EAST PENN
SCHOOL DISTRICT

Physics Matters
July 14, 2025

Unit 1 - Motion and Newton's Laws

STAGE 1 | DESIRED RESULTS

Standards

3.2.9-12.I 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.

Transfer

Students will be able to independently use their learning to...

- ❑ To be able to locate objects in a frame of reference and predict, using mathematical models, where they will be in the future.

Meaning

UNDERSTANDINGS	ESSENTIAL QUESTIONS
Students will understand that... ❑ Motion can be described in terms of position, velocity and acceleration. ❑ Motion can be described both algebraically and graphically. ❑ Complex phenomena can be mathematically modeled. ❑ All measurements have uncertainties (no measurement is exact). ❑ Reaction time varies from person to person. ❑ The motion of people and objects in sports are governed by Newton's laws using mass, position, velocity and acceleration and forces.	*Students will keep considering...* ☐ How can motion be described using the concepts of position, velocity, and acceleration? ☐ What is the effect of reaction time on driving? ☐ How are measurements crucial for understanding the motion? ☐ How can you increase your speed? ☐ How can you throw an object further?

Acquisition

Students will know... ❑ A person has a measurable reaction time. ❑ All measurements have uncertainties or random errors. ❑ Repeated measurements can vary in accuracy and precision. ❑ Random errors can be attributed to the measurement and/or the measuring instrument. ❑ Average velocity = total distance traveled divided by a given time.	*Students will be skilled at...* ☐ Plan and carry out investigations by designing and conducting multiple methods to measure reaction time, analyze the reliability of each method, and communicate findings with evidence. ☐ Use mathematics and computational thinking to analyze variability in measurements and evaluate estimates of measurements as reasonable or unreasonable. ☐ Construct explanations and design solutions to

	❑ The slope of a displacement vs. time graph is equal to the velocity. ❑ Average velocity = total distance traveled divided by a given time. ❑ The slope of a velocity vs. time graph is equal to the acceleration. ❑ Braking distance is dependent on the negative acceleration of the vehicle (brakes, road surface) and reaction time. ❑ Objects at rest remain at rest and objects in motion remain in motion with a constant velocity along a straight line unless acted upon by an external net force. ❑ The acceleration of an object is proportional to the net force on it and inversely proportional to its mass. F/m= a. ❑ Acceleration is a rate of change of velocity. ❑ Weight is the force on an object due to the gravitational attraction between that object and Earth. ❑ All objects on Earth fall with the same acceleration due to gravity = 9.8 m/s2 (if air resistance is ignored). ❑ Newton’s third law states that every force has an equal and opposite force. The two forces act on different objects. ❑ Friction is a force that resists motion.	clarify the differences between average and instantaneous speed using graphical and real-world contexts, such as vehicle speedometers or sports data. ☐ Analyze and interpret data from multiple sources, including strobe photos, graphs, an equation, and motion detector to evaluate speed/motion ☐ Graph, interpret, and calculate motion using graphs of motion ☐ Plan and carry out investigations to measure changes in velocity ☐ Construct explanations using scientific vocabulary to describe how acceleration relates to changes in speed or direction over time, supported by real-world examples. ☐ Use mathematical and computational thinking to calculate speed, distance, and time using the equation for acceleration ☐ Analyze and interpret data from graphical models usch as distance-time and velocity-time graphs Other skills ☐ Examine accelerated motion ☐ Identify the forces acting on an object ☐ Describe weight as the force due to gravity on an object ☐ Apply the terms free fall, projectile, trajectory, and range. ☐ Recognize factors that affect the range of a projectile.

Unit 2 - Energy and Forces

<table>
<tr><th colspan="3">STAGE 1 | DESIRED RESULTS</th></tr>
<tr><th>Standards</th><th colspan="2">Transfer</th></tr>
<tr><td rowspan="5">3.2.9-12.O Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

3.2.9-12.P Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).

3.2.9-12.Q Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.</td><td colspan="2">Students will be able to independently use their learning to understand…
☐ In a closed system, energy is conserved.
☐ Energy can be converted from one form to another.
☐ If work is done on or by a system, the energy of that system will change.</td></tr>
<tr><th colspan="2">Meaning</th></tr>
<tr><td>UNDERSTANDINGS
Students will understand that…
☐ The motion of objects takes into account physics principles of forces and energy.
☐ Apparent weight if affected by the changes in velocity.
☐ An object speeding up and slowing down can be described as a change of the form of energy, but the total energy remains constant.
☐ Apparent weight and lateral forces can be described as g-force.</td><td>ESSENTIAL QUESTIONS
Students will keep considering…
☐ How can energy conservation be used to explain the motion of various objects?
☐ How much apparent weight change do we experience during the motion of an object?
☐ Where does the energy originate when describing the motion of objects?
☐ How are forces and energy related?</td></tr>
<tr><th colspan="2">Acquisition</th></tr>
<tr><td>Students will know…
☐ Changes in velocity with respect to time (accelerations) are responsible for the apparent weight and lateral forces.
☐ Gravitational potential energy: GPE
☐ Kinetic energy is the energy of motion. KE
☐ Spring potential energy is the energy in a compressed or expanded spring.
☐ The sum of all energies in a closed system will remain constant.
☐ Power is the rate of doing work.
☐ Energy and force are related through work.</td><td>Students will be skilled at…
☐ Use mathematical and computational thinking to calculate kinetic energy and gravitational potential energy from motion and height data; develop and use models to visualize their relationship in various systems.
☐ Construct explanations for how mechanical energy transforms throughout a roller coaster track (apply the interplay between GPE and KE)
☐ Engage in argument from evidence and apply the conservation of energy to demonstrate how total mechanical energy is conserved in systems ignoring friction.
☐ Plan and carry out investigations to Identify how accelerations during motion can affect the apparent weight of objects
☐ Use mathematics and computational thinking to</td></tr>
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		calculate work and power based on force and displacement; *construct explanations* using real-world examples.

Unit 3 - Waves

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<tr><th colspan="3">STAGE 1 | DESIRED RESULTS</th></tr>
<tr><th>Standards</th><th colspan="2">Transfer</th></tr>
<tr><td rowspan="5">3.2.9-12.T Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

3.2.9-12.V Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model and that for some situations one model is more useful than the other.</td><td colspan="2">Students will be able to independently use their learning to understand...
☐ Waves transfer energy without transferring matter.
☐ Vibrations and oscillations produce waves.</td></tr>
<tr><th colspan="2">Meaning</th></tr>
<tr><td>UNDERSTANDINGS
Students will understand that...
☐ All musical sounds can be modeled with the concept of standing waves on strings and in air columns and on surfaces.
☐ Light, color, and vision allows us to create all sorts of images.
☐ Mirrors and lenses can be used to create images.</td><td>ESSENTIAL QUESTIONS
Students will keep considering...
☐ How can a vibrating string produce sound?
☐ How can an air column produce sound?
☐ How can different pitch sounds be produced by strings and wind instruments?
☐ How do mirrors produce images?
☐ How do lenses produce images?
☐ How can we use color to create images?</td></tr>
<tr><th colspan="2">Acquisition</th></tr>
<tr><td>Students will know...
☐ Waves can interfere with each other.
☐ Resonance produces large energy waves.
☐ Waves in the audible frequency range are known as sound waves.
☐ Light is another example of a wave that has the same properties as all waves.
☐ The frequency of a vibrating string can be increased by shortening the string or increasing its tension.
☐ As the length of an air column increases, there is a decrease in the frequency produced.</td><td>Students will be skilled at...
☐ Plan and carry out investigations to test and record how string length affects pitch in string instruments or sound generators.
☐ Analyze and interpret data to draw relationships between string tension, frequency of vibration, and sound produced..
☐ Plan and carry out investigations to control the variables of length and tension on a vibrating string
☐ Use mathematical and computational thinking to calculate wave speed, time, and distance using</td></tr>
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	☐ Standing waves (transverse and longitudinal) can be set up on strings or air columns producing specific frequencies of sound. ☐ Light travels in straight lines. If an opaque object is placed in the path, the object will form a shadow. ☐ When light reflects off a mirror, the angle of incidence is equal to the angle of reflection (law of reflection). ☐ The law of reflection can explain why a plane mirror produces images which are the same size as the object and also why concave and convex mirrors can produce larger and smaller images. ☐ Light traveling from one medium to another changes speed and can refract (bend) as it enters the new medium. ☐ A lens is shaped so as to have all parallel rays of light converge at a single point—the focal point. ☐ An image is formed when the light from an object travels through a lens. The image can be larger or smaller than the object. ☐ Colors that you see are due to reflected light.	the wave speed formula. ☐ Analyze, interpret, and observe standing waves and their patterns ☐ Analyze and interpret data to investigate the relationship among wave speed, wavelength, and frequency ☐ Obtain, evaluate, and communicate information to distinguish between transverse and longitudinal waves ☐ Plan and carry out investigations to observe how pitch changes with tube length ☐ Construct explanations for how closed and open tube resonances produce different sound frequencies and harmonics. ☐ Observe the reflection of light by a plane and curved mirror ☐ Use models and construct explanations to identify the normal of a plane mirror ☐ Plan and carry out investigations to measure angles of incidence and reflection for a plane mirror ☐ Obtain (collect evidence), evaluate, and communicate information to support the Law of Reflection ☐ Create and observe real and virtual images in plane, convex, and concave mirrors

Unit 4 - Intro to Circuits

STAGE 1 | DESIRED RESULTS	
Standards	**Transfer**

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<tr>
<td rowspan="5">3.2.9-12.L Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

3.2.9-12.M Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.

3.2.9-12.I 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.

3.2.9-12.O Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

3.2.9-12.S Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.</td>
<td colspan="2">Students will be able to independently use their learning to understand...
☐ All forces between objects, regardless of size or direction, arise from only a few types of interactions.</td>
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<tr>
<th colspan="2">Meaning</th>
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<tr>
<td>UNDERSTANDINGS
Students will understand that...
☐ Moving charges transfer energy as current.
☐ Resistance in an electric circuit limits and controls the amount of current flowing.
☐ There are models that relate current, voltage, and resistance in various circuit configurations.</td>
<td>ESSENTIAL QUESTIONS
Students will keep considering...
☐ What causes electric charges to move?
☐ Why does charge move easier in some materials than others?
☐ How does a circuit allow energy to be transferred?</td>
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<tr>
<th colspan="2">Acquisition</th>
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<tr>
<td>Students will know...
☐ Electric charges can either attract or repel.
☐ Flow of charge is known as electric current.
☐ Current can transfer energy in a circuit.
☐ Ohm's law is the relationship of current, voltage, and resistance in a circuit.
☐ Resistors in series increase the overall resistance of the circuit.
☐ Resistors in parallel decrease the overall resistance of the circuit.
☐ Key vocabulary: Electric force, Attraction, Repulsion, Potential Difference, Voltage, Current, Resistance, Ammeter, Voltmeter, Multimeter, Circuit, Ohm's Law, Series, Parallel</td>
<td>Students will be skilled at...
☐ Construct explanations using evidence to identify two kinds of electric charges and describe the interaction of like and unlike charges
☐ Develop models showing why an electrically charged object can attract an electrically neutral object
☐ Obtain, evaluate, and communicate information from conductivity tests or circuit-building tools to classify materials and differentiate between conducting and insulating materials in terms of the ease that electrons flow in them
☐ Use mathematics and computational thinking to represent relationships between voltage, current, and resistance; construct models of circuit behavior.
☐ Construct explanations to explain the flow of charge through a simple circuit and to illustrate the electric circuit/water analogy
☐ Use mathematics and computational thinking by using Ohm's law to solve circuit problems and explain real-world implications of resistance and power use.
☐ Construct an explanation to justify that current is not "used up" in an electric circuit; rather, the electric potential energy of a charge is converted</td>
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</table>

		to heat energy ☐ Analyze and interpret data to Identify the characteristics of simple series circuits including that the total resistance is equal to the sum of the resistances ☐ Develop and use models to compare and identify the characteristics of simple parallel circuits including voltage and current relationships ☐ Engage in argument from evidence to explain why houses are wired in parallel and describe short circuits and the function of circuit breakers ☐ Use mathematics and computational thinking to calculate power as the product of voltage and current and apply this to simple circuits