Unit 1: Kinematics
UNIT PLAN

AP Physics 1
Unit # 1
Suggested Duration: 21 Days

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UNIT NARRATIVE

This unit is divided into two phases. The first phase includes all lessons up to MUE1 and has a goal of describing 1 Dimensional motion graphically and with equations. The second phase of this unit (between MUE1 and UE1) has the goal of describing 2-Dimensional motion, primarily Projectile Motion.

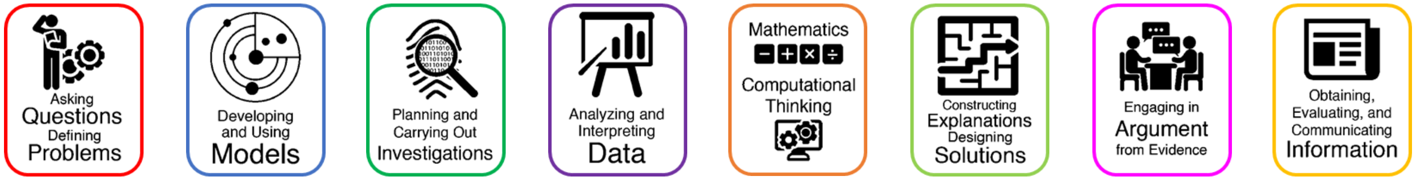
Students begin by exploring motion in one dimension by distinguishing between scalar and vector quantities, specifically comparing distance versus displacement. This distinction introduces the idea that direction is critical for many physical quantities in physics, setting the groundwork for future study of velocity, acceleration and many other vector quantities throughout the course. Then students will begin exploring the simplest type of motion, constant velocity motion, first by observing and describing different types of motion in toys cars to determine the difference between constant and changing motion. Then students are introduced to position-time graphs, velocity-time graphs and motion maps, the primary motion models used in physics. By analyzing and translating between motion graphs, motion maps and narrative scenario descriptions, to be all models/descriptions of a scenario "tell the same story" students will develop deep conceptual understanding of characteristics of each model. Now that students have a qualitative understanding of motion graphs, they are ready to explore the two primary quantitative graph analysis techniques used in introductory physics, calculating slope and area under the curve. These skills will be important for analysis of graphs throughout the course and specifically during Unit 1 allows students to calculate displacement, velocity and acceleration even when not explicitly indicated on a graph.

Students will then progress to constant acceleration motion, where they will use the same motion graphs to explore this more complex type of motion using the same analysis techniques. First students will complete a lab to experimentally determine the variable relationships that define constant acceleration motion. This allows students to discover these relationships before seeing them in the kinematics equations which helps build conceptual understanding about the structure of the equations. Students will then analyze and translate between the motion graphs already introduced with constant velocity motion plus acceleration-time graphs for constant acceleration motion and segmented motion (typically a combination of constant velocity and constant acceleration motion where each occurs in discreet segments of the scenario). This scaffolded approach to motion graphs provides students with opportunity for spiral review of motion graphs analysis to help them compare and contrast constant velocity and constant acceleration motion. Now students are ready to explore free fall motion scenarios, which are a specific type of constant acceleration motion with gravitational acceleration. Free fall motion is a pivotal concept in physics and is related to nearly every other unit in this course, especially in Unit 2: Dynamics. To conclude the first phase of this unit, students will practice their mathematical routines using the kinematics equations to calculate and make claims about displacement, velocity and acceleration. At this point in the unit students should have a solid understanding of how to describe constant velocity motion and constant acceleration motion graphically and mathematically.

The second phase of this unit begins by introducing 2D vectors and how they can be resolved into two perpendicular 1D vector components graphically and using trigonometry, and how vector components can be added together using the Pythagorean Theorem. Students are then ready to explore the relative nature of velocity by considering the way velocity would be described by observers with different reference frames. Next students will be introduced to 2D motion using a simulation of a riverboat crossing where they will experimentally determine the variable relationships that define the time to cross the river and the downstream displacement while crossing. This simulation activity is designed to help students conceptually understand how perpendicular velocity vectors do not directly impact each other but can have indirect affects for a simpler scenario where the 2D motion is constant velocity for both components. This unit culminates in the exploration of projectile motion, which is more complicated than riverboat crossing because it is constant velocity in the horizontal component by constant acceleration (free fall) in the vertical component. Students will first explore the simpler case of horizontal projectile motion, because initial vertical velocity is zero, using slow motion video analysis, experimentally defining variable relationships, and by creating and analyzing position-time and velocity-time graphs for both the horizontal and vertical directions. Finally, students will be ready to explore angled projectile motion using experimental variable relationship discovery, creating and analyzing velocity-time graphs, and calculations that include kinematics equations for the vertical direction.

Focus on Disciplinary Literacy

In science, disciplinary literacy is synonymous with the science and engineering practices. The SEPs are the context through which all science concepts should be taught. In the lessons, you will find the Science and Engineering practices icons when the SEPs are being explicitly used by students.



UNPACKED STANDARDS

Below are the standards **taught** and **assessed** in this unit.

Learning Objective				Essential Knowledge	
Topic #	Topic	LO #	Learning Objective	EK #	
1.1	**Scalars and Vectors in One Dimension**	1.1.A	Describe a scalar or vector quantity using magnitude and direction, as appropriate.	1.1.A.1	Scalars are quantities described by magnitude only; vectors are quantities described by both magnitude and direction.
				1.1.A.2	Vectors can be visually modeled as arrows with appropriate direction and lengths proportional to their magnitude.
				1.1.A.3	Distance and speed are examples of scalar quantities, while position, displacement, velocity, and acceleration are examples of vector quantities. i. Vectors are notated with an arrow above the symbol for that quantity. **Relevant Equation -->** $v = v_0 + at$ ii. Vector notation is not required for vector components along an axis. In one dimension, the sign of the component completely describes the direction of that component. **Derived Equation -->** $v_x = v_{x0} + a_x t$
		1.1.b	Describe a vector sum in one dimension.	1.1.B.1	When determining a vector sum in a given one-dimensional coordinate system, opposite directions are denoted by opposite signs.
1.2	**Displacement, Velocity, and Acceleration**	1.2.A	Describe a change in an object's position.	1.2.A.1	When using the object model, the size, shape, and internal configuration are ignored. The object may be treated as a single point with extensive properties such as mass and charge.
				1.2.A.2	Displacement is the change in an object's position. **Relevant Equation -->** $\Delta x = x - x_0$
		1.2.B	Describe the average velocity and acceleration of an object.	1.2.B.1	Averages of velocity and acceleration are calculated considering the initial and final states of an object over an interval of time.
				1.2.B.2	Average velocity is the displacement of an object divided by the interval of time in which that displacement occurs. **Relevant Equation -->** $v_{avg} = \frac{\Delta x}{\Delta t}$
				1.2.B.3	Average acceleration is the change in velocity divided by the interval of time in which that change in velocity occurs. **Relevant Equation -->**$a_{avg} = \frac{\Delta v}{\Delta t}$

				1.2.B.4	An object is accelerating if the magnitude and/or direction of the object's velocity are changing.
				1.2.B.5	Calculating average velocity or average acceleration over a very small time-interval yields a value that is very close to the instantaneous velocity or instantaneous acceleration.
1.3	**Representing Motion**	1.3.A	Describe the position, velocity, and acceleration of an object using representations of that object's motion.	1.3.A.1	Motion can be represented by motion diagrams, figures, graphs, equations, and narrative descriptions.
				1.3.A.2	For constant acceleration, three kinematic equations can be used to describe instantaneous linear motion in one dimension. **THREE KINEMATIC EQUATIONS -->** $v_x = v_{x0} + a_x t$ $x = x_0 + v_{x0} t + \frac{1}{2} a t^2$ $v_x^2 = v_{x0}^2 + 2a_x(x - x_0)$
				1.3.A.3	Near the surface of Earth, the vertical acceleration caused by the force of gravity is downward, constant, and has a measured value approximately equal to **g = 10 m/s²**
				1.3.A.4	Graphs of position, velocity, and acceleration as functions of time can be used to find the relationships between those quantities. i. An object's instantaneous velocity is the rate of change of the object's position, which is equal to the slope of a line tangent to a point on a graph of the object's position as a function of time. ii. An object's instantaneous acceleration is the rate of change of the object's velocity, which is equal to the slope of a line tangent to a point on a graph of the object's velocity as a function of time. iii. The displacement of an object during a time interval is equal to the area under the curve of a graph of the object's velocity as a function of time (i.e., the area bounded by the function and the horizontal axis for the appropriate interval). iv. The change in velocity of an object during a time interval is equal to the area under the curve of a graph of the acceleration of the object as a function of time.
		BOUNDARY STATEMENT: AP Physics 1 does not expect students to quantitatively analyze nonuniform acceleration. However, students will be expected to be able to qualitatively analyze, sketch appropriate graphs of, and discuss situations in which acceleration is nonuniform. **BOUNDARY STATEMENT:** For all situations in which a numerical quantity is required for g, the value g = 10 m/s will be used. However, students will not be penalized for correctly using the more precise commonly accepted values of **g = 9.8 or 9.81 m/s²**			
1.4	**Reference Frames and Relative Motion**	1.4.A	Describe the reference frame of a given observer.	1.4.A.1	The choice of reference frame will determine the direction and magnitude of quantities measured by an observer in that reference frame.
		1.4.B	Describe the motion of objects as measured by	1.4.B.1	Measurements from a given reference frame may be converted to measurements from another reference frame.

			observers in different inertial reference frames.	1.4.B.2	The observed velocity of an object results from the combination of the object's velocity and the velocity of the observer's reference frame. i. Combining the motion of an object and the motion of an observer in a given reference frame involves the addition or subtraction of vectors. ii. The acceleration of any object is the same as measured from all inertial reference frames.
		BOUNDARY STATEMENT: *Unless otherwise stated, the frame of reference of any problem may be assumed to be inertial.* *Adding or subtracting vectors to find relative velocities is restricted to motion along one dimension for AP Physics 1.*			
1.5	**Vectors and Motion in Two Dimensions**	1.5.A	Describe the perpendicular components of a vector.	1.5.A.1	Vectors can be mathematically modeled as the resultant of two perpendicular components.
				1.5.A.2	Vectors can be resolved into components using a chosen coordinate system.
				1.5.A.3	Vectors can be resolved into perpendicular components using trigonometric functions and relationships.
		1.5.B	Describe the motion of an object moving in two dimensions.	1.5.B1	Motion in two dimensions can be analyzed using one-dimensional kinematic relationships if the motion is separated into components.
				1.5.B.2	Projectile motion is a special case of two-dimensional motion that has zero acceleration in one dimension and constant, nonzero acceleration in the second dimension.

UNDERSTANDINGS AND QUESTIONS

Important big ideas and processes for the unit.

Key Understandings
❑ Vectors are quantities that require a direction to be complete, and scalars are quantities that do not require a direction ❑ Position-time graphs can be analyzed to determine displacement and velocity quantitatively and acceleration qualitatively ❑ Velocity-time graphs can be analyzed to determine displacement and acceleration quantitatively. ❑ Kinematics equations can be used to predict displacement, change in velocity, acceleration, or time (given initial data about a scenario). ❑ Velocity is relative to the observer. ❑ All objects fall with the same constant acceleration of -9.81 m/s^2 (-10 m/s^2 for simplicity) when air resistance is negligible. ❑ Projectile motion is free-fall motion with a horizontal constant velocity. ❑ Projectile motion can be described as a simultaneous horizontal constant velocity and a vertical constant downward acceleration motion.

Key Questions
• What types of graphs are used to model motion? • How are graphs analyzed to describe and predict the motion of objects? • How can equations be used to predict the future displacement and motion of an object? • How can the idea of frames of reference allow two people to tell the truth yet have conflicting reports? • Why is the general rule for stopping your car “when you double your speed, you must give yourself four times as much distance to stop?” • What variables determine the time of flight of a horizontal projectile? The horizontal range? • What variables determine the time of flight of an angled projectile? The horizontal range? The maximum height?

ROADMAP

AT A Glance: Unit #:			
Day	**Date**	**Lesson**	**Lesson Title**
There are four flex days built into this unit to use as needed. Flex days can be used for lessons that take longer than one day or for reteaching material the students may not have gotten during tier 1 instruction.			
1		01	Displacement vs Distance (Scalar vs Vector)
2		02	Constant Velocity Graphs – Day 1
3		03	Constant Velocity Graphs – Day 2
4		04	Displacement from V-t graphs
5		05	Lab – Constant Acceleration – Relationships
6		06	Lab – Constant Acceleration – Speeding Up vs Slowing Down
7		07	Practice – Constant Acceleration
8		08	Graph Matching
9		09	Free Fall Motion Introduction
10		10	Practice – Free Fall Motion
11		11	Practice – Kinematics Equations
12		12	TX_SCI_APPhysics_F24_MUE1
13		13	Reference Frames & Relative Motion
14		14	2D Vectors
15		15	2D Motion Intro - 1
16		16	2D Motion Intro - 2
17		17	Horizontal Projectiles – 1
18		18	Horizontal Projectiles – 2
19		19	Angled Projectiles – 1
20		20	Angled Projectiles – 2
21		Unit Exam	TX_SCI_APPhysics_F24_UE1
22		Success Day	Time Permitting – review the most missed MC and the entire FRQ using Success Day Lesson Plan

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
Day 1 **Distance vs Displacement**	1.1.A Describe a scalar or vector quantity using magnitude and direction, as appropriate. 1.2.A Describe a change in an object's position. **SWBAT** describe the difference between measurements of distance (scalar) and displacement (distance) for a scenario qualitatively and quantitatively.	▪ The goal is for small groups to come up with working definitions for distance vs displacement (or something close) before these physics vocabulary words are introduced. ▪ Comparing Distance and Displacement is a very approachable introduction to scalars and vectors before diving into more complicated quantities like velocity and acceleration. **Teacher Content Background Resources:** Khan – Scalars & Vectors Khan - Displacement PC – Scalars & Vectors PC – Distance & Displacement	Mathematics Computational Thinking
Day 2 **Modeling Constant Velocity 1** **Day 3** **Modeling Constant Velocity 2**	1.2.B Describe the average velocity and acceleration of an object. 1.3.A. Describe the position, velocity, and acceleration of an object using representations of that object's motion. **SWBAT** describe the velocity of an object qualitatively and quantitatively using the slope of a Position-time graph.	▪ Students will create and analyze multiple types of representations of constant velocity motion, including Position-time graphs ▪ This will be an introduction to the different types of representations that are used to model motion for the simplest motion, constant velocity, before exploring accelerated motion and the additional complexities with the modeling and analysis of this type of motion. **Criteria For Success: I have mastered the LO if I can…** ❑ Identify the displacement. ❑ Identify the change in time. ❑ Calculate the magnitude of the velocity. ❑ Identify the direction of the velocity	Developing and Using Models
Day 4 **Displacement from V-t graphs**	1.3.A. Describe the position, velocity, and acceleration of an object using representations of that object's motion. **SWBAT** calculate the displacement of a moving object from a Velocity-time graph.	**Key Points** • Area under a curve always represents the multiplication of the units on the x and y axis, and in physics this helps us determine displacement from V-t graphs • Students will work through a progression of graph analysis questions starting with very simple and increasing in complexity until they are analyzing constant velocity motion with both positive and negative displacement **Criteria For Success: I have mastered the LO if I can…** ❑ Identify displacement on a v-t graph. ❑ Categorize displacement as positive or negative. ❑ Break displacement areas into simple geometrical shapes. ❑ Calculate the area of each simple geometric shape. ❑ Calculate the TOTAL displacement using individual displacements.	Mathematics Computational Thinking

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
Day 05 Lab – Acceleration Day 1	1.2.B Describe the average velocity and acceleration of an object. 1.3.A. Describe the position, velocity, and acceleration of an object using representations of that object's motion. **SWBAT** describe the variable relationships that define constant acceleration motion using experimental data (velocity vs time, position vs time).	• Students will work with lab groups to execute and experiment to explore the relationship between displacement and time, and velocity and time for constant acceleration motion • Students will analyze the motion graphs of experimental data to determine the variable relationships that define constant acceleration motion • This experiment can be completed using vernier carts and tracks that have been propped up on one end to create an incline of using vernier fan carts on flat tracks **Criteria For Success: I have mastered the LO if I can…** ❑ Execute an experiment with proper independent, dependent and constant variables. ❑ Collect and record data for the independent and dependent variables over multiple trials. ❑ Create a graph with the independent variable on the x-axis and the dependent variable on the y-axis. ❑ Use the shape of the graph to determine the variable relationship ❑ Optional - test the variable relationship to confirm it accurately predicts changes to the dependent variable.	Planning and Carrying Out Investigations **Lab Materials Needed:** (Per lab group) • 1 Vernier Track • 1 Vernier Cart (with or without fan) • 1 Vernier Motion Sensor • 1 Student computer • Books to elevate one end of track
Day 06 **Lab – Acceleration Day 2**	1.2.B Describe the average velocity and acceleration of an object. 1.3.A. Describe the position, velocity, and acceleration of an object using representations of that object's motion. **SWBAT** identify slowing down vs speeding up accelerated motion using motion graphs (P-t graphs, V-t graphs).	• Students will work with lab groups execute an investigation into the relationship between the relative direction of velocity and acceleration vectors and speeding up acceleration vs slowing down acceleration • Students will analyze motion graphs from experimental data to determine the relative directions of the velocity vector and the acceleration vector, or the description of the motion graphs that produce the scenarios described as "speeding up" versus "slowing down" **Criteria For Success: I have mastered the LO if I can…** ❑ Step 1. ❑ Step 2 ❑ Step 3 (minimum) ❑ Step 4 ❑ Step 5 (maximum)	

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
Day 07 **Accelerated Motion Practice**	1.3.A. Describe the position, velocity, and acceleration of an object using representations of that object's motion. **SWBAT** create Velocity-time graphs to match narrative scenario descriptions and analyze v-t graphs to make claims about the motion of objects.	▪ Students will investigate multiple scenarios that require them to create and analyze V-t graphs (slope and area under the graph) to make and justify claims about the scenario. **Criteria For Success: I have mastered the LO if I can…** ❑ Step 1. ❑ Step 2 ❑ Step 3 (minimum) ❑ Step 4 ❑ Step 5 (maximum)	Engaging in Argument from Evidence
Day 08 **Graph Matching – Accelerated Motion**	1.3.A. Describe the position, velocity, and acceleration of an object using representations of that object's motion. **SWBAT** Translate between different motion graphs (P-t, V-t, A-t graphs).	▪ First part of this activity asks students to create P-t and V-t graphs that match a given graph using Vernier motion detectors ▪ Second part of this activity asks students to translate between P-t, V-t and A-t graphs for 8 scenarios **Criteria For Success: I have mastered the LO if I can…** ❑ Step 1. ❑ Step 2 ❑ Step 3 (minimum) ❑ Step 4 ❑ Step 5 (maximum)	Developing and Using Models **Lab Materials Needed:** (Per lab group) • 1 Vernier Track • 1 Vernier Cart • 1 Student computer
Day 09 **Free Fall**	1.2.B Describe the average velocity and acceleration of an object. 1.3.A. Describe the position, velocity, and acceleration of an object using representations of that object's motion.	▪ Students will analyze a slow-motion video of several balls being thrown into the air vertically to collect data and create motion graphs **Part 1** ▪ students will collect data and create motion graphs for the falling of a single ball, then compare with group partners who created graphs for other balls to conclude that the falling motion is independent of the mass of an object, and that free-falling motion is constant acceleration with a specific acceleration (we will use -10 m/s^2) for simplicity **Part 2**	**Download video files from Physics Teams → AP Physics Channel → U1 Kinematics → Pivot Interactive Videos**

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
	SWBAT describe the motion of objects in free fall (with negligible air resistance) by analyzing slow motion video.	▪ Students will repeat a similar process as Part 1 but analyzing the motion of a single ball as it is released with initial positive velocity, rises to a maximum height and then fall back down ▪ Students should conclude that the acceleration of free fall is constant throughout the flight of the ball including when it is moving up or down or zero velocity (at the top of the ball's flight). **Part 3** ▪ Students will create motion graphs for the falling of a Styrofoam ball, which has a small enough mass that air resistance is no longer negligible ▪ Students should observe that the slope of the v-t graph for the Styrofoam ball is flatter/less steep and conclude that the change in velocity of the Styrofoam ball is slower than the other balls and hence the acceleration must be smaller as well. *This can be tied into the free body diagram of objects in free fall that typically only have one vertical for, the force of gravity downward, but in cases like the Styrofoam ball, must also have a non-negligible upward force of air resistance.* **Criteria For Success: I have mastered the LO if I can…** ❑ Step 1. ❑ Step 2 ❑ Step 3 (minimum) ❑ Step 4 ❑ Step 5 (maximum)	
Day 10 **Free Fall Practice**	1.3.A. Describe the position, velocity, and acceleration of an object using representations of that object's motion. **SWBAT** create and analyze Velocity-time graphs of vertical free fall motion to determine displacement, velocity and time.	▪ Students will analyze two scenarios about a toy rocket being launched into the sky ▪ This provides extra practice with analysis and interpretation of V-t graphs for the constant acceleration motion of free fall and includes moving upward and moving downward. ▪ **Students should have the AP Physics 1 Equation Table** **Criteria For Success: I have mastered the LO if I can…** ❑ Step 1. ❑ Step 2 ❑ Step 3 (minimum)	

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
		❑ Step 4 ❑ Step 5 (maximum)	
Day 11 **Kinematics Practice**	1.2.B Describe the average velocity and acceleration of an object. 1.3.A. Describe the position, velocity, and acceleration of an object using representations of that object's motion. **SWBAT** calculate quantitative predictions about the motion of an object using the kinematics equations.	▪ Students will work with table partners to practice solving for unknown quantities for motion including time, displacement, velocity and acceleration using kinematics equations. ▪ **Students should have a copy of the AP Physics 1 Equation Table for this activity and be reminded to refer to it as part of the process for answering these questions.** **Criteria For Success: I have mastered the LO if I can…** ❑ Step 1. ❑ Step 2 ❑ Step 3 (minimum) ❑ Step 4 ❑ Step 5 (maximum)	Mathematics Computational Thinking
Day 12 **Mid Unit Exam**	**TX_SCI_APPhysics_F25_MUE1** **Scanning Deadline – 9/11/2025** **All Students must have access to the AP Physics 1 Equation Table (revised for 24-25) for ALL Exams!**		ap-physics-1-Equation Table - 2024.pdf
Day 13 **Reference Frames & Relative Motion**	1.4.A Describe the reference frame of a given observer. 1.4.B Describe the motion of objects as measured by observers in different inertial reference frames. **SWBAT** describe the motion of objects as measured by observers with different reference frames.	▪ Students will examine the velocity of a moving object from multiple frames of reference to develop understanding about the relative nature of vector measurements like velocity. **Criteria For Success: I have mastered the LO if I can…** ❑ Step 1. ❑ Step 2 ❑ Step 3 (minimum) ❑ Step 4	Mathematics Computational Thinking

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
		❑ Step 5 (maximum)	
Day 14 **2D Vectors**	1.5.A Describe the perpendicular components of a vector. **SWBAT** Calculate the perpendicular vector components of a 2D displacement vector using trigonometry.	▪ Students will use graph paper to break 2D vectors (arrows) into perpendicular vector components (horizontal and vertical). ▪ Students will practice the process of using trigonometric functions (sine and cosine) to quantitatively break down 2D displacement vectors into horizontal and vertical components. **Criteria For Success: I have mastered the LO if I can…** ❑ Step 1. ❑ Step 2 ❑ Step 3 (minimum) ❑ Step 4 ❑ Step 5 (maximum)	Mathematics Computational Thinking
Day 15 **2d Motion River Boat 1**	1.5.B Describe the motion of an object moving in two dimensions. **SWBAT** describe the relationships between the boat speed and current speed verses time to cross and downstream displacement.	▪ Students will work in partners using Physics Classroom Riverboat Simulation to investigate the relationships between the horizontal boat velocity and/or the vertical river velocity dependence and the time it takes the boat to cross the river and the amount of downstream displacement while crossing the river. ▪ This activity is included as a scaffold to projectile motion because this 2D velocity is constant velocity in both perpendicular directions, but projectile motion is constant velocity in the horizontal direction and constant acceleration in the vertical direction. ▪ The DO Now for this lesson provides an opportunity to review/practice more with frame of reference and relative velocity by asking students to describe the velocity of the boat from the perspective of different observer locations. **Criteria For Success: I have mastered the LO if I can…** ❑ Step 1 ❑ Step 2 ❑ Step 3 (minimum) ❑ Step 4	Planning and Carrying Out Investigations

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
		❑ Step 5 (maximum)	
Day 16 **2d Motion River Boat 2**	1.5.B Describe the motion of an object moving in two dimensions. **SWBAT** calculate the time and displacement of a riverboat crossing a river given the velocity of the boat and the river.	▪ Students will practice making predictions about the 2D riverboat velocity by using the perpendicular velocity components individually to calculate time to cross and the downstream displacement. **Criteria For Success: I have mastered the LO if I can…** ❑ Step 1 ❑ Step 2 ❑ Step 3 (minimum) ❑ Step 4 ❑ Step 5 (maximum)	**Student computers will be required** for Days 17 (to analyze slow motion video) & 18 (to access the riverboat simulation). **At least 1 computer for 2 students is ideal.** Mathematics Computational Thinking
Day 17 **Horizontal Projectiles video Analysis**	1.5.B Describe the motion of an object moving in two dimensions. **SWBAT** describe the horizontal and vertical components of velocity and the acceleration using slow motion video analysis. **SWBAT** describe the quantitative variable relationships that define the time of flight, maximum height, and range for a horizontal projectile using experimental data as justification.	▪ Students will work in partners and use a slow-motion video of a ball bearing rolling off of a table (a horizontal projectile) to collect data about the position and time of the projectile motion in both the vertical and horizontal directions to describe the type of motion the ball bearing experiences in the horizontal and vertical directions simultaneously. **Criteria For Success: I have mastered the LO if I can…** ❑ Step 1. ❑ Step 2 ❑ Step 3 (minimum) ❑ Step 4 ❑ Step 5 (maximum) Analyzing and Interpreting Data Engaging in Argument from Evidence	Horizontal Launch Video PhET – Projectile Motion

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
Day 18 **Horizontal Projectiles Lab**		▪ Students will work in partners to perform virtual experiments using a PhET simulation. ▪ Students will collect data about the how the time of flight and range of a horizontal projectile are affected by the initial height and the initial velocity of the projectile. ▪ Students will then create graphs for each experiment that will be used to determine the relationship between IV and DV variables. **Criteria For Success: I have mastered the LO if I can…** ❑ Step 1. ❑ Step 2 ❑ Step 3 (minimum) ❑ Step 4 ❑ Step 5 (maximum) Planning and Carrying Out Investigations	**Student computers will be required** for Days 17 (to analyze slow motion video) & 18 (to access PhET simulation). **At least 1 computer for 2 students is ideal.**
Day 19 **Angled Projectiles Lab**	1.5.B Describe the motion of an object moving in two dimensions. **SWBAT** calculate the velocity of a projectile launched at an angle at any point in its trajectory using vector components of velocity. **SWBAT** predict the time of flight, max height and range for a projectile launched at an angle using kinematics equations.	▪ Students will work in partners to perform virtual experiments using a PhET simulation. ▪ Students will collect data about the how the time of flight, range and maximum height of an angled projectile are affected by the initial velocity and launch angle of a projectile. ▪ Students will then create graphs for each experiment that will be used to determine the relationship between IV and DV variables.	PhET – Projectile Motion Mathematics Computational Thinking
Day 20 **Angled Projectiles Practice**		▪ Students will work with table partners to perform calculations to predict the time of flight, range and maximum height for horizontal and angled projectiles. **Criteria For Success: I have mastered the LO if I can…** ❑ Step 1. ❑ Step 2 ❑ Step 3 (minimum) ❑ Step 4 ❑ Step 5 (maximum)	

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
Day 21 **Unit Exam**	**Unit Exam – TX_SCI_APPhysics_F24_UE1** **Scanning Deadline – 9/25/2025** **All Students must have access to the AP Physics 1 Equation Table (revised for 24-25) for ALL Exams!**		ap-physics-1-Equation Table - 2024.pdf

VERTICAL STANDARDS

This section details the **progression** of key student expectations/standards** in the courses **before** and **after** this course. This will help you understand what **prior knowledge skills to build upon** and guide you in knowing what **skills you are preparing your students** for in the subsequent course.

5th Grade Science	6/7 Grade Hybrid Science	8th Grade Science
5.7A investigate and explain how equal and unequal forces acting on an object cause patterns of motion and transfer of energy; and	7.7A calculate average speed using distance and time measurements from investigations; 7.7B distinguish between speed and velocity in linear motion in terms of distance, displacement, and direction; 7.7C measure, record, and interpret an object's motion using distance-time graphs; and	8.7A calculate and analyze how the acceleration of an object is dependent upon the net force acting on the object and the mass of the object using Newton's Second Law of Motion; and

VOCABULARY GLOSSARY

Domain-specific words and definitions for this unit.

Key Content Vocabulary

Distance – the total movement of an object without any regard to direction. How much ground an object has covered despite its starting or ending point.

Displacement – the change in position of an object. It is a vector quantity (has both direction and magnitude). It is represented as an arrow that points from the starting position to the final position.

$$\Delta x = x_{final} - x_{initial}$$

Scalar – A physical quantity or measurement that does not have a specific direction. Some examples of scalar quantities in physics are mass, charge, volume, time, speed.

Vector - A physical quantity or measurement that has a specific magnitude AND direction. Some examples of vector quantities in physics are displacement, velocity, acceleration, force.

Magnitude – the size or extent of something, size, quantity, number

Speed – a scalar measure of how far an object travels per unit of time (meters/second)

Average speed – total distance traveled divided by total time of a trip

$$Avg\ Speed = \frac{total\ distance}{total\ time}$$

Average Velocity – a vector measure of how far an object travels per unit of time (meters/second)

$$velocity = \frac{\Delta x}{time}$$

Position-Time graph – graph describing the motion of an object with time on the horizontal axis and position on the vertical axis

Velocity-Time graph – graph describing the motion of an object with time on the horizontal axis and velocity on the vertical axis

Motion diagram – any diagram that represents the relative motion of objects using arrows or other visual symbols. Often in the

Motion Map (Dot diagram) – a motion diagram that shows a dot that represents the position of an object at constant time intervals (eg. 1 sec or 0.1 sec)

Free Fall Motion - any motion of a body where gravity is the only force acting upon it. An object in the technical sense of the term "free fall" may not necessarily be falling down in the usual sense of the term. An object moving upwards might not normally be considered to be falling, but if it is subject to only the force of gravity, it is said to be in free fall. Objects that can fly or glide are not in free fall.

Acceleration of Gravity (little g)- the acceleration of a body in free fall under the influence of ONLY earth's gravity expressed as the rate of increase of velocity per unit of time and assigned the standard value of 9.80665 m/s/s. *Simplified to 10 m/s/s for this AP Physics*

Resultant vector - the vector sum of two or more vectors

x-component (horizontal component) – the horizontal component of an angled vector

y-component (vertical component)– the vertical component of an angled vector

Vector resolution – the mathematical process of breaking a 2D vector into its perpendicular components (using trigonometry - sine and cosine).

Projectile Motion - the motion of an object thrown (projected) into the air when, after the initial force that launches the object, air resistance is negligible and the only other force that object experiences is the force of gravity. The object is called a projectile, and its path is called its trajectory.

Projectile – an object that is launched into projectile motion.

Trajectory – the path of an object experiencing projectile motion.
x-velocity -the horizontal component of velocity
y-velocity – the vertical component of velocity
initial velocity – the velocity or component of velocity of and object that has just been launched as a projectile
Initial height – the height that a projectile it launched from.
Range – the horizontal distance that a projectile travels while in the air.

Related Vocabulary

Constant velocity Constant acceleration	Inertia "Law of Inertia"	Slowing down Speeding up	"deceleration"