04: Energy, Momentum and Torque

Content Area: **Science**
Course(s): **Physics**
Time Period: **February**
Length: **25 days**
Status: **Published**

Unit Overview:

The purpose of this unit is to give students new ways of looking at the motion of objects. Students will learn the principles of energy and momentum conservation and how these can be used to determine future behaviour of objects. Students will also see how the position of a force can cause an object to to rotate about a pivot point.

Enduring Understandings:

- Energy cannot be created not destroyed, only change forms
- Impulse is the momentum added to an object
- Momentum in a system is conserved
- Momentum measures how hard it is to stop a moving object
- Power is the rate at which energy is added to an object
- Torque measures a force's ability to cause rotation
- When Torques in opposing directions are equal the object will be in equilibrium
- Work is the energy that has been added to an object

Essential Questions:

- What are some physical properties of an object's motion that can be conserved?
- What are some ways we can simplify the study of motion?

Standards/Indicators/Student Learning Objectives (SLOs):

- SWBAT calculate the total energy of a system and show that energy is conserved.
- SWBAT calculate the various types of energy an object may have
- SWBAT define and calculate power.
- SWBAT define and calculate the momentum of an object
- SWBAT define Impulse and explain it's relationship to the change in momentum
- SWBAT define torque and calculate it for various unique situations
- SWBAT identify the relationship between the work done to an object and the energy added
- SWBAT show that when torques in opposing directions are equal, the object is in equilibrium

- SWBAT that the total momentum of all objects before a collision must be conserved after the collision

9-12.HS-PS3-1	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.
9-12.HS-PS2-2	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.
9-12.HS-PS1-3.1.1	students observe patterns in systems at different scales and cite patterns as empirical evidence for causality in supporting their explanations of phenomena. They recognize classifications or explanations used at one scale may not be useful or need revision using a different scale; thus requiring improved investigations and experiments. They use mathematical representations to identify certain patterns and analyze patterns of performance in order to reengineer and improve a designed system.
9-12.HS-PS1-4.2.1	Develop a model based on evidence to illustrate the relationships between systems or between components of a system.
9-12.HS-PS2-3.2.1	Systems can be designed to cause a desired effect.
9-12.HS-PS2-5.3.1	Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.
9-12.HS-PS3-1.4.1	Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.
9-12.HS-PS1-7.5.1	students learn that the total amount of energy and matter in closed systems is conserved. They can describe changes of energy and matter in a system in terms of energy and matter flows into, out of, and within that system. They also learn that energy cannot be created or destroyed. It only moves between one place and another place, between objects and/or fields, or between systems. Energy drives the cycling of matter within and between systems. In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.
9-12.HS-PS2-3.6.1	Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects.
9-12.HS-PS2-6.8.1	Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).
9-12.HS-PS2-3.PS2.A.1	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.
9-12.HS-PS2-2.PS2.A.1	Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object.
9-12.HS-PS2-2.PS2.A.2	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.
9-12.HS-PS3-1.PS3.A.1	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 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.
9-12.HS-PS3-1.PS3.B.1	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.
9-12.HS-PS3-1.PS3.B.2	Energy cannot be created or destroyed, but it can be transported from one place to

	another and transferred between systems.
9-12.HS-PS3-1.PS3.B.3	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.

Lesson Titles:

- Conservation of Energy
- Conservation of Momentum
- Momentum and Impulse
- Rotational Equilibrium
- Torque
- Types of Energy
- Work, Energy and Power

Career Readiness, Life Literacies & Key Skills

WRK.K-12.P.1	Act as a responsible and contributing community members and employee.
WRK.K-12.P.4	Demonstrate creativity and innovation.
WRK.K-12.P.5	Utilize critical thinking to make sense of problems and persevere in solving them.
WRK.K-12.P.8	Use technology to enhance productivity increase collaboration and communicate effectively.
WRK.K-12.P.9	Work productively in teams while using cultural/global competence.

Inter-Disciplinary Connections:

LA.RH.11-12.7	Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, qualitatively, as well as in words) in order to address a question or solve a problem.
LA.RST.11-12.9	Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
LA.RST.11-12.10	By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.
LA.WHST.11-12.1.A	Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.
LA.WHST.11-12.1.B	Develop claim(s) and counterclaims using sound reasoning and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.
LA.WHST.11-12.1.C	Use transitions (e.g., words, phrases, clauses) to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons

	and evidence, and between claim(s) and counterclaims.
LA.WHST.11-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
LA.WHST.11-12.2.E	Provide a concluding paragraph or section that supports the argument presented.
LA.WHST.11-12.10	Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Instructional Strategies/Learning Activities and Levels of Blooms/DOK:

- Class Work: Practice Momentum Problems: Some problems involving conservation of momentum for students to work on in class.
- Classwork; Energy Conservation Video Problems. In this activity you will use the ideas of energy and energy conservation to answer a series of questions about different real life events.
- Classwork: Learning Form. A guided activity to illuminate the key points about impulse.
- Classwork: Learning Form. A guided activity to illuminate the key points about momentum.
- Classwork: Practice Problems. A few problems you can try to make sure you can do things with torque and rotational equilibrium. (Answer Key)
- Homework: Balancing Game. A game that will help you develop an intuitive sense of torque and how to balance torques.
- Homework: Torque Game. Pick the wrench with the most torque.
- Homework: Torque Problem Generator. Get your unique homework problem.
- Lab Activity: Amusement Park Physics. In this activity you will be using the ideas you have learned about energy conservation and circular motion to solve problems about the rides at Great Adventure.
- Lab Activity: Energy Loss on a Bounce. In this activity you will be looking at the energy loss that occurs each time a ball bounces.
- Lab Activity: Energy Transformations. In this activity you will be looking at some of the connections between variables during an energy transformation.
- Lab Activity: Momentum Lab: In this lab you will be looking at changes in momentum that occur in various types of collisions.
- Lab Activity: Physics in the Weight Room. Some practice problems dealing with the equipment found in Delsea's weight room.
- Lab Activity: Video Energy Lab. In this activity you will be using the ideas you have learned about energy to discover some major new ideas on energy
- Lab Activity: Scale Lab. In this activity you will be examining the principle behind a triple beam balances
- Notes from on Rotational Equilibrium
- Notes on Energy Conservation (Video of Lesson)
- Notes on Energy, Power, and Types of Mechanical Energy
- Notes on Momentum and Impulse. (Video Lesson)
- Notes on the idea of momentum conservation (Video)
- Notes on the nature of Torque
- Ownwork: Energy Conservation. Problems involving the transmutation of one type of energy into another type of energy.

- Ownwork: Momentum and Impulse Problems. Problems involving the concepts of momentum and impulse.
- Ownwork: Problems involving Work, Energy and Power. The following will be problems involving the different types of energy and the rate at which energy is added to objects.
- Ownwork: Torque Problems. Problems involving the use of forces to create a rotation.
- Quiz Review: Major ideas, formulas and sample problems for the quiz on momentum and energy.

Modifications

- Tutoring During Delsea 1

ELL Modifications:

- Focus on domain specific vocabulary and key words
- Offer sources for specific topics in primary language (Youtube web resources)
- Repeat, reword and clarify
- Digital Translators
- Use real objects when possible

IEP & 504 Modifications:

- Formula sheets and example problems to use on assessments
- Modeling and showing various examples
- Scaffolding notes
- Students will be able to use calculators and/or other math tools

G&T Modifications:

- Extra labs to do outside the classroom
- Provide links to extension videos or other media
- Increase the level of problems and challenge problems

At Risk Modifications

- Utilize Delsea One to complete assignments, try supplemental material or to modify classroom behaviors
- Reach out to parents

Formative Assessment:

- Quiz 4.1 Energy, Work and Power
- Quiz 4.2 Energy Conservation
- Quiz 4.3 Momentum, Impulse and its conservation
- Quiz 4.4 Torque and Rotational Equilibrium

Summative Assessment:

- Exam 4.1 Energy, Work, Power and Conservation
- Exam 4.2 Momentum and Beyond
- Roller Coaster Design/Build Project

Alternate Assessments:

Performance tasks
Project-based assignments
Problem-based assignments
Presentations
Reflective pieces
Concept maps
Case-based scenarios
Portfolios

Benchmark Assessments:

Skills-based assessment
Reading response
Writing prompt
Lab practical

Resources & Materials:

- Cell Phone Apps for Video Editing
- Chromebooks
- https://sites.google.com/site/delseaphysics1/Home
- Lab Pro Modules and appropriate sensors

- Meter Sticks/metric rules
- Timing Devices

Technology:

- Chromebook
- Class Website
- Ed Puzzle
- Google Classroom
- Google Suite
- Graphical Analysis Program
- Lab Pro Modules and Sensors
- Other
- Promethean Board

TECH.8.1.12	Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
TECH.8.1.12.A.4	Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use mathematical or logical functions, charts and data from all worksheets to convey the results.
TECH.8.1.12.A.CS2	Select and use applications effectively and productively.
TECH.8.1.12.B	Creativity and Innovation: Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.
TECH.8.1.12.B.CS2	Create original works as a means of personal or group expression.
TECH.8.1.12.C	Communication and Collaboration: Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others.
TECH.8.1.12.C.CS1	Interact, collaborate, and publish with peers, experts, or others by employing a variety of digital environments and media.
TECH.8.1.12.D.CS1	Advocate and practice safe, legal, and responsible use of information and technology.
TECH.8.1.12.D.CS2	Demonstrate personal responsibility for lifelong learning.
TECH.8.1.12.E	Research and Information Fluency: Students apply digital tools to gather, evaluate, and use information.
TECH.8.1.12.E.CS2	Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
TECH.8.1.12.E.CS4	Process data and report results.
TECH.8.1.12.F.1	Evaluate the strengths and limitations of emerging technologies and their impact on educational, career, personal and or social needs.
TECH.8.1.12.F.CS3	Collect and analyze data to identify solutions and/or make informed decisions.
TECH.8.2.12	Technology Education, Engineering, Design, and Computational Thinking - Programming: All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the environment.
TECH.8.2.12.C	Design: The design process is a systematic approach to solving problems.

TECH.8.2.12.C.4	Explain and identify interdependent systems and their functions.
TECH.8.2.12.C.CS3	The role of troubleshooting, research and development, invention and innovation and experimentation in problem solving.
TECH.8.2.12.E	Computational Thinking: Programming: Computational thinking builds and enhances problem solving, allowing students to move beyond using knowledge to creating knowledge.
TECH.8.2.12.E.3	Use a programming language to solve problems or accomplish a task (e.g., robotic functions, website designs, applications, and games).
TECH.8.2.12.E.CS1	Computational thinking and computer programming as tools used in design and engineering.