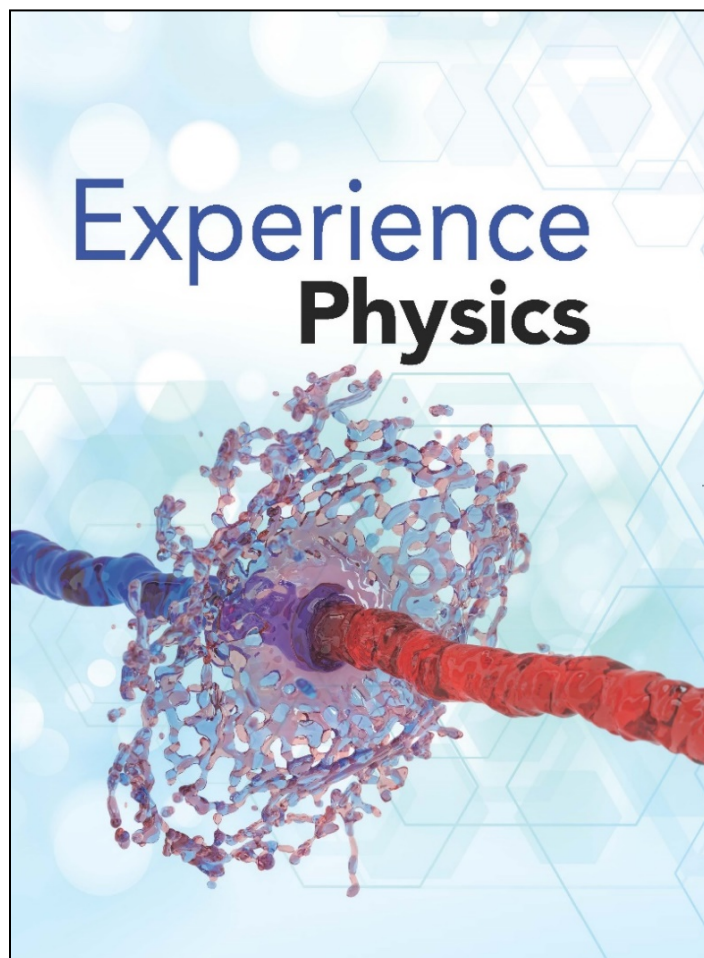


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**to the**  
**Indiana**  
**Academic Standards for Science 2016**  
**Physics I**

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**Introduction**

This document demonstrates how **Experience Physics ©2022** supports the Indiana Academic Standards for Science 2016: Physics I. Correlation references include the Experience Notebook, Teacher Guide, and online digital assets.

Savvas Learning Company is excited to introduce **Experience Physics!**

Students best learn science when they *do* science! Therefore **Experience Physics** puts the focus on the student experience. This modern program implements a learning model that organizes learning around phenomena giving students an authentic, real-world experience. **Experience Physics** includes a variety of hands-on and digital activities designed to reach every learner, and partners with Flinn Scientific to deliver high-quality inquiry labs, engineering workbenches, and performance assessments.

**Phenomenal Experiences** Begin with a relevant and engaging phenomenon. Learning is organized around learning around phenomena, giving students an authentic, real-world experience. **Experience Physics** includes a variety of hands-on and digital activities designed to reach every learner, encouraging students to ask and answer questions, gather evidence, and organize their reasoning as they experience the concepts of physics firsthand.

**Flinn Scientific Partnership** Labs, Engineering Workbenches, dataset activities, and performance tasks enhance the student experience and encourage your class to do more science! Hands-on inquiry labs are available in open-ended, guided, shortened, and advanced versions, perfect for meeting the needs of every student.

**Personalize Instruction** The Teacher Guide allows instructors to personalize their course by selecting from our activities or embedding their own. Enhance instructional plan with Got More Time? Activities, or substitute with Related Phenomena when you want to make a change! Additionally, storyline and Investigation Planners use the 5E model to streamline your prep time.

**Build Mathematical Fluency** Stepped-out examples in the Experience Handbook break down sample problems for clarity and process guidance, while math tutorial videos reinforce mathematical processes. The Physics and Math Skills Workbook includes four pages of review and practice problems for every learning experience. These activities and more guide students as they become more proficient with math and physics concepts.

**Savvas Realize™ Award-Winning Digital Platform** Access all your digital content, virtual labs, simulations, assessments, and student data in ONE location. Savvas Realize has offline accessibility, so students can study from anywhere.

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<b>PI.1) Constant Velocity</b>	
(PI.1.1) Develop graphical, mathematical, and pictorial representations (e.g. a motion map) that describe the relationship between the clock reading (time) and position of an object moving at a uniform rate and apply those representations to qualitatively and quantitatively describe the motion of an object.	<p><b>Student Experience Notebook:</b>            Dot Diagrams, 11            Position Graphs, 12            SEP Develop a Model, 12            Position vs. Time, 16            SEP Develop a Model, 16            Revisit Investigative Phenomenon, #24, 20            Revisit Investigative Phenomenon, #71, 48</p> <p><b>Teacher Guide:</b>  <b>Inquiry Labs:</b> Motion Plots  <b>Performance-Based Assessments:</b> Speed, Acceleration, and Trajectory</p>
(PI.1.2) Describe the slope of the graphical representation of position vs. clock reading (time) in terms of the velocity of the object.	<p><b>Student Experience Notebook:</b>            Speed and Velocity, 13            Sample Problem: An Ant on a Meter Stick, 14            Practice Problem, #13, 14            Practice Problem, #22, 19            Revisit Investigative Phenomenon, #25, 20</p> <p><b>Teacher Guide:</b>  <b>Inquiry Labs:</b> Motion Plots</p>
(PI.1.3) Rank the velocities of objects in a system based on the slope of a position vs. clock reading (time) graphical representation. Recognize that the magnitude of the slope representing a negative velocity can be greater than the magnitude of the slope representing a positive velocity.	<p><b>Student Experience Notebook:</b>            Speed and Velocity, 13            SEP Analyze and Interpret Data, 13</p> <p><b>Teacher Guide:</b>  <b>Digital Activities:</b> Position vs. Time Graphs</p>

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(PI.1.4) Describe the differences between the terms “distance,” “displacement,” “speed,” “velocity,” “average speed,” and “average velocity” and be able to calculate any of those values given an object moving at a single constant velocity or with different constant velocities over a given time interval.	<p><b>Student Experience Notebook:</b> Position and Displacement, 6 SEP Use Mathematics, 6 Sample Problem: Row, Row, Row Your Boat, 10 Practice Problems, #8, #9, 10 Speed and Velocity, 13 SEP Analyze and Interpret Data, 13 Sample Problem: An Ant on a Meter Stick, 14 Practice Problems, #13, 14 Speed and Velocity Graphs, 15 Sample Problem: Driving Distance, 18 Practice Problems, #19, #20, #21, 19 Revisit Investigative Phenomenon, #25, #26, 20</p> <p><b>Teacher Guide:</b> <b>Digital Activities:</b> Velocity and Speed are Different <b>Performance-Based Assessments:</b> Speed, Acceleration, and Trajectory</p>
<b>(PI.2) Constant Acceleration</b>	
(PI.2.1) Develop graphical, mathematical, and pictorial representations (e.g. a motion map) that describe the relationship between the clock reading (time) and velocity of an object moving at a uniformly changing rate and apply those representations to qualitatively and quantitatively describe the motion of an object.	<p><b>Student Experience Notebook:</b> Acceleration, 23 SEP Develop a Model, 23 Constant Acceleration, 26 SEP Develop a Model, 26 Revisit Investigative Phenomenon, #49, #50, 34</p> <p><b>Teacher Guide:</b> <b>Digital Activities:</b> Fast Cars; Acceleration; Acceleration on a Ramp <b>Performance-Based Assessments:</b> Speed, Acceleration, and Trajectory</p>
(PI.2.2) Describe the slope of the graphical representation of velocity vs. clock reading (time) in terms of the acceleration of the object.	<p><b>Student Experience Notebook:</b> Acceleration, 23 Sample Problem: Rolling Down the Hill, 24 Practice Problem, #30, 24 Sample Problem: A Scared Bunny, 29 Practice Problems, #38, #39, 29 Revisit Investigative Phenomenon, #49, 34</p> <p><b>Teacher Guide:</b> <b>Performance-Based Assessments:</b> Speed, Acceleration, and Trajectory</p>

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<p>(PI.2.3) Rank the accelerations of objects in a system based on the slope of a velocity vs. clock reading (time) graphical representation. Recognize that the magnitude of the slope representing a negative acceleration can be greater than the magnitude of the slope representing a positive acceleration.</p>	<p><b>Student Experience Notebook:</b> Acceleration, 23</p> <p><b>Teacher Guide:</b> <b>Digital Activities:</b> Fast Cars</p>
<p>(PI.2.4) Given a graphical representation of the position, velocity, or acceleration vs. clock reading (time), be able to identify or sketch the shape of the other two graphs.</p>	<p><b>Student Experience Notebook:</b> SEP Develop a Model, 12 SEP Develop a Model, 16 SEP Construct an Explanation, 17 Practice Problem, #23, 19 Revisit Investigative Phenomenon, #25, #26, 20 SEP Develop a Model, 23 SEP Develop a Model, 26 CCC Patterns, 26 Revisit Investigative Phenomenon, #49, #50, 34</p> <p><b>Teacher Guide:</b> <b>Inquiry Labs:</b> Motion Plots <b>Digital Activities:</b> Acceleration; Acceleration on a Ramp <b>Performance-Based Assessments:</b> Speed, Acceleration, and Trajectory</p>
<p>(PI.2.5) Qualitatively and quantitatively apply the models of constant velocity and constant acceleration to determine the position or velocity of an object moving in free fall near the surface of the Earth.</p>	<p><b>Student Experience Notebook:</b> Acceleration Due to Gravity, 31 SEP Develop a Model, 31 Sample Problem: Smashing Watermelons, 32 Practice Problems, #43-#46, 33</p> <p><b>Teacher Guide:</b> <b>Inquiry Labs:</b> Free Fall Acceleration <b>Performance-Based Assessments:</b> Speed, Acceleration, and Trajectory; Coin Drop</p>
<b>(PI.3) Forces</b>	
<p>(PI.3.1) Understand Newton's first law of motion and describe the motion of an object in the absence of a net external force according to Newton's first law.</p>	<p><b>Student Experience Notebook:</b> Changing Motion, 52 CCC Cause and Effect, 52</p>

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(PI.3.2) Develop graphical and mathematical representations that describe the relationship among the inertial mass of an object, the total force applied, and the acceleration of an object in one dimension where one or more forces is applied to the object and apply those representations to qualitatively and quantitatively describe how a net external force changes the motion of an object.	<p><b>Student Experience Notebook:</b>            Force Causes an Acceleration, 54            Sample Problem: Mowing the Lawn, 55            Practice Problem, #9, 55            Modeling Force, 60-61            Writing Force-Acceleration Equations, 61            Sample Problem: Will the Wire Break?, 62            Practice Problems, #21, #22, #24, #26, #27, 63            Solving Two-Dimensional Force Problems, 73</p> <p><b>Teacher Guide:</b>  <b>Inquiry Labs:</b> Forces and Motion  <b>Digital Activities:</b> Force, Mass, and Acceleration  <b>Performance-Based Assessments:</b> Force, Mass, and Acceleration</p>
(PI.3.3) Construct force diagrams using appropriately labeled vectors with magnitude, direction, and units to qualitatively and quantitatively analyze a scenario and make claims (i.e. develop arguments, justify assertions) about forces exerted on an object by other objects for different types of forces or components of forces.	<p><b>Student Experience Notebook:</b>            SEP Argue from Evidence, 53            SEP Communicate Information, 57            SEP Develop and Use a Model, 57            Representing Forces, 58-59            SEP Use Mathematics, 58            CCC Systems Models, 59            SEP Develop a Model, 59            Modeling Force, 60-61            SEP Develop and Use a Model, 60            SEP Argue from Evidence, 61            Revisit Investigative Phenomenon, #28, 64            SEP Argue from Evidence, 71            Solving Two-Dimensional Force Problems, 73            Revisit Investigative Phenomenon, #54, 78            SEP Argue from Evidence, 81            SEP Develop a Model, 85</p> <p><b>Teacher Guide:</b>  <b>Inquiry Labs:</b> Forces and Motion; Friction  <b>Digital Activities:</b> Force, Mass, and Acceleration in Action; Forces on Systems; Atmospheric Pressure on a Sealed Container  <b>Performance-Based Assessments:</b> Force, Mass, and Acceleration</p>
(PI.3.4) Understand Newton’s third law of motion and describe the interaction of two objects using Newton’s third law and the representation of action-reaction pairs of forces.	<p><b>Student Experience Notebook:</b>            I Push You, and You Push Back, 57            SEP Develop and Use a Model, 57            SEP Construct an Explanation, 66</p> <p><b>Teacher Guide:</b>  <b>Digital Activities:</b> Newton’s Third of Motion; Newton’s Law of Universal Gravitation</p>

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(PI.3.5) Develop graphical and mathematical representations that describe the relationship between the gravitational mass of an object and the force due to gravity and apply those representations to qualitatively and quantitatively describe how changing the gravitational mass will affect the force due to gravity acting on the object.	<b>Student Experience Notebook:</b> Weight, 66 SEP Analyze and Interpret Data, 66 What Causes Free Fall?, 116-117 CCC Scale, Proportion, and Quantity, 116
(PI.3.6) Describe the slope of the force due to gravity vs. gravitational mass graphical representation in terms of gravitational field.	<b>Student Experience Notebook:</b> SEP Analyze and Interpret Data, 116
(PI.3.7) Explain that the equivalence of the inertial and gravitational masses leads to the observation that acceleration in free fall is independent of an object's mass.	<b>Student Experience Notebook:</b> Acceleration Due to Gravity, 31 What Causes Free Fall?, 116-117  <b>Teacher Guide:</b> <b>Inquiry Labs:</b> Free Fall Acceleration; Investigate Gravity Using Pendulums
<b>(PI.4) Energy</b>	
(PI.4.1) Evaluate the translational kinetic, gravitational potential, and elastic potential energies in simple situations using the mathematical definitions of these quantities and mathematically relate the initial and final values of the translational kinetic, gravitational potential, and elastic potential energies in the absence of a net external force.	<b>Student Experience Notebook:</b> Defining Energy of Motion, 287 Revisit Investigative Phenomenon, #19, 293 Gravitational Potential Energy, 295 SEP Use Mathematics, 295 Elastic Potential Energy, 296-297 Mechanical Energy Bar Charts, 303 SEP Argue from Evidence, 303 Sample Problem: Bowling Ball Bounce, 304-305 Revisit Investigative Phenomenon, #42, 308 Revisit Investigative Phenomenon, #60, 318  <b>Teacher Guide:</b> <b>Inquiry Labs:</b> The Impact of Position on Energy; Pendulums and the Conservation of Energy <b>Digital Activities:</b> Hooke's Law and Elastic Potential Energy; Energy in a Moving Cart; Conservation of Energy <b>Performance-Based Assessments:</b> Rocket Launch
(PI.4.2) Identify the forms of energy present in a scenario and recognize that the potential energy associated with a system of objects and is not stored in the object itself.	<b>Student Experience Notebook:</b> Potential Energy, 294 SEP Argue from Evidence, 303 Revisit Investigative Phenomenon, #42, 308 Revisit Anchoring Phenomenon, #62, 319  <b>Teacher Guide:</b> <b>Digital Activities:</b> Energy in a Moving Cart



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(PI.4.3) Conceptually define “work” as the process of transferring of energy into or out of a system when an object is moved under the application of an external force and operationally define “work” as the area under a force vs. change in position curve.	<p><b>Student Experience Notebook:</b> Positive, Negative, and Zero Work, 282-283</p> <p><b>Teacher Guide:</b> <b>Digital Activities:</b> Classifying Energy and Work</p>
(PI.4.4) For a force exerted in one or two dimensions, mathematically determine the amount of work done on a system by an unbalanced force over a change in position in one dimension.	<p><b>Student Experience Notebook:</b> Calculating Work, 284 Work Done by a Gas, 285-286 SEP Use Mathematics, 286 Revisit Investigative Phenomenon, #20, 293</p> <p><b>Teacher Guide:</b> <b>Inquiry Labs:</b> Gas Particles and Work</p>
(PI.4.5) Understand and apply the principle of conservation of energy to determine the total mechanical energy stored in a closed system and mathematically show that the total mechanical energy of the system remains constant as long as no dissipative (i.e. nonconservative) forces are present.	<p><b>Student Experience Notebook:</b> Mechanical Energy and Work, 302-303 Sample Problem: Bowling Ball Bounce, 304-305 Energy – A Conserved Quantity, 309</p> <p><b>Teacher Guide:</b> <b>Digital Activities:</b> Mechanical Energy</p>
(PI.4.6) Develop and apply pictorial, mathematical or graphical representations to qualitatively and quantitatively predict changes in the mechanical energy (e.g. translational kinetic, gravitational, or elastic potential) of a system due to changes in position or speed of objects or non-conservative interactions within the system.	<p><b>Student Experience Notebook:</b> Mechanical Energy and Work, 302-303 Mechanical Energy Bar Charts, 303 Friction as a Change in Energy, 306 Sample Problem: Car Skidding to a Stop, 307</p> <p><b>Teacher Guide:</b> <b>Digital Activities:</b> Mechanical Energy <b>Performance-Based Assessments:</b> Energy Conversion</p>
<b>(PI.5) Linear Momentum In One Dimension</b>	
(PI.5.1) For an object moving at constant rate, define linear momentum as the product of an object’s mass and its velocity and be able to quantitatively determine the linear momentum of a single object.	<p><b>Student Experience Notebook:</b> Introduction to Linear Momentum, 322 Momentum – a Vector Quantity, 323 SEP Use Mathematics, 323 SEP Use Mathematics, 349</p> <p><b>Teacher Guide:</b> <b>Performance-Based Assessments:</b> Build Your Own Egg-Transport Vehicle</p>

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(PI.5.2) Operationally define “impulse” as the area under a force vs. change in clock reading (time) curve and be able to determine the change in linear momentum of a system acted on by an external force. Predict the change in linear momentum of an object from the average force exerted on the object and time interval during which the force is exerted.	<p><b>Student Experience Notebook:</b> Impulse, 327 SEP Use Mathematics, 327 Revisit Investigative Phenomenon, #9, 329 Impulse-Momentum Theorem, 336-337 SEP Develop a Model, 337 Sample Problem: What a Racket, 340 Practice Problem, #22, 340</p> <p><b>Teacher Guide:</b> <b>Inquiry Labs:</b> Momentum and Impulse During Collisions <b>Digital Activities:</b> Momentum and Baseball</p>
(PI.5.3) Demonstrate that when two objects interact through a collision or separation that both the force experienced by each object and change in linear momentum of each object are equal and opposite, and as the mass of an object increases, the change in velocity of that object decreases.	<p><b>Student Experience Notebook:</b> Conserving Momentum, 331 Sample Problem: Conserving Momentum in Space, 332</p> <p><b>Teacher Guide:</b> <b>Inquiry Labs:</b> Elastic and Inelastic Collisions <b>Digital Activities:</b> Conservation of Momentum</p>
(PI.5.4) Determine the individual and total linear momentum for a two-body system before and after an interaction (e.g. collision or separation) between the two objects and show that the total linear momentum of the system remains constant when no external force is applied consistent with Newton’s third law.	<p><b>Student Experience Notebook:</b> Revisit Investigative Phenomenon, #9, 329 Conserving Momentum, 331 Sample Problem: Conserving Momentum in Space, 332 Impulse-Momentum Theorem, 336-337 SEP Develop a Model, 337 Impulse and Momentum in Collisions, 338 SEP Argue from Evidence, 338 Comparing Momenta in Systems, 339 Sample Problem: What a Racket, 340 Practice Problem, #22, 340</p> <p><b>Teacher Guide:</b> <b>Inquiry Labs:</b> Elastic and Inelastic Collisions <b>Digital Activities:</b> Conservation of Momentum <b>Performance-Based Assessments:</b> Minimizing Car Crash Injuries</p>

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(PI.5.5) Classify an interaction (e.g. collision or separation) between two objects as elastic or inelastic based on the change in linear kinetic energy of the system.	<p><b>Student Experience Notebook:</b> Types of Collisions, 342-343 SEP Argue from Evidence, 343 SEP Use Mathematics, 343 Revisit Investigative Phenomenon, #32, #34, 347 Revisit Anchoring Phenomenon, #53, 363</p> <p><b>Teacher Guide:</b> <b>Inquiry Labs:</b> Elastic and Inelastic Collisions <b>Digital Activities:</b> Kinetic Energy and Collisions</p>
(PI.5.6) Mathematically determine the center of mass of a system consisting of two or more masses. Given a system with no external forces applied, show that the linear momentum of the center of mass remains constant during any interaction between the masses.	<p><b>Student Experience Notebook:</b> Weight, 66 Forces on Extended Systems, 90 What Causes Free Fall?, 116-117 Conserving Momentum, 331</p>
<b>(PI.6) Simple Harmonic Oscillating Systems</b>	
(PI.6.1) Develop graphical and mathematical representations that describe the relationship between the amount of stretch of a spring and the restoring force and apply those representations to qualitatively and quantitatively describe how changing the stretch or compression will affect the restoring force and vice versa, specifically for an ideal spring.	<p><b>Student Experience Notebook:</b> Spring Force, 67 Practice Problem, #36, 68 Sample Problem: Determining Internal Forces, 82 Practice Problem, #63, 82</p> <p><b>Teacher Guide:</b> <b>Digital Activities:</b> Hooke's Law and Elastic Potential Energy</p>
(PI.6.2) Describe the slope of the graphical representation of restoring force vs. change in length of an elastic material in terms of the elastic constant of the material, specifically for an ideal spring.	<p><b>Student Experience Notebook:</b> Spring Force, 67 SEP Plan an Investigation, 67 Sample Problem: Determining Springiness, 68 Practice Problem, #35, 68 Sample Problem: Bowling Ball Bounce, 304-305</p> <p><b>Teacher Guide:</b> <b>Digital Activities:</b> Hooke's Law and Elastic Potential Energy</p>
(PI.6.3) Develop graphical and mathematical representations which describe the relationship between the mass, elastic constant, and period of a simple horizontal mass-spring system and apply those representations to qualitatively and quantitatively describe how changing the mass or elastic constant will affect the period of the system for an ideal spring.	<p><b>Student Experience Notebook:</b> Spring Force, 67 Sample Problem: Determining Springiness, 68 Elastic Potential Energy, 296-297 Sample Problem: Bowling Ball Bounce, 304-305</p> <p><b>Teacher Guide:</b> <b>Inquiry Labs:</b> Mechanical Waves <b>Digital Activities:</b> Hooke's Law and Elastic Potential Energy; Simple Harmonic Motion</p>

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(PI.6.4) Develop graphical and mathematical representations which describe the relationship between the strength of gravity, length of string, and period of a simple mass-string (i.e. pendulum) system apply those representations to qualitatively and quantitatively describe how changing the length of string or strength of gravity will affect the period of the system in the limit of small amplitudes.	<b>Teacher Guide:</b> <b>Inquiry Labs:</b> Investigate Gravity Using Pendulums <b>Digital Activities:</b> Simple Harmonic Motion
(PI.6.5) Explain the limit in which the amplitude does not affect the period of a simple mass-spring (i.e. permanent deformation) or mass-string (i.e. pendulum, small angles) harmonic oscillating system.	For supporting content, please see: <b>Teacher Guide:</b> <b>Digital Activities:</b> Simple Harmonic Motion
<b>(PI.7) Mechanical Waves and Sound</b>	
(PI.7.1) Differentiate between transverse and longitudinal modes of oscillation for a mechanical wave traveling in one dimension.	<b>Student Experience Notebook:</b> Transverse Waves, 468-469 Longitudinal Waves, 472-473  <b>Teacher Guide:</b> <b>Inquiry Labs:</b> Mechanical Waves <b>Digital Activities:</b> Graphs of Waves
(PI.7.2) Understand that a mechanical wave requires a medium to transfer energy, unlike an electromagnetic wave, and that only the energy is transferred by the mechanical wave, not the mass of the medium.	<b>Student Experience Notebook:</b> Mechanical Waves, 466
(PI.7.3) Develop graphical and mathematical representations that describe the relationship between the frequency of a mechanical wave and the wavelength of the wave and apply those representations to qualitatively and quantitatively describe how changing the frequency of a mechanical wave affects the wavelength and vice versa.	<b>Student Experience Notebook:</b> Properties of Waves, 467 Sample Problem: Wave on a Rope, 470 Practice Problems, #8, #9, 470 Sample Problem: Properties of Sound Waves, 474 Practice Problems, #13, #14, 474 Modeling Waves, 475 Sample Problem: Modeling a Sound Wave, 476 Practice Problems, #16-#20, 477 Revisit Investigative Phenomenon, #21, 478  <b>Teacher Guide:</b> <b>Inquiry Labs:</b> Mechanical Waves <b>Digital Activities:</b> Properties of Waves <b>Performance-Based Assessments:</b> Discovering the Speed of Sound in Open Air; Making Waves

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(PI.7.4) Describe the slope of the graphical representation of wavelength vs. the inverse of the frequency in terms of the speed of the mechanical wave.	<p><b>Student Experience Notebook:</b> Properties of Waves, 467 SEP Use Mathematics, 467 Modeling Waves, 475 SEP Use Math, 475 Practice Problem, #20, 477 Revisit Investigative Phenomenon, #22, 478</p> <p><b>Teacher Guide:</b> <b>Performance-Based Assessments:</b> Discovering the Speed of Sound in Open Air; Making Waves</p>
(PI.7.5) Apply the mechanical wave model to sound waves and qualitatively and quantitatively determine how the relative motion of a source and observer affects the frequency of a wave as described by the Doppler Effect.	<p><b>Student Experience Notebook:</b> Moving Wave Source, 480 Sample Problem: A Passing Ambulance, 481 Practice Problems, #26, #27, 481</p>
(PI.7.6) Qualitatively and quantitatively apply the principle of superposition to describe the interaction of two mechanical waves or pulses.	<p><b>Student Experience Notebook:</b> Modeling Wave Interactions, 482-483 SEP Develop a Model, 482 SEP Develop a Model, 483</p> <p><b>Teacher Guide:</b> <b>Inquiry Labs:</b> Interference of Sound Waves <b>Digital Activities:</b> Properties of Waves; Interference</p>
(PI.7.7) Qualitatively describe the phenomena of both resonance frequencies and beat frequencies that arise from the interference of sound waves of slightly different frequency and define the beat frequency as the difference between the frequencies of two individual sound wave sources.	<p>For supporting content, please see: <b>Student Experience Notebook:</b> Beats, 484</p>
<b>(PI.8) Simple Circuit Analysis</b>	
(PI.8.1) Develop graphical, mathematical, and pictorial representations that describe the relationship between length, cross-sectional area, and resistivity of an ohmic device and apply those representations to qualitatively and quantitatively describe how changing the composition, size, or shape of the device affect the resistance.	<p><b>Student Experience Notebook:</b> Conductivity and Resistivity, 188 SEP Plan an Investigation, 188 Ohmic Materials, 423</p> <p><b>Teacher Guide:</b> <b>Inquiry Labs:</b> Electric Resistance and Resistivity</p>

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(PI.8.2) Describe the slope of the graphical representation of resistance vs. the ratio of length to cross-sectional area in terms of the resistivity of the material.	<p><b>Student Experience Notebook:</b> Conductivity and Resistivity, 188</p> <p><b>Teacher Guide:</b> <b>Inquiry Labs:</b> Electric Resistance and Resistivity</p>
(PI.8.3) Develop graphical and mathematical representations that describe the relationship between the amount of current passing through an ohmic device and the amount of voltage (i.e. EMF) applied across the device according to Ohm’s Law and apply those representations to qualitatively and quantitatively describe how changing the current affects the voltage and vice versa.	<p><b>Student Experience Notebook:</b> Ohm’s Law, 422 SEP Use Mathematics, 422</p> <p><b>Teacher Guide:</b> <b>Inquiry Labs:</b> Energy Transmission in Circuits</p>
(PI.8.4) Describe the slope of the graphical representation of current vs. voltage or voltage vs. current in terms of the resistance of the device.	<p><b>Student Experience Notebook:</b> Ohmic Materials, 423</p> <p><b>Teacher Guide:</b> <b>Inquiry Labs:</b> Energy Transmission in Circuits</p>
(PI.8.5) Qualitatively and quantitatively describe how changing the voltage or resistance of a simple series (i.e. loop) circuit affects the voltage, current, and power measurements of individual resistive devices and for the entire circuit.	<p><b>Student Experience Notebook:</b> Series Resistance, 190 SEP Construct an Explanation, 190</p> <p><b>Teacher Guide:</b> <b>Inquiry Labs:</b> Energy Transmission in Circuits <b>Digital Activities:</b> Energy in Electric Circuits; Series and Parallel Circuits</p>
(PI.8.6) Qualitatively and quantitatively describe how changing the voltage or resistance of a simple parallel (i.e. ladder) circuit affects the voltage, current, and power measurements of individual resistive devices and for the entire circuit.	<p><b>Student Experience Notebook:</b> Parallel Resistance, 191 SEP Develop and Use a Model, 191</p> <p><b>Teacher Guide:</b> <b>Inquiry Labs:</b> Energy Transmission in Circuits <b>Digital Activities:</b> Energy in Electric Circuits; Series and Parallel Circuits</p>

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Indiana Academic Standards for Science 2016 Physics I	Experience Physics ©2022
(PI.8.7) Apply conservation of energy concepts to the design of an experiment that will demonstrate the validity of Kirchhoff's loop rule ( $\Sigma DV = 0$ ) in a circuit with only a battery and resistors either in series or in, at most, one pair of parallel branches.	<p><b>Student Experience Notebook:</b> Kirchoff's Loop Rule, 428 SEP Construct an Explanation, 428 Sample Problem: Applying Kirchoff's Loop Rule, 429</p> <p><b>Teacher Guide:</b> <b>Inquiry Labs:</b> Energy Transmission in Circuits</p>
(PI.8.8) Apply conservation of electric charge (i.e. Kirchhoff's junction rule) to the comparison of electric current in various segments of an electrical circuit with a single battery and resistors in series and in, at most, one parallel branch and predict how those values would change if configurations of the circuit are changed.	<p><b>Student Experience Notebook:</b> Kirchoff's Junction Rule, 430 SEP Use Mathematics, 430 Sample Problem: Applying Kirchoff's Junction Rule, 432-433</p> <p><b>Teacher Guide:</b> <b>Digital Activities:</b> Electric Circuits</p>
(PI.8.9) Use a description or schematic diagram of an electrical circuit to calculate unknown values of current, voltage, or resistance in various components or branches of the circuit according to Ohm's Law, Kirchhoff's junction rule, and Kirchhoff's loop rule.	<p><b>Student Experience Notebook:</b> Circuit Elements and Diagrams, 424-425 Analyzing a Circuit, 431</p> <p><b>Teacher Guide:</b> <b>Inquiry Labs:</b> Energy Transmission in Circuits <b>Digital Activities:</b> Electric Circuits</p>