BLUE VALLEY DISTRICT CURRICULUM OVERVIEW

Physics

UNIT 1: Kinematics

ESSENTIAL QUESTIONS	BIG IDEAS
How can position, velocity, and acceleration be used to describe the world around us?	• Students will be able to describe the motion of objects undergoing an acceleration using verbal, mathematical, and graphical models, in 1- and 2- dimensions.

GUIDING QUESTIONS

Content: HS-PS2-1

- With what values can the motion of objects be described?
- What are vectors?
- What effects can an acceleration have on an object's velocity?
- What happens to the velocity of an object as it falls?
- How does the direction of an acceleration relate to the change in an object's speed?
- What path does an object take when it is in projectile motion?

Process

- How can the velocity of an object be determined from a position time graph?
- How can the acceleration of an object and the displacement of an object be determined from a velocity time graph?
- How can the quantities of displacement, initial and final velocity, acceleration, and time be related mathematically?
- How can vectors be combined?

Reflective

- Why does a ball that is dropped off a moving platform look different to different observers (one on the platform vs one viewing from the outside)?
- Why don't objects on earth seem to all fall at the same rate?
- Why does a ball kicked horizontally and a ball dropped, both from the same height, hit the ground at the same time?
- What situations on earth are best described by the assumptions of free-fall motion?

UNIT 2: Dynamics

ESSENTIAL QUESTIONS	BIG IDEAS
How do forces affect our surroundings?	• Students will be able to describe the motion of objects that are experiencing a net force. • Students will be able to apply Newton's Laws of Motion to a variety of situations.

GUIDING QUESTIONS

Content

- What are Newton's Three Laws of Motion?
- What is inertia, and what quantity do we use to represent it?
- What is the relationship between an object's mass, the force acting on it, and its acceleration?
- How can the motion of an object that is not experiencing a net force be described?
- What factors affect the coefficient of friction between two surfaces?
- How are the mass and the weight of an object different?
- What force causes objects to slide down an inclined plane?
- What is the difference between static and kinetic friction?

Process

- How can the forces acting on an object be represented graphically?
- How can the acceleration of an object with multiple forces acting on them be calculated?
- How can the acceleration of systems of multiple masses, such as Atwood Machines, be calculated?
- How can the coefficient of friction between two surfaces be calculated?
- What effect does the mass of an object have on the force of friction acting on the object?

Reflective

- Why does it feel like I am pushed into the back of my seat when I first hit the gas when the light turns green?
- Why can't astronauts "swim" in space?
- Why is it easier to keep a car moving than it is to start it moving?
- Why does the mass of an astronaut remain the same when they go to a different planet, but their weight changes?
- What is the maximum angle that a inclined plane can be at before an object slides down it?
- When a truck and a car collide, which one experiences the larger force?

UNIT 3: Gravity and Circular Motion

ESSENTIAL QUESTIONS	BIG IDEAS
How does society make use of uniform circular motion?	• Students understand the effects of a centripetal force on objects in motion. • Students understand that gravity is a force that acts both at a distance and universally.

GUIDING QUESTIONS

Content

- What keeps an object moving in a circle?
- What is centripetal force, and how does it affect an object's motion?
- What factors affect the force of gravity between two objects?
- What is Newton's Law of Universal Gravitation?

Process

- How are the force of gravity between two objects, the mass of the objects, and the distance between the objects mathematically related?
- How can the velocity of an object moving in uniform circular motion be calculated?
- How does changing the velocity of an object in uniform circular motion affect its radius of motion?

Reflective

- Why do astronauts on the ISS experience weightlessness?
- How do space probes utilize gravitational assists?
- Why do you feel heavier at the bottom of a loop-the-loop compared to the top?
- What would happen to the orbits of planets if the sun collapsed into a black hole?
- Why does water stay in a bucket when you spin it in a vertical path?
- Why is the speed limit on a turn smaller than on a straight away?
- Why is a year on Mars longer than a year on Earth?

UNIT 4: Work, Energy, and the Laws of Thermodynamics

ESSENTIAL QUESTIONS	BIG IDEAS
If energy is always conserved, where does the energy go when my phone dies?	• Students understand the conservation of energy, and can describe it using mathematical models. • Students will be able to describe the processes of energy transfer, and track where energy flows to and from.

GUIDING QUESTIONS

Content:HS-PS3-1; HS-PS3-2; HS-PS3-3; HS-PS3-4

- What is energy, and what is its SI units?
- What does it mean for energy to be conserved?
- When is mechanical energy not conserved?
- How is work related to energy?
- What is mechanical advantage?
- What is the second law of thermodynamics?

Process

- How can the kinetic and potential energy of an object be calculated?
- How can energy transfers be diagrammed for the motion of an object?
- How can the conservation of energy be modeled mathematically?
- How can the energy lost from of system be calculated?
- How can the mechanical advantage of a system be calculated?

Reflective

- How is energy from coal changed to usable energy in the home?
- Why are some cars more energy efficient than others?
- Are renewable energy sources a viable alternative to coal?
- Why doesn't a cup of coffee get hotter when it sits out?
- Why is the highest hill on a roller coaster always the first one?
- Why don't bouncy balls bounce up to the exact same height as they were dropped from?

UNIT 5: Linear Momentum

ESSENTIAL QUESTIONS	BIG IDEAS
How do we stay safe during collisions?	• Students will be able to mathematically model and explain the conservation of momentum in closed systems where collisions and separations occur. • Students will be able to explain how the momentum of a system can change, and design ways to change the amount of force experienced during a collision.

GUIDING QUESTIONS

Content: HS-PS2-2; HS-PS2-3

- What is momentum, and what are its SI units?
- What differentiates elastic, inelastic, and perfectly inelastic collisions?
- How can forces change the momentum of a system?

Process

- How can the conservation of momentum be modeled mathematically?
- How can the direction of objects' motion after a collision be predicted?
- How can the average force acting on an object during a collision be calculated?

Reflective

- If momentum is conserved, how does anything start moving?
- Why do cannons recoil when they are fired?
- When two ice skaters push off from each other, why does the lighter skater move faster?
- How do airbags protect you during a car crash?
- Why are newer cars with plastic, easily breakable panels safer than older, steel framed vehicles?
- Why do smaller cars seem to sustain more damage in crashes than larger ones?
- How can a device be designed in order to minimize the impulse on an object?
- How can protective helmets be designed better to prevent injuries such as concussions or CTE?

UNIT 6: Electrostatics

ESSENTIAL QUESTIONS	BIG IDEAS
How do charged particles interact with their surroundings without being in direct contact?	• Students will be able to describe the effects of charges on each other, and explain the process by which objects obtain charge. • Students will be able to relate the electrostatic force and the gravitational force under the framework of fields.

GUIDING QUESTIONS

Content: HS-PS2-4; HS-PS3-5

- What is the atom made of, what is the charge of each component, and which component can carry charge from place to place?
- What does it mean for something to be quantized, and how does that relate to electric charge?
- What is the conservation of charge?
- What occurs when an object is grounded?
- What is the difference between a conductor and an insulator?
- What are electric fields, and how do they influence charged particles?
- How can charged particles be described in terms of energy?

Process

- How can an electroscope be used to describe the charge on an object?
- What different ways can objects gain an electric charge?
- How can the attractive or repulsive force between two charged objects be calculated?
- How are the electrostatic force and the gravitational force similar and different?
- How can electric fields be represented graphically?

Reflective

- Why do you get shocked more during the winter instead of during the summer?
- How is lightning formed?
- Why does your hair stand up when touching a Van de Graaff generator?
- Why is touching a 120-Volt outlet more dangerous than touching a 100,000-Volt Van de Graaff generator?
- How are electric fields used in particle accelerators?

UNIT 7: Circuits and Induction

ESSENTIAL QUESTIONS	BIG IDEAS
How do electrical circuits convert electrical energy to useable forms?	• Students will be able to determine the potential difference, current, and power across components in an electrical circuit, and mathematically represent the relationships between them. • Students will be able to describe the relationship between electricity and magnetism.

GUIDING QUESTIONS

Content: HS-PS3-1; HS-PS2-5; HS-PS2-6

- What is an electric current, and what is its SI unit?
- What are the defining characteristics of a series circuit?
- What are the defining characteristics of a parallel circuit?
- What are Kirchhoff's Rules?
- What is meant by conventional current? Which way does charge actually flow in a circuit?
- What is a magnetic field?
- How can a magnet be used to create an electric current?

Process

- How can electrical circuits be represented schematically?
- How can the potential difference, current, and resistance be calculated for circuit elements connected in series, parallel, or a combination of both?
- What happens to the overall resistance in a series circuit when resistors are added? In a parallel circuit? What happens to the total current in each circuit?
- How can the rate of energy usage for a circuit be calculated?

Reflective

- Why is your house wired in parallel instead of series?
- What is the function of a circuit breaker in a home?
- Why is copper typically used to wire a house instead of aluminum? Instead of silver/gold?
- Is the north pole of the earth also magnetically north?
- As current flows from high potential to low potential, where does the energy go?
- Why do power lines transmit current at high voltages?
- How much electrical energy do you use in a day?

UNIT 8: Simple Harmonic Motion and Waves

ESSENTIAL QUESTIONS	BIG IDEAS
How does information travel across large distances to your devices?	• Students will be able to connect simple harmonic motion of pendulums and mass-spring systems to the motion of waves. • Students will be able to describe wave motion and interactions for mechanical and electromagnetic waves.

GUIDING QUESTIONS

Content: HS-PS4-1; HS-PS4-3; HS-PS4-4

- What is simple harmonic motion?
- What factors affect the period of a pendulum and the period of a mass-spring system?
- What is frequency, wavelength, and wave speed?
- What differentiates a mechanical wave from an electromagnetic wave?
- How do waves interact with their surroundings and other waves?
- What is resonance?
- What is the Doppler Effect?
- How does the electromagnetic spectrum ordering relate to the energy of the waves?
- How did the single and double slit experiments provide evidence that light acts as a wave?

Process

- How are frequency and wavelength related?
- How can the motion of pendulums and mass-spring systems be described mathematically?

Reflective

- How are the qualities of waves (wavelength, frequency, amplitude) relate to physical, observable properties?
- How do musical instruments change the wavelengths of the waves they produce in order to create different pitches?
- Why do we describe light sometimes as a wave and sometimes as a particle?
- Is it safe to put your face in front of the microwave?
- Why can’t anyone hear you scream in space?
- Why do images that are underwater look distorted?
- Why do sirens sound higher pitched when they are coming toward you and lower pitched after they pass?

UNIT 9: Geometric Optics

ESSENTIAL QUESTIONS	BIG IDEAS
How do optical devices such as camera, telescopes and microscopes create images?	• Students will be able to model the reflection and refraction of light.

GUIDING QUESTIONS

Content: HS-PS4-2; HS-PS4-5

- What is the difference between reflection and refraction?
- What is focal length?
- What is Snell's Law?
- What is the difference between a real image and a virtual image?
- Under what conditions does total internal reflection occur?

Process

- How can a ray diagram be used to illustrate how images are created with flat, convex, and concave mirrors?
- How can a ray diagram be used to illustrate how images are created with converging and diverging lenses?
- How is magnification calculated?
- How is the index of refraction for a material calculated?

Reflective

- Why do different objects appear different colors?
- Why do parking garages and supermarkets use convex mirrors instead of concave mirrors?
- How do corrective lenses serve to fix vision problems?
- What is the smallest flat mirror that can be used to see your whole body?
- What are the benefits and disadvantages of refracting or reflecting telescopes?
- How is information transmitted through fiber optic cables?

UNIT 10: Fluids

ESSENTIAL QUESTIONS	BIG IDEAS
How does the physics of fluids differ from the physics of solids?	• Students will be able to describe the buoyant force and use it to explain the floating and sinking of objects. • Students will be able to explain the effects that a moving fluid have on their surroundings.

GUIDING QUESTIONS

Content: HS-PS2-1

- What is density?
- How does the specific gravity of an object or material relate to its density?
- What effect does velocity of a fluid have on its pressure?
- What causes a buoyant force to act on an object, and in what direction does it act?
- What is viscosity, and how does it affect the flow of a fluid?

Process

- How can the buoyant force on an object be calculated?
- How can the percent of an object's volume that is submerged when floating be calculated?
- How can we predict whether an object will float or sink?

Reflective

- How can a flammable substance such as oil burn when it is spilled in water?
- How does the properties of a fluid affect the design of hydraulic brakes?
- How can a boat that is made of a very dense material, such as steel, still float?
- What shape of container will be the most effective at floating with an added weight load?
- Why do cars passing at high speeds feel as if they are being pulled together?
- What causes "the bends" for divers?
- How do airplanes generate lift?