Westside High School
Physical Science Curriculum Map
2018-2019

Teacher: **Hoots** **Revised:** 5-30-18

Map is still under construction and will be revised throughout the year.

WESTSIDE HIGH SCHOOL SCIENCE CURRICULUM MAP

Teacher:

Quarter 1

Topic:

- **Elements, Matter, and Interactions**
- **Matter in Organisms**

Essential Questions:

Students will consider……

- How can one explain the structure and properties of matter?
- How do substances combine or change (react) to make new substances?
- How does one characterize and explain these reactions and make predictions about them?

Students develop an understanding of the substructure of atoms and provide more mechanistic explanations of the properties of substances. Students use the periodic table as a tool to explain and predict the properties of elements. Phenomena involving nuclei are also important to understand, as they explain the formation and abundance of the elements. The crosscutting concepts of patterns, and energy and matter are called out as organizing concepts for these disciplinary core ideas. Chemical reactions, including rates of reactions and energy changes, can be understood by students at this level in terms of the collisions of molecules and the rearrangements of atoms. Using this expanded knowledge of chemical reactions, students explain important biological and geophysical phenomena. In these performance expectations, students demonstrate proficiency in developing and using models, planning and conducting investigations, and communicating scientific and technical information, and to use these practices to demonstrate understanding of the core ideas.

- How do organisms obtain and use energy they need to live and grow?
- How do matter and energy move through ecosystems?

High school students can construct explanations for the role of energy in the cycling of matter in organisms and ecosystems. Students apply mathematical concepts to develop evidence to support explanations of the interactions of photosynthesis and cellular respiration and develop models to communicate these explanations. Students relate the nature of science to how explanations may change in light of new evidence and the implications for our understanding of the tentative nature of science. Students understand organisms' interactions with each other and their physical environment, how organisms obtain resources, change the environment, and how these changes affect both organisms and ecosystems. In addition, students utilize the crosscutting concepts of matter and energy to make sense of ecosystem dynamics.

Students will…..

- Video: Lewis dot structures
- Watch video and take notes. I will check the notes to ensure that all appropriate information has been collected, if not they will fix it.
- Video: Ionic1 and 2 and covalent bonds
- Worksheet on Lewis dot structures and ionic bonds
- Ionic vs. Molecular bonds
- Video: Covalent bonds

AR STANDARDS / SKILLS

CONTENT VOCABULARY WITHIN THE STANDARD WILL BE TAUGHT THROUGHOUT DAILY OBJECTIVES / GOALS.

PSI-PS1-1 Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. [AR Clarification Statement: This PE is partially addressed in this course. Examples of properties that could be predicted from patterns could include types of bonds (ionic and covalent) formed, numbers of bonds formed, and hydrogen bonds in water.] [Assessment Boundary: Assessment is limited to main group elements.]

PSI-PS1-2 Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. [AR Clarification Statement: This PE is partially addressed in this course. Examples could include recognizing patterns to identify types of chemical reactions, such as, combustion, single replacement, double replacement, decomposition and synthesis.] [Assessment Boundary: Assessment does not include predicting chemical products.]

PSI-PS1-3 Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. [AR Clarification Statement: This PE is partially addressed in this course. Emphasis is on understanding of the strengths of forces between particles including hydrogen bonding in water. Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.] [AR Assessment Boundary: Assessment limited to materials of same states of matter.]

PSI-PS1-4 Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. [Clarification Statement: This PE is partially addressed in this course. Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved.] [Assessment Boundary: Assessment does not include calculating the total bond energy changes during a chemical reaction from the bond energies of reactants and products.]

PSI-PS1-7 Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. [AR Clarification Statement: This PE is partially addressed in this course. Emphasis is on demonstrating conservation of atoms through balancing chemical equations and assessing students' use of mathematical thinking, not on memorization and rote application of problem-solving techniques.] [Assessment Boundary: Assessment does not include the mole concept or complex chemical reactions.]

PSI-ESS2-7 Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. [AR Clarification Statement: This PE is partially addressed in this course. Emphasis in this course is on identifying and describing the evidence for simultaneous co-evolution and the causes, effects, and feedbacks between the biosphere and Earth's other systems. Geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples could include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of life forms.] [Assessment Boundary: Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems.]

PSI-LS1-5 Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. [AR Clarification Statement: This PE is partially addressed in this course. Emphasis is on using photosynthesis as an example of a chemical reaction including energy transfer. Examples of models could include diagrams, chemical equations, and conceptual models.] [Assessment Boundary: Assessment does not include specific biochemical steps.]

PSI-LS1-7 Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy. [AR Clarification Statement: This PE is partially addressed in this course. Emphasis is on using physical systems as examples of chemical reactions such as cellular respiration and photosynthesis. Examples of models could include diagrams, chemical equations, and conceptual models.] [Assessment Boundary: Assessment should not include specific biochemical steps.]

HS-LS2-1.

HS-LS2-2.

PSI-LS2-4 Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. [AR Clarification Statement: This PE is partially addressed in this course. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem.] [Assessment Boundary: Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.]

PSI2-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. [AR Clarification Statement: Examples could focus on researching then designing one aspect at a time (e.g., health advantages and disadvantages of using polystyrene vs. polyethylene for constructing a water bottle.)]

Science/Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts:	
Developing and Using Models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. § Develop a model based on evidence	**PS1.A: Structure and Properties of Matter** § Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (PSI-PS1-1) § The periodic table orders elements	**Patterns** § Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (PSI-PS1-1,PSI-PS1-2,	

to illustrate the relationships between systems or between components of a system. (PSI-PS1-4) § Use a model to predict the relationships between systems or between components of a system. (PSI-PS1-1) **Planning and Carrying Out Investigations** Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. § 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. (PSI-PS1-3) **Using Mathematics and Computational Thinking** Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based	horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (PSI-PS1-1,PS-PS1-2) § The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (PSI-PS1-3,PSI-PS2-6) § A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (PSI-PS1-4) **PS1.B: Chemical Reactions** § Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (PSI-PS1-4) § The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (PSI-PS1-2, PSI-PS1-7) **PS2.B: Types of Interactions** § Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and	PSI -PS1-3) **Energy and Matter** § The total amount of energy and matter in closed systems is conserved. (PSI-PS1-7) § Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (PSI-PS1-4) -- ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** § Science assumes the universe is a vast single system in which basic laws are consistent. (PSI-PS1-7) **Energy and Matter** § Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (PSI-LS1-5) § Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (PSI-LS1-7) **Energy and Matter** § Energy cannot be created or destroyed—it only moves between one place and another	

on mathematical models of basic assumptions. § Use mathematical representations of phenomena to support claims. (PSI-PS1-7) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. § Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (PSI-PS1-2) **Developing and Using Models** Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. § Use a model based on evidence to illustrate the relationships between systems or between components of a system. (PSI-LS1-5,PSI-LS1-7)	transformations of matter, as well as the contact forces between material objects. (PSI-PS1-1, PSI-PS1-3) **ESS2.D: Weather and Climate** § Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (PSI-ESS2-7) **ESS2.E: Biogeology** § The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it. (PSI-ESS2-7) **LS1.C: Organization for Matter and Energy Flow in Organisms** § The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (PSI-LS1-5) § As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (PSI-LS1-7) § As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy	place, between objects and/or fields, or between systems. (PSI-LS2-4)	

Using Mathematics and Computational Thinking Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. § Use mathematical representations of phenomena or design solutions to support claims. (PSI-LS2-4) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories. § Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (PSI2-ETS1-2)	needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. (PSI-LS1-7) **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** § Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (PSI-LS2-4) **ETS1.C: Optimizing the Design Solution** Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (PSI2-ETS1-2)		

Activities/Skills	Assessments	Resources	Vocabulary

Quarter 2 **Topic:** ● **Forces and Motion** ● **Energy**
Essential Questions: Students will consider… · How can one explain and predict interactions between objects and within systems of objects? The topic is organized into two ideas: forces and motion and types of interactions. Students build an understanding of forces and interactions and Newton's Second Law. Students also develop understanding that the total momentum of a system of objects is conserved when there is no net force on the system. Students are able to use Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. Students are able to apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. Students demonstrate proficiency in planning and conducting investigations, analyzing data and using math to support claims, and applying scientific ideas to solve design problems, and to use these practices to demonstrate understanding of the core ideas. The crosscutting concepts of cause and effect and structure and function are called out as organizing concepts for these disciplinary core ideas. · How do forces and energy affect matter? Students develop a computational model to calculate the change in energy within components of a system. Students are able to use models to illustrate energy at a macroscopic scale. In the PS3 performance expectations, students demonstrate proficiency in developing and using models, planning and conducting investigations, using math to support claims, applying scientific ideas to solve design problems, and to use these practices to demonstrate understanding of the core ideas. The crosscutting concepts of systems and system models and energy and matter are called out as organizing concepts for these disciplinary core ideas.

I will…..

Rube Goldberg Project 200pts

Objective: Students will create a chain reaction project to show examples of Newton's second law, kinetic and potential energies and energy conversions.

ARNGSS:

- PSI-PS3-3 Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.*
- PSI-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).
- PSI-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.
- PSI-PS2-1 Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
- PSI-PS2-3 Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.*

Students will be graded on the following: RUBRIC

1. Does it work? Students will get 3 tries to get the contraption to work all the way through. After that 3 points will be deducted with each try.

2. The contraption must have at least 10 or more "events".

3. Something MUST drop. The higher the object falls, the better your calculation will be.

4. The last event must complete a task of some sort: ring a bell, pop a balloon, flip a switch, let a balloon go, feed an animal, etc. Whatever you want to end with - **but it must be approved first.**

5. **CALCULATIONS AND SCIENCE INFORMATION THAT MUST BE INCLUDED:**
    a. **Show Newton's 2nd Law** - An object will accelerate in the direction the force is applied (F=ma)
    b. **Kinetic Energy** must be calculated once in one place and show where and how. ($KE=½ mv^2$)
    c. **Potential energy** must be calculated in one place and show where and how. All calculations must show all five parts. (PE=mgh)

   EVERYONE in the group must take the calculations each. EACH of you will take the measurements individually and calculate the answers. This will allow each of you to compare your answers to see if they match up. If not, go back and investigate where you went wrong. (If you do not do the calculations yourself, you will not be prepared for the exam over them)

6. All concept sketches must be included with the project. Details to be included in the final sketch:
    A. All conversions (KE to PE to KE)
    B. Label the action/reactions (1-10)
    C. Newton's 2nd law in 4 or more places
    D. ALL places of calculations. (answers only)
    E. Description of each event

7. You may bring ANYTHING from home (within reason). Let me know what you are bringing into use.

8. Daily comments must be made EVERY day for a daily grade for the team. You are responsible for holding each other accountable for making daily comments. It's worth 10 points per day, which will add up over the course of the project. Comments will include the following:
    A. An account of what ***you*** contributed
    B. Everything that was accomplished that day(what did you try that worked and what didn't work?) **Be specific.**
    C. You will not receive credit saying "we worked on the project" or **having less than 3 sentences**.

9. Type a paper **HALF YOUR GRADE!!! (100pts)**

   (Each one of you will do a paper, not a group thing)

    1. Paper must follow the following guidelines.
        a. Title - **3 points**
        b. Font must be 12pt, either Arial or Times New Roman ONLY - **3 points**
        c. Typed and double spaced - **3 points**
        d. Follow the typical format of a paper. (no listing or bullet points) - **3 points**
    2. PE to KE to PE each step - **10 points**
    3. Calculations (5 places, answers only) - **10 points**
    4. Explanation of each step - **10 points**
    5. How Newton's 2nd law is applied and explained in at least 4 places - **12 points**

   Reflection and Evaluation:

6. What did you learn? (SPECIFIC: NEWTON'S LAW, KE, PE, ENERGY TRANSFER, ETC)(7-10 sentences) **- 10 points CHANGE POINTS HERE**
7. Explain the evolution of your project: How did your project evolve from the original sketch to the end result? What worked as planned and what did you have to modify to work differently? (5-7 sentences) - **15 points**
8. What would/should you change and why? (3-5 sentences) - **15 points**
9. What were the best things about the project? (3-5 sentences) - **6 points**

9. When presenting:

A. One student must explain the processes taking place in the project, including energy conversions taking place and action/reactions. (read the paper)

B. Another student will work the contraption

C. Another student will present the calculations and show where they are taken. (calculations must be worked out and handed in with the project)

D. Another student will present the sketch

- This project will be started on November 3/6, 2017 and presentation day will be December 8/11, 2017
- The only size limit is that it must fit in the box. The box may be manipulated in any fashion to fit your design.
- Contraption must work with no help. Point will be deducted accordingly.
- Days 1 & 2 must only be used to work and sketch out different ideas. (you may not start until I sign off on a drawing)
- December 6/7 will be a "final looks" day to work out any bugs and make sure it works properly.
- The groups may work after school IF the entire group shows up.
- You may NOT share items with other teams
- You may NOT touch another team's box. (this will result in a zero)
- ALL items must be accounted for in each box
- Stay in your work area!! Do not wander around the room and visit with other groups.

Rube Goldberg Machine

Previous Rube Goldberg machines from my classes:

2017

2016

2015

-

AR STANDARDS / SKILLS *CONTENT VOCABULARY WITHIN THE STANDARD WILL BE TAUGHT THROUGHOUT DAILY OBJECTIVES / GOALS*
PSI-PS2-1 Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. [AR Clarification Statement: This PE is partially addressed in this course. Emphasis on qualitative analysis of data. Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object rolling down a ramp, or a moving object being pulled by a constant force.] [AR Assessment Boundary: Assessment is limited to qualitative analysis of one-dimensional motion and to macroscopic objects moving at non-relativistic speeds.] HS-ESS1-1. PSI-PS2-3 Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.* [Clarification Statement: Examples of evaluation and refinement could include determining the success of the device in protecting an object from damage and modifying the design to improve it. Examples of a device could include a football helmet or a parachute.] [Assessment Boundary: Assessment is limited to qualitative evaluations and/or algebraic manipulations.] HS-ESS1-2. PSI-PS2-5 Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current. [Assessment Boundary: Assessment is limited to designing and conducting investigations with provided materials and tools.] PSI-PS2-6 Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.* [Clarification Statement: Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.] [Assessment Boundary: Assessment is limited to provided molecular structures of specific designed materials.] PSI-ESS1-5 Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks. [AR Clarification Statement: Emphasis is on the ability of plate tectonics to explain the ages of crustal (continental and oceanic) rocks. Examples could include evidence of the ages of oceanic crust (lithosphere that includes crust and upper mantle and the asthenosphere) increasing with distance from mid-ocean ridges (a result of divergent boundaries/plate spreading) and the ages of North American continental crust increasing with distance away from a central ancient core (a result of past plate interactions).]

PSI3-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. [AR Clarification Statement: Examples of global challenges could include energy distribution, protective sports equipment, and transportation safety designs (automobile safety and shipping/packing materials).]

PSI-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. [AR Clarification Statement: This PE is partially addressed in this course. Emphasis is on explaining the meaning of mathematical expressions used in the model. Models could include spreadsheet analysis or other computer interfaces] [AR Assessment Boundary: Assessment is limited to basic algebraic expressions or computations.

PSI-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). [Clarification Statement: Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above the earth, and the energy stored between two electrically-charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.] [AR Assessment Boundary: Assessment is limited to mechanical energy.]

PSI-PS3-3 Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* [Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.] [Assessment Boundary: Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.]

PSI-PS3-4 Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). [Clarification Statement: Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.] [Assessment Boundary: Assessment is limited to investigations based on materials and tools provided to students.]

PSI4-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. [AR Clarification Statement: Examples could include building and evaluating wind turbines, solar cells, solar ovens, and generators.]

Science/Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts:	
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical and empirical models. § Plan and conduct an investigation individually and collaboratively to	**PS1.A: Structure and Properties of Matter** § The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (PSI-PS2-6) **PS2.A: Forces and Motion** § Newton's second law accurately predicts changes in the motion of macroscopic objects. (PSI-PS2-1)	**Cause and Effect** § Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (PSI-PS2-1, PSI-PS2-5) § Systems can be designed to cause a desired effect.	

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. (PSI-PS2-5) **Analyzing and Interpreting Data** Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. § Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (PSI-PS2-1) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. § Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (PSI-PS2-3) **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and	§ 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. (PSI-PS2-3) **PS2.B: Types of Interactions** § Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (PSI-PS2-5) § Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (PSI-PS2-6) **PS3.A: Definitions of Energy** § “Electrical energy” may mean energy stored in a battery or energy transmitted by electric currents. (PSI-PS2-5) **ESS1.C: The History of Planet Earth** Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. (PSI-ESS1-5) **ESS2.B: Plate Tectonics and Large-Scale System Interactions** § Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth’s	(PSI-PS2-3) **Structure and Function** § Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (PSI-PS2-6) **Patterns** § Empirical evidence is needed to identify patterns. (PSI-ESS1-5) ***----------------------------------Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (PSI3-ETS1-1) **Systems and System Models** § When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.	

reliability of the claims, methods, and designs. § 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). (PSI-PS2-6) **Engaging in Argument from Evidence** Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. § Evaluate evidence behind currently accepted explanations or solutions to determine the merits of arguments. (PSI-ESS1-5) **Asking Questions and Defining Problems** Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations. § Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (PSI3-ETS1-1) **--** **Connections to Nature of Science**	surface and provides a framework for understanding its geologic history. (PSI-ESS1-5) **ETS1.A: Defining and Delimiting Engineering Problems** § Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (PSI-PS2-3) **ETS1.C: Optimizing the Design Solution** § Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (PSI-PS2-3) **ETS1.A: Defining and Delimiting Engineering Problems** § Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (PSI3-ETS1-1) § Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (PSI3-ETS1-1)	(PSI-PS3-4) § 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. (PSI-PS3-1) **Energy and Matter** § Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (PSI-PS3-3) § Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems. (PSI-PS3-2) **--** ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** § Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing	

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena § Theories and laws provide explanations in science. (PSI-PS2-1) Laws are statements or descriptions of the relationships among observable phenomena. (PSI-PS2-1) **Developing and Using Models** Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. § Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (PS-PS3-2) **Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. § 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. (PSI-PS3-4) **Using Mathematics and Computational Thinking**	**PS3.A: Definitions of Energy** § 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. (PSI-PS3-1,PS-PS3-2) § At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (PSI-PS3-2, PSI-PS3-3) § These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (PSI-PS3-2) **PS3.B: Conservation of Energy and Energy Transfer** § Conservation of energy means that the total change of energy in any system is always equal to the total energy	costs and risks. (PSI-PS3-3) § New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (PSI4-ETS1-3) --- ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** § Science assumes the universe is a vast single system in which basic laws are consistent. (PSI-PS3-1)	

Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. § Create a computational model or simulation of a phenomenon, designed device, process, or system. (PSI-PS3-1) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. § Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (PSI-PS3-3) Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (PSI4-ETS1-3)	transferred into or out of the system. (PSI-PS3-1) § Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (PSI-PS3-1,PSI-PS3-4) § 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. (PSI-PS3-1) § The availability of energy limits what can occur in any system. (PSI-PS3-1) § Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (PSI-PS3-4) **PS3.D: Energy in Chemical Processes** § Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (PSI-PS3-3,PSI-PS3-4) **ETS1.A: Defining and Delimiting Engineering Problems** § Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk		

	mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (PSI-PS3-3) **ETS1.B: Developing Possible Solutions** When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (PSI4-ETS1-3)		
Activities/Skills	**Assessments**	**Resources**	**Vocabulary/Terms**
	•		• **Newton's 2nd law** •

Quarter 3 **Topic: Waves**
Essential Questions: Students will consider… · How are waves used to transfer energy and send and store information?

Students apply understanding of how wave properties and the interactions of electromagnetic radiation with matter can transfer information across long distances, store information, and investigate nature on many scales. Students understand that combining waves of different frequencies can make a wide variety of patterns and thereby encode and transmit information. Students also demonstrate their understanding of engineering ideas by presenting information about how technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy. Students demonstrate proficiency in asking questions and using mathematical thinking to demonstrate understanding of the core ideas. The crosscutting concepts of cause and effect and stability and change are highlighted as organizing concepts for these disciplinary core ideas.

I will…..

- Create a google slides presentation with a minimum of 20 slides.
- 1. Compare and contrast analogue signals and digital signals.(4-5 slides)
- 2. What are advantages and disadvantages of digital transmission? (Name 3 of each) (6-8 slides)
- 3. What are advantages and disadvantages of digital storage of information? (Name 3 of each) (6-8 slides)
- 4. Design a solution for making cell phone reception more clear using the information collected about digital signals. (4-5 slides)
- Use the following videos for information - however you do not have to watch them all. Use the internet for information also. DO NOT COPY AND PASTE!! DO NOT PLAGIARIZE!!!
- You may work alone or with a partner (no more than 2) Share the slide presentation with me and each other and work on it equally together.

AR STANDARDS / SKILLS

CONTENT VOCABULARY WITHIN THE STANDARD WILL BE TAUGHT THROUGHOUT DAILY OBJECTIVES / GOALS.

PSI-PS4-1 Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. [AR Clarification Statement: This PE is partially addressed in this course. Examples of data could include seismic waves and sound waves traveling through air and water.] [AR Assessment Boundary: Assessment is limited to describing relationships qualitatively.]
PSI-PS4-2 Evaluate questions about the advantages of using a digital transmission and storage of information. [Clarification Statement: Examples of advantages could include that digital information is stable because it can be stored reliably in computer memory, transferred easily, and copied and shared rapidly. Disadvantages could include issues of easy deletion, security, and theft.]
PSI-5-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. [AR Clarification Statement: Examples of possible problems could include cell phone reception, emergency radio transmission, and earthquake notification.]

Science/Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts:	

Asking Questions and Defining Problems Asking questions and defining problems in grades 9–12 builds from grades K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations. § Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design. (PSI-PS4-2) **Using Mathematics and Computational Thinking** Mathematical and computational thinking at the 9-12 level builds on K-8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. § Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations. (PSI-PS4-1) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent	**●PS4.A: Wave Properties** § The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. (PSI-PS4-1) § Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. (PSI-PS4-2) **ETS1.C: Optimizing the Design Solution** § Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (PSI5-ETS1-2)	**Cause and Effect** § Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (PSI-PS4-1) **Stability and Change** § Systems can be designed for greater or lesser stability. (PSI-PS4-2) **-----------------------------------** ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Engineering, Technology, and Science on Society and the Natural World** § Modern civilization depends on major technological systems. (PSI-PS4-2) Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.(PSI-PS4-2)	

student-generated sources of evidence consistent with scientific ideas, principles and theories. Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (PSI5-ETS1-2)			
Activities/Skills	**Assessments**	**Resources**	**Vocabulary/Terms**
•	• Lab • Powerpoint	• Internet •	• **Frequency** • **Hertz** • **Wavelength** • **Amplitude** • **Electromagnetic Spectrum** • **Digital transmission** • **Media**

Quarter 4

Topic: Interactions of Humans and the Environment

Essential Questions:

Students will consider……

· How do humans depend on Earth's resources?

· How do people model and predict the effects of human activities on Earth's climate?

There are strong connections to mathematical practices of analyzing and interpreting data. The performance expectations strongly reflect the many societally relevant aspects of Earth and space science (resources, hazards, and environmental impacts) with an emphasis on using engineering and technology concepts to design solutions to challenges facing human society. Students understand the complex and significant interdependencies between humans and the rest of Earth's systems through the impacts of natural hazards, our dependencies on natural resources, and the environmental impacts of human activities. In the life science performance expectations, students are expected to demonstrate proficiency in the use of computer simulation models and engaging in argument from evidence; and to use these practices to demonstrate understanding of the core ideas. The crosscutting concepts of stability and change; cause and effect; and systems and system models are called out as organizing concepts for these disciplinary core ideas. While the performance expectations couple particular practices with specific disciplinary core ideas, instructional decisions should include use of many practices that lead to the performance expectations.

I will…..

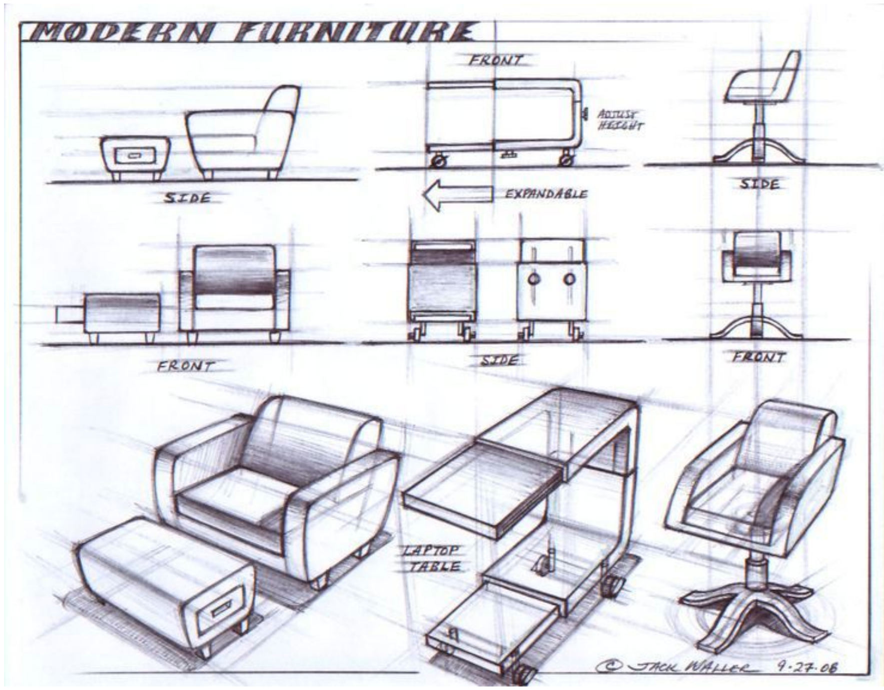
What is the environmental impact the textile/furnishings industry has when making usable products for the public?

A. Everyone in class will research EACH material. The group will create the furnishings drawing and the recycled version of it, **but the research is done individually**.
B. You will research the real materials that would/could be used in making the furnishings. (The recycled version is not done until the end, after the research)
C. Refer to the rubric and grade yourself before you call yourself "finished". If you have any questions, **please ask me! I will help!**
D. You may use videos to gain information. If you find one that you cannot access, please send me an email so I can get it released. **Do not wait until the last minute!**
E. EVERY research question response must be cited! You may use the same citation for more than one question, but EACH ONE must be cited, even if it's the same. But you must use at least 3 different sources. You can use more, but you have to have at least 3. (just cut and paste the URL into the box for the citation)

1. TEXTILES:

Create an item to be used in the home such as lamp, carpet, curtains, table, chair, foot stool, shelf, trash basket, toilet, decor for the house, trunk, art (large wall art) etc. Draw out the design using real-world materials such as metal, wood, plastic, etc. Fully color and label the drawing and where it can be manufactured. (100 pts) THE ITEMS YOU MAKE ARE THE ONES YOU ARE RESEARCHING. (for example: if you are creating a lamp, you will research the lamp made from 3 different materials)

This is the type of drawing I am looking for.



2. TOYS: Create an item to be used for a child, for example: Stuffed toy, train set, blocks, cars/trucks, etc. Draw out the design using real-world materials such as stuffed animals, plastic, fabrics, wooden, etc.. Fully color and label the drawing and where it can be manufactured. (100 pts) THE ITEMS YOU MAKE ARE THE ONES YOU ARE RESEARCHING. (for example:

3. Research each item using the following guidelines: (200 pts) (must use and cite at least 3 sources) EACH TOPIC WILL HAVE 5-7 SENTENCES AND THE CITATIONS WILL BE IN EACH BOX..
    a. Where is it made?
    b. What processes are used to create this material? (this is going to be extensive)
        i. How is it “harvested”?
        ii. What kinds of chemicals are used to treat it?
        iii. How much water is used?
        iv. How far does the material travel? (from harvest, to treatment, to creating the clothing, to selling)
        v. What impact does the total travel of the material have on the environment? (land, air and/or sea)
        vi. How does the government regulate the manufacturing and distribution of this material?
    c. How is this material typically disposed?

d. Can this material be recycled? If so, how? Where? Can it be recycled here in Jonesboro? What are the environmental repercussions for recycling this material? (in other words which is worse on the environment: recycling or throwing it away?)
e. How can this material be reused? (describe 3 ways it can be repurposed)
f. What are some alternatives to this material that have less of an ecological impact?

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AR STANDARDS / SKILLS

CONTENT VOCABULARY WITHIN THE STANDARD WILL BE TAUGHT THROUGHOUT DAILY OBJECTIVES / GOALS.

PSI-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.* [AR Clarification Statement: This PE is partially addressed in this course. Examples of human activities could include urbanization, fracking, greenhouse gases and dams. [AR Assessment Boundary: Assessment is to include student choice from multiple scenarios.]

PSI-LS4-5 Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species. [AR Clarification Statement: This PE is partially addressed in this course. Emphasis is on physical changes to the environment (temperature change and acidification).]

PSI-ESS2-1 Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features. [AR Clarification Statement: Emphasis is on how the appearance of land features (mountains, valleys, and plateaus) and sea floor features (trenches, ridges, and seamounts) are a result of both constructive forces (volcanism, tectonic uplift, and orogeny) and destructive mechanisms (weathering, mass wasting, and coastal erosion).

PSI-ESS3-1 Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. [AR Clarification Statement: This PE is partially addressed in this course. Emphasis in this course is on key natural resources. Examples could include access to fresh water (rivers, lakes, and groundwater), regions of fertile soils (river deltas) and high concentrations of minerals and fossil fuels. Examples of natural hazards could include from interior processes (volcanic eruptions), surface processes (tsunamis, mass wasting, and soil erosion), and severe weather (hurricanes, floods, and droughts). Examples of the results of changes in climate that could affect populations or drive mass migrations could include changes to sea level and regional patterns of temperature and precipitation.]

PSI-ESS3-2 Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.* [AR Clarification Statement: This PE is partially addressed in this course. Emphasis is on identifying possible problems to be solved (conservation, recycling, and minimizing impacts).]

PSI6-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. [AR Clarification Statement: Examples could include research and analysis of the spread of zebra mussels, decline of chestnut trees, and the impact of fracking.]

PSI6-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. [AR Clarification Statement: Examples of design challenges could include solving man-made erosion problems, reducing thermal/light pollution, and safe disposal of fracking waste fluids.]

PSI6-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. [AR Clarification Statement: Examples could include the environmental effects of certain plastics (cost, safety, biodegradability, and recyclability) and evaluating the tradeoffs for each source of energy production.]

PSI6-ETS1-4 Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem. [AR Clarification Statement: Examples of possible simulations could include spreadsheet analysis or other computer interfaces. Examples of possible computer simulation resources could include PhET, ArcGIS, and InTeGrate-SERC.]

Science/Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts:	
Engaging in Argument from Evidence Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current or historical episodes in science. § Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (PSI-LS4-5) § Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations). (PSI-ESS3-2) **Asking Questions and Defining Problems** Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions	**LS2.C: Ecosystem Dynamics, Functioning, and Resilience** § Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (PSI-LS2-7) **LS4.C: Adaptation** § Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the extinction–of some species. (PSI-LS4-5) § Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost.	**Stability and Change** § Much of science deals with constructing explanations of how things change and how they remain stable. (PSI-LS2-6) **Cause and Effect** § Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (PSI-LS4-5, PSI-ESS3-1) **Systems and System Models** § Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (PSI6-ETS1-4) ------------------------------------ ***Connections to Engineering, Technology, and Applications of Science***	

and design problems using models and simulations. § Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (PSI6-ETS1-1) **Using Mathematics and Computational Thinking** Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. § Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (PSI6-ETS1-4) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories. § Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer	(PSI-LS4-5) **LS4.D: Biodiversity and Humans** § Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (PSI-LS2-7) § Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (PSI-LS2-7) **ESS2.A: Earth Materials and Systems** § Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (PSI-ESS2-1) **ESS3.A: Natural Resources** § Resource availability has guided the development of human society. (PSI-ESS3-1) § All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social	**Influence of Science, Engineering, and Technology on Society and the Natural World** § Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (PSI-ESS3-2) § Analysis of costs and benefits is a critical aspect of decisions about technology. (PSI-ESS3-2) § New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (PSI6-ETS1-1, PSI6-ETS1-3) --------------------------------- ***Connections to Nature of Science*** **Science Addresses Questions About the Natural and Material World** § Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. (PSI-ESS3-2) § Science knowledge indicates what can happen in natural systems—not what should happen. The latter involves	

review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (PSI-ESS3-1) § Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (PSI-LS2-7) § Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (PSI6-ETS1-2) Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (PSI6-ETS1-3)	regulations can change the balance of these factors. (PSI-ESS3-2) **ESS3.B: Natural Hazards** § Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations. (PSI-ESS3-1) **ETS1.A: Defining and Delimiting Engineering Problems** § Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (PSI6-ETS1-1) § Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (PSI6-ETS1-1) **ETS1.B: Developing Possible Solutions** § When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (PSI-LS2-7, PSI-ESS3-2, PSI6-ETS1-3)	ethics, values, and human decisions about the use of knowledge. (PSI-ESS3-2) Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues. (PSI-ESS3-2)	

	§ Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (PSI6-ETS1-4) **ETS1.C: Optimizing the Design Solution** § Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (PSI6-ETS1-2)		
Activities/Skills	**Assessments**	**Resources**	**Vocabulary/Terms**