**NACA UbD Unit Template**

[**Rob Unit 1 Feedback Form**](https://docs.google.com/forms/d/17qqCLnpNN-N1QI7VOwaw2CFAFyY2u0K9zk4Ju-isGWc/viewform?usp=send_form)

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| Designer: Rob Salazar | Unit #: 1 | Calendar Window: Weeks 3-5: 8/30-9/16 |

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| Stage 1 - Desired Results |
| Unit Big Idea: * Analyzing Data
* Developing Solutions
* Newton’s Second Law
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| Meaning (EQs and EUs) |
| Unit EQs: * How are mass, force, and acceleration related?
* What is the best way to optimize a design?
 | Unit EUs: * Newton’s second law accurately predicts changes in the motion of macroscopic objects
* Data analysis and scientific thinking help us solve design problems
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| Outcomes (Knowledge and Skills) |
| Unity Knowledge Outcomes: Lesson 1Lesson 2Lesson 3 | Unit Skills Outcomes: Lesson 1Lesson 2Lesson 3 |

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| Stage 2 - Assessment Evidence |
| **Transfer Statement**: I want my students to learn \_\_\_\_\_\_\_\_\_\_ so that in the long-run, on their own, they will be able to \_\_\_\_\_\_\_\_\_\_\_. (A transfer statement is the foundation of your unit summative assessment, described below.) |
| 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. [Clarification Statement: Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object rolling down a ramp, or a moving object being pulled by a constant force.] [Assessment Boundary: Assessment is limited to one-dimensional motion and to macroscopic objects moving at non-relativistic speeds.]Students develop a mathematical relationship that relates force, mass, and acceleration that they will use for their design.* Relationship is based on data that:
	+ represents net forces on an object, the object’s (constant) mass, and acceleration
	+ organized using tables, graphs, charts, and/or vector drawings
* Tools, technologies, and/or models are used in analysis of data
* Identified relationships include:
	+ comparison between the acceleration of objects of different masses experiencing the same force
	+ constant acceleration due to gravity, shown by a constant ratio between net force to mass
* Evidence is used to show that observations can be modeled with a = Fnet/m
* Identifies cause & effect relationships between force, mass, and acceleration
* Describes the formula Fnet=ma in terms of causality
 | **Summative Assessment** Unit Assessment Title and Description: UNIT PERFORMANCE TASK(S): * Use mathematical relationships developed through experimentation (Newton’s second law) to design, evaluate, and refine a device that minimizes the force on a <???> during a collision

What (cognitive verb + big idea): Apply data analysis and scientific thinking to develop design solutions.Why (enduring understandings): To understand that…scientific thinking and data analysis are key to the engineering process.How (GRASPS, but without the colored boxes):* Goal: Design a device that minimizes the force on an object
* Role: Engineer
* Audience: Commercial Entity
* Situation: Request for design that will minimize the force
* Product, Performance, and Purpose: Physical prototype, blueprint, and written explanation of the research and math behind the design
* Standards and Criteria for Success: Design fulfills the proficiency level of the design rubric
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| 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.\* [Clarification Statement: Examples of evaluation and refinement could include determining the success of the device at protecting an object from damage and modifying the design to improve it. Examples of a device could include a football helmet or a parachute.] [Assessment Boundary: Assessment is limited to qualitative evaluations and/or algebraic manipulations.Students design a device that minimizes the force on an object in collision* Design includes
	+ concept that reducing the acceleration on an object (by decreasing the change in velocity and/or the time interval of the change) reduces the force on the object
	+ explains how this concept is used in the device to either increase the time interval or decrease the change in velocity
	+ describes scientific rationale for choice of materials and structure
* Describes criteria and constraints (e.g. cost, mass, maximum force applied, societal requirements)
	+ Includes quantification when appropriate
	+ Explains tradeoffs that come with the criteria and constraints
* Evaluates design
	+ Describes rationale for design
	+ Compares design to list of criteria and constraints
	+ Test and evaluate device based on ability to minimize force
	+ Describes unanticipated effects or design performance issues
* Refines design solution
	+ Uses test results to improve the device
	+ Refinements extend impact time, reduce the change in velocity, reduce the device map, and/or consider a cost-benefit analysis
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| Stage 3 - Plan for Learning |

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|  | ***Lesson Big Idea/Title and Topical EQ*** | Activities to Support the Lesson (feel free to link in electronic resources) | Unit Modifications (aligned to IEPs) | Formative Assessment of the Lesson |
| Lesson 1 | Big Idea/Title: EQ:  |  |  |  |
| Lesson 2 | Big Idea/Title: EQ:  |  |  |
| Lesson 3 | Big Idea/Title: EQ:  |  |  |
| Lesson 4 | Big Idea/Title: EQ:  |  |  |
| Lesson 5 | Big Idea/Title: EQ:  |  |  |
| Lesson 6 | Big Idea/Title: EQ:  |  |  |
| Lesson 7 | Big Idea/Title: EQ:  |  |  |
| Lesson 8 | Big Idea/Title: EQ:  |  |  |
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| Standards |
| **NGSS - Performance Expectations** |
| * 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. [Clarification Statement: Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object rolling down a ramp, or a moving object being pulled by a constant force.] [Assessment Boundary: Assessment is limited to one-dimensional motion and to macroscopic objects moving at non-relativistic speeds.]
* 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.\* [Clarification Statement: Examples of evaluation and refinement could include determining the success of the device at protecting an object from damage and modifying the design to improve it. Examples of a device could include a football helmet or a parachute.] [Assessment Boundary: Assessment is limited to qualitative evaluations and/or algebraic manipulations.]
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| **NGSS - 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)

**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)

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* Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-1),(HS-PS2-4)

**Scientific Knowledge is Based on Empirical Evidence*** Science knowledge is based on empirical evidence. (HS-ESS2-3)
* Science disciplines share common rules of evidence used to evaluate explanations about natural systems. (HS-ESS2-3)
* Science includes the process of coordinating patterns of evidence with current theory. (HS-ESS2-3)
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| **NGSS - Disciplinary Core Ideas** |
| **PS2.A: Forces and Motion (HS-ESS1-6)*** Newton’s second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1)

**ESS1.A: The Universe and Its Stars (HS-PS2-1),(HS-PS2-2),(HS-PS2-4);(HS-PS3-1),(HS-PS3-4) (HS-PS4-3)*** The study of stars’ light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (HS-ESS1-2),(HS-ESS1-3)

**ESS1.C: The History of Planet Earth (HS-PS2-1),(HS-PS2-2),(HS-PS2-4)*** 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. (HS-ESS1-6)

**ESS2.C: The Roles of Water in Earth's Surface Processes (HS-PS2-1),(HS-PS2-4)*** The abundance of liquid water on Earth’s surface and its unique combination of physical and chemical properties are central to the planet’s dynamics. These properties include water’s exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks. (HS-ESS2-5)
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| **NGSS - 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),(HS-PS2-5)(HS-PS4-1)(HS-ESS3-1)
* Systems can be designed to cause a desired effect. (HS-PS2-3)(HS-PS4-5)
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| **CCSS - ELA/Literacy** |
| * 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),(HS-PS2-6)(HS-PS4-2),(HS-PS4-3),(HS-PS4-4) (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-5),(HS-ESS1-6)(HS-ESS2-2),(HS-ESS2-3)(HS-ESS3-1)
* 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)(HS-PS4-1),(HS-PS4-4)
* WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS2-3),(HS-PS2-5)(HS-PS3-3),(HS-PS3-4),(HS-PS3-5)
* WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS2-1),(HS-PS2-5)(HS-PS3-4),(HS-PS3-5)
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| **CCSS - Mathematics** |
| MP.2 Reason abstractly and quantitatively. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4)(HS-PS3-1),(HS-PS3-2),(HS-PS3-3),(HS-PS3-4),(HS-PS3-5) (HS-PS4-1),(HS-PS4-3) (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-3),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)(HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3)(HS-ESS3-1)* MP.4 Model with mathematics. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4)(HS-PS3-1),(HS-PS3-2),(HS-PS3-3),(HS-PS3-4),(HS-PS3-5) (HS-PS4-1)(HS-ESS1-1),(HS-ESS1-4) (HS-ESS2-1),(HS-ESS2-3)
* 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),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5),(HS-PS2-6)(HS-PS3-1),(HS-PS3-3)(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)(HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3)(HS-ESS3-1)
* HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5),(HS-PS2-6)(HS-PS3-1),(HS-PS3-3)(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6) (HS-ESS2-1),(HS-ESS2-3),
* HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5),(HS-PS2-6), (HS-PS3-1),(HS-PS3-3)(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)(HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3)(HS-ESS3-1)
* HSA.SSE.A.1 Interpret expressions that represent a quantity in terms of its context. (HS-PS2-1),(HS-PS2-4) (HS-PS4-1),(HS-PS4-3)(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)
* 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),(HS-PS2-4)(HS-PS4-1),(HS-PS4-3)
* HSA.CED.A.1 Create equations and inequalities in one variable and use them to solve problems. (HS-PS2-1),(HS-PS2-2)
* 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),(HS-PS2-2)(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)(HS-ESS3-1)
* HSA.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS2-1),(HS-PS2-2)(HS-PS4-1),(HS-PS4-3) (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4)
* 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)
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| **Indigenous Standards** |
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