Unit 2: Forces and Energy

Content Area: **Science**
Course(s): **Science**
Time Period: **Marking Period 1**
Length: **6-8 Weeks**
Status: **Published**

Unit Overview

This unit helps students develop an understanding of important qualitative ideas about energy, including that the interactions of objects can be explained and predicted using the concept of transfer of energy from one object or system of objects to another and that the total change of energy in any system is always equal to the total energy transferred into or out of the system. Students understand that moving objects have kinetic energy and that objects may also contain stored (potential) energy, depending on their relative positions. Students will also come to know the difference between energy and temperature and begin to develop an understanding of the relationship between force and energy.

Performance Expectations

MS-PS2-1	Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.
MS-PS2-2	Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
MS-PS2-4	Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.
MS-PS3-1	Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

Three Dimensions

Science and Engineering Practices

Planning and Carrying Out Investigations

Asking questions and defining problems in 6-8 builds from K-5 experiences and progresses to specifying relationships between variables and clarifying arguments and models.

- Plan an investigation individually and collaboratively and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to

support a claim. (MS-PS2-2)

Analyzing and Interpreting Data

Analyzing data in 6-8 builds on K-5 and preogresses to extending quantitative analysis to investigations, distinguishing between correlation and basic statistical techniques of data and error analysis.

- Construct and interpret graphical displays of data to identify linear and non-linear relationships. (MS-PS3-1)

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 6-8 builds on K-5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- Apply scientific ideas or principles to design an object, tool, process, or system. (MS-PS2-1)

Engaging in Argument from Evidence

Engaging in argument from evidence in 6-8 builds from K-5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).

- Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenonmenon or a solution to a problem. (MS-PS2-4)

Connections to Nature of Science

Scientific Knowledge Is Based on Empirical Evidence

- Scientific knowledge is based on logical and conceptual connections between evidence and explanations. (MS-PS2-2), (MS-PS2-4)

Disciplinary Core Ideas

PS2.A: Forces and Motion

- For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, ut in the opposite direction (Newton's Third Law). (MS-PS2-1)
- The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. (MS-PS2-2)
- All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame adn arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. (MS-PS2-2)

PS2.B: Types of Interactions

- Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass (e.g., Earth and the sun). (MS-PS2-4)

PS3.A: Definintions of Energy

- Motion energy is probably called kinetic energy; it is proportional to the mass of the moving object and grows the square of its speed. (MS-PS3-1)

Crosscutting Concepts

Systems and System Models

- Models can be used to represent systems and their interactions - such as inputs, processes, and outputs-

and energy and matter flows within systems. (MS-PS-2-1), (MS-PS2-4)

Stability and Change

- Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales. (MS-PS2-2)

Scale, Proportion, and Quantity

- Proportional relationships (e.g., speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. (MS-PS3-1)

Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology of Society and the Natural World

- The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (MS-PS2-1)

Knowledge, Skills, and Assessment

Essential Insights and Understandings/Guiding Questions	Critical Knowledge and Skills	
How do you describe the motion of an object?	An object is in motion if it changes position relative to a reference point. **Skill: SWBAT...** • **Determine when an object is in motion.**	**A** M in w

To calculate the speed of an object, divide the distance the object travels by the amount of time it takes to travel the distance. When you know both speed and direction of an object's motion, you know the velocity of an object. You can show the motion of an object on a line graph in which you plot distance versus time.

Skill: SWBAT...

- **Calculate an object's speed.**
- **Describe what velocity is.**
- **Demonstrate how to graph motion.**

In science, acceleration refers to increasing speed, decreasing speed, or changing direction. You can use both a speed-versus-time graph and a distance-versus-time graph to analyze the motion of an accelerating object.

Skill: SWBAT...

- **Describe the motion of an object as it accelerates.**
- **Demonstrate how to graph acceleration.**

How do objects react to forces?

Like velocity and acceleration, a force is described by its strength and by the direction in which it acts. A nonzero net force causes a change in the object's motion.

Skill: SWBAT...

- **Evaluate how strength and direction impact force.**
- **Describe how balanced and unbalanced forces are related to an object's motion.**

Two factors that affect the force of friction are the types of surfaces involved and how hard the surfaces are pushed together. Two factors affect the gravitational attraction between objects: their masses and distance.

Skill: SWBAT...

- **Describe friction and identify factors that determine the friction between two objects.**
- **Identify the factors that affect the gravitational force between two objects.**

	Newton's First Law of Motion states: objects at rest will remain at rest and objects moving at a constant velocity will continue moving at a constant velocity unless they are acted upon by nonzero net forces. Newton's Second Law of Motion states: the acceleration of an object depends on its mass and on the net force acting on it. Newton's Third Law of Motion states, if one object exerts a force on another object, then the second object exerts a force of equal strength in the opposite direction on the first object. **Skill: SWBAT...** • **Demonstrate Newton's First Law of Motion.** • **Demonstrate Newton's Second Law of Motion.** • **Demonstrate Newton's Third Law of Motion.** Free fall is motion where the acceleration is caused by gravity. Satellites in orbit around Earth continuously fall toward Earth, but because Earth is curved they travel around it. **Skill: SWBAT...** • **Describe the motion of an object during free fall.** • **Describe the factors that keep objects in orbit around Earth.**	**A** ar co ac
How is energy conserved in a transformation?	Since the transfer of energy is work, then power is the rate at which energy is transferred, or the amount of energy transferred in a unit of time. The two basic types of energy are kinetic energy and potential energy. **Skill: SWBAT...** • **Explain how energy, work, and power are related.** • **Compare and contrast the two basic types of energy.** You can find an object's mechanical energy by adding together the object's kinetic energy and potential energy. Forms of energy associated with the particles of objects include nuclear energy, thermal energy, electrical energy, electromagnetic energy, and chemical energy. **Skill: SWBAT...** • **Explain how to determine an object's mechanical energy.**	**A** U m m pr **A** C gr he th **A** L co

- **Describe other forms of energy.**

All forms of energy can be transformed into other forms of energy.
According to the law of conservation of energy, energy cannot be created or destroyed.

Skill: SWBAT...

- **Explain how different forms of energy are related.**
- **Demonstrate the law of conservation of energy.**

Suggested Resources

www.ck12.org

Speed and Velocity

- http://www.ck12.org/section/Speed-and-Velocity-%3A%3Aof%3A%3A-Motion-%3A%3Aof%3A%3A-CK-12-Physical-Science-For-Middle-School/

Acceleration

- http://www.ck12.org/physics/Acceleration/

Forces

- http://www.ck12.org/physics/Types-of-Forces/

Combining Forces

- http://www.ck12.org/physical-science/Combining-Forces-in-Physical-Science/

Friction

- http://www.ck12.org/physics/Friction/

Gravity

- http://www.ck12.org/physics/Gravity/

Newton's First Law of Motion

- http://www.ck12.org/physics/Newtons-First-Law/

Newton's Second Law of Motion

- http://www.ck12.org/physics/Newtons-Second-Law/

Newton's Third Law of Motion

- http://www.ck12.org/physics/Newtons-Third-Law/

Free Fall

- http://www.ck12.org/physics/Free-Fall/

Circular Motion

- http://www.ck12.org/physics/Circular-Motion/

Kinetic Energy

- http://www.ck12.org/physics/Kinetic-Energy/

Potential Energy

- http://www.ck12.org/physics/Potential-Energy/

Law of Conservation of Energy

- http://www.ck12.org/na/Power-Law-of-Conservation-of-Energy-1/lesson/Law-of-Conservation-of-Energy-xi-physics/

Technology Integration

ck12 Flexbook

Chromebooks

iPads

Cellular Devices

Internet

SmartBoard

Differentiation

Differentiation for special education:

- General modifications may include:
    - Modifications & accommodations as listed in the student's IEP
    - Assign a peer to help keep student on task
    - Modified or reduced assignments
    - Reduce length of assignment for different mode of delivery
    - Increase one-to-one time
    - Working contract between you and student at risk
    - Prioritize tasks
    - Think in concrete terms and provide hands-on-tasks
    - Position student near helping peer or have quick access to teacher
    - Anticipate where needs will be
    - Break tests down in smaller increments
- Content specific modifications may include
    - address misconceptions relating to forces and motion
    - pre-generated graphs
    - mathematical formulas provided
    - teach with visuals
    - scale models
    - lab demonstrations

Differentiation for ELL's:

- General modifications may include:
    - Strategy groups
    - Teacher conferences
    - Graphic organizers
    - Modification plan
    - Collaboration with ELL Teacher
- Content specific vocabulary important for ELL students to understand include: motion, International System of Units, distance, speed, average speed, instantaneous speed, velocity, slope, acceleration, force, newton, net force, friction, sliding friction, static friction, fluid friction, rolling friction, gravity, mass, weight, inertia, free fall, satellite, centripetal force, energy, kinetic energy, potential energy, gravitational potential energy, elastic potential energy, mechanical energy energy, nuclear energy, thermal energy electrical energy, electromagnetic energy, chemical energy, energy transformation, law of conservation of energy

Differentiation to extend learning for gifted students may include:

- **SI Units** Investigate other units that are smaller than a meter, such as nanometers, picometers, and femtometers then order the results on a number line and describe items that are measured using these small units.
- **Space Shuttle's Speed** In the first two minutes after blastoff, the space shuttle travels about 3 kilometers. By the end of 8 min, it is covering about 8 kilometers per minute. Given this information, students will find the average speed for the first 2 minutes of flight and the instantaneous speed at the end of 8 minutes, both in units of kilometers per hour.
- **The Subatomic World** Research the motion of subatomic particles, what happens in linear accelerators and supercolliders, and the speeds of the small particles.
- **Acceleration of the Space Shuttle** On liftoff, the space shuttle goes from zero to 28,200 km/h in 8

minutes. Students will calculate the acceleration in kilometers per minute per minute and write a description of what it means.

- **Bicycle Racers** Students will determine how bicycle racers adjust their position and select their clothing to reduct friction and research the aerodynamics of racing bicycles.
- **Information Literacy** Research Galileo's work on the acceleration of falling objects.
- **Plant Response to Gravity** Research how plants respond to gravity, focusing on the term *gravitropism*.
- **Write World Problems** Create a word problem involving the relationships among force, mass, and acceleration.
- **Design a Rocket** Design a balloon rocket to illustrate Newton's third law of motion, identifying the action and reaction forces.
- **Persuasive Writing** Research the use of nuclear fission to produce electrical energy for consumers, create a list of the advantages and disadvantages of this source of energy, then write a persuasive paragraph arguing for or against the use of nuclear fission reactors.
- **Energy in Food** The chemical energy stored in food is generally measured in kilocalories (1 kilocalorie = 1,000 calories). Students will find out ways their body uses calories and in what form the body stores calories that it does not need.
- **Research Pendulums** Research the motion of pendulums to find out why all pendulums eventually slow to a stop unless there is energy input.
- **Energy and Matter** Research how the law of conservation of energy had to be adjusted after Einstein published his theory of special relatively in 1905.

21st Century Skills

CRP.K-12.CRP1	Act as a responsible and contributing citizen and employee.
CRP.K-12.CRP2	Apply appropriate academic and technical skills.
CRP.K-12.CRP4	Communicate clearly and effectively and with reason.
CRP.K-12.CRP6	Demonstrate creativity and innovation.
CRP.K-12.CRP7	Employ valid and reliable research strategies.
CRP.K-12.CRP8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP.K-12.CRP9	Model integrity, ethical leadership and effective management.
CRP.K-12.CRP11	Use technology to enhance productivity.
CRP.K-12.CRP12	Work productively in teams while using cultural global competence.