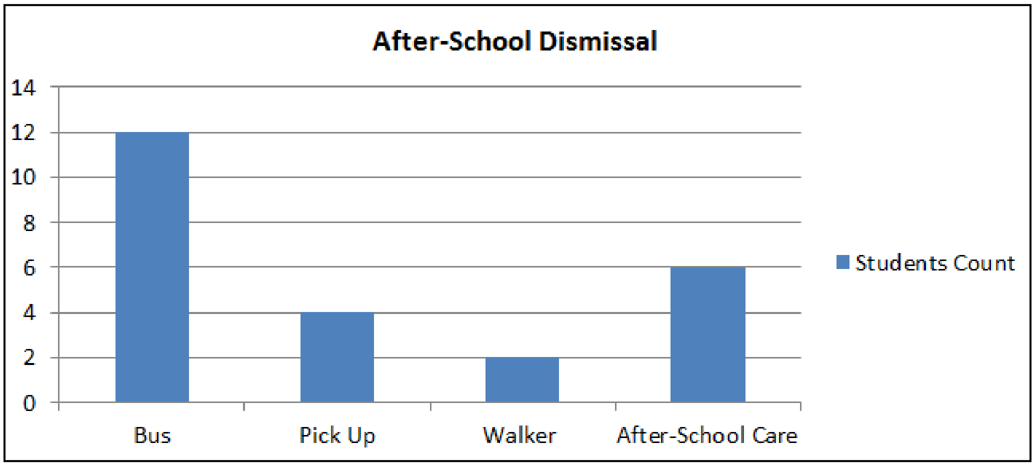
Identify the following as input or output scenarios:

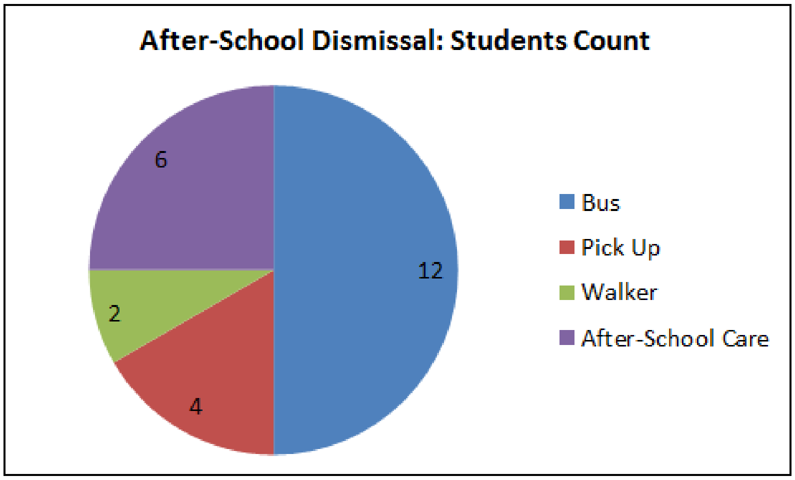
a. Gyroscope for sensing the tilt event INPUT OUTPUT
b. Screen for displaying the game INPUT OUTPUT
c. Tapping the screen INPUT OUTPUT
d. Tablet vibrates INPUT OUTPUT
e. Tablet makes a buzzer sound INPUT OUTPUT

2. Fill in the blanks with the correct word from the box below.
   a. A computer is made of tiny electronic _______________ which can either be charged (On) or uncharged (Off).
   b. A(n) _______________ stores a value of 1 or 0.
   c. Run Length Encoding is a technique used to encode data of a(n) _______________.
   d. A(n) _______________ is made up of 8 bits.

image	byte	bit	transistors

3. Below are two different representations of the same data collected from Mylo's classroom.
   - The number of students who take the bus home (Bus)
   - The number of students who get picked up by car (Pick Up)
   - The number of students who walk home (Walker)
   - The number of students who stay at school for after-school child care (After-School Care)





a. Fill in the table below with the correct counts.

Dismissal Option	Number of Students
Bus	
Pick Up	
Walker	
After-School Care	

b. What information can you draw from the pie chart that is not easily shown in the column chart?

4. Below is the code for the frog prince in a Tynker program.

a. What is the name of the variable being used?

____

b. What is the event that triggers the variable to change?

____

c. How does the value of the variable change?

____

d. Explain what the On Start script does.

____

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Energy: Conversions
Check for Understanding

5. Describe an example from your life in which you watched potential energy change to kinetic energy. What evidence led you to see that potential energy changed to kinetic energy?

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6. In the boxes below, indicate whether the characteristic is a property of energy transfer, energy conversion, or both. Write "X" if it is a characteristic; leave the box blank if it is not a characteristic. One box is already completed for you.

	Energy changes form	Can occur with light energy
Energy Transfer		X
Energy Conversion		

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7. Draw a line to match the form of energy with an example of the energy.

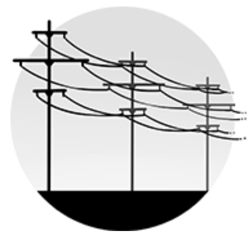
Light

Thermal

Electrical

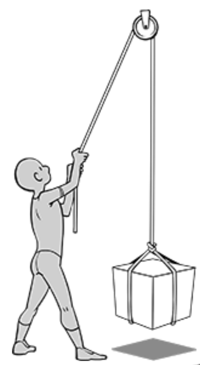
Mechanical

Oven



Power lines

Pulley



Light bulb

8. Use two of the forms of energy from the word bank to make the following statement true (there are many possible answers).

Light	Mechanical
Electrical	Thermal
Chemical	Nuclear

_____________ energy can be converted into ____________ energy.

Give evidence that makes the statement above true.

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9. Use the picture below to answer the question.

The picture above shows a solar panel that is charging a cell phone battery. Explain the energy conversion process shown in this picture.

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Explain what human need or want is being met by the energy conversion in the picture.

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____
____
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