

	Work Stations	Pinning It!	Ramp Race
Student Experience	Students rotate around the stations writing observations and explanations of how each station relates to work and what they think the components of work are.	Students try to drive a push-pin into a wooden block by dropping a ping-pong ball and a golf ball on the pin. Students identify the factors that go into potential energy.	Students construct two ramps; both start from the same height and end rolling flat on the ground or table. Students “race” marbles down the ramps and figure out how to determine the velocity of the marbles at the bottoms of ramps. Students compare final velocities and try to interpret why they are relatively the same.
T4T Material	Teacher’s choice: block of wood, string, cart, ramp, weight, pulley, heavy object	For each group: 1 golf ball, 1 ping-pong ball, 1 push pin, 1 wooden block.	For each group: 4 blinds, two 4-inch tubes, two 10-inch tubes.
Big Idea	If work is to be done, a force is needed. If an object is forced to move, it takes more work to move it further. $W = F\Delta x$	$PE = mgh$ $\Delta PE = W$ It takes work to lift an object. Once it is lifted it has potential energy. That potential energy can be used to do work.	Marbles may take different amounts of time to reach the bottom but their final velocities are relatively the same. Conservation of Energy $\Delta PE = \Delta KE$
Connection to Culminating Activity	Work is a central concept for the culminating activity.	By placing objects in strategic positions, they can store potential energy for later use.	Mechanical energy is conserved
CA Standards	IE1. d	PH2. b and c; IE1. d, j	PH2. c; IE1. b, c, j
Next Gen Sci Standards	HS-PS3-1 Asking questions and defining problems. Constructing explanations and designing solutions.	HS-PS3-2 Asking questions and defining problems. Constructing explanations and designing solutions.	HS-PS3-2 Asking questions and defining problems. Analyzing and interpreting data. Constructing explanations and designing solutions.
Time	One 55 min period	One 55 min period	Two 55 min periods

Physics – Conservation of Energy – The Chain Reaction Recycling Machine

These lessons are not intended to be a complete unit, but, rather a learning activity guide for concept attainment. Teachers should supplement these lessons with appropriate reading material and problem sets.

	Energy of Motion	Simple Machines and Other Concepts	The Chain Reaction Recycling Machine
Student Experience	<p>Students use one of the ramps from Ramp Race to investigate the connection between height of the ramp and velocity of the ball at the bottom of the ramp.</p> <p>Students collect data and investigate the relationship between PE and KE for the ball on the ramp and model the equation for the KE.</p> <p>$KE = \frac{1}{2} mv^2$</p>	<p>Students rotate through stations and play/look at simple machines and other concepts.</p> <p>They describe what they do.</p> <p>They try to imagine how each could help to connect their ramp to someone else's ramp.</p> <p>They draw a sketch of how they plan to connect their ramp to someone else's ramp.</p>	<p>Students connect all other ramps to make a whole-class chain reaction machine. The last ramp places a plastic bottle in the plastic recycling bin and a wad of paper in the paper recycling bin.</p> <p>Students determine potential energy, kinetic energy, work done by friction on their ramp, work done to start the next ramp.</p>
T4T Material	One ramp from "Ramp Race" and height adjusters (books, other tubes, etc.)	Simple Machines Stations	The Cart
Big Idea	$KE = \frac{1}{2} mv^2$	Simple machines get work done. They can be used to make connections in the chain reaction (Rube Goldberg) machine.	<p>Energy can transfer from one form to another.</p> <p>Work done by friction can be calculated by using the ideas of conservation of energy.</p>
Connection to Culminating Activity	Mechanical energy is conserved. KE can be determined by measuring mass and velocity.	Simple machines are inspirations for connecting the ramps.	-----
CA Standards	PH2. a	none	PH2. a, b, c
Next Gen Sci Standards	<p>HS-PS3-1 Asking questions and defining problems. Analyzing and interpreting data. Constructing explanations and designing solutions.</p>	<p>Asking questions and defining problems. Constructing explanations and designing solutions.</p>	<p>HS-PS3-3 Asking questions and defining problems. Analyzing and interpreting data. Constructing explanations and designing solutions.</p>
Time	One 55 min period	One 55 min period	1 week