

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

Grade Level &/or HS Subject: Physics

Unit Name: Forces and Motion Part 2

Plain English Summary: This unit is meant to expand upon a basic understanding of motion and forces. It will include vector language so that directions and changes in direction can be taken into account mathematically, as can forces to the left and right, for instance, on the same object. Newton's Laws are the main content focus, with a skill emphasis on designing experiments and mathematical modeling.

Stage 1 Desired Results		
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 Which branch(es) of science apply:	<i>Transfer</i>	
	<i>Students will be able to independently use their learning to...</i> Ask questions and define problems Develop and use models Plan and carry out experiments Analyze and interpret data using computational thinking (Choose the appropriate content-specific transfer goals)	
	<i>Meaning-Making</i>	
	<i>Students will understand that...</i> Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. Objects' inertia makes them maintain constant velocity (Newton's 1 st Law) unless acted upon by a net external force Objects exert equal but opposite forces on each other, which gives rise to pairs of forces that we can see with gravity, magnets, and electrical charges (Newton's 3 rd Law) Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. Motion can be modeled graphically with respect to time, and features of those graphs relate to position, velocity and acceleration Gravity causes a consistent acceleration on all objects near the surface of the Earth, regardless of their mass	ESSENTIAL QUESTIONS <i>Students will keep considering...</i> How can one predict an object's continued motion, change in motion, or stability? How do I model what I observe in the form of equations or graphs? What underlying forces explain the variety of interactions observed? How can we use empirical evidence to differentiate between cause and correlation

PS	Some quantities are vectors, and some are scalars, which effects how those quantities can be interpreted when modeling the motion of an object.	and make claims about specific causes and effects?
<i>Knowledge and Skills Acquisition</i>		
	<p style="text-align: center;">UNDERSTANDINGS</p> <p><i>Students will know...</i></p> <ul style="list-style-type: none"> • Newton's 1st 2nd and 3rd Laws • Forces are pushes or pulls that can cause changes in velocity of objects • Mass is how we measure an object's inertia • Inertia is an object's resistance to forces or changes in motion. • How to organize data that represent the net force on a macroscopic object, its mass (which is held constant), and its acceleration (e.g., via tables, graphs, charts, vector drawings) • How to use tools, technologies, and/or models to analyze the data and identify relationships within the datasets, including: <ul style="list-style-type: none"> ○ A more massive object experiencing the same net force as a less massive object has a smaller acceleration, and a larger net force on a given object produces a correspondingly larger acceleration; and ○ The result of gravitation is a constant acceleration on macroscopic objects as evidenced by the fact that the ratio of net force to mass remains constant. • How to use the analyzed data as evidence to describe that the relationship between the observed quantities is accurately modeled across the range of data by the formula $a = F_{net}/m$ (e.g., double force yields double acceleration, etc.). • How to use the data as empirical evidence to distinguish between causal and correlational relationships linking force, mass, and acceleration. • That electrical forces and magnetic forces decrease with increased distance (Tape Experiment) • Weight is a force of gravity, usually from the Earth on a person • Gravitational forces are due to the attraction of masses; electrical forces and magnetic forces are due to the attraction or repulsion of electric charges or magnetic poles. • Distance traveled is average speed * time while change in position is average velocity * time • Change in velocity is acceleration * time 	<p><i>Students will be skilled at...</i></p> <p>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.</p> <p>Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.</p> <p>Apply techniques of algebra and functions to represent and solve scientific and engineering problems.</p>

	<ul style="list-style-type: none">• The slope of a position v. time graph tells us how fast and which direction something is moving; a steeper slope means a faster object• The slope of a velocity v. time graph tells us how rapidly and in which direction something is accelerating; a steeper slope means a larger acceleration.• How to solve problems using the kinematics equations	
	<div>KEY VOCABULARY</div> <div>Position Velocity Acceleration Scalar Vector Mass Inertia Force Force of Gravity / Weight Internal Force Normal Force Friction Coefficient of Friction Electric Force Newton’s Laws Vector Components</div>	
Stage 2 – Evidence		
Evaluative Criteria	Assessment Evidence	
Quality of question(s); Quality of experimental design + data collection; justification for analysis of data.	<div>PERFORMANCE TASK(S):</div> <div>Automation</div> <div>Goal: Students will conduct experiments on two different objects (one constant velocity, one free-fall) to determine their kinematics parameters through data collection and graphical analysis. Students will then, given a specific drop height, predict the distance the constant velocity object must travel. Students will perform a test of their predictions with the objects.</div>	<div>Differentiation Considerations:</div> <div>Choice in instruments used, range of data taken, car and dropped object used</div>

<p>Graphing accuracy</p>	<p>Role: The student works for a chocolate company that uses conveyor belts in assembly-line production. They hope to have a continuously moving belt, but that requires precise timing between the belt speed and the time for objects to be dropped unto the belt (almonds, for instance). They want you to come up with a mathematical model that will allow them to drop objects from any height onto the belt with precise timing.</p> <p>Audience: Students need to convince the head of manufacturing (your teacher)</p> <p>Situation: See above</p> <p>Products + Performances: Students need to produce a graph with best-fit line and explanations of constants for each object, and an overarching equation that relates the positions of both objects. Lastly, the students will perform a drop that shows intersection of the two materials.</p> <p>Standards: See column to the left.</p> <p>Modified Atwood's Machine</p> <p>Goal: to conduct a set of inquiry experiments to determine what affects the acceleration of a modified Atwood's machine.</p> <p>Role: Scientists</p> <p>Audience: The Class</p> <p>Situation: Lab Groups + Whole class to put the pieces together. Each group will vary one parameter, but as a class all relevant parameters will be tested so that a complete picture can be developed.</p> <p>Product/Purpose: The students will develop a graph, equation, and explanation of that equation to present to the class relating their variable to the acceleration of the system.</p> <p>Standards: See to the left</p>	<p>Choice in what to investigate; presentation can be written or oral/visual (PPT)</p>
<p>Process skills displayed (see standard inquiry rubric); appropriate graph correctly labelled; reasonably equation and explanation</p>		