EAST PENN SCHOOL DISTRICT

Physics Matters
DATE OF APPROVAL

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

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.

ESSENTIAL QUESTIONS

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.
- ❑ The slope of a displacement vs. time graph is equal to the velocity.

Students will be skilled at...

- ❑ Compare methods of finding reaction time
- ❑ Evaluate estimates of measurements as reasonable or unreasonable.
- ❑ Define and contrast average and instantaneous speed.
- ❑ Use strobe photos, graphs, an equation, and motion detector to measure speed.
- ❑ Graph, interpret, and calculate

	❑ 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.	motion using graphs of motion. ❑ Measure changes in velocity. ❑ Define acceleration using words. ❑ Calculate speed, distance, and time using the equation for acceleration. ❑ Interpret distance-time and velocity-time graphs for different types of motion. ❑ 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

STAGE 1 | DESIRED RESULTS

Standards

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.

Transfer

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.

Meaning

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.

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?

Acquisition

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.

Students will be skilled at…

- Identify kinetic energy, KE, and gravitational potential energy, GPE.
- Apply the interplay between GPE and KE to a roller-coaster ride.
- State and apply the conservation of energy and relate it to the motion of various object.
- Identify how accelerations during motion can affect the apparent weight of the objects.
- Use the definition of Work and Power as they apply to the motion of objects.

Unit 3 - Waves

<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.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.
❑ Standing waves (transverse and longitudinal) can be set up on strings or</td><td>Students will be skilled at…
❑ Observe the effect of string length on the pitch of the sound produced.
❑ Observe the effect of tension on the pitch of the sound produced.
❑ Control the variables of length and tension on a vibrating string.
❑ Observe and calculate the motion of a wave pulse.
❑ Observe and identify standing waves and their patterns.
❑ Investigate the relationship among wave speed, wavelength, and frequency.
❑ Distinguish between transverse and longitudinal waves.
❑ Observe how pitch changes with tube length.
❑ Observe the effect of closing one end of the tube.</td></tr>
</table>

	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.	❑ Observe the reflection of light by a plane and curved mirror. ❑ Identify the normal of a plane mirror ❑ Measure angles of incidence and reflection for a plane. ❑ Collect evidence to support the Law of Reflection. ❑ Create and observe real and virtual images in plane, convex, and concave mirrors.

Unit 4 - Intro to Circuits

<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.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</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></tr>
<tr><th colspan="2">Meaning</th></tr>
<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></tr>
<tr><th colspan="2">Acquisition</th></tr>
<tr><td>Students will know…
❑ Electric charges can either attract or repel.
❑ Flow of charge is known as electric current.</td><td>Students will be skilled at…
❑ Identify two kinds of electric charges and describe the interaction of like and unlike charges.
❑ Explain why an electrically charged object can attract an electrically neutral object.</td></tr>
</table>

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.	❑ Current can transfer energy in a circuit. ❑ Ohm's law is the relationship of current, voltage, and resistance in a circuit. ❑ Resistors in series increases the overall resistance of the circuit. ❑ Resistors in parallel decreases 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	❑ Differentiate between conducting and insulating materials in terms of the ease that electrons flow in them. ❑ Describe the concepts in an electrical circuit including voltage, current, and resistance. ❑ Use each concept to explain the flow of charge through a simple circuit and to illustrate the electric circuit/water analogy. ❑ Use Ohm's law (V = IR) to calculate circuit variables. ❑ Explain that current is not "used up" in an electric circuit, rather, the electric potential energy of a charge is converted to heat energy as the charge flows through a resistor. ❑ Identify the characteristics of simple series circuits including that the total resistance is equal to the sum of the resistances of the resistors, the current is constant throughout the circuit, and the sum of the voltages across the resistors equals the voltage across the voltage source. ❑ Identify the characteristics of simple parallel circuits including the inverse of the total resistance is equal to the sum of the inverses of the resistors, the voltage across each resistor is the same as the voltage source, and the sum of the currents in the branches equals the current output by the voltage source. ❑ Explain why houses are wired in parallel and describe short circuits and the function of circuit breakers. ❑ Define electrical power as the product of voltage and current and apply this to simple circuits.