High School - Physics

North Boone CUSD 200

UNITS (5/5 SELECTED)	SUGGESTED DURATION
Unit 1: Motion	*35 lessons*
Unit 2: Newton's Laws of Motion	*40 lessons*
Unit 3: Momentum	*30 lessons*
Unit 4: Work and Energy	*30 lessons*
Unit 5: Circular Motion & Center of Gravity	*25 lessons*

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-PS2-3.: Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.

HS-PS3-1.: 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

HS-PS3-2.: 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).

HS-PS2-4.: Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

HS-PS3-3.: Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

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.
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.
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HS-PS3-2	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).

Unit 1: Motion

High School - Physics - *Last Updated on March 21, 2019*

DESIRED RESULTS

Enduring Understandings	Essential Question(s)
The motion of an object can be described and predicted using known relationships between the following variables: displacement, velocity, acceleration, and time. Vectors can be used to represent and predict the two-dimensional motion of an object	How do we make predictions about velocity and acceleration of everyday means of transportation such as bicycles, cars, or high speed trains? How do we solve problems in which objects are projected into the air?

Students will know (Knowledge):	Students will be able to (Skills):
• Key concepts and vocabulary associated with one and two dimensional motion, including: frame of reference (motion is relative), displacement, average velocity, instantaneous velocity, speed, acceleration, free fall, scalar, vector, vector quantity, resultant, components of a vector, resolution, projectile motion, elapsed time, rate, relative • Velocity has both a magnitude, called speed, and a direction • That the direction of acceleration is not always the same as the direction of velocity because it depends on the direction of the motion and on whether the velocity is increasing or decreasing • Free fall acceleration is the same for all objects, regardless of mass • Neglecting air resistance, a projectile has a constant horizontal velocity and a constant downward free-fall acceleration • In the absence of air resistance, projectiles follow a parabolic path • Outside factors that could affect motion • Satellites are fast moving projectiles	• Correctly use key concepts and vocabulary associated with one and two dimensional motion in discussions, investigations, and problem solving • Describe motion in terms of frame of reference, displacement, time, and velocity • Construct and interpret graphs of position versus time • Describe motion in terms of changing velocity • Compare graphical representations of accelerated and nonaccelerated motions • Apply equations to calculate distance, time, or velocity under conditions of constant acceleration • Relate the motion of a freely falling body to motion with constant acceleration • Distinguish between a scalar and a vector • Add and subtract vectors using the graphical method • Multiply and divide vectors by scalars • Identify appropriate coordinate systems for solving problems with vectors • Use a vector diagram drawn to scale to find the resultant of two velocities • Resolve vectors into two components • Apply equations to solve problems involving projectile motion • Describe situations in terms of frame of reference • Solve problems involving relative velocity

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 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.

HS-PS2-4.: Use mathematical representations of Newton’s Law of Gravitation and Coulomb’s Law to describe and predict the gravitational and electrostatic forces between objects.

HS-PS3-3.: Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

HS-ETS1-2.: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3.: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

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.
HS-PS2-2	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.
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.
HS-PS2-4	Use mathematical representations of Newton’s Law of Gravitation and Coulomb’s Law to describe and predict the gravitational and electrostatic forces between objects.

DESIRED RESULTS

Enduring Understandings	Essential Question(s)
Newton's laws describe the predictable ways in which forces interact to change the motion of objects. Multiple forces act on an object.	How can Newton's laws be applied in solving real world problems such as designing safer cars and more effective restraint systems?

Students will know (Knowledge):	Students will be able to (Skills):
• Key concepts and vocabulary associated with Newton's Laws of Motion, including: force, inertia, equilibrium, weight, friction, law of inertia, mass, Newton's first law of motion, air resistance, fluid, inversely, Newton's second law of motion, Pascal, pressure, terminal speed, terminal velocity, interaction, Newton's third law of motion, types of forces - net, normal, support, action, and reaction • The distinction between mass, weight, and volume • The mass of an object is dependent on the type and number of atoms in it, not its location • Action and reaction forces are equal in strength and opposite in direction	• Correctly use key concepts and vocabulary associated with Newton's Laws of Motion in discussions, investigations, and problem solving • Describe how force affects the motion of an object • Interpret and construct free-body diagrams depicting the multiple forces that act on an object • Explain the relationship between the motion of an object and the net external forces that act on the object • Determine the net external force on an object • Describe an object's acceleration in terms of its mass and the net force acting on it • Determine the direction and magnitude of the acceleration caused by a known net force • Identify action-reaction pairs • Find the direction and magnitude of normal forces • Describe air resistance as a form of friction

STANDARDS

HS-PS2-2.: 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.

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.

PRIORITY STANDARDS

HS-PS2-2	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.
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.

Unit 3: Momentum

High School - Physics - *Last Updated on March 21, 2019*

DESIRED RESULTS

Enduring Understandings	Essential Question(s)
Collisions in which there are transfers of momentum occur frequently in life. The world of sports affords many examples of collisions including the motion of balls against rackets in tennis and the motion of players' bodies against each other in football. Momentum is proportional to the mass and velocity of an object and is conserved in collisions.	What information must athletes consider about the ball and their own bodies in order to play effectively?

Students will know (Knowledge):	Students will be able to (Skills):
• Key concepts and vocabulary about momentum and collisions, including: momentum, impulse, perfectly inelastic collision, elastic collision, conserved, law of conservation of momentum • That in all interactions between isolated objects, momentum is conserved • That in every interaction between two isolated objects, the change in momentum of the first object is equal to and opposite the change in momentum of the second object • That in a perfectly inelastic collision, momentum is conserved, but kinetic energy is not conserved • That in an inelastic collision, kinetic energy is converted to internal elastic potential energy when the objects deform; and, some kinetic energy is also converted to sound energy and internal energy • That both momentum and kinetic energy are conserved in an elastic collision • That few collision are elastic or perfectly inelastic	• Correctly use key concepts and vocabulary about momentum and collisions in discussion, investigations, and problem solving • Compare the momentum of different moving objects • Compare the momentum of the same object moving with different velocities • Identify examples of change in the momentum of an object • Describe changes in momentum in terms of force and time • Compare the total momentum of two objects before and after they interact • Predict the final velocities of objects after collisions • Identify different types of collisions • Compare conservation of momentum and conservation of kinetic energy in perfectly inelastic and elastic collisions • Find the final velocity of an object in perfectly inelastic and elastic collisions

STANDARDS

HS-PS3-1.: 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

HS-PS3-2.: 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).

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Unit 4: Work and Energy

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DESIRED RESULTS

Enduring Understandings	Essential Question(s)
Work, energy,and power are related to one another. Although energy can change from one form to another, it is always conserved.	How can the science of work and power help us design effective and efficient machines?

Students will know (Knowledge):	Students will be able to (Skills):
• Key concepts and vocabulary associated with work and energy, including: work, kinetic energy, work-kinetic energy theorem, potential energy, gravitational potential energy, elastic potential energy, spring constant, mechanical energy, power, efficiency, fulcrum, Joule, law of conservation of energy, level, machine, mechanical advantage, pulley, watt • Work is done on an object only when a net force acts on the object to displace it in the direction of a component of the net force • The amount of work done on an object by a force is equal to the component of the force along the direction of motion times the distance the object moves • Objects in motion have kinetic energy because of their mass and speed • The net work done on or by an object is equal to the change in the kinetic energy of the object • Potential energy is energy associated with an object's position • At least two forms of potential energy are gravitational potential energy and elastic potential energy • Energy can change form but can never be created or destroyed • Mechanical energy is the sum of the kinetic energy and total potential energy associated with a system	• Correctly use key concepts and vocabulary associated with work and energy in discussions, investigations, and problem solving • Recognize the difference between the scientific and ordinary definitions of work • Define work by relating it to force and displacement • Identify where work is being performed in a variety of situations • Calculate the net work done when many forces are applied to an object • Identify different forms of energy • Calculate kinetic energy for an object • Apply the work-kinetic energy theorem to solve problems • Distinguish between kinetic and potential energy • Classify different types of potential energy • Calculate the potential energy associated with an object's position • Recognize the forms that conserved energy can take • Relate the concepts of energy, time, and power • Calculate power • Explain the effect of machines on work and power

Students will know (Knowledge):	Students will be able to (Skills):
• In the absence of friction, mechanical energy is conserve, so the amount of mechanical energy remains constant • Power is the rate at which work is done or the rate of energy transfer • Machines with different power ratings do the same amount of work in different time intervals	

Unit 5: Circular Motion & Center of Gravity

High School - Physics - *Last Updated on March 21, 2019*

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HS-ETS1-3.: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

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Unit 5: Circular Motion & Center of Gravity

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DESIRED RESULTS

Enduring Understandings	Essential Question(s)
Objects move in a circular path when there is a centrally directed force. The concept of circular motion helps to explain phenomena such as orbital motion or torque.	What are some examples of things 'moving in circles' that make our lives easier? How does the science of circular motion, center of gravity, and rotational mechanics help us explain the effectiveness and efficiency of these things?

Students will know (Knowledge):	Students will be able to (Skills):
• Key concepts and vocabulary associated with circular motion, center of gravity, and rotational mechanics including: axis, centrifugal force, centripetal force, linear speed, revolution, rotation, rotational speed, tangential speed, center of gravity, center of mass, neutral equilibrium, stable equilibrium, unstable equilibrium, angular momentum, law of conservation of angular momentum, lever arm, linear momentum, rotational inertia, rotational velocity, torque • An object that revolves about a single axis undergoes circular motion • An object in circular motion has a centripetal acceleration and a centripetal force, which are both directed toward the center of the circular path • From within a rotating frame of reference, there seems to be an outwardly directed centrifugal force which can simulate gravity • The center of gravity of an object tossed in the air follows a smooth parabolic path, even if the object spins or wobbles • For everyday objects, the center of gravity is the same as the center of mass • An object will remain upright if its center of gravity is above an area of support • An object is in stable equilibrium when any displacement raises it center of gravity	• Correctly use key concepts and vocabulary associated with circular motion, center of gravity, and rotational mechanics in discussions, investigations, and problem solving • Solve problems involving centripetal acceleration • Explain how the apparent existence of an outward force in circular motion can be understood as inertia resisting the centripetal force • Distinguish between torque and force • Calculate the magnitude of a torque on an object

Students will know (Knowledge):	Students will be able to (Skills):
• Torque is a measure of a force's tendency to rotate an object • The torque on an object depends on the magnitude of the applied force and on the lever arm • Balanced torques acting on an object produce no change in rotation • When the center of gravity is not over the base of support, the gravitational force produces a torque that causes toppling • The greater the rotational inertia, the harder it is to change the rotational speed of an object • Angular momentum is conserved when no external torque acts on an object	