Madison Public Schools

Conceptual Physics - Unit 2 - Energy and Momentum Conservation

Unit Focus

Students will explore how energy is converted from one form to another, and how energy can be transformed into useful work, as mechanical and electrical. Students will investigate how energy and momentum are related to one another, particularly in cars and car crashes. Ultimately, students will apply their understanding and skills to design novel approaches to safety devices that can be used to protect people. Students will be required to apply mathematical and graphical analysis to their data as they interpret and communicate their results.

Stage 1: Desired Results - Key Understandings

Standard(s)

Next Generation Science
High School Physical Sciences: 9 - 12

- 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*
- Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. *HS-PS2-3*
- Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. *HS-PS3-1*
- 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). *HS-PS3-2*

Next Generation Science Standards (DCI)
Science: 9

- 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*
- "Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents. *PS3.9.A1*
- At the macroscopic scale, energy manifests itself in multiple

Transfer

T1 Make observations and ask questions to define a problem based on prior knowledge and curiosity that stimulates further exploration, analysis, and discovery.
T2 Analyze qualitative and quantitative data to interpret patterns, draw conclusions, and/or make predictions.

Meaning

Understanding(s)	Essential Question(s)
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.	**Q1** Where does the energy of a system come from? How does it change? Where does it go? **Q2** What happens when objects collide? **Q3** How can the force an object experiences in a collision be reduced?

Acquisition of Knowledge and Skill

Knowledge	Skill(s)
K1 Total energy is conserved in a closed system; energy is converted from one form to another **K2** Momentum is conserved in a collision **K3** Increasing the time of a collision decreases the average force and maximum force on an object during the collision **K4** Kinetic energy increases with the square of the velocity **K5** A force can do work on an object to change its energy (W = F x d)	**S1** Calculating potential and kinetic energy for an object **S2** Calculating the force on an object in a collision **S3** Describing the result of a collision of 2 cars moving at different speeds

Stage 1: Desired Results - Key Understandings		
ways, such as in motion, sound, light, and thermal energy. *PS3.9.A3* • 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* • Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g., relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. *PS3.9.B3* • Although energy cannot be destroyed, it can be converted to less useful forms-for example, to thermal energy in the surrounding environment. *PS3.9.D1* **Student Growth and Development 21st Century Capacities Matrix** *Critical Thinking* • Synthesizing: Students will be able to thoughtfully combine information/data/evidence, concepts, texts, and disciplines to draw conclusions, create solutions, and/or verify generalizations for a given purpose. *MM.1.3* *Creative Thinking* • Innovation: Students will be able to take an existing solution or object in order to consider limitations and possible transformations. *MM.2.1*	**K6** Heat is a form of energy	