Phoenixville Area School District Understanding by Design (UbD) Science Template

Grade Level &/or HS Subject: Physics **Unit Name: Momentum and Collisions**

<table>
<tr><th colspan="3">Stage 1 Desired Results</th></tr>
<tr><td rowspan="4">Overarching NGSS & PA 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.

HS-PS2-2

Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when</td><td colspan="2">Transfer</td></tr>
<tr><td colspan="2">Students will be able to independently use their learning to…

Ask questions and define problems
Develop and use models
Plan and carry out experiments
Analyze and interpret data using computational thinking
Obtain, evaluate, and communicate information (supported by evidence)
Construct explanations and design solutions

(Choose the appropriate content-specific transfer goals)</td></tr>
<tr><td colspan="2">Meaning-Making</td></tr>
<tr><td>Students will understand that…

Newton’s second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

They can 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

Scientific and engineering ideas can be applied to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.

Although energy cannot be destroyed, it can be converted to less useful forms — for example, to thermal energy in the surrounding environment</td><td>ESSENTIAL QUESTIONS
Students will keep considering...

What is the relationship between the structure of a material and the maximum force it experiences during a collision?

When is momentum conserved? How can we change the momentum of an object?

Is energy conserved in collisions?</td></tr>
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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.* **Which branch(es) of science apply:** **PS**	***Knowledge and Skills Acquisition***	
	UNDERSTANDINGS *Students will know…* Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. Momentum is a vector. Impulse is the change in momentum and can be calculated using F*t 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 Criteria and constraints also include satisfying any requirements set by society, such 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 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 (tradeoffs) may be needed. Elasticity of an object is determined by composition, and affects the way objects behave when colliding, specifically how much energy is conserved.	*Students will be skilled at…* Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. Use mathematical representations of phenomena to describe explanations. 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.
	KEY VOCABULARY Momentum Impulse Conservation of Momentum Kinetic Energy Elasticity Elastic Inelastic Perfectly Inelastic Explosions	

<table>
<tr><th colspan="3">Stage 2 – Evidence</th></tr>
<tr><th>Evaluative Criteria</th><th colspan="2">Assessment Evidence</th></tr>
<tr><td>Quality design that reduces max acceleration by at least 80%; meets specifications; reasonable explanation for why it works well</td><td>PERFORMANCE TASK(S):

Collision Competition

Goal: Students will attempt to minimize the maximum acceleration experienced by a cart hitting a brick.
Role: Car Safety Engineers
Audience: They’re trying to come up with the best design, objectively.
Situation: All carts will start the same distance from the brick on the same angle of track. There will be a maximum length from the front of the cart that students are allowed to build, and they are not allowed to impair the motion of the cart at all. There are no cost limits on the designs, only the size constraint. Students can keep trying new designs until time runs out (another constraint).
Product/Purpose: The most successful cart design at reducing maximum acceleration since that’s one of the most important features of car design. Students will offer an explanation for why they felt their design was the best.
Standards: See left</td><td>Differentiation Considerations:

Students can use whatever materials they want to try, and can try as many as they like</td></tr>
<tr><td>Accuracy of answers and explanations; lab/inquiry process skills</td><td>OTHER EVIDENCE:

• HW – these will consist of a range of questioning goals, from basic things like vocab understanding to conceptual understanding to application
• Quizzes – MC or FR where work is required; similar to HW, could be fact recall, conceptual understanding or application being assessed.
• Test – 1 for the unit, will contain a mix of recall and application focused on the understandings and knowledge from Stage 1

(What evidence will be collected to determine whether Stage 1 goals were achieved?)</td><td>Differentiation Considerations:

• Notes allowed on some assessments
• Partial credit + test corrections</td></tr>
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