



Physics - Unit 5 - Work and Energy

Unit Focus

Students will explore three different types of mechanical energy: kinetic energy, potential gravitational energy, and potential elastic/spring energy as well as conservation of energy, the work-energy theorem and power. Students will begin with analyzing the three common types of mechanical energy (kinetic, potential gravitational, and potential elastic). They will analyze transformation between these types of energy to uncover the conservation of energy theorem. They will continue with analyzing the transformation of work into energy and energy into work in order to uncover the work-energy theorem. Students will also explore the six types of simple machines and their advantages and disadvantages and uncover how to calculate actual mechanical advantage, ideal mechanical advantage and efficiency. They will uncover that the rate the energy transfers is called power. The unit will also include a focus on the change in motion of two objects in a collision or an explosion. Students will connect these ideas to safety features in automobiles (seat belts, air bags, crumple zones). Students will be able to describe how these safety features result in a smaller force on the passengers in a vehicle. As a part of this unit, students will also spend time looking at the importance of units and unit conversions in calculations and understanding of what units and numbers really mean. The unit lasts approximately 3.5 weeks, spending around 2 weeks on Work and Energy and 1.5 weeks on Momentum.

Stage 1: Desired Results - Key Understandings

Standard(s)	Transfer	
Next Generation Science Standards Performance Expectations: High School Physical Sciences - Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system. (HS-PS2-2) - Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects). (HSPS3-2) - Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. (HS-PS3-3) Next Generation Science Standards (DCI) Science: 10 - Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. (PS2.9.A2) - If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (PS2.9.A3) - Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single	<i>Students will be able to independently use their learning to...</i> T1 Create models to explore complex systems, show mastery of key science concepts, and/or develop solutions through creation of a product open to testing and redesign.	
	Meaning	
	Understanding(s)	Essential Question(s)
	<i>Students will understand that...</i> U1 Each form of energy can be converted into other forms of energy or into work (e.g. kinetic to potential, mechanical to electrical). U2 While energy within a system is continually changing forms, and being transferred, the total energy of the system is conserved. U3 When the energy of one system changes, the energy of the other system must also change but the total energy must remain constant. U4 The faster a given object is moving, the more energy it possesses.	<i>Students will keep considering...</i> Q1 Where does the energy of a system come from? How does it change? Where does it go? Q2 How can I thoughtfully improve my design based on my data? Q3 How can we make cars and driving safer?

Stage 1: Desired Results - Key Understandings

quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (PS3.9.A2) • Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (PS3.9.B1) • Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (PS3.9.B2)	U5 Each form of energy can be converted into other forms of energy or into work (e.g. kinetic to potential, mechanical to electrical). U6 When two objects within a system collide the total momentum within the system is conserved. U7 Energy can be transferred from object to object through collision.	
Madison Public Schools Profile of a Graduate • Design: Engaging in a process to refine a product for an intended audience and purpose. (POG.2.2) • Collective Intelligence: Working respectfully and responsibly with others, exchanging and evaluating ideas to achieve a common objective. (POG.3.1)	Acquisition of Knowledge and Skill	
	Knowledge	Skill(s)
	<i>Students will know...</i> K1 kinetic energy is the energy of motion K2 potential energy is stored energy and can be chemical, nuclear, elastic or gravitational K3 kinetic and potential together are the mechanical energy of an object K4 the total energy of an object is conserved if only conservative forces act on the object K5 non conservative forces can remove mechanical energy from an object and convert it to heat K6 in order to change the energy of an object, work must be done on the object K7 work can be positive or negative ; it can add or remove mechanical energy of an object K8 power is work per unit time and has a unit of Watts K9 momentum is conserved in collisions and explosions K10 in order to change the momentum of an object, a net force is applied K11 the change in momentum of an object equals the applied net force times the time the force is applied	<i>Students will be skilled at...</i> S1 calculate gravitational potential energy, elastic potential energy and kinetic energy of an object S2 use the conservation of energy to solve problems S3 use the work energy theory to analyze objects that have friction acting on them S4 apply kinematics and force principles to predict the motion of objects involving transfer of energy S5 use conservation of momentum to predict motion of objects involved in collisions and explosions.