# Physics: Forces and Interactions

## Stage 1 Desired Results

ESTABLISHED GOALS:

*Competencies:*

- ***Scale, Proportion, & Quantity: Students will demonstrate the ability to describe and represent the significance of changes in observable and non-observable phenomena in terms of relative scale, proportion, and quantity.***
- ***Systems & System Models: Students will demonstrate the ability to investigate and analyze a natural or human designed system in terms of its boundaries, inputs, outputs, interactions, and behaviors and use this information to develop a system model that can be used to understand and empirically evaluate the accuracy of models in terms of representing the underlying system.***
- ***Nature of Science: Student will demonstrate the ability to work collaboratively and individually to generate testable questions or define problems, plan and conduct investigations using a variety of research methods in a various settings, analyze and interpret data, reason with evidence to construct explanations in light of existing theory and previous research, and effectively communicate the research processes and conclusions.***
- ***Students will demonstrate the ability to analyze and summarize text and integrate knowledge to make meaning of discipline-specific materials.***
- ***Students will demonstrate the ability to produce coherent and supported writing in order to communicate effectively for a range of discipline-specific tasks, purposes, and audiences.***
- ***Students will demonstrate the ability to speak purposefully and effectively by strategically making decisions about content, language use, and discourse style.***

*Content Standards:*

- 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 an object, its mass, and its acceleration.
- 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.
- 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.
- HS-PS2-4. Use mathematical representations of Newton's Law of Gravitation to describe and predict the gravitational forces between objects.

### *Transfer*

*Students will be able to independently use their learning to **determine cause and effect relationships and make informed decisions based upon the results.***

### *Meaning*

ENDURING UNDERSTANDINGS

*Students will understand that…*

- 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.
- systems can be designed to cause a desired effect.
- when investigating or describing a system, the boundaries and initial conditions of the system need to be defined.

ESSENTIAL QUESTIONS

- *What if the motion of objects was not predictable?*

### *Acquisition*

*Students will know…*

- that Newton's second law accurately predicts changes in the motion of macroscopic objects.
- that momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. In any system, total momentum is always conserved.
- that if a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system.
- that Newton's law of universal gravitation provide the mathematical models to describe and predict the effects of gravitational forces between distant objects.
- that forces at a distance are explained by fields (gravitational) permeating space that can transfer energy through space.
- that criteria and constraints also include satisfying any requirements set by society, such

*Students will be skilled at…*

- analyzing data to support a claim.
- using mathematical representations to describe, predict, and support claims.
- applying scientific and engineering ideas to design, evaluate, and refine a device.

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| | as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them.<br>• that criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed.<br><br>*vocabulary*:<br><br>average velocity, acceleration, vector, ∑F =ma, v+d/t, a=Δv/Δt, scalar, Ft=Δmv, frame of reference, V=at+Vo, Vf2=2a(x)+Vo2, Delta v, slope, "myth of the negative", X=1/2at2+Vot+X, delta x, Vavg=x/t, Cos, inverse Tan, resultant, Vecotr notation, Sin, angle | |
| ***Content Area Literacy Standards*** | | ***21st Century Skills*** |
| • 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.<br>• RST.11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.<br>• RST.11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.<br>• RST.11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*.<br>• RST.11-12.5 Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.<br>• 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.<br>• RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.<br>• RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.<br>• WHST.11-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.<br>• WHST.11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.<br>• WHST.11-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.<br>• WHST.11-12.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.<br>• WHST.11-12.7 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.<br>• WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text | • *reason effectively*<br>• *use systems thinking*<br>• *solve problems*<br>• *communicate clearly* |

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| selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.<br>• WHST.11-12.9 Draw evidence from informational texts to support analysis, reflection, and research. | |

| Stage 2 - Evidence | |
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| ***Evaluative Criteria*** | ***Assessment Evidence*** |
| | PERFORMANCE TASK(S): |
| | OTHER EVIDENCE: |

## Stage 3 – Learning Plan

*Summary of Key Learning Events and Instruction*

| ***Language Arts Integration*** | ***Mathematics Integration*** |
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| • 1.OA.1 Use | **• HSA-CED.A.1 - Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.**<br>**• 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.**<br>**• HSA-CED.A.4 - Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations**<br>**• HSA-SSE.A.1 - Interpret expressions that represent a quantity in terms of its context.**<br>**• 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**<br>**• HSF-IF.C.7 - Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases** |

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| | • **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.**<br>• **HSN-Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling.**<br>• **HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.**<br>• **HSS-ID.A.1 - Represent data with plots on the real number line (dot plots, histograms, and box plots).**<br>• **MP.2 - Reason abstractly and quantitatively.**<br>• **MP.4 - Model with mathematics.** |
| ***Technology Integration*** | ***District Materials*** |
| ● 1.OA.1 Use | |
| ***Science and Engineering Practices*** | |
| S&EP 2. Developing and using models<br>S&EP 3. Planning and carrying out investigations<br>S&EP 4. Analyzing and interpreting data<br>S&EP 5. Using mathematics and computational thinking<br>S&EP 6. Constructing explanations (for science) and designing solutions (for engineering)<br>S&EP 8. Obtaining, evaluating, and communicating information | |