Wethersfield Public Schools

WHS Curriculum: Integrated Science

Grade(s)	9
Unit Title and Purpose	**Unit 1a. Nature of Science and Forging Academic Skills Into Habits** The student will develop a durable working foundation of understanding about the nature of science, the scientific field, and scientific habits and skills. Along with this content, the student will refine and add additional academic habits to their skillsets.
Timeframe	6 weeks

Vision of the Graduate

Communicator: Students will communicate with peers and the teacher about content ideas, questions, and problems that arise. Students will be encouraged to kindly and compassionately try to bring out their best in their workgroup.
Problem solver: Students will utilize the academic strategies and the scientific method to effectively problem solve from collected data and evidence to create understanding, models, and descriptions of scientific concepts. This will include ongoing reevaluation of their own level of understanding, selecting (with support) the steps necessary to improve their confidence and competence with the topic and academically.
Collaborator: Students will sometimes take the role of receiver and other times that of leader when working with others in class. Grouping will be changed periodically to expose all students to different personalities, views, and perspectives.

Unit Priority Standards

Understandings about the Nature of Science (NGSS Appendix H):

- Scientific investigations use a variety of methods
- Scientific knowledge is based on empirical evidence
- Scientific knowledge is open to revision in light of new evidence
- Scientific models, laws, mechanisms, and theories explain natural phenomena
- Science is a way of knowing
- Scientific knowledge assumes an order and consistency in natural systems
- Science is a human endeavor
- Science addresses questions about the natural and material world

Science and Engineering Practices (NGSS Appendix F):

1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Unit Supporting Standards

CCSS.ELA-LITERACY.RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
CCSS.ELA-LITERACY.RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

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CCSS.ELA-LITERACY.WHST.9-10.1.D. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
CCSS.ELA-LITERACY.WHST.9-10.2.A. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

Essential Questions

Science Content

What are the goals of science?

Are there things that cannot be investigated scientifically?

How does one "do" science?

How does one communicate in science?

How does one measure properly in science?

What is the difference between a scientific theory and an idea?

How can a fact in science be seen as true and still be open to change as new technologies and data are considered?

How do scientists organize their thinking and effectively communicate their conclusions?

Why do all high school students need to take science?

Academic

What kind of habits do I need to adopt to make me successful in high school?

How do I really learn something?

How are learning and memorizing different?

How do I balance and manage my time effectively with these new expectations?

What individual behaviors are conducive to the positive experiences of group and class learning?

Performance Expectations: Skills	Performance Expectations: Essential Knowledge/Concepts
1. Understand one clear example of a proper science experiment and use as a template to base future experimentation on. 2. Identify similarities and differences and use these to categorize or organize a set of objects based on patterns 3. Use tools to properly measure size, mass, temperature, and other properties of physical objects. 4. Organize collected data into a data table and/or a graph. 5. Make and record observations objectively and without subjective interpretation. 6. Identify and properly use various scientific equipment. 7. Practice using logic, deduction, and inference to guide a scientific investigation.	1. Science evolved from philosophy (the search for truth), and natural philosophy (looking for truths in the natural world). 2. The natural universe includes matter, energy, forces, time, space, other variations such as antimatter, dark energy, etc. , and the interactions of all of the above. 3. By its very nature science cannot address supernatural phenomena, but many things once thought to have been supernatural have been explained in the natural world. 4. Using logic and tools like Occam's Razor help to streamline scientific investigations. 5. Science looks to learn objective truths about the natural world. 6. Data are pieces of information that can be either qualitative or quantitative. 7. Work in science involves classification,

8. Correctly analyze data, information, and investigations for validity, looking for possible biases and errors. 9. Communicate the results of scientific investigations using proper format and terminology. 10. Identify and communicate in the proper units used in the scientific community. 11. Accurately use scientific notation and measurement prefixes. 12. Identify elements of the natural world studied in science from the biggest (universe) to the smallest (string theory) with a growing familiarity of the scale of the universe. 13. Interpret complex visuals (ex: H-R star chart) to identify trends, patterns, or specific information.	experimentation, and theorization. Not all things that look "sciency" are scientific. 8. Controlled experiments seek to identify and measure the effect of a single IV on a single DV. 9. A scientific law is a rule of nature that is discovered and articulated. 10. A theory is an explanation based on evidence. In common language a theory is considered weak, but a well vetted scientific theory can be as strong as a law. 11. Uncertainty is a consideration of all scientific knowledge. If you are able to imagine and not disprove an alternate explanation, no matter how strong your understanding, future discoveries or evidence may change the currently accepted understanding. This is inherent to the process of evolving understanding of the natural world. 12. Understanding in science comes from the collective learning of the scientific community, and is vetted through a process of peer review. ("I stand on the shoulders of giants…"- Isaac Newton) 13. Scientific habits of mind such as inference, logical deduction, isolating variables, and controlled investigations, can be applied to many different areas of life. 14. Scientists communicate measurements using the S.I. (metric) system of measurements. 15. Numerous tools are used to measure and conduct scientific investigations. 16. Scientists need to be consistent in their measurements and methods. Sometimes scientists look for possible sources of error within their or others' work. 17. Most scientists strive to be objective, but it is an ongoing challenge to analyze for and identify biases when they occur. Biases may undermine and invalidate presented information.

Transferable Academic Skills and Knowledge:

1. Each class will together create a social contract based on shared values and expectations.
2. Develop an organizational system for physical resources that allows students to find important papers when they need them.
3. Develop productive personal daily habits for success in High School.
    a. Check Google Classroom and PowerSchool daily for each class, and/or use a written agenda.
    b. Have a routine for charging chromebook every evening and bringing it every day.
    c. Develop phone/device strategies for outside of the classroom.
        i. Connect phone to GC for assignments to provide helpful reminders.

ii. Determine if utilizing phone tools (e.g., study session timers, instrumental study music, calculator, etc…) is helpful while studying, or if it is more helpful to put phone away.
   d. Create an appropriate environment for study outside of class.
   e. Investing 20 minutes per day/night per class beyond class to complete work and actively study.
   f. Engage in short sessions of work every day, rather than waiting for deadlines.
4. Communicate.
   a. Respectfully email teachers when help or clarification is needed.
   b. Add labeled pictures or diagrams is an acceptable way to improve written communication.
5. Take an active part in the learning process.
   a. Interpret new information in a way that resonates with previous learning.
   b. Make personal connections with new content and skills.
   c. Look for the edge of current understanding; finding where confusion with new learning begins, so that it can be resolved.
6. Review work before submitting it for a grade.
   a. Resolve issues in spelling and grammar checks.
   b. Start sentences with a capital letter and end with a period.
   c. Use consistent number format and include units when appropriate.
   d. If a question or prompt asks for explanation, include a minimum of 3 complete sentences.
   e. Ensure every section is completed, including identifying info (name, date, period #)
   f. Reread directions after completing work to check if all were followed.
   g. If work is late, include an explanation above name on papers or in the private comments section
7. Pay attention to oneself while studying:
   a. Do you lose focus easily? Can you use a timer to stay on task for 10 minutes at a time?
   b. Do you need to study music (instrumental, quiet, not interesting) to help block out distractions? Do nature sounds or white noise work better for you?
   c. Do you need to plan breaks every 25 minutes (Pomodoro Sessions)?
   d. Are you distracted by your phone or do you use it as a tool? Do you need to go to airplane mode while trying to work?
8. Actively read for understanding.
   a. Annotate, highlight, and interact with information in other ways to engage and focus on new learning. (We will build on and refine this throughout the year.)
9. Refine research habits.
   a. When searching online, find sites that are legitimate, appropriate, and that present information in a way that helps you.
   b. Use modifying terms to effectively find what you need.
   c. Seek a connection between what you find online and content from class before investing time with it.
   d. If you understand the idea, put it in your own words and personalize it. Never copy responses.
10. Seek help when needed:
   a. If you come across something you do not understand, persist in accessing various resources:
      i. Look in notes or other provided classroom resources
      ii. Ask a classmate for help
      iii. Ask the teacher for help
      iv. If none of the above work, “Googling” can be a last resort
   b. Attend extra help after school or during a mutual study hall (if the teacher has one).

Student Learning Tasks & Resources	Suggested Teacher Materials/Resources

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● Measurement Lab: Students will do a classification lab where they take measurements to support or reject a hypothesis. Students are able to identify and demonstrate proper techniques of measurement using the metric system. ● Penny Lab: Students design and conduct a proper experiment to solve a problem: In what year did the composition of pennies change? ● Writing Task: Students select a “superseded” theory in science history and analyze it: What led to its creation? What new evidence led to it being rejected? What theory replaced it? ● Students use scientific notation to describe the natural world from the largest to smallest things known. ● Students use observations to make logical inferences. ● Students identify the components of an experiment using correct terminology and identify potential errors in design.	● Unit Study Guide ● Unit Practice Test ● One Clear Basic Example of an experiment done properly (e.g., mice and juice, plants and fertilizer) ● Experimental Design "Cheat Sheet" Summary ● Active Reading Unit 01 Reading for Understanding ● Differentiated level reading selections such as those from NEWSELA and others. ● Online Review Tools relating to the topic. ● Online Video Question Tools based on this unit.

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Grade(s)	9
Unit Title and Purpose	**Unit 1b. The Big Bang Sets the Stage and Setting the Stage for Success this Year** Students will investigate the origins of the universe (including time, space, matter, forces, and energy), Students will also be introduced to essential academic skills needed in high school while also establishing a strong foundational knowledge of the nature of science.
Timeframe	2 weeks

Vision of the Graduate

Communicator: Students will communicate with peers and the teacher about content ideas, questions, and problems that arise. Students will be encouraged to kindly and compassionately try to bring out their best in their workgroup.
Problem Solver: Students will utilize the academic strategies and the scientific method to effectively problem solve from collected data and evidence to create understanding, models, and descriptions of scientific concepts. This will include ongoing reevaluation of their own level of understanding, selecting the steps necessary (with support) to improve their confidence and competence with the topic and academically.
Collaborator: Students will begin to understand that science only progresses through genuine collaboration as the scientific community needs to come to a consensus for something to be considered scientifically true. Students will sometimes take the role of receiver and other times that of leader when working with others in class. Grouping will be changed periodically to expose all students to different personalities, views, and perspectives.

Unit Priority Standards

HS-ESS1-2. Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.
HS-ESS1-3. Communicate scientific ideas about the way stars, over their life cycle, produce elements.

Science and Engineering Practices
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, 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.

Obtaining, Evaluating, and Communicating Information: Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.

- Communicate scientific ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

- A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence.

Disciplinary Core Ideas
ESS1.A: The Universe and Its Stars

- The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.
- The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gasses, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe.
- Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode.

Crosscutting Concepts

Energy and Matter

- Energy cannot be created or destroyed–only moved between one place and another place, between objects and/or fields, or between systems.
- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

Interdependence of Science, Engineering, and Technology

- Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.
- Science assumes the universe is a vast single system in which basic laws are consistent.

Unit Supporting Standards

CCSS.ELA-LITERACY.RST.9-10.1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
CCSS.ELA-LITERACY.RST.9-10.2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
CCSS.ELA-LITERACY.RST.9-10.9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.
CCSS.ELA-LITERACY.WHST.9-10.1.A. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.
CCSS.ELA-LITERACY.WHST.9-10.2.D. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

Essential Questions

Where did the universe come from? How did we get here?

How can scientists figure out a true history of the Universe with no eye witness accounts?

How can we represent objects from the very small to the very large?

Performance Expectations: Skills	Performance Expectations: Essential Knowledge/Concepts
1. Modeling a. Develop acceptable models in various formats, including labeled diagrams i. Develop a skeleton sketch of the Big Bang	1. The Big Bang Theory objectively explains the creation of the universe as we know it, including: a. Matter b. Energy c. Forces d. (Empty) Space

b. Interpret and analyze models of scientific phenomenon 2. Explain how the Law of Conservation of Mass and Energy can be used to understand phenomenon and evaluate claims 3. Operate safely and appropriately in a science laboratory setting 4. Provide examples of collective learning in scientific history	e. Time f. "Other"/Dark Matter g. The interactions between them 2. The four fundamental forces emerged from the early universe as: a. the force of gravity b. the electromagnetic force c. the strong nuclear force d. the weak nuclear force 3. The process of the big bang started with a singularity, then a quick period of rapid expansion, followed by a period of cooling and the formation of the forces and then matter ("dot, bang, cool") 4. The four pillars of the Big Bang Theory are: a. The Universe is Expanding- Galaxies are moving away from each other and us b. Background Radiation- A lot of leftover energy from the bang was shifted from visible light to microwave radiation as it moved outward c. Nucleosynthesis- Light elements were formed first, then heavier elements. The ratios of elements in the universe are consistent with the predictions of the Big Bang Theory d. Galaxies and Other Large Structures- When gravity took over after the bang "clumps" of galaxies would have formed as they are 5. Big Bang Theory: If the universe is expanding, there must have been a time when it was infinitely small a. Scientists currently do not know what happened before the singularity (dot), nor are they agreed upon how (or if) the expansion of the known universe will continue forever. This acknowledgement of the limits of current understanding is an important distinction. Explanations need not be completed in one go. 6. The big bang and the stars are the basis of all elements in our universe. a. The first two lightest atoms to form were the simplest elements on the periodic table (Hydrogen and Helium). With these basic ingredients and conditions, the first

	stars formed. b. These stars acted as “furnaces” to manufacture the elements up through #26 (Iron) through nuclear fusion c. When some stars “die” as a supernova, the massive explosion creates the heavier elements beyond Iron. 7. The dynamic nature of stars involves different life cycles according to their size. 8. Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. Nuclear fusion within stars releases electromagnetic energy.

Transferable Academic Skills and Knowledge:

1. Test preparation and test taking; reflecting on the results of the previous unit test, and anticipating the next unit test. Students reflect on the following:
    a. Did you accept the teacher’s offer to clarify and rephrase questions on the test you were unsure of?
    b. Did you "mine the test" for information? Often information is given away in other questions, answers, or diagrams.
    c. How was your pacing on the test? Did you delay too long on some questions? Did you give up on other questions too easily, just randomly guessing?
    d. Did you use scrap paper to do a brain dump prior to the test, and keep track of skipped questions and found information during the test?
    e. Do you see how preparation for the test at the end of the unit begins on the first day of a new unit?
    f. Do you see how cumulative 20 min homework and study sessions outside of class can lead to your being more comfortable and confident with material during the test? If you did not space out your learning, do you see how your confidence and performance may be different than if you did?
2. Build academic confidence. Students reflect on the following:
    a. How have you grown as a learner in Q1?
    b. What good academic habits have you adopted?
    c. What academic habits do you still need to work on?
3. Engage in the learning process beyond complying with what you are asked to do.

Student Learning Tasks & Resources	Suggested Teacher Materials/Resources
● Students draw and describe what is happening in a “dot-bang-cools” (formation of the known universe) skeleton sketch explaining the Big Bang Theory. ● Students use a balloon model to create data reflecting the expansion of the universe. ● Student writing task: Students write a self-reflection paper in which they reflect on their performance on the first test and make a SMART goal for the next quarter.	● Big Bang Balloon Lab ● Reading for Understanding Unit Packet ● Differentiated level reading selections such as those from NEWSELA and others ● Skeleton Sketch / Concept Map for the Big Bang. ● Unit Study Guide ● Unit Practice Test ● Powers of 10x ● Scale of the Universe Simulation ● Khan Academy: How Did Our View of the Universe Change? ● How to Science: WHS Student Student Guide

	● PHET Lab simulations ● Video Reviews and Quizzes

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Grade(s)	9
Unit Title and Purpose	**Unit 2. Understanding Matter and Forging Academic Skills Into Habits** The student will develop a durable working foundation of understanding about the nature of matter, and extend that understanding into their world view. Along with this content, the student will further refine and add additional academic habits to their skillsets.
Timeframe	8 weeks

Vision of the Graduate

Communicator: Students will communicate with peers and the teacher about content ideas, questions, and problems that arise. Students will be encouraged to kindly and compassionately try to bring out their best in their workgroup.
Problem solver: Students will utilize the academic strategies and the scientific method to effectively problem solve from collected data and evidence to create understanding, models, and descriptions of scientific concepts. This will include ongoing reevaluation of their own level of understanding, selecting the steps necessary (with support) to improve their confidence and competence with the topic and academically.
Collaborator: Students will sometimes take the role of receiver and other times that of leader when working with others in class. Grouping will be changed periodically to expose all students to different personalities, views, and perspectives.

Unit Priority Standards

HS-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.
HS-PS1-8. Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.

Science and Engineering Practices
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.

- Use a model to predict the relationships between systems or between components of a system.
- Develop a model based on evidence to illustrate the relationships between systems or between components of a system.

Disciplinary Core Ideas
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.
- The periodic table orders elements 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.

PS1.C: Nuclear Processes

- Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process.

Crosscutting Concepts
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.

Energy and Matter

- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

Unit Supporting Standards

HS-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.
HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
CCSS.ELA-LITERACY.RST.9-10.9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.
CCSS.ELA-LITERACY.WHST.9-10.1.A. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

Essential Questions

Science Content

What is our universe made of? How can we explain all of the different types of matter that exist in our universe?

What do we know about the atom and how do we know these things even though no one has ever actually seen one?

Why is the periodic table so important?

Science Process

How can we make conclusions about things that are too small for us to see?

How do scientists organize information in a way that makes it easy to see patterns and trends?

How do scientists move forward in understanding an idea without being sure of every detail?

What is the point of a scientific model if they are not like the real thing?

How should I obtain, organize, and present data?

Academic

Am I taking tests the best way?

How do I know if I know something?

Am I a better student than I was at the start of the year?

Performance Expectations: Skills	Performance Expectations: Essential Knowledge/Concepts
1. Organize collected data in a data table 2. Make and record observations objectively and without interpretation 3. Use the equation for density to a. Make qualitative comparisons (ex: two objects are the same size but one is more massive- compare the densities) b. Make quantitative claims (solve for density, mass, or volume given the other two quantities) 4. Direct vs. inverse relationships	1. Matter a. Matter has mass and occupies volume b. Heat and cold do not have measurable mass c. Mass can be converted into energy, and vice versa ($E=mc^2$) 2. Our understanding of matter has evolved over time a. Democritus (400 BCE)- The atom as the basic building block matter. Atoms are tiny, uncuttable, solid particles.

a. Identify whether two variables have a direct or inverse relationship based on how changing one variable affects the other
b. Identify whether two variables have a direct or inverse relationship based on a given equation (direct: numerator, inverse: denominator)

5. Understand how the Law of Conservation of Mass and Energy can be used to understand phenomena and evaluate claims
6. Understand what the "per" means in dimensional units and use that to make predictions (ex: If a substance has a density of 1.5 g/cm^3, how much mass does 1 cm^3 of the substance have? What about 2 cm^3 of the substance?)
7. Describe how scientists were able to make conclusions about an atom even though they were not able to directly see it
8. Explain how scientific models (ex: Bohr model of the atom) can be useful even if they are not completely accurate
9. Identify basic trends in the periodic table
10. Use the periodic table to make claims about properties of elements on the macro and micro scale
11. Explain how differences in nature eventually trend towards stability (ex. isotopes)

b. Dalton (1804)
    i. All matter is composed of extremely small particles called atoms.
    ii. Atoms of a given element are identical in size, mass, and other properties.
    iii. Atoms of different elements differ in size, mass, and other properties.
    iv. Atoms can combine to form compounds. A given compound always has the same proportion of atoms
    v. Atoms cannot be created or destroyed but can combine and rearrange in chemical reactions
c. Chemists/Alchemists in the 1700's and 1800's were rapidly discovering new elements. As new elements were discovered, they were trying to think of a way to organize their discoveries: based on atomic weight or properties?
d. Mendeleev (1869)- used both properties and atomic weight to organize in a single table which included already discovered elements and could be used to predict as-yet-undiscovered elements

3. Chemical and Physical Properties
    a. Chemical properties are observed during a chemical reaction
        i. Ex: Flame test, reactivity with an acid
    b. Physical properties can be observed without altering the identity of the substance
        i. Ex: Malleability, phase, color, luster, hardness, density, mass, conductivity, magnetism
4. Density
    a. Qualitative understanding- how tightly packed together mass is
    b. Dimensional understanding- grams PER mL for liquids, grams PER cm^3 for solids
    c. Quantitative understanding- Density = Mass/Volume
5. The different properties of elements can be

explained by their different atomic structures (form and function)

6. As experimental evidence uncovered new properties of atoms, our understanding of their structure changed
    a. Dalton: Atoms as indivisible “chunks”
    b. Thompson
        i. Applying a high voltage to two metal electrodes produced a cathode ray. Measurements lead to the conclusions that the ray was made of particles which were (1) smaller than atoms and (2) negatively charged
        ii. Revised model: Atoms are made up of smaller negatively charged particles (electrons) spread throughout a positively charged cloud, like plums in plum pudding
    c. Rutherford
        i. When positively charged alpha particles are fired at a piece of gold foil…(1) most pass through (2) a few are slightly deflected (3) a very small number “bounce back”
        ii. Revised model: (1) Atoms are mostly empty space. (2) The negatively charged electrons orbit around (3) a small positively charged nucleus in the center
    d. Bohr
        i. Different elements have different emission spectrums, meaning they are giving off different amounts of energy
        ii. Electrons move around the nucleus in orbits of fixed sizes and energies
        iii. There are problems with the Bohr model. For instance, why don’t the electrons “fall” into the nucleus? The Bohr model also fails to explain some atomic behaviors, specifically for heavier atoms.
    e. Quantum

	i. We will not cover the other models in depth but but students should know that their Bohr model is not “complete” and that scientists are still learning more and revising their model of the atom even today ii. Schrodinger developed a “quantum” model of the atom where electrons are in “clouds of probability” and it is impossible to know their exact location iii. Protons and neutrons can be further divided into quarks iv. All particles may be able to be explained by vibrating strings (string theory) 7. The periodic table, created before the understanding of atomic structure, still accurately represents trends in atomic structure (form and function) a. The table is organized by atomic number, which corresponds to the number of protons b. The atomic mass corresponds to the number of protons plus the number of neutrons c. In “regular” uncharged elements, the number of electrons is equal to the number of protons d. The columns of the periodic table correspond to the number of valence electrons, which are what determine the properties and reactivity of elements i. We can represent this using a Lewis Dot Diagram 8. There can be multiple “types” of atoms for each element a. “Regular”- Identity determined by the number of protons i. Most elements have a “regular” version of an atom that is the most abundant because it is the most stable version b. Ion- Atoms of the same element with different numbers of electrons and therefore different charges

	c. Isotopes- Atoms of the same element with different numbers of neutrons and therefore different masses i. Although different isotopes are possible, they are less abundant because they are less stable than the "regular" version and will decay into a more stable isotope over time ii. The mass listed in the periodic table is the weighted average of the mass of all the isotopes

Transferable Academic Skills and Knowledge:

Students continue to develop, practice, and refine academic skills and concepts from the previous units; in addition they will:

1. Make distinctions between understanding and memorizing.
    a. Things that you truly understand are more durable and easy to recall.
    b. Interpreting new information based on your personal life experiences and associations may be the most important step in determining whether you learn something or don't.
2. Work effectively in a group.
    c. What "roles" need to be played within the group? How can we delegate?
    d. Any member of the group can help to lead the group to success. If one person is disengaged, anyone can kindly invite them back into the activity. If someone monopolizes discussion, anyone might kindly reset the activity of the group to get input from other members.
    e. How should norms in a work group differ from norms in a social group?
    f. What can we do if our group is having a conflict or disagreement?

Student Learning Tasks & Resources	Suggested Teacher Materials/Resources
● Draw and explain the "Goldie" (periodic table tile) Skeleton Sketch ● Writing Task: Students research an element and design an election campaign and slogan for that element. ● Sort different objects (first, drawings of aliens and then samples of elements) into an organized table. ● Explore properties of various element samples. ● Practice analyzing any element in the periodic table, correctly interpreting the name, chemical symbol, atomic mass, atomic number, number of protons, neutron, electrons, and valence electrons, and then predict how any of these might change for isotopes or ions of the same element. ● Record qualitative and quantitative data based on the chemical and physical properties of elements.	● Reading for Understanding Unit Packet ● Differentiated level reading selections such as those from NEWSELA and others. ● Unit Study Guide ● Unit Practice Test ● Periodic Table with full color key and electron distribution for each element included. ● PHET or similar lab simulations ● Online Reviews and Quizzes

● Analyze and construct a scientific model of a typical atom and describe how both an ion or an isotope would differ. ● Identify or draw a Bohr model, or simplified Lewis dot diagram for any of the first 20 elements.	

Wethersfield Public Schools

WHS Curriculum: Integrated Science

Grade(s)	9
Unit Title and Purpose	**Unit 3. Forces, Motions, and Curating Learning Strategies** The student will develop a basic working understanding of the interactions between matter forces and energy while taking further ownership adopting and practicing academic habits
Timeframe	8 weeks

Vision of the Graduate

Communicator: Students will communicate with peers and the teacher about content ideas, questions, and problems that arise. Students will be encouraged to kindly and compassionately try to bring out their best in their workgroup.
Problem Solver: Students will leverage mathematical equations to solve problems related to linear motion, accelerated motion, circular motion, and ultimately universal gravitation. Students will utilize the academic strategies and the scientific method to effectively problem solve from collected data and evidence to create understanding, models, and descriptions of scientific concepts. This will include ongoing reevaluation of their own level of understanding, selecting the steps necessary (with support) to improve their confidence and competence with the topic and academically.
Collaborator: Students will sometimes take the role of receiver and other times that of leader when working with others in class. Grouping will be changed periodically to expose all students to different personalities, views, and perspectives.

Unit Priority Standards

HS-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.
HS-PS2-4. Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects
CCSS.ELA-LITERACY.RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
CCSS.ELA-LITERACY.RST.9-10.5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).
CCSS.ELA-LITERACY.RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

Science and Engineering Practices
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.

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena: Theories and laws provide explanations in science.

- Laws are statements or descriptions of the relationships among observable phenomena.

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 to describe explanations.

Disciplinary Core Ideas
PS2.A: Forces and Motion

- Newton's second law accurately predicts changes in the motion of macroscopic objects.

PS2.B: Types of Interactions

- Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects.
- 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.

Crosscutting Concepts

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

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.

Unit Supporting Standards

HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.

Essential Questions

Science Content

Why do the objects in our universe move in the way they do? How can we explain their motion? How can we predict future motion?

Why did atoms form with the structure that they did?

Why did our universe and solar system form with the structure that it did?

How can objects influence each other without even touching?

Science Process

Why do scientific theories sometimes support and sometimes contradict my own intuitions?

How does one connect a scientific idea or formula with objects in the real world?

How should I convincingly convey my results objectively?

What are the laws behind phenomena?

Does the entire universe, from the very large to the small, follow the same set of laws? Should it?

Academic

What new academic habits work well for me?

Are there still "bad" habits from earlier this year I haven't dropped?

Performance Expectations: Skills	Performance Expectations: Essential Knowledge/Concepts
1. Explain how relationships (direct and inverse) are represented in graphs and draw a conclusion about the relationship between two variables based on the shape of their graph. 2. Accurately graph data in a easy-to-read and non-biased way.	1. Atoms are held together through a combination of the electromagnetic force and strong force. a. The electromagnetic force pulls the electrons towards the nucleus. b. The strong force keeps the protons in the nucleus from moving apart.

a. Title the graph in a way that includes the IV and DV when appropriate
b. Label the axes/variables
c. Include the units
d. Number the axes in equal intervals
e. Scale axes in a way that clearly shows trend
f. Determine the most appropriate type of graph based on the data collected (bar vs. line vs. pie chart)

3. Explain what the "per" means in dimensional units and use that to make predictions (ex: If an object is traveling 10 m/s, how far will it travel in 1 second? 2 seconds?).
4. Make claims and construct explanations based on laws and trends using claim/evidence/reasoning (CER) model.
5. Identify paradoxes or contradictions that new evidence presents.
6. Identify the laws of motion inherent in real life situations.
7. Physically demonstrate the laws of motion with various materials and scenarios.

2. Coulombic Force- the force between charged particles (the "electro" part of the electromagnetic force).
    a. Direction: Opposite charges attract, like charges repel.
    b. Magnitude/Size: The strength of the Coulombic force has an inverse relationship with distance.
3. Gravity can be used to understand how large scale objects (universe, solar system, etc) are held together. Our understanding of gravity and motion has changed over time.
4. Newton's 1st Law: "An object in motion stays in motion and an object at rest stays at rest unless acted upon by an unbalanced external force."
    a. An object traveling at a constant velocity either has no forces acting on it or balanced forces acting on it.
        i. Velocity describes an object's speed (m/s) and direction of travel.
    b. An object that is accelerating has an unbalanced force acting on it.
        i. An object is accelerating if its velocity (speed OR direction) is changing.
5. Newton's 2nd Law: a=F/m (often seen as F=ma but the alternate version a=F/m develops a better conceptual understanding).
    a. Acceleration has a direct relationship with force.
    b. Acceleration has an inverse relationship with mass.
6. Newton's 3rd Law: "Every action has an equal and opposite reaction"
    a. Any time two objects interact, a force pair is created where each object experiences a force from the other.
    b. The two forces involved in the force pair are equal in size and opposite in direction.
7. Newton's Law of Universal Gravitation
    a. Gravity is a force that acts between ANY two objects with mass (the force pulling the apple down to the Earth is the same force that keeps the moon from floating away).

	b. Direction: Gravity is always an attractive force (unlike Coulombic force). c. Magnitude/Size: Gravity has an inverse relationship with distance (like Coulombic force). 8. The orbits of planets can be explained using Newton's Laws. a. If there were no forces acting on an object, it would travel in a straight line at a constant speed. b. Objects traveling in a circle are accelerating because they are changing direction. Therefore, they must have an unbalanced force acting on them that points towards the center of their circular path ("centripetal force"). c. For planets in orbit, the centripetal force is gravity. d. Objects in orbit are "falling" at a sufficient speed that their trajectory matches the curve of the Earth. If objects are not "falling" at the correct speed of in the correct direction, they may instead collide with the Earth (meteorites) or move right past it (meteoroid that never becomes a meteor). 9. Our understanding of gravity evolved over time and is still not complete. a. Newton: able to explain the behavior and effects of gravity but not what caused it. b. Einstein's Special Relativity: Nothing can travel faster than the speed of light. i. The Law of Special Relativity conflicted with the "instantaneous" model of the gravitational force proposed by Newton. c. Einstein's General Relativity: Massive objects cause a warping of Space-Time which affects how other nearby objects move through that Space-Time. This is what is felt as "Gravity." i. Experimental evidence for this theory came in 2015 when a gravitational wave was detected and measured. ii. Einstein's Theory of General

	Relativity has not been successfully applied to very small scales, where Quantum Theory is instead used. d. Physicists are still on a quest for a "unifying" theory of the universe that can explain both large and small scales. i. Particle Physics could act as a unifying theory except that physicists have not yet detected a predicted "Graviton" particle that could explain gravity.

Transferable Academic Skills and Knowledge:

1. Practicing metacognition
    a. More mature learners seem to be more aware of what they know and don't know.
    b. Practice realistic awareness over magical thinking.
    c. Attitude can affect one's confidence and performance. A student who is scared to say out loud that they realistically think they will get an A on the next test, will not feel the confidence of a student that can.
2. Effectively using a study guide
    a. Reflect and record perceived understanding of content on a study guide to somewhat accurately predict a potential score on an assessment at any time during the unit.
    b. Use the study guide to diagnose misunderstandings or gaps in understanding.
        i. If it is something that you used to understand but forgot, review your notes or do additional practice.
        ii. If it is something that you never understood, seek help from the teacher or from online learning resources.
3. The more positive academic habits and personal ownership a student has in the learning process, the more confidence (and hopefully less stress) they will have to maintain a healthy work-life balance.
4. Approach studying in a way that works best for you.
5. Understanding the process of forgetting and how to ensure remembering things you choose to.
    a. Short term and long term memory work very differently. Relying on cramming at the last minute and short term memory is not sustainable.
    b. Select personally meaningful examples/connections to solidify understanding rather than memorizing.
    c. Use card sets, graphic organizers (skeleton sketches), and/or study guides to scaffold and support individual learning process.
6. Scientific Habits of Mind/Open Mindset: A willingness to change one's view when presented with new or contrary evidence transfers into all classes and increasingly in life situations.
7. "Growth mindset"- making mistakes is part of the learning process. Getting something wrong is an opportunity.

Student Learning Tasks & Resources	Suggested Teacher Materials/Resources
Tasks ● Draw and explain the skeleton sketch of Newton's Laws. ● Draw and explain the skeleton sketch of Coulomb's Laws. ● Create a short video (or use another approved format) demonstrating understanding of Newton's Laws in real life	● Unit 03 Reading for Understanding Packet ● Differentiating level reading selections such as those from NEWSELA and others. ● Online Review Tools relating to the topic. ● Online Video Question Tools and Reviews based on this unit. ● PHET SimLab Planet Motion (or similar)

● Writing Task: You meet someone at a family wedding who has a very low opinion of science steeped in conspiracy. They tell you they don't believe in gravity. Write them a one page letter trying to convince them the law of gravity exists.	● Elegant Universe: Einstein's Dream (starting around 13:30ish) (or similar) ● Various physics "toys" bowling balls, hockey pucks, ramps, blocks, hot wheels track and cars, Newton's cradles, etc…

Wethersfield Public Schools

WHS Curriculum: Integrated Science

Grade(s)	9th Grade
Unit Title and Purpose	**Unit 4. The Nature and Uses of Energy and Owning My Role in Learning** The student will create a durable foundational understanding of various forms of energy, energy transformations, and interactions between energy with matter and forces. Additionally the student will evaluate their growing role in the learning process moving forward.
Timeframe	8 weeks

Vision of the Graduate

Communicator: Students will use models, drawings, and demonstrations to explain the fundamental nature of light and electricity. They will communicate with peers and the teacher about content ideas, questions, and problems that arise. Students will be encouraged to kindly and compassionately try to bring out their best in their workgroup.
Problem Solver: Students will utilize the academic strategies and the scientific method to effectively problem solve from collected data and evidence to create understanding, models, and descriptions of scientific concepts. This will include ongoing reevaluation of their own level of understanding, selecting the steps necessary (with support) to improve their confidence and competence with the topic and academically.
Collaborator: Students will sometimes take the role of receiver and other times that of leader when working with others in class. Grouping will be changed periodically to expose all students to different personalities, views, and perspectives.

Unit Priority Standards

HS-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.
HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
HS-PS4-3. Evaluate the claims, evidence, and the reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other
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.

Science and Engineering Practices
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.

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.

- Create a computational model or simulation of a phenomenon, designed device, process, or system.
- Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations.

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 natural and designed worlds. Arguments may also come from current scientific or historical episodes in science.

- Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

- A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence.

Disciplinary Core Ideas

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.

PS3.A: Definitions of Energy

- "Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents. (secondary)
- 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.

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 transferred into or out of the system.
- Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
- 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.
- The availability of energy limits what can occur in any system.

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.
- Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other.

PS4.B: Electromagnetic Radiation

- Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features.

Crosscutting Concepts

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Systems and System Models

- 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.
- 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.

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.

Unit Supporting Standards

HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.
HS-PS1-8. Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.
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 motion of particles (objects) and energy associated with the relative positions of particles (objects).
HS-PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation are absorbed by matter.
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.
HS-PS4-3. Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.

Disciplinary Core Ideas

PS2.B: Types of Interactions

- Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4)

Essential Questions

Science Content

How do energy, forces, and matter interact?

Can one kind of energy be changed into any other kind of energy?

What is the relationship between Forces and Energy?

Science Skills

What makes the results of one experiment stronger than another?

What is the best way of presenting my data?

Academic

How do I balance my responsibilities in school with my leisure time?

What are the study rituals that I'm taking with me into next year?

What did I learn about myself as a learner this year?

Performance Expectations: Skills	Performance Expectations: Essential Knowledge/Concepts

Wethersfield Public Schools

WHS Curriculum: Integrated Science

1. Explain how the Law of Conservation of Mass and Energy can be used to understand phenomena and evaluate claims. 2. Select appropriate measurement tools based on the quantity being measured in a lab setting. 3. Use lab materials appropriately. 4. Interpret equations as statements about relationships between variables. 5. Design an experiment to test a hypothesis based on known laws or facts. 6. Use a variety of materials to directly show transformations in energy (and sometimes forces) from one form to another. 7. Apply understanding of energy dynamics to propose new sources and ways to store energy. 8. Consider potential sources of energy for human use and discuss the advantages and disadvantages of each source.	1. A force acting on an open system can transfer energy into or out of the system. a. An system has energy if it is moving (kinetic energy) or if the objects within the system have the potential to move due to their position (potential energy) b. If there are no external forces acting on a system, the system is closed and there is no energy transferred in or out. c. Some forces (like friction) transfer energy out of the system as heat. 2. Temperature is a measure of the thermal energy within a substance, which is related to the kinetic energy of the atoms in the substance. a. Heat is a transfer of thermal energy from one substance to another. b. Heat can be transferred in various ways. i. Conduction ii. Convection iii. Radiation 3. Energy can also change forms within a system in an energy transformation. 4. Circuits are examples of energy transformations. a. Current is the flow of charges. (kinetic energy) b. The voltage of a battery is related to the potential energy the battery gives the charges. (potential energy) c. Charges gain potential energy (voltage) as they travel through the battery and lose potential energy (voltage) as they travel through various circuit elements. i. When charges “lose” potential energy, it is being transformed into other forms based on the type of circuit element. Ex: radiant energy (lightbulb) or sound energy (speaker) or kinetic energy (motor) or heat (resistors and all the others too). ii. The voltages lost through each circuit element should add up to the voltage gained through the battery in order for energy to be conserved. d. Current has a direct relationship with Voltage and an inverse relationship with

	Resistance (Ohm's Law: Current = Voltage/Resistance). i. Conductor- A material through which charge can easily flow (low resistance). ii. Insulator- A material through which charge cannot easily flow (high resistance). 5. Electromagnetic devices also make use of energy transformations and connections between electricity and magnetism a. Motors transform electric energy into kinetic energy. i. A moving charge (current) generates a magnetic field around it (electromagnet). ii. An electromagnet placed in the presence of a magnet will move. b. Generators transform kinetic energy into electric energy. i. A moving magnet induces a current. 6. Any energy that we use in our lives needs to come from somewhere and can be traced back to previous sources. a. Potential sources of energy for human use can be classified as renewable or non-renewable and each source has both advantages and disadvantages. b. Energy output can never exceed the Energy input and in practice is always smaller than the Energy input due to "waste" energy. i. The most common form of waste energy is heat. ii. Efficiency is a measure of how much of the input energy is transformed into useful output energy. iii. Many opportunities exist for students to consider potential sources of energy for human use, all with various trade offs. 7. Energy can be transferred by waves a. Wave- Traveling disturbance that transfers energy across space.

	b. Sound Waves- Traveling disturbances through matter. Speed of sound in air is about 300 m/s (3 x 10^2 m/s). c. Electromagnetic Waves- Traveling disturbances through electromagnetic fields. Speed of electromagnetic waves through empty space is 300,000,000 m/s (3 x 10^8 m/s). 8. Frequency and wavelength are important characteristics of waves. a. Frequency- The number of vibrations per second that the wave causes as it passes by. b. Wavelength- The distance between wave peaks. 9. Our perceptions of waves are based on their characteristics. a. For sound waves, our brain translates the frequency of the sound wave into pitch. b. For electromagnetic waves, our brain can only interpret a small range of frequencies. i. Electromagnetic waves within this range are known as “visible light” and our brains translate their frequencies into different colors. ii. Electromagnetic waves existing outside this range are invisible to us but they are still there even though we can not see them with our naked eye. iii. The frequency of electromagnetic waves also has a direct relationship with the energy carried by that wave. 10. Electromagnetic waves are organized into the electromagnetic spectrum based on their size, or wavelength. a. All types of electromagnetic waves travel at the same speed in a vacuum. b. The differentiating factor between the types of electromagnetic waves is their sizes. c. Sound is not a part of the electromagnetic spectrum though it is still an example of a wave.

	i. It is a disturbance in matter and cannot travel through empty space. ii. It travels slower than the electromagnetic waves. 11. When waves encounter a change in medium, they can be: a. Reflected- Bounce back into the original medium. b. Transmitted- Pass through into the new medium. i. When waves are transmitted at an angle, they are also refracted (bent). 12. Our understanding of light has evolved over time. a. Scientists used to argue whether light was a particle or a wave. b. Thomas Young showed that light was a wave in his double slit experiment. c. The wave model of light could not accurately explain the photoelectric effect. d. Einstein won the Nobel Prize for explaining the photoelectric effect by saying that light was both a particle and a wave, a statement that would pave the way to the development of Quantum Mechanics.

Transferable Academic Skills and Knowledge:

1. Apply learned strategies in daily practice to create a personalized and productive workflow both in and out of the classroom.
2. Reflect on self care, work-life balance, and basic goal-setting for the future.
3. Formally inventory the skills they've tried this year and anticipate which they will carry into future learning.
4. Reflect:
    a. What did I learn about myself as a learner this year?
    b. What am I interested to learn about in the future?
    c. What future careers might interest me?

Student Learning Tasks & Resources	Suggested Teacher Materials/Resources
● Draw and explain the "Xavier" (electromagnetic spectrum) Skeleton Sketch. ● Transforming Energies: Students use a variety of materials to manipulate energies from one form to another. They select what media (podcast, video, graphic novel) to communicate this first-hand transformation process.	● Hand Crank Generators ● Motor Kits ● Various electronic items, fans, motors, solar cells, batteries, speakers, open circuits components, and circuit kit materials. ● Reading for Understanding Unit Packet

● Mini Lab Stations: Students circulate around the room to participate in energy lab stations, focusing on a hands-on task, skill, or concept at each station. ● Writing Task: Students write a formal lab report based on an experiment.	● Differentiated level reading selections such as those from NEWSELA (or others). ● Unit Study Guide ● Unit Practice Test ● PHET Lab simulations