## Unit #3 Acceleration & Accelerated Motion

Constant acceleration, graphing constant acceleration & free fall

**Big Idea:** All objects in free fall move with the same constant acceleration.

**Essential Questions:**

- What is the difference between acceleration and velocity?
- What cause accelerations?
- Differentiate between average, instantaneous and constant acceleration…
- What is free fall?
- What kind of motion results in an acceleration?
- What determines whether an acceleration causes an increase or a decrease in speed?

**Vocabulary:**

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| acceleration | average acceleration | instantaneous acceleration |
| constant acceleration | free fall | |

Students who demonstrate understanding can:

**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.**[Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.] [*Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.*]

**HS-PS2-2.** **Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.**[Clarification Statement: Emphasis is on the quantitative conservation of momentum in interactions and the qualitative meaning of this principle.] [*Assessment Boundary: Assessment is limited to systems of two macroscopic bodies moving in one dimension.*]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

## 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. (HS-PS2-1)

**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.

**Constructing Explanations and Designing Solutions**

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

- Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-PS1-2)

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***Connections to Nature of Science***

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

- Theories and laws provide explanations in science. (HS-PS2-1)
- Laws are statements or descriptions of the relationships

## Disciplinary Core Ideas

**PS2.A: Forces and Motion**

- Newton's second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1)

**PS3.A: Definitions of Energy**

**PS1.A: Structure and Properties of Matter**

- 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. (HS-PS1-2)

**PS1.B: Chemical Reactions**

- 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. (HS-PS1-2),

## Crosscutting Concepts

**Cause and Effect**

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-1)

**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-PS1-2),

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| among observable phenomena. (HS-PS2-1) | | |

*Connections to other DCIs in this grade-level:*

**HS.PS3.C** (HS-PS2-1); **HS.ESS1.A** (HS-PS2-1) **HS.ESS1.C** (HS-PS2-1) **HS.ESS2.C** (HS-PS2-1)

*Articulation of DCIs across grade-bands:*

**MS.PS2.A** (HS-PS2-1), **MS.PS3.C** (HS-PS2-1)

*Common Core State Standards Connections:*

*ELA/Literacy -*

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| **RST.11-12.1** | Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. *(HS-PS2-1)* |
| **RST.11-12.7** | Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS2-1) |
| **WHST.11-12.9** | Draw evidence from informational texts to support analysis, reflection, and research. *(HS-PS2-1)* |

*Mathematics -*

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| **MP.2** | Reason abstractly and quantitatively. (HS-PS2-1) |
| **MP.4** | Model with mathematics. (HS-PS2-1) |
| **HSN.Q.A.1** | Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS2-1) |
| **HSN.Q.A.2** | Define appropriate quantities for the purpose of descriptive modeling. *(HS-PS2-1)* |
| **HSN.Q.A.3** | Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-1) |
| **HSA.SSE.A.1** | Interpret expressions that represent a quantity in terms of its context. (HS-PS2-1) |
| **HSA.SSE.B.3** | Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS2-1) |
| **HSA.CED.A.1** | Create equations and inequalities in one variable and use them to solve problems. (HS-PS2-1) |
| **HSA.CED.A.2** | Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. *(HS-PS2-1),(* |
| **HSA.CED.A.4** | Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *(HS-PS2-1)* |
| **HSF-IF.C.7** | Graph functions expressed symbolically and show key features of the graph, by in hand in simple cases and using technology for more complicated cases. *(HS-PS2-1)* |
| **HSS-IS.A.1** | Represent data with plots on the real number line (dot plots, histograms, and box plots). *(HS-PS2-1)* |