

<b>Grade:</b> 4 <b>Subject:</b> Science	<b>Unit 3: Motion and Design</b>
<b>Big Idea/Rationale</b>	<ul style="list-style-type: none"> <li>• This unit is a Science and Technology for Children (STC) kit developed by the National Science Resources Center at the Smithsonian Institute in Washington, D.C. In Motion and Design, students explore the physics of motion and apply these concepts to technological design. Using plastic construction materials, weights, rubber bands, and propellers, students design and build vehicles. Students record their designs using technical two-view and three-view drawings. They test how fast the vehicles move and use their findings to redesign the vehicles to move more efficiently. Cost analysis is one of the students' design requirements. As students design their vehicles, they intuitively apply concepts such as friction and kinetic and potential energy. They also explore the effect of gravity on motion. The unit concludes by challenging students to solve a design challenge and to present their findings to the class.</li> </ul>
<b>Enduring Understanding (Mastery Objective)</b>	<ul style="list-style-type: none"> <li>• Understand that a force is any push or pull on an object. An unbalanced force is needed to make a resting object move, to bring a moving object to rest, or to change the direction of a moving object.</li> <li>• Know that force can change the speed of an object. Greater forces can change the speed of an object faster than smaller forces.</li> <li>• Understand that friction is a force that occurs when two surfaces rub together. Friction opposes motion</li> <li>• Understand that if the same force is applied to a lighter vehicle and a heavier vehicle will change more than the speed of the heavier vehicle.</li> <li>• Observe that energy can be stored in a rubber band and released to turn an axle or spin a propeller to make a vehicle move.</li> <li>• Observe a spinning propeller exerts a force that pushes air back and moves a vehicle forward</li> <li>• Understand that friction must be considered when a vehicle is being designed.</li> <li>• Observe air resistance is a force that can slow the speed of a moving vehicle</li> <li>• Learn that design requirements specify how a vehicle or other product must perform.</li> <li>• Understand that cost is often an important consideration in designing a product.</li> <li>• Learn about engineers and how they develop, modify and improve designs to meet specific requirements.</li> <li>• Build vehicles from technical two and three -view drawings.</li> <li>• Record vehicle designs through drawings.</li> <li>• Observe how an object moves and describe its motion and changes in motion.</li> <li>• Measure the time it takes a vehicle to move a given distance.</li> </ul>

	<ul style="list-style-type: none"> <li>• Collect and record data and analyze it to determine representative values</li> <li>• Predict the effect of an applied force on how a vehicle travels under various conditions.</li> <li>• Record and compare distance a vehicle travels under various conditions</li> <li>• Design a vehicle that is propelled by a stored energy.</li> <li>• Solve design problems using previously collected data</li> <li>• Communicate results of an investigation through record sheets, written observations, drawings, and class discussions.</li> </ul>
<b>Essential Questions (Instructional Objective)</b>	<ul style="list-style-type: none"> <li>• What are the best tools used to measure and evaluate data?</li> <li>• What are the characteristics of technical drawings?</li> <li>• How does an unbalanced force move a vehicle?</li> <li>• What effect does the weight of an object have upon its movement?</li> <li>• What special features are found on the lunar rover?</li> <li>• How can a rubber band be used to move a plastic vehicle?</li> <li>• What is the relationship between the number of times a rubber band is turned and the distance the plastic vehicle will move?</li> <li>• What is friction?</li> <li>• What role does friction play in vehicular motion?</li> <li>• How does a sail affect the motion of a vehicle?</li> <li>• How does a propeller affect the motion of a vehicle?</li> <li>• How is this movement alike and different from the other vehicles?</li> <li>• What features are not needed to make a vehicle move smoothly and therefore can be removed?</li> <li>• How can the information learned in this unit be used complete a challenge?</li> </ul>
<b>Content (Subject Matter)</b>	<p>Lesson 1 - Designing Vehicles- Getting Started</p> <ul style="list-style-type: none"> <li>• Students will develop strategies and skills for information gathering and problem-solving, using appropriate tools and technologies.</li> </ul> <p>Lesson 2-A - Using Drawings to Record and Build</p> <ul style="list-style-type: none"> <li>• Make a drawing of the vehicle that they built</li> <li>• Build a vehicle by following a 2-view technical drawing</li> </ul> <p>Lesson 2-B - Using Drawings to Record and Build</p> <ul style="list-style-type: none"> <li>• Identify details that are important in technical drawings and compare their drawing to a technical drawing.</li> <li>• Read and learn more about technical design.</li> </ul> <p>Lesson 3 - Pulling a Vehicle: Looking at Force</p> <ul style="list-style-type: none"> <li>• Draw conclusions about the effect of differently weighted strings on the motion of string-pulled vehicles</li> </ul> <p>Lesson 4 - Testing the Motion of Vehicles Carrying a Load</p>

- Investigate the effects of a load on motion.
- Measure the time it takes for a loaded vehicle to move a given distance.
- Discuss and graph the results and observations.

#### Lesson 5 - Designing Vehicles to Meet Requirements

- Design vehicles and a system to pull them.
- Read and learn about specialized vehicle, the Lunar Rover.

#### Lesson 6 - Evaluating Vehicle Design: Looking at Rubber Band Energy

- Attempt to move their vehicles using rubber band energy.
- Discuss and evaluate the design of the vehicle.

#### Lesson 7 - Testing the Effects of Rubber Band Energy

- Predict and investigate how variations in rubber band energy affect the distance the vehicle travels.
- Understand the relationship between the number of turns of the rubber band around the axle and the distance traveled.

#### Lesson 8 - Looking at Friction

- Brainstorm what is known about friction.
- Evaluate specific design features that reduce or increase friction on vehicles propelled by a rubber band.
- Understand the role of friction in vehicular motion.

#### Lesson 9 - Designing and Building a Vehicle with a Sail

- Brainstorm how a sail might affect the motion of an axle-driven vehicle.
- Adapt a vehicle to hold a cardboard sail and make observations about the influence of a sail on a vehicles motion.
- Reflect upon their work.

#### Lesson 10 - Testing the Effects of Air Resistance on a Vehicle's Motion

- Test how air resistance influences a vehicles motion.
- Discuss and compare the results to real-world objects designed to minimize air resistance.
- Read a selection to learn more about racing vehicles that are designed to minimize air resistance and a woman who was a pioneer in drag racing.

#### Lesson 11 - Building a Propeller-Driven Machine

- Understand how a propeller affects motion and design.

#### Lesson 12 - Analyzing the Motion and Design of Propeller-Driven Vehicles

- Discuss the motion and design of their vehicles and compare these features to those built previously built vehicles.
- Propose design changes for their vehicles.

	<p>Lesson 13A - Looking at Cost</p> <ul style="list-style-type: none"> <li>• Determine the cost for their vehicle.</li> </ul> <p>Lesson 13 B - Looking at Cost</p> <ul style="list-style-type: none"> <li>• Modify their vehicles to reduce the cost and evaluate the strength and performance of their vehicles.</li> <li>• Discuss trade- offs involving costs, performance, and appearance.</li> </ul> <p>Lesson14 - Planning Our Final Design Challenge</p> <ul style="list-style-type: none"> <li>• Review the roles appropriate for working in groups.</li> <li>• As team members, independently record and collectively brain storm possible solutions to a challenge; then select one solution to carry out.</li> <li>• Present their plans to the class for feedback.</li> <li>• Learn more about engineering as an interesting career by reading a selection</li> </ul> <p>Lesson15 - Refining our Design</p> <ul style="list-style-type: none"> <li>• Change any design plans needed to complete challenge.</li> </ul>
<p><b>Skills/ Benchmarks (CCSS Standards)</b></p>	<ul style="list-style-type: none"> <li>• <b>5.1.4.A.1:</b> Demonstrate understanding of the interrelationships among fundamental concepts in the physical, life, and Earth systems sciences.</li> <li>• <b>5.1.4.A.2:</b> Use outcomes of investigations to build and refine questions, models, and explanations</li> <li>• <b>5.1.4.A.3:</b> Use scientific facts, measurements, observations, and patterns in nature to build and critique scientific arguments.</li> <li>• <b>5.1.4.B.2:</b> Measure, gather, evaluate, and share evidence using tools and technologies.</li> <li>• <b>5.1.4.B.3:</b> Formulate explanations from evidence.</li> <li>• <b>5.1.4.C.1:</b> Monitor and reflect on one’s own knowledge regarding how ideas change over time.</li> <li>• <b>5.1.4.C.2:</b> Revise predictions or explanations on the basis of learning new information.</li> <li>• <b>5.1.4.C.3:</b> Present evidence to interpret and/or predict cause-and-effect outcomes of investigations.</li> <li>• <b>5.1.4.D.1:</b> Actively participate in discussions about student data, questions, and understandings.</li> <li>• <b>5.1.4.D.2:</b> Work collaboratively to pose, refine, and evaluate questions, investigations, models, and theories.</li> <li>• <b>5.1.4.D.3:</b> Demonstrate how to safely use tools, instruments, and supplies.</li> <li>• <b>5.2.4.C.3:</b> Draw and label diagrams showing several ways that energy can be transferred from one place to another.</li> <li>• <b>5.2.4.E.1:</b> Demonstrate through modeling that motion is a change in position over a period of time.</li> <li>• <b>5.2.4.E.2:</b> Identify the force that starts something moving or changes its</li> </ul>

	<p>speed or direction of motion.</p> <ul style="list-style-type: none"><li>• <b>5.2.4.E.4:</b> Investigate, construct, and generalize rules for the effect that force of gravity has on balls of different sizes and weights.</li></ul>
<b>Materials and Resources</b>	<ul style="list-style-type: none"><li>• Motion and Design - Science and Technology for Students (STC), National Science Resources Center, Washington, D.C. 1997</li><li>• Student activity pages, quizzes</li></ul>
<b>Notes</b>	