**Accelerating Learning—A Physics with Earth & Space Science Example**

**Can we use the data from pre-assessments, post assessments, and embedded formative assessments from previous units to guide out pre-unit planning? Focus on the progressions of the Science and Engineering Practices and Crosscutting Concepts as specific Disciplinary Core Ideas are taught within the upcoming unit and pre-assessment data can be used to ascertain that information.**

**Example of Acceleration**: **Physics with Earth & Space Science, Bundle 2 - Part B (How is motion affected by gravity?) - 2B - (How are celestial bodies affected by gravity?)\_**

There are 4 “power” standards bundled together in Bundle 2 - Part B:

HS-PS3-2-4 HS-PS2-1 HS-ESS1-4 HS-ESS1-6

which include the following:

* **Crosscutting Concepts:**
	+ Cause and Effect
		- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
	+ Energy and Matter
		- Energy cannot be created or destroyed; it only moves between one place and another place, between objects and/or fields, or between systems.
	+ Scale, Proportion, and Quantity
		- Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).
	+ Stability and Change
		- Much of science deals with constructing explanations of how things change and how they remain stable.
* **Science & Engineering Practices:**
	+ Analyzing and Interpreting 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.
	+ Using Mathematics and Computational Thinking
		- Use mathematical representations of phenomena to describe explanations.
	+ Constructing Explanations and Designing Solutions
		- Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.
	+ Developing and Using Models
		- Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.
* **Disciplinary Core Ideas:**
	+ PS1.C: Nuclear Processes
		- Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials. (secondary)
	+ PS2.A: Forces and Motion
		- Newton’s second law accurately predicts changes in the motion of macroscopic objects.
	+ PS3.A: Definitions of Energy
		- Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system’s total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms.
		- At the macroscopic 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.
	+ ESS1.B: Earth and the Solar System
		- Kepler’s laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system.
	+ ESS1.C: The History of Planet Earth
		- Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth’s formation and early history.

**Before** beginning the unit, compare the High School expectations to the 8th grade expectations. Look for specific alignments in each of the dimension progressions. The variation between the two grade levels identifies your targeted learning. Use data from the pre-assessment to determine which students need extra support in each dimension.

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| **3 Dimensional Progressions for Each Dimension in the Bundled Standards** |
|  | 8th Grade | High School |
| Cause and Effect | * classify relationships as causal or correlational, and recognize that correlation does not necessarily imply causation.
* use cause and effect relationships to predict phenomena in natural or designed systems.
* understand that phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.
 | * understand that empirical evidence is required to differentiate between cause and correlation and to make claims about specific causes and effects.
* suggest cause and effect relationships to explain and predict behaviors in complex natural and designed systems.
* propose causal relationships by examining what is known about smaller scale mechanisms within the system.
* recognize changes in systems may have various causes that may not have equal effects
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| Energy and Matter | * matter is conserved because atoms are conserved in physical and chemical processes.
* within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter.
* energy may take different forms (e.g. energy in fields, thermal energy, energy of motion).
* transfer of energy can be tracked as energy flows through a designed or natural system.
 | * the total amount of energy and matter in closed systems is conserved.
* describe changes of energy and matter in a system in terms of energy and matter flows into, out of, and within that system.
* energy cannot be created or destroyed; it only moves between one place and another place, between objects and/or fields, or between systems.
* energy drives the cycling of matter within and between systems.
* in nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.
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| Scale, Proportion, and Quantity | * observe time, space, and energy phenomena at various scales using models to study systems that are too large or too small.
* understand phenomena observed at one scale may not be observable at another scale, and the function of natural and designed systems may change with scale.
* use proportional relationships (e.g., speed as the ratio of distance traveled to time taken) to gather information about the magnitude of properties and processes.
* represent scientific relationships through the use of algebraic expressions and equations.
 | * understand the significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.
* recognize patterns observable at one scale may not be observable or exist at other scales, and some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly.
* use orders of magnitude to understand how a model at one scale relates to a model at another scale.
* use algebraic thinking to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).
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| Stability and Change | * explain stability and change in natural or designed systems by examining changes over time, and considering forces at different scales, including the atomic scale.
* changes in one part of a system might cause large changes in another part.
* systems in dynamic equilibrium are stable due to a balance of feedback mechanisms, and stability might be disturbed by either sudden events or gradual changes that accumulate over time
 | * understand much of science deals with constructing explanations of how things change and how they remain stable.
* quantify and model changes in systems over very short or very long periods of time.
* see some changes are irreversible, and negative feedback can stabilize a system, while positive feedback can destabilize it.
* recognize systems can be designed for greater or lesser stability.
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| Analyzing and Interpreting Data | * Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships.
* Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal and spatial relationships.
* Distinguish between causal and correlational relationships in data.
* Analyze and interpret data to provide evidence for phenomena.
* Apply concepts of statistics and probability (including mean, median, mode, and variability) to analyze and characterize data, using digital tools when feasible.
* Consider limitations of data analysis (e.g., measurement error), and/or seek to improve precision and accuracy of data with better technological tools and methods (e.g., multiple trials).
* Analyze and interpret data to determine similarities and differences in findings.
* Analyze data to define an optimal operational range for a proposed object, tool, process or system that best meets criteria for success.
 | * 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.
* Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.
* Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.
* Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.
* Evaluate the impact of new data on a working explanation and/or model of a proposed process or system.
* Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success.
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| Using Mathematics and Computational Thinking | * Use digital tools (e.g., computers) to analyze very large data sets for patterns and trends.
* Use mathematical representations to describe and/or support scientific conclusions and design solutions.
* Create algorithms (a series of ordered steps) to solve a problem.
* Apply mathematical concepts and/or processes (e.g., ratio, rate, percent, basic operations, simple algebra) to scientific and engineering questions and problems.
 | * Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system.
* Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.
* Apply techniques of algebra and functions to represent and solve scientific and engineering problems.
* Use simple limit cases to test mathematical expressions, computer programs, algorithms, or simulations of a process or system to see if a model “makes sense” by comparing the outcomes with what is known about the real world.
* Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3 , acre-feet, etc.).
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| Constructing Explanations and Designing Solutions | * Construct an explanation that includes qualitative or quantitative relationships between variables that predict(s) and/or describe(s) phenomena.
* Construct an explanation using models or representations.
* Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students’ own experiments) 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.
* Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real world phenomena, examples, or events.
* Apply scientific reasoning to show why the data or evidence is adequate for the explanation or conclusion.
* Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process or system.
 | * Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.
* Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.
* Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.
* Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.
* Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade-off considerations.
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| Developing and Using Models | * Evaluate limitations of a model for a proposed object or tool.
* Develop or modify a model— based on evidence – to match what happens if a variable or component of a system is changed.
* Use and/or develop a model of simple systems with uncertain and less predictable factors.
* Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena.
* Develop and/or use a model to predict and/or describe phenomena.
* Develop a model to describe unobservable mechanisms.
* Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales.
 | * Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism or system in order to select or revise a model that best fits the evidence or design criteria.
* Design a test of a model to ascertain its reliability.
* Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.
* Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.
* Develop a complex model that allows for manipulation and testing of a proposed process or system.
* Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
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| PS1.C: Nuclear Processes  | The fact that matter is composed of atoms and molecules can be used to explain the properties of substances, diversity of materials, states of matter, phase changes, and conservation of matter.  | The sub-atomic structural model and interactions between electric charges at the atomic scale can be used to explain the structure and interactions of matter, including chemical reactions and nuclear processes. Repeating patterns of the periodic table reflect patterns of outer electrons. A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy to take the molecule apart. |
| PS2.A: Forces and Motion  | The role of the mass of an object must be qualitatively accounted for in any change of motion due to the application of a force.  | Newton’s 2nd law (a=F/m or F=ma) and the conservation of momentum can be used to predict changes in the motion of macroscopic objects. |
| PS3.A: Definitions of Energy | Kinetic energy can be distinguished from the various forms of potential energy. Energy changes to and from each type can be tracked through physical or chemical interactions. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter. | The total energy within a system is conserved. Energy transfer within and between systems can be described and predicted in terms of energy associated with the motion or configuration of particles (objects). |
| ESS1.B: Earth and the Solar System  | The solar system contains many varied objects held together by gravity. Solar system models explain and predict eclipses, lunar phases, and seasons. | Kepler’s laws describe common features of the motions of orbiting objects. Observations from astronomy and space probes provide evidence for explanations of solar system formation. Changes in Earth’s tilt and orbit cause climate changes such as Ice Ages. |
| ESS1.C: The History of Planet Earth | Rock strata and the fossil record can be used as evidence to organize the relative occurrence of major historical events in Earth’s history. | The rock record resulting from tectonic and other geoscience processes as well as objects from the solar system can provide evidence of Earth’s early history and the relative ages of major geologic formations |

 **Accelerated Instruction:**

Begin by teaching a whole group lesson on the **grade level standard** with a defined learning intention and success criteria.

Depending on where you are in your instructional pace for the year, you work with your PLC to determine whether you move forward with the full curriculum, use the Amplify @Home condensed units or a combination thereof focusing on the deficiencies identified in the initial assessing.

Based on the formative assessments and initial data collection you may add or emphasize specific dimensions as needed for your class. Active planning and preparedness are of the utmost importance. For those students who struggle, additional guided instruction may be required.

Use your pre-assessments and post-assessments to determine growth areas as well as areas which still need to be addressed in additional instructional settings. Remember that the dimensions spiral across the year as well as year to year. Be cognizant of the fact that proficiency in the early part of the year will look different from proficiency at the end of the year as students continue their growth and progress. Decide with your PLC what level of mastery is expected for the point of the year you are in and assess to that level and above.

**We also strongly believe that teachers need to include independent reading in their units. Students get better at reading by reading.**