/ Schools Science Vision

;chools' vision of science education is to ensure that from early childhood to the end of the 12th grade, all students have heightened curiosity and an ;e; possess sufficient knowledge of science and engineering to engage in discussions; are able to learn and apply scientific and technological inform ınd have the skills such as critical thinking, problem solving, and communication to enter careers of their choice, while having access to connections l technology.

Shelby County Schools has employed The Tennessee Academic Standards for Science to craft meaningful curricula that is innovative and provide a nities that extend beyond mastery of basic scientific principles.

lby County Schools Board of Education adopted a set of ambitious, yet attainable goals for school and student performance. The District is committe described in our strategic plan, Destination 2025. In order to achieve these ambitious goals, we must collectively work to provide our students with d instruction. The Tennessee Academic Standards for Science provide a common set of expectations for what students will know and be able to do be located in the Tennessee Science Standards Reference. Tennessee Academic Standards for Science are rooted in the knowledge and skills tha st-secondary study or careers. While the academic standards establish desired learning outcomes, the curriculum provides instructional planning de ıese outcomes. The curriculum maps contain components to ensure that instruction focuses students toward college and career readiness. Educat andards as a roadmap for curriculum and instruction. The sequence of learning is strategically positioned so that necessary foundational skills are s ınt mastery of the standards.

ıal is to ensure our students graduate ready for college and career. Being College and Career Ready entails, many aspects of teaching and learning / their scientific learning in the classroom and beyond. These valuable experiences include students being facilitators of their own learning through p cally. The Science and Engineering Practices are valuable tools used by students to engage in understanding how scientific knowledge develops. Tl t "processes and proficiencies" with longstanding importance in science education. The science maps contain components to ensure that instructior understanding how science and engineering can contribute to meeting many of the major challenges that confront society today. The maps are cen ınents: the Tennessee Academic Standards for Science, Science and Engineering Practices, Disciplinary Core Ideas, Crosscutting Concepts, and F

Academic Standards for Science were developed using the National Research Council's 2012 publication, A Framework for K-12 Science Educatior framework presents a new model for science instruction that is a stark contrast to what has come to be the norm in science classrooms. Thinking al morizing concepts and solving mathematical formulae. Practicing science had become prescribed lab situations with predetermined outcomes. The ı ;-dimensional approach to science education that capitalizes on a child's natural curiosity. The Science Framework for K-12 Science Education prov eloping the effective science practices. The *Framework* expresses a vision in science education that requires students to operate at the nexus of thr ıce and Engineering Practices, Crosscutting Concepts, and Disciplinary Core Ideas. The *Framework* identified a small number of disciplinary core ic learn with increasing depth and sophistication, from Kindergarten through grade twelve. Key to the vision expressed in the *Framework* is for student ideas in the context of science and engineering practices. The importance of combining Science and Engineering Practices, Crosscutting Concepts ıted in the *Framework* as follows:

erformance expectations that are aligned to the framework must take into account that students cannot fully understand scientific and engineering ic ɔractices of inquiry and the discourses by which such ideas are developed and refined. At the same time, they cannot learn or show competence in ntext of specific content. (NRC Framework, 2012, p. 218)

ˌkills and dispositions to use scientific and engineering practices needed to further their learning and to solve problems, students need to experience nultiple practices in developing a particular core idea and apply each practice in the context of multiple core ideas. We use the term "practices" inste ɔ emphasize that engaging in scientific investigation requires not only skill but also knowledge that is specific to each practice. Students in grades K- ht practices over each grade band. Crosscutting concepts have application across all domains of science. As such, they are a way of linking the diffe ıtting concepts have value because they provide students with connections and intellectual tools that are related across the differing areas of discipl ıeir application of practices and their understanding of core ideas. There are seven crosscutting concepts that bridge disciplinary boundaries, unitin elds of science and engineering. Their purpose is to help students deepen their understanding of the disciplinary core ideas and develop a coherent ed view of the world.

nt to support effective planning and instruction to rigorous standards. It is *not* meant to replace teacher planning, prescribe pacing or instructional pra merely "cover the curriculum," but rather to "uncover" it by developing students' deep understanding of the content and mastery of the standards. T ɔle about and intentionally align the learning target (standards and objectives), topic, text(s), task, and needs (and assessment) of the learners are b ıs about how to support student learning toward such mastery. Teachers are therefore expected--with the support of their colleagues, coaches, lead s--to exercise their professional judgment aligned to our shared vision of effective instruction, the Teacher Effectiveness Measure (TEM) and related ver, while the framework allows for flexibility and encourages each teacher/teacher team to make it their own, our expectations for student learning a must ensure all of our children have access to rigor—high-quality teaching and learning to grade level specific standards, including purposeful suppo arning across the content areas.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions & defining problems 2. Developing & using models 3. Planning & carrying out investigations 4. Analyzing & interpreting data 5. Using mathematics & computational thinking 6. Constructing explanations & designing solutions 7. Engaging in argument from evidence 8. Obtaining, evaluating, & communicating information	<u>**Physical Science**</u> **PS 1:** Matter & its interactions **PS 2:** Motion & stability: Forces & interactions **PS 3:** Energy **PS 4:** Waves & their applications in technologies for information transfer <u>**Life Sciences**</u> **LS 1:** From molecules to organisms: structures & processes **LS 2:** Ecosystems: Interactions, energy, & dynamics **LS 3:** Heredity: Inheritance & variation of traits **LS 4:** Biological evaluation: Unity & diversity <u>**Earth & Space Sciences**</u> **ESS 1:** Earth's place in the universe **ESS 2:** Earth's systems **ESS 3:** Earth & human activity <u>**Engineering, Technology, & the Application of Science**</u> **ETS 1:** Engineering design **ETS 2:** Links among engineering, technology, science, & society	1. Patterns 2. Cause & effect 3. Scale, proportion, & quantity 4. Systems & system models 5. Energy & matter 6. Structure & function 7. Stability & change

ıression

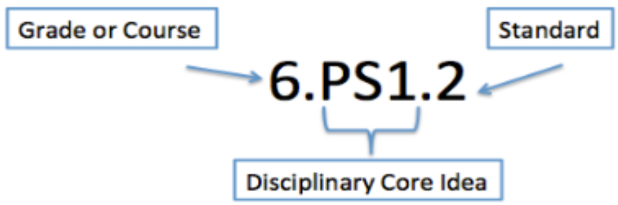
elementary science experience, students can observe and measure phenomena using appropriate tools. They are able to organize objects and ide single properties and later by multiple properties. They can create and interpret graphs and models that explain phenomena. Students can keep n ıl observations and identify simple patterns. They are able to design and conduct investigations, analyze results, and communicate the results to ot ıriosity, interest and enjoyment of the scientific world view, scientific inquiry, and the scientific enterprise into middle school.

middle school science experience, students can discover relationships by making observations and by the systematic gathering of data. They can lid arguments. Their focus has shifted from the general to the specific and from the simple to the complex. They use scientific information to make ·vation of the natural world. They recognize that there are both negative and positive implications to new technologies.

ıate, former students should be literate in science, understand key science ideas, aware that science and technology are interdependent human ent ıitations, familiar with the natural world and recognizes both its diversity and unity, and able to apply scientific knowledge and ways of thinking for in

ıe Standards

ִ Level/Course Overview: An overview that describes that specific content and themes for each grade level or high school course.
linary Core Idea: Scientific and foundational ideas that permeate all grades and connect common themes that bridge scientific disciplines.
ard: Statements of what students can do to demonstrate knowledge of the conceptual understanding. Each performance indicator includes a specifi
ıeering practice paired with the content knowledge and skills that students should demonstrate to meet the grade level or high school course standaı



ience Curriculum Maps

ide to help teachers and their support providers (e.g., coaches, leaders) on their path to effective, college and career ready (CCR) aligned instructioı ation 2025. It is a resource for organizing instruction around the Tennessee Academic Standards for Science, which define what to teach and what grade level. The map is designed to reinforce the grade/course-specific standards and content (scope) and provides *suggested* sequencing, pacing, ırces. Our hope is that by curating and organizing a variety of standards-aligned resources, teachers will be able to spend less time wondering wha ality materials (though they may both select from and/or supplement those included here) and have more time to plan, teach, assess, and reflect witl ɹrove practice and best meet the needs of their students.

ıt to support effective planning and instruction to rigorous standards. It is *not* meant to replace teacher planning, prescribe pacing or instructional pra merely "cover the curriculum," but rather to "uncover" it by developing students' deep understanding of the content and mastery of the standards. T ɔle about and intentionally align the learning target (standards and objectives), topic, text(s), task, and needs (and assessment) of the learners are b ıs about how to support student learning toward such mastery. Teachers are therefore expected--with the support of their colleagues, coaches, lead s--to exercise their professional judgment aligned to our shared vision of effective instruction, the Teacher Effectiveness Measure (TEM) and related ver, while the framework allows for flexibility and encourages each teacher/teacher team to make it their own, our expectations for student learning a must ensure all of our children have access to rigor—high-quality teaching and learning to grade level specific standards, including purposeful suppo arning across the content areas.

SCS Physics Curriculum Map

Unit 2 Two Dimensional Kinematic	Unit 3 Forces	Unit 4 Work and Energy	Unit 5 Momentum	Unit 6 Circular Motion and Gravitation	Unit 7 Heat Energy and Thermo.	Unit 8 Electric Forces, Fields and Energy	Unit 9 Capacitors, Resistors and Circuits	Unit 10 Waves and Sound	Unit 11 Light and Light Behavior
2 weeks	4 weeks	3 weeks	3 weeks	3 weeks	2 weeks	4 weeks	3 weeks	3 weeks	4 weeks

UNIT 1: One Dimensional Kinematics [3 weeks]

ing Question(s)

ts move?

lards, Explanations, Misconceptions n [1.5 weeks]	Learning Outcomes/Phenomena (Anchor, Driving)	3-Dimensional Instructional Approach (SEPs and CCCs) *Suggestions	Vocabulary and C
l Stability: Forces and oraically solve problems velocity and constant e -dimension. the models they have developed evaluate systems. For a system nt acceleration, the net force on constant throughout the : problem solving should be e proportional reasoning, beyond on of variables. udents may have difficulty nding that the magnitude of a ment is the length of the line path between two points an the distance travelled. Point although the odometer on a car	**Essential Questions** • How can understanding various physical properties about motion be useful in understanding everyday occurrences? • What variables can you manipulate to affect the movement of objects? **Learning Outcomes** Solve motion and conceptual problems regarding velocity, acceleration, and displacement algebraically. **Phenomenon** When you stretch out a spring and release it, the spring goes back and forth between being compressed and being stretched out.	**Science and Engineering Practice** 1. Asking questions and defining problems 2. Developing and using models 3. Planning and Carrying Out Investigations 4. Analyzing and Interpreting Data 5. Using Mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in Argument from Evidence 8. Obtaining, evaluating, and communicating information **Cross Cutting Concepts** 1.Pattern 2.Cause and Effect 3.Systems and System Models 4.Scale, Proportion, and Quantity	**Vocabulary** Frame of reference, c displacement, speed, instantaneous velocity fall **Curricular Materials** **HMH Physics – Moti Dimension - Chapte** Acceleration Lab: https://my.hrw.com/co s2017/tn/gr9-12/hmd_phy_978132 pages/teacher/data/cl bewarelab.pdf **Graphing Calculator** TI-83/84 Graphing Ca Sheet: Motion in One https://my.hrw.com/co s2017/tn/gr9-12/hmd_phy_978132 pages/teacher/data/cl

ıat it has been driven 5 mi, the ment may have been 0 mi. ıdents believe that the average always the average of the and ending speed.			ator/hssp0200t_graph **Virtual Lab:** Acceleration of Gravit relationship among po acceleration for a free https://my.hrw.com/co s2017/tn/gr9- 12/hmd_phy_978132 lyhedron_virtual_labs aoghomeframeset.htr Web Resource- http://hmdscienceexp cs/ch02/

ing Question(s)

ts move?

lards, Explanations, Misconceptions n [1.5 weeks]	Learning Outcomes/Phenomena (Anchor, Driving)	3-Dimensional Instructional Approach (SEPs and CCCs) *Suggestions	Vocabulary and Curricu
;y: Forces and Interactions stigate and evaluate the nematical relationship (using phing or computers) of one - natic parameters (distance, ed, velocity, acceleration) with ct's position, direction of motion, d lead students to differentiate d vector properties and or each. In eighth grade, provides limited exposure to the es to modeling the motion of an , the focus was on creating the is not appropriate to use some ations to develop basic	**Essential Questions** ● How can understanding various physical properties about motion be useful in understanding everyday occurrences? ● What variables can you manipulate to affect the movement of objects? **Learning Outcomes** ● Given various examples of quantities, categorize them as scalar or vector quantities. ● Solve motion and conceptual problems regarding velocity, acceleration, and displacement using displacement-time graphs and velocity-time graphs. **Phenomenon**	**Science and Engineering Practice** 1. Asking questions and defining problems 2. Developing and using models 3. Planning and Carrying Out Investigations 4. Analyzing and Interpreting Data 5. Using Mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in Argument from Evidence 8. Obtaining, evaluating, and communicating information **Cross Cutting Concepts** 1.Pattern	**Vocabulary** Frame of reference, distance, disp average velocity, instantaneous ve free fall **Curricular Materials** **HMH Physics – Motion in Chapter 2** **Demonstration:** ● Displacement – HM ● Acceleration – HMI Position-Time Graphs Velocity-Time Graphs Free Fall and the Accelerati

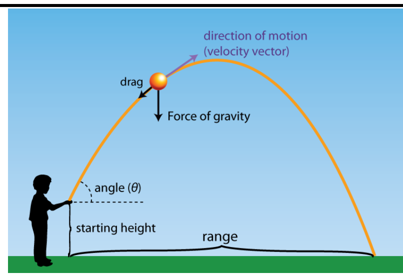
ons. Students should not be ɪ translate between models that of multiple objects on the same propriate to introduce the tives (slopes of tangents) and ɪder curves) to aid in the ng between representations. ɪminence of angles measured ɪdents may develop the : the x component of a vector is using the cosine function. This / be corrected by using oard in which the angles are : y-axis.	Motion: https://www.ngssphenomena.com/new-gallery-1/41na4f0lnigidena81kqjwk4ge2un2 Free fall: https://www.ngssphenomena.com/new-gallery-1/3mw481bgv3bag2zbo39y97d6yyjezf	2.Cause and Effect 3.Systems and System Models 4.Scale, Proportion, and Quantity	**Graphing Calculator:** TI-83/84 Graphing Calculat Sheet: Motion in One Dimer https://my.hrw.com/content/2017/tn/gr9-12/hmd_phy_97813288337 ages/teacher/data/chap02/g or/hssp0200t_graphcalc_ti8 **Virtual Lab:** Acceleration of Gravity: Exp relationship among position acceleration for a free-fallin https://my.hrw.com/content/2017/tn/gr9-12/hmd_phy_97813288337 hedron_virtual_labs/acceler homeframeset.html Web Resource- http://hmdscienceexplore.hr s/ch02/

UNIT 2: Two Dimensional Kinematics **[2 weeks]**

ing Question(s)

ts move?

lards, Explanations, Misconceptions th [2 weeks]	Learning Outcomes/Phenomena (Anchor, Driving)	3-Dimensional Instructional Approach (SEPs and CCCs) *Suggestions	Vocabulary and Cu
l Stability: Forces and elop a model to predict the nensional projectile based upon initial velocity, and angle at hed. er on the understanding that ical forces act independently of nts may develop this idea using (cell phones, tablets, web it frame by frame analysis. oject of known size as , students can develop function and y separately. Use of free- n be included to permit separate omponent. Related predictions height or situations where the a different height than the ation should also be included. A e created for the motion of a ings of varying lengths to affix neter stick at equal intervals. , tradeoffs between height and oserved as the initial launch ominence of angles measured udents may develop the the x component of a vector is using the cosine function. This be corrected by using	**Essential Questions** • When is the vertical component of a vector used? • When is the horizontal component of a vector used? • What component of a projectile's motion has the greatest effect on its height, or its range of motion? • Which will hit the ground first: an object shot from a cannon, or the same object allowed to fall straight down? **Learning Outcomes** • Given various examples of quantities, categorize them as scalar or vector quantities. • Given a projectile launched at an angle, select the correct equation from a list for calculating: the maximum height of travel, time of flight and/or the maximum horizontal distance covered. • Given a scenario where a projectile is being launched at an angle, answer the following conceptual questions. **Phenomenon**	**Science and Engineering Practice** 1. Asking questions and defining problems 2. Developing and using models 3. Planning and Carrying Out Investigations 4. Analyzing and Interpreting Data 5. Using Mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in Argument from Evidence 8. Obtaining, evaluating, and communicating information **Cross Cutting Concepts** 1.Pattern 2.Cause and Effect 3.Systems and System Models 4.Scale, Proportion, and Quantity	**Vocabulary** Scalar, vector, resultant, vector, projectile motion **Curricular Materials** **HMH Physics – Two-Dir and Vectors - Chapter 3** Animations and Simulatic https://my.hrw.com/conte 17/tn/gr9- 12/hmd_phy_978132883 ysics/p03_03as155/index Lab: Projectile motion: https://my.hrw.com/conte 17/tn/gr9- 12/hmd_phy_978132883 es/teacher/data/chap03/h ab.pdf

oard in which the angles are : y-axis.	 		

Unit 2 Two Dimensional Kinematic	Unit 3 Forces	Unit 4 Work and Energy	Unit 5 Momentum	Unit 6 Circular Motion and Gravitation	Unit 7 Heat Energy and Thermo.	Unit 8 Electric Forces, Fields and Energy	Unit 9 Capacitors, Resistors and Circuits	Unit 10 Waves and Sound	Unit ' Light a Light Behavi
2 weeks	4 weeks	3 weeks	3 weeks	3 weeks	2 weeks	4 weeks	3 weeks	3 weeks	4 wee

UNIT 3: Forces [4 weeks]

ing Question(s)

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lards, Explanations, Misconceptions th [0.5 week]	Learning Outcomes/Phenomena (Anchor, Driving)	3-Dimensional Instructional Approach (SEPs and CCCs) *Suggestions	Vocabulary and Cu
;tability: Forces and **free-body diagrams** to ct and non-contact forces t. Use the diagrams in graphical or component-based d with Newton's first and edict the position of the object s act in a constant **net force**	**<u>Essential Questions</u>** ● How can we use forces and the Laws of Motion to understand motion of objects? ● How does describing motion allow us to make predictions about real-life phenomena? ● How and why can we use initial conditions and knowledge of Newton's Laws to predict an object's motion? **<u>Learning Outcomes</u>**	**<u>Science and Engineering Practice</u>** 1. Asking questions and defining problems 2. Developing and using models 3. Planning and Carrying Out Investigations 4. Analyzing and Interpreting Data 5. Using Mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in Argument from Evidence 8. Obtaining, evaluating, and communicating information **<u>Cross Cutting Concepts</u>**	**<u>Vocabulary</u>** Force, inertia, net force, e normal force, static force, coefficient of friction **<u>Curricular Materials</u>** **HMH Physics – Force Motion - Chapter 4** Animations and Simulatic Force: https://my.hrw.com/conte 17/tn/gr9-

t force and Newton's laws have 8.PS2.3 and 8.PS2.4. At that ıgrams are introduced as a tool rces acting on an object. In the use of free-body diagrams, te to include vectors that must rallel and perpendicular includes objects on inclined orojectile motion as addressed ry object has no inertia. independent of mass. ect is not moving, there is no ting on it. ing that moves, will eventually a stop. Rest is the "natural" all objects.	• Given Newton's laws of motion, analyze scenarios related to inertia, force, and action-reaction. • Given various examples of quantities, categorize them as scalar or vector quantities. • Given the static and kinetic friction coefficients (μs and μk); select the appropriate coefficient of friction and calculate the force necessary to move the object. • Select the correct vector diagram to illustrate all forces on an object affected by gravity, friction and an applied force. • Given an inclined plane, the required coefficient of friction and an object of a specific mass, select the appropriate trigonometry functions to determine whether the object will slide down the plane or not. • Explain the relationship between the motion of an object and the net external force acting on the object. **Phenomenon**	1. Structure and Function 2. Students apply patterns in structure and function to unfamiliar phenomena.	12/hmd_phy_978132883 ysics/p04_03as17/index.l Friction: https://my.hrw.com/conte 17/tn/gr9-12/hmd_phy_978132883 ysics/p04_04as156/index Lab: Force and Changes in Mo https://my.hrw.com/conte 17/tn/gr9-12/hmd_phy_978132883 es/teacher/data/chap04/h f

ing Question(s)

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lards, Explanations, Misconceptions th [0.5 week]	Learning Outcomes/Phenomena (Anchor, Driving)	3-Dimensional Instructional Approach (SEPs and CCCs) *Suggestions	Vocabulary and (Materials

;tability: Forces and Interactions

er evidence to defend the claim **aw of motion** by explaining nced forces have upon objects or are moving at constant

e able to discuss mass as a ie amount of inertia in an of kg. Beginning as early as ıave been developing an ıravity. Experiments te of acceleration of objects in d to determine earth's ;trength which can then be used ct's gravitational mass. A ('s Law and subsequent use of ɔwn spring constant can be an object's inertial mass

ry object has no inertia. independent of mass. ing that moves, will eventually a stop. Rest is the "natural" all objects.

Essential Questions

- How can we use forces and the Laws of Motion to understand motion of objects?
- How does describing motion allow us to make predictions about real-life phenomena?
- How and why can we use initial conditions and knowledge of Newton's Laws to predict an object's motion?

Learning Outcomes

- Given Newton's laws of motion, analyze scenarios related to inertia, force, and action-reaction.
- Given various examples of quantities, categorize them as scalar or vector quantities.
- Given the static and kinetic friction coefficients (μs and μk); select the appropriate coefficient of friction and calculate the force necessary to move the object.
- Select the correct vector diagram to illustrate all forces on an object affected by gravity, friction and an applied force.
- Given an inclined plane, the required coefficient of friction and an object of a specific mass, select the appropriate trigonometry functions to determine whether the object will slide down the plane or not.
- Explain the relationship between the motion of an object and the net external force acting on the object.

Phenomenon
Inertia:
https://www.ngssphenomena.com/sleddinginertia/2017/1/9/1jnskbcm3tssibwe8wcpcw97tzhxpw

Science and Engineering Practice

1. Asking questions and defining problems
2. Developing and using models
3. Planning and Carrying Out Investigations
4. Analyzing and Interpreting Data
5. Using Mathematics and computational thinking
6. Constructing explanations and designing solutions
7. Engaging in Argument from Evidence
8. Obtaining, evaluating, and communicating information

Cross Cutting Concepts

1.Cause & Effect
2.Scale, Proportion, and Quantity
3.Constructing explanations and designing solutions

Vocabulary

Force, inertia, net force, e weight, normal force, stat friction, coefficient of fricti

Curricular Materials

HMH Physics – Forces a of Motion - Chapter 4

Lab:
Inertia:
https://my.hrw.com/conte /hss2017/tn/gr9-12/hmd_phy_978132883 abpages/teacher/data/cha _quicklab.pdf
Discovering Newton's Lav
https://my.hrw.com/conte /hss2017/tn/gr9-12/hmd_phy_978132883 abpages/teacher/data/cha _lab.pdf

Newton's First Law of Mo

ing Question(s)

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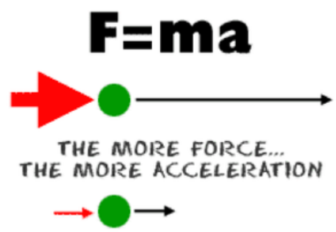
lards, Explanations, Misconceptions gth [1 week]	Learning Outcomes/Phenomena (Anchor, Driving)	3-Dimensional Instructional Approach (SEPs and CCCs) *Suggestions	Vocabulary and (Materials
, conduct, and analyze the led investigation to explore the **'s second law of motion** in a a net unbalanced force, Fnet = t. liscussions about ecosystem tively stable ecosystems, es to the impact of introduced stable ecosystems. Under ecosystems remain in a nic equilibrium. Catastrophic / entire ecosystems. This clude the loss of soils in the bitat. Students can research n examples such as a glacial volcanism in Hawaii, or wetland orida everglades, and sion examples such as the ral areas to agricultural and t abandonment, forest fire er natural disaster events. The ght include movement from rough several communities to nity. ect is not moving, there is no ting on it. uous force is needed for	**Essential Questions** ● How can we use forces and the Laws of Motion to understand motion of objects? ● How does describing motion allow us to make predictions about real-life phenomena? ● How and why can we use initial conditions and knowledge of Newton's Laws to predict an object's motion? **Learning Outcomes** ● Explain the relationship between the motion of an object and the net external force acting on the object. ● 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. **Phenomenon**	**Science and Engineering Practice** 1. Asking questions and defining problems 2. Developing and using models 3. Planning and Carrying Out Investigations 4. Analyzing and Interpreting Data 5. Using Mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in Argument from Evidence 8. Obtaining, evaluating, and communicating information **Cross Cutting Concepts** 1.Cause & Effect 2.Scale, Proportion, and Quantity 3.Constructing explanations and designing solutions	**Vocabulary** Force, inertia, net force, e weight, normal force, stat friction, coefficient of fricti **Curricular Materials** **HMH Physics – Forces a of Motion - Chapter 4** (p Lab: Newton's Second Law of

us motion.			

ing Question(s)

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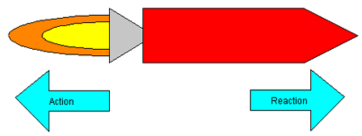
lards, Explanations, Misconceptions gth [1 week]	Learning Outcomes/Phenomena (Anchor, Driving)	3-Dimensional Instructional Approach (SEPs and CCCs) *Suggestions	Vocabulary and Materials
tability: Forces and Interactions examples of forces between volving gravitation, electrostatic, l forces to explain **Newton's** introduces Newton's third law. , students are encouraged to uired skill of drawing free-body nize that third law pairs must be it objects. Use of these free- again encouraged to explain ctions such as friction, tions, and normal forces, and ns between these three. microscopic interactions acroscopic explanations for such as walking. Students e systems where equal forces ent, such as collisions between ntly different masses, e.g., a fly ndshield of a moving car. n forces cancel each other.	**<u>Essential Questions</u>** ● How can we use forces and the Laws of Motion to understand motion of objects? ● How does describing motion allow us to make predictions about real-life phenomena? ● How and why can we use initial conditions and knowledge of Newton's Laws to predict an object's motion? **<u>Learning Outcomes</u>** ● Explain the relationship between the motion of an object and the net external force acting on the object. ● 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. ● Use mathematical representations of Newton's Law of Gravitation and	**<u>Science and Engineering Practice</u>** 1. Asking questions and defining problems 2. Developing and using models 3. Planning and Carrying Out Investigations 4. Analyzing and Interpreting Data 5. Using Mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in Argument from Evidence 8. Obtaining, evaluating, and communicating information **<u>Cross Cutting Concepts</u>** 1.Cause & Effect 2.Scale, Proportion, and Quantity 3.Constructing explanations and designing solutions	**<u>Vocabulary</u>** Force, inertia, net force, e weight, normal force, stat friction, coefficient of fricti reaction **<u>Curricular Materials</u>** **HMH Physics – Forces of Motion - Chapter 4** (p Lab: Newton's Third Law of M

	Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. **Phenomenon**  		

ing Question(s)

nove?

lards, Explanations, Misconceptions gth [1 week]	Learning Outcomes/Phenomena (Anchor, Driving)	3-Dimensional Instructional Approach (SEPs and CCCs) *Suggestions	Vocabulary and Materials
stability: Forces and experimental evidence to ir resistance is a velocity rce that leads to terminal an experiment, students sistance as the dependent therefore be able to manipulate can be done by considering a an object falling at its terminal S2.5) Doing so will reveal that qual to the weight force. By , the drag force is also varied. If gnificant air resistance is used, ty can be determined when t from a significant ommon misconception is to d weight force as a third law ect.)	**Essential Questions** • What is terminal velocity? • Do different objects have different 'terminal velocity' speeds, or is it based on gravity/friction? **Learning Outcomes** • Explain the cause of air resistance. • Identify the variables that affect the amount of air resistance and to describe the manner in which those variables affect the amount of air resistance. • Describe the changes in speed, air resistance, net force and acceleration for an object falling under the influence of air resistance. • Explain why an object experiences a terminal velocity and why mass is an important factor affecting the terminal velocity value. • Compare and contrast	**Science and Engineering Practice** 1. Asking questions and defining problems 2. Developing and using models 3. Planning and Carrying Out Investigations 4. Analyzing and Interpreting Data 5. Using Mathematics and computational thinking 6. Constructing explanations and designing solutions 7. Engaging in Argument from Evidence 8. Obtaining, evaluating, and communicating information **Cross Cutting Concepts** 1. Stability and Change 2. Energy and Matter 3. Scale, Proportion, and Quantity	**Vocabulary** air resistance, drag force velocity. **Curricular Materials** **HMH Physics – Motion i Dimension - Chapter 2 (** Lab: Air Resistance: https://my.hrw.com/conte /hss2017/tn/gr9-12/hmd_phy_978132883 abpages/teacher/data/ch _probewarelab_b.pdf Parachute: https://my.hrw.com/conte /hss2017/tn/gr9-12/hmd_phy_978132883 abpages/teacher/data/ch _stem.pdf

l faster than lighter ones	free fall motion to the falling motion of an object experiencing air resistance. **Phenomenon**  *Discovery Education: Physics of Skydiving* Good choice for a lesson warm up: this short video concisely illustrates the forces on a skydiver from the moment she jumps to the moment her feet hit ground. We like it because it's a very visual way to depict the effects of air resistance. The jumper reaches terminal velocity twice during her descent: once before she opens the parachute and again after she deploys the chute. The video will help kids understand that terminal velocity involves a balance of gravity and drag forces. https://www.youtube.com/watch?v=ur40O6nQHsw		