Curriculum Units and Learning Outcomes

Content Area: Intro to Physics	**Grade Level: 9**
Unit Title: Energy	

Unit Summary:
This unit introduces many forms of energy: the energy things have because they are moving, because of where they are or because of what they're like inside. All forms of energy, whether microscopic or macroscopic, are classified either due to relative location or due to motion. The Law of Conservation of Energy is applied qualitatively and quantitatively to mechanical systems through the use of a mathematical formula, bar graphs and diagrams, with particular focus on roller coasters, pendulums and masses on springs and simple machines. Students use the formula, graphs and diagrams to solve problems such as finding the speed, KE and PE of an object. Applications to problems concerning free fall are also considered.

Massachusetts Standards:

- HS-PS3-1. Use algebraic expressions and the principle of energy conservation to calculate the change in energy of one component of a system when the change in energy of the other component(s) of the system, as well as the total energy of the system including any energy entering or leaving the system, is known. Identify any transformations from one form of energy to another, including thermal, kinetic, gravitational, magnetic, or electrical energy, in the system.
    - Clarification Statement: Systems should be limited to two or three components and to thermal energy; kinetic energy; or the energies in gravitational, magnetic, or electric fields.
- HS-PS3-2. Develop and use a model to illustrate that energy at the macroscopic scale can be accounted for as either motions of particles and objects or energy stored in fields.
    - Clarification Statements: Examples of phenomena at the macroscopic scale could include evaporation and condensation, the conversion of kinetic energy to thermal energy, the gravitational potential energy stored due to position of an object above the earth, and the stored energy (electrical potential) of a charged object's position within an electrical field. Examples of models could include diagrams, drawings, descriptions, and computer simulations

Enduring Understandings: Students will understand that:

- Energy is conserved for an isolated system
- Energy is stored in the motion of objects or particles [kinetic]; in the arrangement of objects or particles in a field [potential]
- Energy is transferred into and out of a system in three ways: working [force applied over distance], heating [particle level collisions] and radiating [light & electromagnetic waves]
- Energy storage and transfer can be represented using bar graphs, pie charts, and mathematical formula
- Energy is present everywhere, helps us solve problems and engineer solutions
- A machine is a device used to multiply forces or simply to change the direction of forces. The concept that underlies every machine is the conservation of energy. A machine cannot put out more energy than is put into it.

Essential Questions:

- What is energy & how can its presence be recognized?
- What is meant by a 'system'?
- How does Conservation of Energy affect daily life?
- What changes in energy occur when mechanical work is done?
- What changes in energy occur when waves like light/electromagnetic waves are involved?
- What changes in energy occur when heat is produced?
- How are changes in energy applicable to our daily lives?

Students will demonstrate KNOWLEDGE of:	**Students will be SKILLED at**:
● The energy stored due to macroscopic or microscopic objects' location in a field [gravitational and electric potential energy]; and the energy stored in the form of motion [kinetic energy for particles in gas or a lamborghini] ● Three means of Energy Transfer:	● Identifying two ways energy is stored [1. motion of objects or particles 2. location and arrangement of particles. ● Describing the three ways that energy is transferred [force applied through distance [working, W], particle level collisions [heating, Q] and in waves [radiating, R].

○ HEAT: When there is an exchange of energy with the environment because of the movement and collision of objects (or microscopic particles) energy is transferred by heating [Q], and the temperature changes. ○ RADIATION: When there is an exchange of energy with the environment due to radiating waves [R], the light intensity and color of the object changes or the pitch of sound changes ○ WORK: When there is a change in the location or motion of an object, there is an exchange of energy due to working [W]	● Representing changes in internal energy storage and processes of energy transfer. ● Identifying the components of a system and recognizing when a system is isolated or not. ● Utilizing the law of conservation of energy to solve conceptually and mathematically based word problems. ● Building a device that transforms the manner in which energy is stored in the system.

Estimated Duration: 5 - 6 weeks