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| **Energy: Unit 3 – (7 weeks)**  **OVERVIEW:** This unit introduces students to the topic of energy and the ideas of energy conservation. The students begin by developing understandings about the different forms of energy (i.e. Kinetic and Potential). Students then connect these concepts to develop an understanding about the law of conservation of energy. Furthermore, the unit provides the students with tools to deepen their knowledge about renewable and non-renewable sources of energy, and how using these sources affect the environment. While studying this unit, the students have the opportunity to make connections between the ideas of conservation of energy and conservation of momentum, especially in the study of elastic collisions.  The foundations to develop an understanding of radioactivity are also introduced here. A connection is made between the student understandings of radioactivity and energy conservation through a critical assessment about nuclear energy use pros and cons. A very important component of the scientific work is the process of peer review. In this unit the students are introduced to the peer review process by allocating time throughout the lessons for them to write an essay paper on one of the energy topics suggested, and then having this paper reviewed by a group of their classmates before submitting it to the teacher. | |
| **Standards**  **Supporting Content Standards**  **SP2. Students will evaluate the significance of energy in understanding the structure of matter and the universe.**   1. Relate the energy produced through fission and fusion by stars as a driving force in the universe. 2. Explain how the instability of radioactive isotopes results in spontaneous nuclear reactions.   **SP3. Students will evaluate the forms and transformations of energy.**   1. Analyze, evaluate, and apply the principle of conservation of energy and measure the components of work-energy theorem by  * describing total energy in a closed system. * identifying different types of potential energy. * calculating kinetic energy given mass and velocity. * relating transformations between potential and kinetic energy.  1. Explain the relationship between matter and energy.   **Characteristics of Science Standards**  **SCSh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.**   1. Exhibit the above traits in their own scientific activities. 2. Recognize that different explanations often can be given for the same evidence. 3. Explain that further understanding of scientific problems relies on the design and execution of new experiments which may reinforce or weaken opposing explanations.   **SCSh2. Students will use standard safety practices for all classroom laboratory and field investigations.**   1. Follow correct procedures for use of scientific apparatus. 2. Demonstrate appropriate technique in all laboratory situations. 3. Follow correct protocol for identifying and reporting safety problems and violations.   **SCSh3. Students will identify and investigate problems scientifically.**   1. Suggest reasonable hypotheses for identified problems. 2. Develop procedures for solving scientific problems. 3. Collect, organize and record appropriate data. 4. Graphically compare and analyze data points and/or summary statistics. 5. Develop reasonable conclusions based on data collected. 6. Evaluate whether conclusions are reasonable by reviewing the process and checking against other available information.   **SCSh4. Students will use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.**   1. Develop and use systematic procedures for recording and organizing information. 2. Use technology to produce tables and graphs. 3. Use technology to develop, test, and revise experimental or mathematical models.   **SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.**   1. Trace the source on any large disparity between estimated and calculated answers to problems. 2. Consider possible effects of measurement errors on calculations. 3. Recognize the relationship between accuracy and precision. 4. Express appropriate numbers of significant figures for calculated data, using scientific notation where appropriate. 5. Solve scientific problems by substituting quantitative values, using dimensional analysis and/or simple algebraic formulas as appropriate.   **SCSh6. Students will communicate scientific investigations and information clearly.**   1. Write clear, coherent laboratory reports related to scientific investigations. 2. Write clear, coherent accounts of current scientific issues, including possible alternative interpretations of the data 3. Use data as evidence to support scientific arguments and claims in written or oral presentations. 4. Participate in group discussions of scientific investigation and current scientific issues.   **The Nature of Science Standards**  **SCSh7. Students will analyze how scientific knowledge is developed.**   1. The universe is a vast single system in which the basic principles are the same everywhere. 2. Universal principles are discovered through observation and experimental verification. 3. From time to time, major shifts occur in the scientific view of how the world works. More often, however, the changes that take place in the body of scientific knowledge are small modifications of prior knowledge. Major shifts in scientific views typically occur after the observation of a new phenomenon or an insightful interpretation of existing data by an individual or research group. 4. Hypotheses often cause scientists to develop new experiments that produce additional data. 5. Testing, revising, and occasionally rejecting new and old theories never ends.   **SCSh8. Students will understand important features of the process of scientific inquiry.**   1. Scientific investigators control the conditions of their experiments in order to produce valuable data. 2. Scientific researchers are expected to critically assess the quality of data including possible sources of bias in their investigations’ hypotheses, observations, data analyses, and interpretations. 3. Scientist use practices such as peer review and publication to reinforce the integrity of scientific activity and reporting. 4. The merit of a new theory is judged by how well scientific data are explained by the new theory. 5. The ultimate goal of science is to develop an understanding of the natural universe which is free of biases. 6. Science disciplines and traditions differ from one another in what is studied, techniques used, and outcomes sought.   **Reading Standard**  **SCSh9. Students will enhance reading in all curriculum areas by:**   1. Reading in all curriculum areas  * Read technical texts related to various subject areas. * Building vocabulary knowledge * Demonstrate an understanding of contextual vocabulary in various subjects. * Use content vocabulary in writing and speaking. * Explore understanding of new words found in subject area texts.  1. Establishing context  * Explore life experiences related to subject area content. Determine strategies for finding content and contextual meaning for unknown words.   **ELA Reading and Writing Standards**  ELACC11-12RI1: Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.  ELACC11-12RI7: Integrate and evaluate multiple sources of information presented indifferent media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.  **Math Standards**  MCC9‐12.N.VM.1 (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., v, |v|, ||v||, v).  MCC9‐12.N.VM.2 (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.  MCC9‐12.N.VM.3 (+) Solve problems involving velocity and other quantities that can be represented by vectors.  MCC9‐12.N.VM.4 (+) Add and subtract vectors.  MCC9‐12.N.VM.4a (+) Add vectors end‐to‐end, component‐wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.  MCC9‐12.N.VM.4b (+) Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum. | **Enduring Understandings**   1. Energy exists in various forms and can be transformed from one form to another (Law of Conservation of Energy). 2. The mechanical energy of a system is the sum of its kinetic and potential. 3. Kinetic and potential energy are descriptions of the forms that energy can have. 4. Work is the result of the displacement of an object under the action of a force. 5. There is a relationship between matter and energy in the equation E = mc2. 6. Vast amounts of energy are produced in fission and fusion reactions. 7. Nuclear fission and fusion are the processes that create the array of elements in the universe. 8. Temperature is a measure of the average kinetic energy for the molecules/atoms in a substance. 9. Heat flow is the energy transfer between objects due to a temperature difference between them. 10. The energy that a substance has due to its temperature is its internal energy. 11. Power is the amount of energy used by a system in a given unit time. 12. Electrons are outside the nucleus and the protons and neutrons are located inside the nucleus.   13. Radioactivity is the process of sequential steps by which unstable radioactive isotopes decay into stable isotopes. |
| **Essential Questions**   1. Why are humans dependent on transformations of energy? 2. Why and how is energy conserved? 3. Why does society spend a lot of resources on controlling thermal energy? 4. Why are we unable to do any nuclear experiments in physics this year? 5. What happens to the energy in two different objects when the two objects collide? 6. Why may a substance feel cold to the touch to one person but warm to another? | **Key Vocabulary Terms/Language**  Energy transformations, potential energy, kinetic energy, conservation of energy, electric potential energy, elastic potential energy, gravitational potential energy, work, force, gravity, closed system, matter, conservation of momentum, elastic collision, inelastic collision, heat, temperature, internal energy, structure of matter, formation of matter, fission, fusion, radioactivity, power, significant figures, calculate, experiment, precision measure, accuracy, SI units, describe, scientific notation, conclusion, hypothesis, data, contrast, compare, variable, infer, analyze, predict, interpret. |
| **Misconceptions** | **Proper Conceptions** |
| * Two objects traveling side-by-side must have the same speed | * The objects traveling side-by-side do not always have the same speed. An example of this is two objects traveling in a circle can be side-by-side yet traveling at different speeds. |
| * Velocity is always positive. | * Velocity is a vector quantity, the negative or positive sign of the velocity is related to the direction of motion. |
| * Acceleration and velocity travel in the same direction. | * Acceleration and velocity not always point in the same direction. The vectors themselves do not travel; they describe a rate of change in a direction. An example of acceleration and velocity in different directions is when an object is decelerating. An object that is decelerating (negative acceleration) has acceleration in the opposite direction of the velocity. |
| * Velocity is classified as a force. | * Velocity is not a force. Force is measured in Newtons (N), and velocity is measured in m/s (distance/ time). |
| * If velocity is zero, then the acceleration must be zero also. | * When an object changes direction by 180º will reach an instant velocity of zero but will also experience acceleration in the opposite direction of its original motion. An example of this is when an object is thrown upward and reaches its maximum high, its velocity is zero. However, it is being accelerated downwards with an acceleration of 9.8m /s 2. |
| * A positive slope for a negative velocity indicates that the object is speeding up. | * In a graph of velocity vs. time, the positive slope of a negative velocity implies that the object is slowing down. |
| * The position vs. time graph and velocity vs. time graph plot the path of an object. | * The position vs. time graph indicates the velocity of an object and its distance from the origin, not its path. The velocity vs. time graph indicates the acceleration of an object. |
| * Heavier objects fall faster than lighter objects. | * All objects fall at the same rate neglecting air resistance. |
| * The acceleration of an object falling downward depends upon its mass. | * The acceleration of a falling object is independent of mass. The acceleration of a falling object depends of the magnitude of the gravitational acceleration acting upon it. |
| * Acceleration and velocity are the same. | * Acceleration is the rate of change of velocity. |
| * Freely falling bodies only move downward. (ex. satellites) | * Freely falling bodies such as a satellite fall toward the earth, creating a circular orbit rather than falling ‘downward’. |
| * Gravity does not exist in a vacuum. | * Gravitational force is caused by mass. Planets, stars and even you produce gravitational fields. |
| * Gravity is only present when objects are falling. | * Gravity is always present. The acceleration of gravity is the result of the gravitational force exerted by the presence of mass. |
| * When an object is traveling with a horizontal velocity, and is thrown upward, the path the object follows is along a line. | * When an object is traveling with a horizontal velocity, and is thrown upward, the object actually makes a parabolic path. |
| * Nuclei disappear when they decay. | * Radioactive decay does not cause nuclei to disappear. |
| * Half-life is half the time for the radioactivity to disappear. | * Radioactivity never really disappears completely. If it does, there is no set timeframe for the absence of radioactivity. |
| * You get contaminated by radiation. | * Contamination occurs from exposure to radioactive matter (i.e. dust from a nuclear explosion) not from nuclear radiation (i.e. alpha, beta and gamma). |
| * Radiation makes things radioactive like some communicable disease. | * When something absorbs nuclear radiation it doesn't itself become radioactive. The only exception to this is if you use a neutron source, which are very rare in nature and normally have to be made. In this case a minuscule fraction of the nuclei can sometimes absorb a neutron becoming unstable and giving off a particle to settle down. As far as student understanding is concerned, this is never the case with alpha, beta and gamma radiation. |
| * Beta particles are electrons; therefore they come from an atom's electron shells. | * A beta particle is an electron that's created when a neutron changes into a proton. So a beta particle comes from a change in the nucleus, not from the electrons surrounding it. |
| * Alpha particles cause more ionizations than beta particles | * If we have an alpha and beta particle of the same energy then they'll tend to cause roughly the same number of ionizations before coming to rest (say, 100 000 in air). This is because both particles have the same amount of energy to 'spend' on ionization and the cost of ionization is more of a function of what's being ionized (i.e. an air molecule) than what's doing it. However, alpha particles tend to lose their energy in a very short distance because they are much more likely to ionize a given atom at a given distance than the equivalent beta particle. Alpha particles cause ionizations that are concentrated in a fairly short distance whereas with beta particles they are more spread out. |
| **Unit Requirements**   * **GaDOE Outline for Culminating Performance Tasks with accompanying rubric, see** [**pp. 5 – 16 of Georgia Performance Standards Framework for Science – Physics**](http://www.gpb.org/chemistry-physics/physics/1502) * **Unit Assessment with Blueprint and DOK levels** | |
| **Section 2 – Nuclear Physics ( 3.5 Weeks)** | |
| **Learner Targeted Objectives and Goals**   1. Subatomic Physics    1. The Nucleus       1. Identify the properties of the nucleus of an atom       2. Explain why some nuclei are unstable       3. Calculate the binding energy of various nuclei    2. Nuclear Decay       1. Describe the three modes of nuclear decay       2. Predict the products of nuclear decay       3. Calculate the decay constant and the half-life of a radioactive substance    3. Nuclear Reactions       1. Distinguish between nuclear fission and nuclear fusion       2. Explain how a chain reaction is utilized by nuclear reactors       3. Compare fission and fusion reactors    4. Particle Physics       1. Define the four fundamental interactions of nature       2. Identify the elementary particles that make up matter       3. Describe the standard model of the universe | **Knowledge and Skills**   1. Discuss properties of atomic nucleus; identify mass number, atomic number, and neutron number; explain why some nuclei are unstable; and show how to calculate binding energy. 2. Describe the three types of radioactive decay, show how to predict the outcome of nuclear decay, define the decay constant, and show how to calculate the half-life of a radioactive substance. 3. Distinguish between nuclear fission and nuclear fusion and explore nuclear chain reactions 4. Discuss the four fundamental interactions of nature and their mediating particles, classify the elementary particles that make up matter, and describe the standard model of the universe. |
| **Mandatory Activities & Performance Tasks- Must be included for EVERY UNIT (supporting PDF documents should be hyperlinked to tasks)**   * **Writing Activities**   + [**Georgia Performance Standards Framework for Science Writing Activity, pp. 5 - 16**](http://www.gpb.org/chemistry-physics/teachers) * **Laboratory Activities**    + [PhET : Nuclear Fission Simulation - Student Guide](http://www.gpb.org/chemistry-physics?ID=11332) * **Literature Reviews**    + [Too Fast to be True](http://www.google.com/url)   + [Older Stars, New Age for the Universe](http://www.thephysicsfront.org/items/detail.cfm)   + [Cell Phones on the Brain](https://www.georgiastandards.org/Frameworks/GSO%20Frameworks/9-12%20Science%20Traditional%20Physics%20Framework%20Energy.pdf) * **Case Studies**   + [The Benign Hamburger](https://www.georgiastandards.org/Frameworks/GSO%20Frameworks/9-12%20Science%20Traditional%20Physics%20Framework%20Energy.pdf)     - [The Benign Hamburger Teaching Notes](http://www.thephysicsfront.org/items/detail.cfm) | **Supplemental Resources**   * [GaDOE framework and ELA standards](http://www.thephysicsfront.org/static/unit.cfm) * supporting resources aligned to the unit of study   + [Furry Elephant - Radioactivity and Atomic Physics Explained](http://www.explorelearning.com/index.cfm)   + [Khan Academy Physics Tutorials](http://www.sciencenewsforkids.org/2011/04/cell-phones-on-the-brain/#physics)   + [GPB Chemistry and Physics Instructor Resource Request Link](http://sciencecases.lib.buffalo.edu/cs/files/benign_burger.pdf)   + [GPB Chemistry and Physics Web Page](http://www.sciencenewsforkids.org/2012/03/too-fast-to-be-true/)     - Nuclear Science Unit Resources:       * [Physics 1501: Nuclear Science – Part I](http://www.furryelephant.com/content/radioactivity/)       * [Physics 1502: Nuclear Science – Part II](http://www.explorelearning.com/index.cfm)   + [Physics Lab Online Resource Index Page](http://sciencecases.lib.buffalo.edu/cs/files/benign_burger_notes.pdf)   + [The Physics Front Homepage](https://www.georgiastandards.org/Frameworks/GSO%20Frameworks/9-12%20Science%20Traditional%20Physics%20Framework%20Energy.pdf)     - [Algebra-Based Physics: Particles and Interactions and the Standard Model Units](http://www.sciencenewsforkids.org/2004/05/older-stars-new-age-for-the-universe-2/?sb=14&course=4) * Holt Physics Textbook pages for *Subatomic Physics*  pp. 788 - 930 * Bell Ringer activities   + Holt Physics Textbook pages for *Standardized Test Prep*  pp. 824 - 825 * Gizmo simulations:   + [Half-Life](http://www.khanacademy.org/?method=cResource.dspDetail&ResourceID=369)   + [Nuclear Decay](http://www.gpb.org/chemistry-physics/teachers?method=cResource.dspDetail&ResourceID=490) * PowerPoint/Prezi notes   + [The ABC’s of Radiation](http://dev.physicslab.org/Lessons.aspx)   + [Nuclear Physics PowerPoint](http://www.thephysicsfront.org/index.cfm?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&ved=0CCYQFjAB&url=http://www.ktaggart.co.uk/physics/PowerPoint/KTGCSENotes/GCSE-27-NuclearPhysics.ppt&ei=2WRFULf7D4-I9QT3kIGoAQ&usg=AFQjCNEy4DPMgyC7hwlik99hRI40hjz9Dw&sig2=nHsan-25u3H39twhGh5FtQ) |
| **Suggested Activities and Performance Tasks**   * [PhET : Nuclear Fission Simulation - Student Guide](http://www.gpb.org/chemistry-physics/physics/1501?ID=11332) | **Common Assessments**   * **Section Assessment Resources**    + [GPB Chemistry and Physics Instructor Resource Request Link](http://www.lbl.gov/abc/presentations/AAPT2005/AAPT2005.html) |