**Physical Science Curriculum Revision**

**Semester 1: Chemistry**

**PS1: Matter and Its Interactions**

***How can one explain the structure, properties, and interactions of matter?***

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| **PS1.A: Structure and Properties of Matter**  ***Essential Question: How do particles combine to form the variety of matter one observes?***  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. The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. | | | | |
| **TOPIC** | **Performance Expectation** | **Science & Engineering**  **Practice** | **Crosscutting Concepts** | **Resources** |
| **Properties of Matter**  Pearson Textbook Phys. Science CIA  Chapter 2  2.1-2.3 | **HS-PS1-3:**  Plan and conducting investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. | [**Planning and Carrying Out Investigations**](http://www.nap.edu/openbook.php?record_id=13165&page=59)  [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.](http://www.nap.edu/openbook.php?record_id=13165&page=59)  [-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. (HS-PS1-3)](http://www.nap.edu/openbook.php?record_id=13165&page=59) | [**Patterns**](http://www.nap.edu/openbook.php?record_id=13165&page=85)  [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. (HS-PS1-3)](http://www.nap.edu/openbook.php?record_id=13165&page=85) | [Powers of Ten, 80’s IBM video](https://www.youtube.com/watch?v=0fKBhvDjuy0)  [Scale of the Universe](http://htwins.net/scale2/)  [Chemical and Physical Change virtual labs](http://vital.cs.ohiou.edu/steamwebsite/downloads/ChangeLab.swf)  [Separating mixtures virtual lab](http://www.harcourtschool.com/activity/mixture/mixture.html) |
| **Periodic Table**  Chapter 5  5.1-5.3 | **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. | [**Developing and Using Models**](http://www.nap.edu/openbook.php?record_id=13165&page=56)  [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.](http://www.nap.edu/openbook.php?record_id=13165&page=56)  [-Use a model to predict the relationships between systems or between components of a system. (HS-PS1-1)](http://www.nap.edu/openbook.php?record_id=13165&page=56) | [**Pattern**](http://www.nap.edu/openbook.php?record_id=13165&page=85)s  [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.](http://www.nap.edu/openbook.php?record_id=13165&page=85) (HS-PS1-1) | [Periodic Table of Videos - Each element has a short video including properties , demos & experiments](http://periodicvideos.com/)  [Interactive Periodic table with lots of features](http://www.rsc.org/periodic-table)    [A series of labs to model the periodic table](http://www.umanitoba.ca/outreach/crystal/Grade%209/Cluster%202/S1-2%20-%20Chemistry%20and%20Periodic%20Table%20Unit%20Plan.doc)  Nova Elements - movie and app with atom builder |
| **States of Matter**  Chapter 3  3.1-3.3 | **HS-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. | [**Planning and Carrying Out Investigations**](http://www.nap.edu/openbook.php?record_id=13165&page=59)  [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.](http://www.nap.edu/openbook.php?record_id=13165&page=59)  [-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. (HS-PS1-3)](http://www.nap.edu/openbook.php?record_id=13165&page=59) | [**Patterns**](http://www.nap.edu/openbook.php?record_id=13165&page=85)  [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.](http://www.nap.edu/openbook.php?record_id=13165&page=85)  (HS-PS1-3) | [States of matter virtual lab](http://www.harcourtschool.com/activity/states_of_matter/)    [melting point techniques](http://www.wiredchemist.com/chemistry/instructional/laboratory-tutorials/determination-of-melting-point)  [labs and activities on the investigation of melting and freezing point](http://www.middleschoolchemistry.com/lessonplans/chapter2/lesson4)  [Inter and intramolecular forces](http://www.middleschoolchemistry.com/teacherbackground/chapter4/intramolecular_intermolecular.php) |
| **Atomic Structure**  Chapter 4  4.1-4.3 | **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. | [**Developing and Using Models**](http://www.nap.edu/openbook.php?record_id=13165&page=56)  [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.](http://www.nap.edu/openbook.php?record_id=13165&page=56)  [-Use a model to predict the relationships between systems or between components of a system.](http://www.nap.edu/openbook.php?record_id=13165&page=56) (HS-PS1-1) | [**Patterns**](http://www.nap.edu/openbook.php?record_id=13165&page=85)  [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.](http://www.nap.edu/openbook.php?record_id=13165&page=85) (HS-PS1-1) | [Building an atom](http://phet.colorado.edu/en/simulation/build-an-atom)  [Activities and resources to engage learners](http://www.middleschoolchemistry.com/lessonplans/chapter4/lesson1)  [Hands on group activities](http://www.middleschoolchemistry.com/lessonplans/chapter4/lesson2) |

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| **PS1.B: Chemical Reactions**  ***Essential Question: How do substances combine or change (react) to make new substances? How does one characterize and explain these reactions and make predictions about them?***  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 by changes in kinetic energy. In many situations a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. 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. Chemical processes and properties of materials underlie many important biological and geophysical phenomena. | | | | |
| **TOPIC** | **Performance Expectation** | **Science & Engineering**  **Practice** | **Crosscutting Concepts** | **Resources** |
| **Chemical Bonds**  Chapter 6  6.1-6.4 | **HS-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.  **HS-PS1-5**  Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. | [**Developing and Using Models**](http://www.nap.edu/openbook.php?record_id=13165&page=56)  [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.](http://www.nap.edu/openbook.php?record_id=13165&page=56)  -Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS1-4)  **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.  -Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. (HS-PS1-5) | **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. (HS-PS1-4)  [**Patterns**](http://www.nap.edu/openbook.php?record_id=13165&page=85)  [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.](http://www.nap.edu/openbook.php?record_id=13165&page=85) (HS-PS1-5) | [Gumdrop lab for modeling ionic and covalent bonds](http://images.pcmac.org/SiSFiles/Schools/GA/BryanCounty/RHMiddle/Uploads/DocumentsCategories/Documents/Gumdrop%20lab_2.pdf)  [Animation Explanation of Bonds](http://www.kentchemistry.com/links/bonding/bondingflashes/bond_types.swf)  [Change in energy lab](http://www.middleschoolchemistry.com/lessonplans/chapter6/lesson7) |
| **Chemical Reactions**  Chapter 6  6.1-6.3  Chapter 7  7.1-7.3  Chapter 8  8.1-8.4  shortened  **Included with Chemical Reactions**  **Solutions, Acids & Bases** | **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-PS1-4:**  Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends on the changes in total  bond energy.  **HS.PS1-7**  Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. | **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 future. (HS-PS1-2)  **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 to illustrate the relationships between systems or between components of a system. (HS-PS1-4)  **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 support claims. (HS-PS1-7) | [**Patterns**](http://www.nap.edu/openbook.php?record_id=13165&page=85)  [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.](http://www.nap.edu/openbook.php?record_id=13165&page=85) (HS-PS1-2)  **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. (HS-PS1-4)  **Energy and Matter**  The total amount of energy and matter in closed systems is conserved. (HS-PS1-7) | [Chemical Reactions - awesome teacher resources](http://www.nclark.net/ChemicalReactions)    [Reactions, products and leftovers](http://phet.colorado.edu/en/simulation/reactants-products-and-leftovers)  [Using a chemical change to predict an unknown](http://www.middleschoolchemistry.com/lessonplans/chapter6/lesson6)  [If you’re not part of the solution, you’re part of the precipitate](https://www.teachengineering.org/view_activity.php?url=collection/mis_/activities/mis_pharma/mis_pharma_lesson01_activity1.xml)  [Alien Juice Bar acids and base indicators](http://www.lawrencehallofscience.org/static/scienceview/scienceview.berkeley.edu/html/showcase/flash/juicebar.html)  [Experiments with Acids and Bases](http://funsci.com/fun3_en/acids/acids.htm)  [Virtual Acid Base Lab](http://phet.colorado.edu/en/simulation/ph-scale-basics) |

**Semester 2: Physics**

**PS2: Motion and Stability: Forces and Interaction**

***How can one explain and predict interactions between objects and within systems of objects?***

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| **PS2.A: Forces and Motion**  ***Essential Question: How can one predict an object’s continued motion, changes in motion, or stability?***  Newton’s Second Law accurately predicts changes in the motion of macroscopic objects. Momentum is defined for a particular frame of reference; it is the mass times the velocity of the objects. If a system interacts with objects outside itself, the total momentum of the system can change; however, and such change is balanced by changes in the momentum of objects outside the system. | | | | |
| **TOPIC** | **Performance Expectation** | **Science & Engineering**  **Practice** | **Crosscutting Concepts** | **Resources** |
| **Motion**  Chapter 11  11.1-11.3 | **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-PS2-3:**  Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.\* | **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. (HS-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. (HS-PS2-3) | **Cause and Effect**  -Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2- 1)  -Systems can be designed to cause a desired effect. (HS-PS2-3) | [relative motion](http://www.classzone.com/books/ml_science_share/vis_sim/mfm05_pg7_relmotion/mfm05_pg7_relmotion.html)  [physics resources for all topics](http://www.physicsclassroom.com/)  [Walking Displacement Lab](http://www.google.com/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=1&cad=rja&uact=8&ved=0CB4QFjAA&url=http%3A%2F%2Fkawameeh.twpunionschools.org%2Fsubsites%2Fhbormann%2Fdocuments%2FDistance%2520and%2520Displacement%2520Lab-1.docx&ei=tNYSVd_jL5feoASC74CwDg&usg=AFQjCNHgtI5Tiv2i__hCMPGUiJoa29vg8w&sig2=ZpVCRFQOO5OWCKuewAPjAQ&bvm=bv.89184060,d.cGU)  [Speed and Velocity Lab](http://www.google.com/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=2&cad=rja&uact=8&ved=0CCMQFjAB&url=http%3A%2F%2Fwww.am.dodea.edu%2Flejeune%2Fbms%2FLion_Docs%2Fdocuments%2FSpeedandVelocityLab.doc&ei=NtkSVZiuJo7joAST74CQDg&usg=AFQjCNFnqLqyBJb7wNQgFEcPdoYelI5QQg&sig2=dteUQdvY0q43FUHjkVSXEg&bvm=bv.89184060,d.cGU)  [Vector Project](http://ciese.org/curriculum/vectorproj/) |
| **Forces & Motion**  Chapter 12  12.1-12.3 | [Newton’s laws interactive tutorial](http://www.google.com/url?q=http%3A%2F%2Fwww.sciencechannel.com%2Fgames-and-interactives%2Fnewtons-laws-of-motion-interactive%2F&sa=D&sntz=1&usg=AFQjCNHWmTR9NgAEtBu70ozz4vplsWgb8g)  [Newton's Laws Bundle](http://www.cpalms.org/Public/PreviewResource/Preview/46066)  [Is Friction Good or Bad?](https://docs.google.com/file/d/0B5vZUViZFtxaNXAzcllGRTRiSG8/edit)  [Accident Reconstruction](http://www.thephysicsfront.org/items/Load.cfm?ID=4941) |

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| **PS2.B: Types of Interactions**  ***Essential Question: What underlying forces explain the variety of interactions observed?***  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, electrical, and magnetic) permeating space that can transfer energy through space. Magnets or electrical currents cause magnetic fields; electrical charges or changing magnetic fields cause electrical fields. Attraction and repulsion between electrical charges at the atomic scale explain the structure, properties, ***and*** transformations of matter as well as the contact forces between material objects. | | | | |
| **TOPIC** | **Performance Expectation** | **Science & Engineering**  **Practice** | **Crosscutting Concepts** | **Resources** |
| **Universal Forces**  Chapter Sections  12.4, 20.1 | **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. | **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. (HS-PS2-4) | **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. (HS-PS2-4) | [**phet universal forces simulation and labsheet**](http://phet.colorado.edu/en/simulation/legacy/gravity-force-lab)  [**Slideshow for section 12.4 universal forces**](http://www.slideshare.net/robtownsend/12-4-universal-forces-part-1) |
| **Gravity**  pgs 380-382  pg 796 | [Egg Drop](http://weirdsciencekids.com/EggDropExperiment.html)  [$20 Gravity Challenge (Lab)](http://www.thirteen.org/edonline/ntti/resources/lessons/gravity/index.html)  [NASA activities and labs about gravity](http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Microgravity_Teachers_Guide.html)  [Gravity Lab (helps explain orbit)](https://www.teachengineering.org/view_activity.php?url=collection/cub_/activities/cub_mars/cub_mars_lesson04_activity1.xml) |
| **Electricity** | **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. | [**Planning and Carrying Out Investigations**](http://www.nap.edu/openbook.php?record_id=13165&page=59)  [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.](http://www.nap.edu/openbook.php?record_id=13165&page=59)  [-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. (HS-PS2-5)](http://www.nap.edu/openbook.php?record_id=13165&page=59) | **Cause and Effect**  -Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-5) | [E & M Tutorial](http://www.google.com/url?q=http%3A%2F%2Fippex.pppl.gov%2Ftemp%2FE%2526M.swf&sa=D&sntz=1&usg=AFQjCNE0ENsCkNTNzhiHdik-Fg9gwyN_XA)  [Electricity Lessons](https://www.google.com/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=9&cad=rja&uact=8&ved=0CFcQFjAI&url=https%3A%2F%2Fwww.portlandgeneral.com%2Fcommunity_environment%2Fcommunity_involvement%2Four_programs%2Fdocs%2Fbasic_electricity_lessons_9-12.pdf&ei=m-jTVKr-D8yoogTS8YL4BA&usg=AFQjCNE3YbHCU_IQ7QIUAJyNYwc9fFmhDA&sig2=1S9J9ysaAJmMMbaZLf4A_Q&bvm=bv.85464276,d.cGU)  [Squishy Circuits](http://www.pbs.org/parents/adventures-in-learning/2014/02/electric-play-dough/)  [Salt Water Circuit](https://www.teachengineering.org/view_activity.php?url=collection/cub_/activities/cub_desal/cub_desal_lesson01_activity1.xml) |
| **Magnetism** | E[lectricity & Magnetism lab](http://www.doe.virginia.gov/testing/sol/standards_docs/science/2010/lesson_plans/physical_sci/energy/sess_PS-11bc.pdf)  [Magnetosphere 7min discovery movie](https://www.youtube.com/watch?v=yEYy_nVC4L0)  [Earth's Magnetic Field Reading](http://www.windows2universe.org/earth/Magnetosphere/earth_magnetic_poles.html)  [Space Weather (magnetic events)](http://www.spaceweatherlive.com/en/news)  [Quizlet Magnetism Vocab. Deck with Pictures](https://quizlet.com/84626214/magnetism-flash-cards/)  [Transformer Virtual Lab](http://www.glencoe.com/sites/common_assets/science/virtual_labs/E15/E15.html)  [Build a virtual electromagnet](http://www.fossweb.com/delegate/ssi-wdf-ucm-webContent/Contribution%20Folders/FOSS/multimedia/Magnetism_and_Electricity/electromagnet.html) |

**PS3: Energy**

***How is energy transferred or conserved?***

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| **PS3.A: Definition of Energy**  ***Essential Question: What is 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. At microscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. 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. | | | | |
| **TOPIC** | **Performance Expectation** | **Science & Engineering**  **Practice** | **Crosscutting Concepts** | **Resources** |
| **Energy**  Chapter 15.1 | **HS-PS3-2**  Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).  **HS.PS3-3**  Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.\* | **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 to illustrate the relationships between systems or between components of a system. (HS-PS3-2)  **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. (HS-PS3-3) | **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. (HS- PS3-3)  Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems. (HS-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 costs and risks. (HS-PS3-3) | [Build a cork launcher](http://www.instructables.com/id/Cork-Shooter/) |
| **Energy Resources** | [Solar Projects](http://www.builditsolar.com/Projects/Educational/educational.htm)  [National Renewable Energy Lab - resource and project ideas](http://www.nrel.gov/education/educational_resources.html) |

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| **PS2.B: Conservation of Energy and Energy Transfer**  ***Essential Questions: What is meant by conservation of energy?***  ***How is energy transferred between objects or systems?***  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. 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). Any object or system that can degrade with no added energy is unstable. Eventually it will do so, but if the energy releases throughout the transition are small, the process duration can be very long (e.g., long-lived radioactive isotopes). | | | | |
| **TOPIC** | **Performance Expectation** | **Science & Engineering**  **Practice** | **Crosscutting Concepts** | **Resources** |
| **Energy Conversion & Conservation**  Chapter 15.2 | **HS-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). | [**Planning and Carrying Out Investigations**](http://www.nap.edu/openbook.php?record_id=13165&page=59)  [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.](http://www.nap.edu/openbook.php?record_id=13165&page=59)  [-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. (HS-PS3-4)](http://www.nap.edu/openbook.php?record_id=13165&page=59) | **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. (HS-PS3-4) | [Energy Transfer Practice](http://dev.physicslab.org/Document.aspx?doctype=5&filename=Compilations_CPworkbook_ConservationEnergy.xml)  [**Socks and Temperature Activity-Heat Transfer**](http://www.cpalms.org/Public/PreviewResource/Preview/46119) |
| **Thermal Energy**  Chapter 16.1 | [Various simulations about heat and energy](http://phet.colorado.edu/en/simulations/category/physics/heat-and-thermodynamics)  [Power of the Sun](http://sciencenetlinks.com/lessons/star-power-discovering-the-power-of-sunlight/) |

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| **PS1.C: Nuclear Processes**  ***Essential Questions: What forces hold nuclei together and mediate nuclear processes?***  Nuclear processes include fusion, fission, and radioactive decays of unstable nuclei. The total number of neutrons plus protons does not change in any nuclear process. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rock and other materials from the isotope ratios present. Normal stars cease producing light after having converted all of the material in their cores to carbon or, for more massive stars, to iron. Elements more massive than iron are formed by fusion processes but only in the extreme conditions of supernova explosions, which explains why they are relatively rare. | | | | |
| **TOPIC** | **Performance Expectation** | **Science & Engineering**  **Practice** | **Crosscutting Concepts** | **Resources** |
| **Nuclear Chemistry**  Chapter 4  4.1-4.3 | **HS-PS1-8**  Develop models to illustrate the changes composition of the nucleus of the atoms and the energy released during the processes of fission, fusion and radioactive decay. | **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 to illustrate the relationships between systems or between components of a system. (HS-PS3-2) | **Energy and Matter**  In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-PS1-8) | [M&M Radioactive Decay Lab](http://www.alexandria.k12.mn.us/cms/lib01/MN01000334/Centricity/Domain/202/Half-life%20M%20and%20M%20lab.doc)  https://phet.colorado.edu/en/simulation/legacy/nuclear-fission |
| **Radioactivity**  Chapter 10.1 | [Radioactive Dating Game](http://phet.colorado.edu/en/simulation/radioactive-dating-game) |
| **Decay**  Chapter 10.2-10.3 | [half-life nuclear decay simulation](http://faculty.uncfsu.edu/jcastill/labs/Half.doc)  [Yucca mountain information](http://www.yuccamountain.org/) |
| **Fission & Fusion**  Chapter 10.4 | [hippocampus - demos & videos](http://www.hippocampus.org/Chemistry)  [Fission Phet Simulation](https://phet.colorado.edu/en/simulation/legacy/nuclear-fission) |

**PS4: Waves and Their Applications in Technologies for Information Transfer**

***How are waves used to transfer energy and information?***

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| **PS4.A: Wave Properties**  ***Essential Question: What are the characteristic properties and behaviors of waves?***  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. 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. When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells. | | | | |
| **TOPIC** | **Performance Expectation** | **Science & Engineering**  **Practice** | **Crosscutting Concepts** | **Resources** |
| **Mechanical Waves & Sound**  Chapter 17  17.1-17.2 | **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-PS4-2**  Evaluate questions about the advantages of using a digital transmission and storage of information. | **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. (HS-PS4-1)  **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. (HS-PS4-2) | **Cause and Effect**  Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS4-1)  **Stability and Change**  Systems can be designed for greater or lesser stability. (HS-PS4-2) | [Waves Lesson](http://www.physicsclassroom.com/class/waves/Lesson-1/Categories-of-Waves)  [Online High Frequency Hearing Test](http://www.noiseaddicts.com/2009/03/can-you-hear-this-hearing-test/)  [**Background information**](http://www.physicsclassroom.com/class/sound/Lesson-1/Sound-is-a-Mechanical-Wave)  [**Simulations for sound waves**](http://phet.colorado.edu/en/simulations/category/physics/sound-and-waves) |
| **E & M Spectrum**  Chapter 18.1 | **HS.PS4-4**  Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.  **HS.PS4-5**  Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.\* | **Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs.  -Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible. (HS-PS4-4)  -Communicate technical information or 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). (HS-PS4-5) | **Cause and Effect**  Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. (HS-PS4-4)  Systems can be designed to cause a desired effect. (HS-PS4-5) | [Electromagnetic Spectrum](http://www.e-missions.net/elabs/?/electromagnetic_mission_description/)  [EM Spectrum Activities](http://chandra.harvard.edu/edu/formal/ems/ems_highContents.html)  [Nasa tour of the EM spectrum](http://missionscience.nasa.gov/ems/emsVideo_01intro.html) |
| **Light**  Chapter  18.3-18.5  19.1 | [Cool Cosmos Web Exploration](http://coolcosmos.ipac.caltech.edu/cosmic_classroom/multiwavelength_astronomy/multiwavelength_astronomy/overview.html)  [**Exploring the EM**](https://www.teachengineering.org/view_lesson.php?url=collection/clem_/lessons/clem_waves_lessons/clem_waves_lesson04.xml) |
| **Optics**  Chapter 19.1-19.4 | [Optics hands-on activities](http://www.google.com/url?q=http%3A%2F%2Fwww.optics4kids.org%2Fhome%2Fcontent%2Fclassroom-activities%2Fadvanced%2F&sa=D&sntz=1&usg=AFQjCNF0gvHRUk8QeJClhX4yWiB9uzKo1Q)  [Physics Zone: Optics Lesson](http://www.sciencejoywagon.com/physicszone/09optics/)  [Warm up activities for mirrors](http://pedagoguepadawan.net/186/reflection-and-refraction-activities/) |

**\**This performance expectation integrated traditional science content with engineering through a practice or disciplinary core idea.***

**Other Resources:**

**Great general websites for activities:**

[**http://www.csun.edu/science/software/simulations/chemistry.html**](http://www.csun.edu/science/software/simulations/chemistry.html)

[**http://onlinelabs.in/physics**](http://onlinelabs.in/physics)

[**http://www.resa.net/curriculum/curriculum/science/professionaldevelopment/ngss-pd/lesson-plans-exploring-ngss/**](http://www.resa.net/curriculum/curriculum/science/professionaldevelopment/ngss-pd/lesson-plans-exploring-ngss/)

**Physical Science Dropbox-**

**NGSS standard links for PHet activities**

**Engaging YouTube channels for all sorts of short videos relating to Chemistry & Physics:**

**Veritasium** -

[**https://www.youtube.com/user/1veritasium**](https://www.youtube.com/user/1veritasium)

Discovery Science News

[**Discovery Science News Stories in Physics**](https://www.youtube.com/user/DNewsChannel/search?query=physics)

**Sixty Symbols**

[**www.sixtysymbols.com**](http://www.sixtysymbols.com)

**Minute Physics**

[**https://www.youtube.com/user/minutephysics**](https://www.youtube.com/user/minutephysics)

**Annenberg Learner - Chemistry**

[**http://www.learner.org/resources/series218.html**](http://www.learner.org/resources/series218.html)

**Annenberg Learner - Physics**

[**http://www.learner.org/resources/series213.html**](http://www.learner.org/resources/series213.html)

**Quizlet**

[**www.quizlet.com**](http://www.quizlet.com)

**Excellent source of interactive vocabulary decks with picture and sound. Free as a non-teacher, $25.00 per year to subscribe.**

**Chemistry experiments**

[**http://www.middleschoolchemistry.com/lessonplans/**](http://www.middleschoolchemistry.com/lessonplans/)

**Teach engineering.org**

[**https://www.teachengineering.org/search\_standards.php?select\_state=Next%20Generation%20Science%20Standards**](https://www.teachengineering.org/search_standards.php?select_state=Next%20Generation%20Science%20Standards)

**APPS to Use - (starting with iPad?)**

**Padlet -** interactive white-board to post to. Kids can access on any internet device

**Wavepad -** visualize wave forms, record voices and frequencies.

**Zipgrade-** quick checks and easy grading scanned with your phone

**Photon**- use this for Phet Simulations. It runs flash apps from the internet. Great for science simulations.

**Circuit Builder** - apps for building circuits that kids can really investigate and design without complication.

**Online textbook and curriculum reso: ck12.org** [**http://www.ck12.org/physical-science/**](http://www.ck12.org/physical-science/)

At ck12.org, you can download a textbook and modify it to meet the needs of your individual classroom. For example, once you select a textbook, you may edit the text to include the units you want to address in your classroom. You can add a classroom, assignments, upload word documents and google docs for students to access online. You could also print out individual assignments for enrichment or homework assignments. Within each lesson, there are different links to animations, videos, games, Khan Academy links etc. This can be an excellent resource for day to day activities as well as for students who need tutorials for missing work. You can also had a button and directly link articles, videos, animations etc. like pinterest.

**Planning Resources**

Free website links the subject you teach with the specific NGSS standard and crosscutting concepts you want to cover.

[**http://concord.org/ngss/**](http://concord.org/ngss/)

Looking to take your lessons to the next level? Visit our district Century 21 Resource page to see how you can tweak your existing levels to take the lessons higher.

[www.wcsd21.com](http://www.wcsd21.com)

**Video Sources**

Subscription service with NGSS standards and curriculum materials - Twig at Carolina

<https://www.twigcarolina.com/list/>

**Formative assessment tools and apps**

**Plickers** - formative assessment app. Only one camera smart device required to record a response from the whole room. [www.plickers.com](http://www.plickers.com)

**Zipgrade** - scan an exit ticket or a test with just one camera smart device. This is a teacher time saver.

[www.zipgrade.com](http://www.zipgrade.com)