Unit #19 Relativity

General Relativity & Special Relativity

Big Ideas:

- Nature behaves differently near the speed of light.

Essential Questions:

- What happens to the time between ticks of a moving clock?
- What types of processes does time dilation apply to?
- What happens to the length of a moving object as its speed approaches "c" (speed of light)?
- What does it mean to say mass and energy are equivalent?
- What is the connection between an accelerated frame of reference and gravity?
- What happens when matter and antimatter collide?
- What distinguishes a black hole from any other star?

Vocabulary:

theory of relativity	proper time	time dilation
length contraction	proper length	rest mass
rest energy	gravitational lensing	black hole
gravity waves	principle of equilevalence	

Next Generation Priority 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 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.*]

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	Disciplinary Core Ideas	Crosscutting Concepts
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)	**PS2.A: Forces and Motion** • Newton's second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1)	**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) •

Connections to other DCIs in this grade-level:

HS.PS3.C (HS-PS2-1); **HS.PS4.B** (HS-PS2-5); **HS.ESS1.A** (HS-PS2-1),(**HS.ESS1.B** (HS-PS2-4); **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 -

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 -

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)*