Course: *Physics* **Unit #3:** Energy	**Year of Implementation:** 2023-2024

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Stage One - Desired Results

Link(s) to New Jersey Student Learning Standards for this course:
https://www.state.nj.us/education/cccs/2020/
https://www.state.nj.us/education/cccs/2020/2020%20NJSLS-CLKS.pdf
https://www.nj.gov/education/standards/ela/Docs/2016NJSLS-ELA_Companion9-10.pdf
https://www.nj.gov/education/standards/ela/Docs/2016NJSLS-ELA_Companion11-12.pdf

- **Unit Standards:**
  - ***Content Standards***
    - 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.
    - HS-PS3-2 - 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).
    - HS-PS3-3 - Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
  - ***21st Century Life & Career Standards***
    - 9.4.12.CI.1 - Demonstrate the ability to reflect, analyze and use creative skills and ideas
    - 9.4.12.IML.3 - Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.
  - ***English Companion Standards***

        - RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
        - WHST.9-10.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
        - WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation
        - WHST.9-10.9 - Draw evidence from informational texts to support analysis, reflection, and research

    - ***Interdisciplinary Content Standards***
        - MP.2 - Reason abstractly and quantitatively.
        - MP.4 - Model with mathematics.
        - HSN-Q.A.1 - Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
        - HSN-Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling.
        - HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
        - HSA-SSE.A.4 - Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
    - ***NJ Statutes:*** NJ State law mandates the inclusion of the following topics in lesson design and instruction as aligned to elementary and secondary curriculum.

      Amistad Law: N.J.S.A. 18A 52:16A-88 Every board of education shall incorporate the information regarding the contributions of African-Americans to our country in an appropriate place in the curriculum of elementary and secondary school students.

      Holocaust Law: N.J.S.A. 18A:35-28 Every board of education shall include instruction on the Holocaust and genocides in an appropriate place in the curriculum of all elementary and secondary school pupils. The instruction

shall further emphasize the personal responsibility that each citizen bears to fight racism and hatred whenever and wherever it happens.

LGBT and Disabilities Law: N.J.S.A. 18A:35-4.35 A board of education shall include instruction on the political, economic, and social contributions of persons with disabilities and lesbian, gay, bisexual, and transgender people, in an appropriate place in the curriculum of middle school and high school students as part of the district's implementation of the New Jersey Student Learning Standards (N.J.S.A.18A:35-4.36) A board of education shall have policies and procedures in place pertaining to the selection of instructional materials to implement the requirements of N.J.S.A. 18A:35-4.35.

Diversity and Inclusion (N.J.S.A. 18A:35-4.36a) A board of education shall incorporate instruction on diversity and inclusion in an appropriate place in the curriculum of students in grades kindergarten through 12 as part of the district's implementation of the New Jersey Student Learning Standards.

Asian American and Pacific Islanders (AAPI) P.L.2021, c.410 Ensures that the contributions, history, and heritage of Asian Americans and Pacific Islanders (AAPI) are included in the New Jersey Student Learning Standards (NJSLS) for Social Studies in kindergarten through Grade 12 (P.L.2021, c.416)

For additional information, see

NJ Amistad Curriculum: http://www.njamistadcurriculum.net/

Diversity and Inclusion: https://www.nj.gov/education/standards/dei/index.shtml

- *(Sample Activities/ Lessons): https://www.nj.gov/education/standards/dei/samples/index.shtml*

Asian American and Pacific Islanders:

- *Asian American and Pacific Islander Heritage and History in the U.S.*
  A Teacher's Guide from EDSITEment offering a collection of lessons and resources for K-12 social studies, literature and arts classrooms that center around the experiences, achievements and perspectives of Asian Americans and Pacific Islanders across U.S. history.

Transfer Goal: Students will be able to independently use their learning to build, construct, interpret and/or refine a device that transfers energy among various forms and then utilize a mathematical model to account for the flow of energy into or out of the system and between its various forms.

As aligned with LRHSD Long Term Learning Goal(s):

Students will be better able to:

- design, critique, and carry out experiments in order to investigate scientific questions and/or propose solutions.
- collect, interpret, and analyze data in order to solve a defined problem.
- apply mathematics to express relationships efficiently and accurately.
- draw evidence-based conclusions from data in order to make informed decisions.
- construct, interpret, and refine models (scientific and mathematical) to explain the physical and natural world.
- effectively communicate scientific ideas and evidence-based arguments to an appropriate audience through written and oral means.

Enduring Understandings	*Essential Questions*
Students will understand that. . . *EU 1* work is required to change the energy of an object, and the rate of that energy change is power. *EU 2* energy can neither be created nor destroyed, though it is continually transferred from one object to another and between its various possible forms.	*EU 1* ● What is the best way to perform work on an object? ● How can it be determined that an object has energy? ● What is the most useful type of energy? ● How can power be generated? *EU 2* ● Where does energy come from? ● How much energy does a person use in a typical week and where does it come from?

	● What role does heat play as a form of energy within a system? ● What is the best way to keep track of the energy changes in a system?
<u>Knowledge</u> *Students will know . . .* *EU 1* ● models such as diagrams, drawings, descriptions, simulations, graphs, and equations can be used to account for energy changes in a system.(PS3.A-B) ● that work done on an object depends on the orientation of the applied force with the displacement of the object.(PS3.C) ● energy is a quantitative property of a system that depends on the motion and interactions of matter within that system. (PS3.A) ● kinetic energy of an object depends on the mass and speed of the object. (PS3.A) ● potential energy of an object or system can be thought of as stored energy and depends on the position of the object or objects. (PS3.A) ● gravitational potential energy results from an object's position above the earth.(PS3.A) ● power is the rate at which energy is transformed or work is done.	*<u>Skills</u>* *Students will be able to. . .* *EU 1* ● identify if a particular force is capable of doing work on an object. ● describe qualitatively how work can change the mechanical energy of a system. (SEP6) ● calculate the work done on an object when the applied force and displacement are known. (SEP5) ● energy manifests itself in multiple ways including motion, sound, light, and thermal energy. ● develop a computational model to illustrate that the mechanical energy of an object can be accounted for by its motion and its position relative to other objects. (SEP2) ● utilize mathematical models and computational thinking to calculate the kinetic and potential energy of an object or within a system of objects. (SEP5) ● design an investigation that applies the Work-Energy theorem to determine variables such as force and speed. (SEP3) ● differentiate between work and power. ● relate the energy transferred to a system to power. ● plan and carry out an experiment to determine the power generated by a person or device. (SEP3)

EU 2 ● models can be used to predict and show the relationship between systems or between energy within a system and the components of that system.(PS3.B) ● mechanical energy is the sum of potential and kinetic energy. (PS3.B) ● predictions based on models have limited precision and reliability due to assumptions and approximations. ● there are quantities in nature that cannot be created or destroyed. (PS3.B) ● many science and engineering problems focus on the transfer of energy. (PS3.B) ● energy is continually transferred between its various possible forms.(PS3.B) ● the total change in energy for a system is always equal to the total energy transferred into or out of the system. (PS3.B) ● the availability of energy limits what can occur in a system.	*EU 2* ● develop and use a model to account for the change in energy among the components of a system. (SEP2) ● use a model to account for energy that flows into or out of a system. (SEP2) ● plan and carry out an investigation that applies the conservation of energy principle to predict and describe system behavior. (SEP3) ● design, build, and refine a device that converts energy from one form to another. (SEP6)
Stage Two - Assessment	
Stage Three - Instruction	

Learning Plan: **Suggested Learning Activities to Include Differentiated Instruction and Interdisciplinary Connections: Each learning activity listed must be accompanied by a learning goal of A= Acquiring basic knowledge and skills, M= Making meaning and/or a T= Transfer.** *The following color codes are used to notate activities that correspond with interdisciplinary connections and 21st Century Life & Career Connections (which involves Technology Literacy): Red = Interdisciplinary Connection; Purple = 21st Century Life & Career Connection*

PHENOMENON 1*:* Roller Coasters (A/M, EU1, 2)

Goal: Students will be able to analyze, describe, and calculate energy transformations that occur along a typical roller coaster track.

1. Show video of a roller coaster (https://www.youtube.com/watch?v=oAJLKDMihnU) - any roller coaster video on youtube that shows the roller coaster in motion can work. Relate to students' experiences if they have ridden one.
    a. Ask students a few discussion questions such as (A/M, EU1, 2):
        i. Why is the first hill the highest?
        ii. How does energy get transformed during the trip of the roller coaster?
        iii. How does energy get transformed during the trip of the roller coaster?
        iv. How would friction affect the car as the trip from start to finish occurs?
2. Students will "brainstorm" different types of energy in their everyday lives. Then in small groups, try to classify each. (A/M, EU1)
3. Teacher-led Discussion/Notes: Classifying energy and how the types of energy are defined. (A, EU1)
4. Students will create KWL charts about energy. (A/M, EU1)
5. Discussion: How do we know work is done on an object? Is work always done when energy is used? (A, EU1)
6. Teacher-Led Discussion/Notes: Work, Energy, and Power (A/M, EU 1).
    a. Questions for discussion:
        i. How might work be related to Power?
        ii. How much power does it take to do a certain amount of work?
        iii. What are some everyday objects that we might use that might display the power generated by the object (i.e. lawnmowers, cars, etc.)?
7. Activity: Students will look at scenarios involved with lifting, dropping, carrying, and holding various objects to try to determine when work is done and energy is used. (M, EU1)
8. Students will solve problems and complete calculations on quantities such as work, potential energy, kinetic energy, and power. (A/M, EU 1)
9. Activity: Students will calculate the amount of power they generate walking up a flight of stairs. (M, EU1)

Relate back to phenomenon:

10. Activity: Have students analyze an electric bill comparing energy used in a month to some other task requiring work/energy. The comparison can show the enormity of the energy used by the average household. Students should research the energy and cost it takes to power a roller coaster. (T, EU1)

PHENOMENON 2: Skate park - PhET Simulations- Energy Forms and Changes, & Energy Skate Park - (https://phet.colorado.edu/en/simulations/energy-skate-park). (A, EU1,2)

Goal: Students will be able to analyze, describe, and calculate energy transformations that occur at a skate park.

1. Teacher-led Discussion/Notes: Conservation laws and how they apply to energy. (A, EU2)
2. Demo: Ball on a looped track. Relate back to Phenomenon 1. Perform and ask the following: (A/M, EU1, 2)
    a. Where should the ball start to make it around the loop?
    b. What causes the ball to not go as high as where it started from (friction)?
    c. What is the critical point of release that would make the ball from inside the loop?
3. Mechanical Universe Videos (https://www.youtube.com/watch?v=8BDHN2bY1bg) – Conservation of Energy, & Potential Energy. (A, EU2)
4. Students will solve problems and calculate quantities utilizing the conservation of energy equation. Relate and connect back to first phenomenon, the roller coaster (M, EU1, 2).
5. Activity: Students will create a lab that uses a Galileo Track placed at an angle and ball bearing to calculate whether energy was conserved along the track as it rolls down the ramp (M/T, EU1,2).
6. Video and Discussion: (e.g. ballistic pendulum https://youtu.be/_2NzcTfaUtw). Relate back to collisions/momentum. Ask students the question: Describe what is going on in the video with concepts that we learned before (force, collision, momentum) and integrate the new concept of conservation of energy (A/M, EU2).

Relate back to phenomena:

7. Writing task: Have students write a paragraph explaining the energy transformations that take place in either a roller coaster or at a skate park. The paragraph must include key words such as: work, potential energy, kinetic energy, conservation of energy, and power. (M, EU1,2)

Pacing Guide

Unit #	*Title of Unit*	*Approximate # of teaching days*
1	Kinematics	40
2	Newton’s Laws & Forces	40
3	Energy	30
4	Electricity and Magnetism	40
5	Waves	30

Instructional Materials

A fully equipped physics lab

Accommodations

Special Education: The curriculum will be modified as per the Individualized Education Plan (IEP). Students will be accommodated based on specific accommodations listed in the IEP.
Students with 504 Plans: Students will be accommodated based on specific accommodations listed in the 504 Plan.
English Language Learners: Students will be accommodated based on individual need and in consultation with the ELL teacher.
Students at Risk of School Failure: Students will be accommodated based on individual need and provided various structural supports through their school.
Gifted and Talented Students: Students will be challenged to enhance their knowledge and skills through acceleration and additional independent research on the subject matter.