

**Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual**

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
INQI.A.1 Inquiry	Identify Questions and Concepts that Guide Scientific Investigations	Experimental design should demonstrate logical connections between a knowledge base and conceptual understanding.	Demonstrate an understanding of the process of developing scientific hypotheses (e.g., formulate a testable hypothesis based on literature research and prior knowledge, and select the correct form for a hypothesis statement based on a given scenario).	8	formulating a hypothesis	11 33 48 65 79	formulate a testable hypothesis formulate a testable hypothesis formulate a hypothesis form a hypothesis write a hypothesis
INQI.A.2 Inquiry	Identify Questions and Concepts that Guide Scientific Investigations	Experimental design should demonstrate logical connections between a knowledge base and conceptual understanding.	Identify and select experimental variables (independent and dependent) and devise methods for controlling relevant conditions.	40 42 43 54 251	defining variables control and experimental variables dependent and independent variables in graphs importance of changing one variable at a time in an experiment changing the natural frequency of a stretched rubber band	11 82 82 166	recognizing and controlling variables determine which variable has the greatest effect dependent and independent variables variables that affect the performance of the generator

**Correlation to South Carolina Science Standards
Foundations of Physics
 Student Text and Investigation Manual**

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
INQI.B.1 Inquiry	Design and Conduct Investigations	Science builds on prior knowledge, thus prior knowledge about major concepts, laboratory apparatus, laboratory techniques, and safety should be used in designing and conducting a scientific investigation.	Demonstrate an understanding of the process of testing scientific hypotheses (e.g., design and conduct a scientific investigation based on the major concepts in the area being studied).	242	finding a basic cycle of harmonic motion	43	perform experiment
				432	making a simple capacitor	65	investigate motion on a roller coaster
				456	an experiment with a wire and compass	67	investigate motion on a roller coaster
				463	building an electromagnet with wire and a nail	82	design an experiment
				467	experiment demonstrating electromagnetic induction	201	design a procedure to separate a mixture

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
INQI.B.2 Inquiry	Design and Conduct Investigations	Science builds on prior knowledge, thus prior knowledge about major concepts, laboratory apparatus, laboratory techniques, and safety should be used in designing and conducting a scientific investigation.	Select and use appropriate instruments to make the observations necessary for the investigation, taking into consideration the limitations of the equipment.	18 25	measuring distance accuracy and precision of measurements	1 6 28 43 60 67 67 82 85 201 202	estimating length accuracy and resolution and printing set up the ultimate pulley measure and record the distance measure input and output forces measure vertical distance set up the straight track measure the length of the string design and test a way to increase natural frequency determine the equipment you will need conduct your experiment

**Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual**

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
INQI.B.3 Inquiry	Design and Conduct Investigations	Science builds on prior knowledge, thus prior knowledge about major concepts, laboratory apparatus, laboratory techniques, and safety should be used in designing and conducting a scientific investigation.	Select the appropriate safety equipment needed to conduct an investigation and identify safety precautions for the handling of materials and equipment used in an investigation.	543	safety factors	79 129 131 150 159 160 176 176 185 192 206	safety note safety precautions safety precautions safety note safety note electromagnet safety safety note heat safety safety tip gas pressure safety note acid safety
INQI.B.4 Inquiry	Design and Conduct Investigations	Science builds on prior knowledge, thus prior knowledge about major concepts, laboratory apparatus, laboratory techniques, and safety should be used in designing and conducting a scientific investigation.	Describe the proper response to emergency situations in the laboratory	543	safety factors	79 129 131 150 159 160 176 176 185 192 206	safety note safety precautions safety precautions safety note safety note electromagnet safety safety note heat safety safety tip gas pressure safety note acid safety

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
INQI.B.5 Inquiry	Design and Conduct Investigations	Science builds on prior knowledge, thus prior knowledge about major concepts, laboratory apparatus, laboratory techniques, and safety should be used in designing and conducting a scientific investigation.	Identify possible sources of error and appropriate controls in an experimental design.	25 42	why accuracy and precision are important controlling variables in experiments	43 45 202	discuss sources of error discuss sources of errors identify two sources of experimental error

**Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual**

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
INQI.B.6 Inquiry	Design and Conduct Investigations	Science builds on prior knowledge, thus prior knowledge about major concepts, laboratory apparatus, laboratory techniques, and safety should be used in designing and conducting a scientific investigation.	Organize and display data in useable and efficient formats, such as tables, graphs, maps, cross sections and mathematical expressions.	43	constructing a graph	13	create a graph
				44	graphical models	15	record data in a table
				54	constructing a graph	16	describe the graph
				55	create a graph from a data table	16	create a graph
				60	creating the acceleration formula from experiments	17	use a data table
				66	developing the formulas for a model of motion with constant acceleration	18	record data
						21	record results in table
						22	uniform acceleration model
				142	finding x and y components of velocity for model rocket	22	create graphs
						24	create an algebraic model
				282	write a formula relating velocity of wave to period and wavelength	27	record position and time data
						28	solve second law equation for string tension
				290	the process of digital sound reproduction	29	record mass and force
				312	light intensity follows an inverse square law	32	develop a model that predicts acceleration
				411	the waveform of AC electricity	37	make a graph
						38	make a graph
						43	sketch four graphs
						43	create algebraic model
						49	write a formula
						56	create a graph
						66	record data in table

Correlation to South Carolina Science Standards

Foundations of Physics

Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
						66	create a graph of speed vs. position
						70	record data in table
						82	record your data in table
						82	make three different graphs
						82	create data table for self-designed experiment
						87	sketch a graph
						94	give an equation that describes your observations
						135	graph voltage vs. current
						136	graph voltage vs. current
						151	make a graph of voltage vs. time
						160	create a graph
						167	make a graph of voltage vs. number of magnets
						169	make a current vs. voltage graph for the diode
						189	Bernoulli's equation

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
INQI.B.7 Inquiry	Design and Conduct Investigations	Science builds on prior knowledge, thus prior knowledge about major concepts, laboratory apparatus, laboratory techniques, and safety should be used in designing and conducting a scientific investigation.	Draw conclusions based on qualitative and/or quantitative data.	7	revising explanations through observation	16	what do the results tell you?
				8	refining theories based on observations	18	are the accelerations different?
				10	the usefulness of phlogiston theory despite being incorrect	19	does the ball accelerate?
				71	parachutes and air resistance	43	what would happen if...?
				306	explain why hearing can be damaged by loud sounds	58	explain why the angular acceleration is different
						80	explain your observations
						87	explain how force applied causes the response
						90	explain why higher tension makes waves move faster
						92	explain how wind might cause big waves in water
						109	explain how the colored filters work
						132	what conclusions can you draw?
						133	analyze data and explain a rule
						204	build models of Na and Cl and use them to explain bonding

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
INQI.B.8 Inquiry	Design and Conduct Investigations	Science builds on prior knowledge, thus prior knowledge about major concepts, laboratory apparatus, laboratory techniques, and safety should be used in designing and conducting a scientific investigation.	Discuss the impact of sources of error on experiments.	25 42	why accuracy and precision are important controlling variables in experiments	43 45 202	discuss sources of error discuss sources of errors identify two sources of experimental error

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
INQI.B.9 Inquiry	Design and Conduct Investigations	Science builds on prior knowledge, thus prior knowledge about major concepts, laboratory apparatus, laboratory techniques, and safety should be used in designing and conducting a scientific investigation.	Communicate and defend the scientific thinking that resulted in conclusions.	188	perpetual motion machines	12	do your results agree with hypothesis?
				306	explain why hearing can be damaged by loud sounds	16	what do the results tell you?
						18	are the accelerations different?
						19	does the ball accelerate?
						33	does your experiment confirm your hypothesis?
						43	what would happen if...?
						50	does your experiment provide confirmation?
						58	explain why the angular acceleration is different
						66	does this agree with your hypothesis?
						80	explain your observations
						87	explain how force applied causes the response
						90	explain why higher tension makes waves move faster
						92	explain how wind might cause big waves in water
						109	explain how the colored filters work
						132	what conclusions can you draw?

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
						133	analyze data and explain a rule
INQI.C.1 Inquiry	Use Technology and Mathematics to Improve Investigations and Communications	Scientific investigations can be improved through the use of technology and mathematics. While it is acknowledged that the System International is the accepted measurement system in science, opportunities to use the U.S. Customary System are encouraged...	Select and use appropriate technologies to achieve appropriate precision and accuracy of data collection, analysis, and display.		data tables and graphs can be created on computer or graphing calculator	6 6 15 18 21 21 85 129 153 153 202	precision in measurement collecting data with precision collect time data with precision collect time data with precision conduct the experiment plan the experiment select appropriate technology to make measurements choose circuit parts to light a bulb make measurement with precision making measurements with precision find the mass to the nearest tenth of a gram

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
INQI.C.2 Inquiry	Use Technology and Mathematics to Improve Investigations and Communications	Scientific investigations can be improved through the use of technology and mathematics. While it is acknowledged that the System International is the accepted measurement system in science, opportunities to use the U.S. Customary System are encouraged...	Discriminate between valid and questionable data.	11	acceptance of the Copernican model of the solar system on the basis of scientific evidence	12	was this experiment better or worse than the first?
				44	checking a graphical model's accuracy	97	reliability of a double-blind test
				103	evaluating perpetual motion claims	97	did the method give an accurate result?

**Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual**

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
INQI.C.3 Inquiry	Use Technology and Mathematics to Improve Investigations and Communications	Scientific investigations can be improved through the use of technology and mathematics. While it is acknowledged that the System International is the accepted measurement system in science, opportunities to use the U.S. Customary System are encouraged...	Select and use mathematical formulas and calculations to express and interpret laboratory measurements.	60	creating the acceleration formula from experiments	10	calculate percent difference
				66	developing the formulas for a model of motion with constant acceleration	13	find percent error
				282	write a formula relating velocity of wave to period and wavelength	22	uniform acceleration model
				312	light intensity follows an inverse square law	24	create an algebraic model
				412	average voltage and current of AC power	25	find the average time
						28	solve second law equation for string tension
						32	develop a model that predicts acceleration
						37	calculate percent difference
						38	calculate percent difference
						43	create algebraic model
						43	calculate percent difference
						49	write a formula
						58	find average of three trials
						67	calculate average of three times
						71	calculate average work and power
						83	calculate percent error
						94	give an equation that describes your observations

**Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual**

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
						189	Bernoulli's equation
						202	find percent composition
						208	calculating percent yield
INQI.C.4 Inquiry	Use Technology and Mathematics to Improve Investigations and Communications	Scientific investigations can be improved through the use of technology and mathematics. While it is acknowledged that the System International is the accepted measurement system in science, opportunities to use the U.S. Customary System are encouraged...	Demonstrate an understanding of and interpret trends and patterns in data.	43	graphs are a way of representing data	13	is there a trend in measurements?
				45	recognizing patterns using graphs	63	as mechanical advantage increases what happens to length of pulled string?
				54	understanding patterns in relationships between variables	66	what does the graph tell you?
				56	indicate relationships between variables in graphs	82	analyze data
				246	understanding graphs of harmonic motion	133	did battery voltage change?
				304	comparison of wave forms from guitar sounds		
				307	decibel level vs. frequency graph for human hearing		
				427	diagramming electric fields using field lines		
				443	diagramming magnetic fields using magnetic field lines		
				479	current vs.voltage graph for a transistor		

**Correlation to South Carolina Science Standards
Foundations of Physics
 Student Text and Investigation Manual**

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
INQI.C.5 Inquiry	Use Technology and Mathematics to Improve Investigations and Communications	Scientific investigations can be improved through the use of technology and mathematics. While it is acknowledged that the System International is the accepted measurement system in science, opportunities to use the U.S. Customary System are encouraged...	Draw a "best fit" curve through data points using computer software and/or graphing calculators.	43	draw a smooth curve; do NOT simply connect the dots	16	find the slope of the line
				48	slope of a position vs. time graph	19	find the slope of the line
				63	acceleration and slope of a speed vs. time graph		

**Correlation to South Carolina Science Standards
Foundations of Physics
 Student Text and Investigation Manual**

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
INQI.C.6 Inquiry	Use Technology and Mathematics to Improve Investigations and Communications	Scientific investigations can be improved through the use of technology and mathematics. While it is acknowledged that the System International is the accepted measurement system in science, opportunities to use the U.S. Customary System are encouraged...	Calculate the slope of the curve and use correct units for the value of the slope for linear relationships.	48 63	slope of a position vs. time graph acceleration and slope of a speed vs. time graph	16 19	find the slope of the line find the slope of the line

**Correlation to South Carolina Science Standards
Foundations of Physics
 Student Text and Investigation Manual**

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
INQI.C.7 Inquiry	Use Technology and Mathematics to Improve Investigations and Communications	Scientific investigations can be improved through the use of technology and mathematics. While it is acknowledged that the System International is the accepted measurement system in science, opportunities to use the U.S. Customary System are encouraged...	Perform dimensional analysis calculations.	20 59	converting units using dimensional analysis determining units of acceleration		

**Correlation to South Carolina Science Standards
Foundations of Physics
 Student Text and Investigation Manual**

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
INQI.C.8 Inquiry	Use Technology and Mathematics to Improve Investigations and Communications	Scientific investigations can be improved through the use of technology and mathematics. While it is acknowledged that the System International is the accepted measurement system in science, opportunities to use the U.S. Customary System are encouraged...	Perform calculations using numbers expressed in scientific notation.	28 34	expressing very large and very small numbers using scientific notation expressing numbers in scientific notation	8 51	scientific notation practice using scientific notation

**Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual**

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
INQI.D.1 Inquiry	Formulate and revise scientific explanations and models using logic and evidence	Scientific explanations and models are developed and revised through discussion and debate.	Construct scientific explanations or models (physical, conceptual, and mathematical) through discussion, debate, logic, and experimental evidence.	60	creating the acceleration formula from experiments	10	calculate percent difference
				66	developing the formulas for a model of motion with constant acceleration	13	find percent error
				113	build and test a prototype structure out of toothpicks	16	what do the results tell you?
				282	write a formula relating velocity of wave to period and wavelength	18	are the accelerations different?
				306	explain why hearing can be damaged by loud sounds	19	does the ball accelerate?
				312	light intensity follows an inverse square law	22	uniform acceleration model
						24	create an algebraic model
						28	solve second law equation for string tension
						32	develop a model that predicts acceleration
						37	calculate percent difference
						38	calculate percent difference
						43	what would happen if...?
						43	calculate percent difference
						43	create algebraic model
						49	write a formula
						58	explain why the angular acceleration is different
						80	explain your observations

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
						83	calculate percent error
						83	design and construct a pendulum
						85	create a system that oscillates
						87	explain how force applied causes the response
						90	explain why higher tension makes waves move faster
						92	explain how wind might cause big waves in water
						94	give an equation that describes your observations
						109	explain how the colored filters work
						132	what conclusions can you draw?
						133	analyze data and explain a rule
						163	design and test different electric motors
						189	Bernoulli's equation
						191	build an air-speed tester
						202	find percent composition
						208	calculating percent yield

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
INQI.D.2 Inquiry	Formulate and revise scientific explanations and models using logic and evidence	Scientific explanations and models are developed and revised through discussion and debate.	Develop explanations and models that demonstrate scientific integrity.	10	the usefulness of phlogiston theory despite being incorrect	13	compare prediction to measurement
				11	Ptolemy model vs. Copernicus model of the solar system	22	uniform acceleration model
				40	making a good model	22	compare calculation with graph estimate
				44	using a graphical model to make a prediction and checking the model's accuracy	22	how do you measured positions compare to model?
				60	creating the acceleration formula from experiments	24	create an algebraic model
				66	developing the formulas for a model of motion with constant acceleration	28	solve second law equation for string tension
				71	parachutes and air resistance	29	does experiment agree with prediction?
				282	write a formula relating velocity of wave to period and wavelength	32	develop a model that predicts acceleration
				297	frequency spectrum	43	create algebraic model
				312	light intensity follows an inverse square law	43	how does the measurement compare to your prediction?
						49	write a formula
						76	compare predicted mass to actual mass
						94	give an equation that describes your observations
		114	are there differences between your prediction and measurement?				

Correlation to South Carolina Science Standards

Foundations of Physics

Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
						189 Bernoulli's equation 204 build models of Na and Cl and use them to explain bonding	

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
INQI.D.3 Inquiry	Formulate and revise scientific explanations and models using logic and evidence	Scientific explanations and models are developed and revised through discussion and debate.	Revise explanations or models.	7	revising explanations through observation	12	do your results agree with hypothesis?
				8	refining theories based on observations	16	what do the results tell you?
				188	perpetual motion machines	18	are the accelerations different?
				306	explain why hearing can be damaged by loud sounds	19	does the ball accelerate?
						33	does your experiment confirm your hypothesis?
						43	what would happen if...?
						50	does your experiment provide confirmation?
						58	explain why the angular acceleration is different
						66	does this agree with your hypothesis?
						80	explain your observations
87	explain how force applied causes the response						
90	explain why higher tension makes waves move faster						
92	explain how wind might cause big waves in water						
109	explain how the colored filters work						
132	what conclusions can you draw?						

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
						133	analyze data and explain a rule
INQI.E.1 Inquiry	Recognize and analyze alternative explanations and models	Scientific criteria are used to discriminate among plausible explanations.	Compare current scientific models with experimental results.	11	Ptolemy model vs. Copernicus model of the solar system	12	do your results agree with hypothesis?
				40	making a good model	13	compare prediction to measurement
				44	using a graphical model to make a prediction and checking the model's accuracy	22	how do you measured positions compare to model?
				188	perpetual motion machines	22	compare calculation with graph estimate
				297	frequency spectrum	29	does experiment agree with prediction?
						33	does your experiment confirm your hypothesis?
						43	how does the measurement compare to your prediction?
						50	does your experiment provide confirmation?
						66	does this agree with your hypothesis?
						76	compare predicted mass to actual mass
						114	are there differences between your prediction and measurement?

**Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual**

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
INQI.E.2 Inquiry	Recognize and analyze alternative explanations and models	Scientific criteria are used to discriminate among plausible explanations.	Select and defend, based on scientific criteria, the most plausible explanation or model.	10	the usefulness of phlogiston theory despite being incorrect	12	was this experiment better or worse than the first?
				11	acceptance of the Copernican model of the solar system on the basis of scientific evidence	97	reliability of a double-blind test
				44	checking a graphical model's accuracy	97	did the method give an accurate result?
				71	parachutes and air resistance	204	build models of Na and Cl and use them to explain bonding
				103	evaluating perpetual motion claims		
INQI.F.1 Inquiry	Communicate and Defend a Scientific Argument	Experimental processes, data, and conclusions should be communicated in a clear and logical manner.	Develop a set of laboratory instructions that someone else can follow.	42	writing lab procedures	43	write a procedure
						201	develop a procedure
INQI.F.2 Inquiry	Communicate and Defend a Scientific Argument	Experimental processes, data, and conclusions should be communicated in a clear and logical manner.	Develop a presentation to communicate the process and conclusion of a scientific investigation.	42	writing procedures in a lab notebook helps make sure your results are repeatable	122	communicate your findings
						122	present your findings
						175	display information you found for your element
						202	keep detailed notes as you work

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
INQI.G.1 Inquiry	Understandings about Scientific Inquiry	Historical and current scientific knowledge, current research, technology, mathematics, and logic should be the basis for conducting investigations and drawing conclusions.	Analyze how science and technology explain and predict relationships.	4	learning about natural laws through inquiry and observation	80	explain the physics of a diver's somersaults
				12	all technology is based on fundamental laws of physics	92	how does sound get through tiny cracks?
				19	problems in the real world use both metric and English units	126	explain how polarizing sunglasses work
				31	use of nanotechnology		
				51	analyzing motion with video and strobe photography		
				52	strobe photography		
				72	antilock brakes application		
				73	antilock braking systems		
				80	applications of Newton's first law		
				90	examples of Newton's third law in the real world		
				104	reducing friction and hovercraft and maglev trains		
				105	friction is useful for brakes and tires		
				109	jack-in-the-box uses a spring		
				112	design of structures		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
				112	relationship between science and engineering and technology		
				118	examples of scalars		
				130	kicked soccer ball acts as a projectile launched at an angle		
				131	hang time		
				133	example of gymnast for forces applied at an angle		
				138	robot navigation application		
				139	inertial navigation system		
				144	examples of objects moving in a circle		
				147	speedometers and odometers		
				149	centripetal force at the amusement park		
				154	the orbits of planets and comets		
				155	satellite motion application		
				156	HEO and geostationary orbit		
				167	SUV rollovers and center of gravity		
				172	bicycle physics application		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
				172	bicycle physics application		
				196	hydroelectric power application		
				211	output power from plants is input power for animals		
				227	accident reconstruction		
				232	angular momentum of skater spinning and diver		
				234	gyroscopes and angular momentum		
				235	jet engines application		
				243	oscillators are used in communications and music and clocks		
				243	examples of oscillators		
				250	why airplanes have tails		
				257	quartz crystals application		
				259	wing-beat cycle of a hummingbird		
				262	examples of waves		
				263	waves can carry information		
				280	microwave ovens application		
				290	stereo sound		
				299	understanding human hearing		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
				323	glow-in-the-dark plastic		
				325	the printing press		
				337	rainbows are an example of dispersion		
				347	the compound microscope		
				365	polarized sunglasses and LCD computer screens		
				369	technological advances have allowed discovery of the expanding universe		
				372	holography application		
				390	breakdown voltage and lightning		
				392	hybrid gas/electric cars application		
				398	holiday lights wired in series		
				401	why aren't birds electrocuted?		
				410	paying for electricity		
				413	circuits in your house		
				413	wiring application		
				413	wiring application		
				418	charge of everyday objects		
				429	electron beam accelerators		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
				430	almost all electric appliances use capacitors		
				433	cameras use capacitors to supply energy for flash bulbs		
				434	how television works application		
				448	how does a compass work?		
				451	MRI application		
				458	where coils are used		
				462	electromagnet in a toaster		
				472	maglev train application		
				473	how magplanes levitate		
				492	computers and electronic addition of numbers application		
				516	refrigerator application		
				527	windchill factor		
				534	energy-efficient building application		
				560	deep water submarine Alvin application		
				585	laser application		
				608	how engines work		
				615	smoke detectors		
				621	exposure to UV radiation		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
				623	creation of CAT scans		
				631	nuclear power application		
				646	a standard model for particle physics		
INQI.G.1.a Inquiry	Understandings about Scientific Inquiry	Historical and current scientific knowledge, current research, technology, mathematics, and logic should be the basis for conducting investigations and drawing conclusions.	Defend the idea that conceptual principles and knowledge guide scientific inquiry	440	scientists have never found single magnetic poles		
				568	understanding how gravity works inside atoms		
				583	the meaning of the uncertainty principle		
				637	areas of active research in physics		
				640	unresolved questions of history of universe		
				641	research on future of the universe		
				641	research on future of the universe		

**Correlation to South Carolina Science Standards
Foundations of Physics
 Student Text and Investigation Manual**

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
INQI.G.1.b Inquiry	Understandings about Scientific Inquiry	Historical and current scientific knowledge, current research, technology, mathematics, and logic should be the basis for conducting investigations and drawing conclusions.	Discuss how the available body of scientific knowledge, historical and current, influences the design, interpretation, and evaluations of investigations.	52	Dr. Harold Edgerton and strobe photography		
				155	first artificial human- made Earth satellite was Sputnik		
				178	Great Pyramid of Giza and simple machines		
				257	Pierre and Jacques Curie and the piezoelectric effect		
				269	wave motion and equilibrium		
				290	technological breakthrough of sound recording		
				310	past theories of light		
				325	history of printing		
				348	the usefulness of recorded images		
				349	the telescope		
				361	Young's double-slit experiment		
				368	Einstein's thinking revolutionized physics		
				447	discovering and using magnetism		
				501	search for elements and alchemy		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
				561	the Alvin research submarine		
				575	discovery of helium		
				625	turning lead into gold		
				641	research on future of the universe		
INQI.G.2 Inquiry	Understandings about Scientific Inquiry	Historical and current scientific knowledge, current research, technology, mathematics, and logic should be the basis for conducting investigations and drawing conclusions.	Discuss the reasons scientists and engineers conduct investigations and the methods they use to conduct investigations.	7	in science inquiry is used to uncover truth	43	follow the scientific method
				113	the engineering design cycle	163	apply steps of the design cycle to building different electric motors
				543	failure analysis in the design process	173	designing and building logic circuits
				560	deep water submarine Alvin application		
				644	proof of Einstein's theory of general relativity		
				645	astronomers find black holes by what is around them		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
INQI.G.3 Inquiry	Understandings about Scientific Inquiry	Historical and current scientific knowledge, current research, technology, mathematics, and logic should be the basis for conducting investigations and drawing conclusions.	Demonstrate and discuss the use of technology as a method for enhancing data collection, data manipulation, and advancing the fields of science and technology.	12	all technology is based on fundamental laws of physics		
				12	engineers design practical devices for solving problems		
				13	x-ray and ultrasound technology are used in medicine		
				31	use of nanotechnology		
				31	use of nanotechnology		
				51	analyzing motion with video and strobe photography		
				72	antilock brakes application		
				72	antilock brakes application		
				112	designing a bridge		
				112	relationship between science and engineering and technology		
				138	use of robots		
				155	geostationary satellites		
				172	bicycle physics application		
				196	hydroelectric power application		
196	hydroelectric power application						

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
				209	range of power for common devices		
				216	energy from ocean tides		
				217	research into tidal power		
				228	seat belts and air bags		
				235	jet engines application		
				235	jet engines application		
				243	oscillators are used in communications and music and clocks		
				257	quartz crystals application		
				257	quartz crystals application		
				263	waves can carry information		
				263	medical technology using waves		
				280	microwave ovens application		
				280	microwave ovens application		
				289	stethoscopes used to hear sound vibrations		
				293	uses of Doppler radar		
				296	ultrasound technology		
				311	invention of electric light		
				325	the printing press		
				325	the printing press		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
				336	fiber optics are used for surgical inspections		
				349	the telescope		
				369	technological advances have allowed discovery of the expanding universe		
				372	holography application		
				378	importance of electricity		
				392	hybrid gas/electric cars application		
				392	hybrid gas/electric cars application		
				413	wiring application		
				413	wiring application		
				429	electron beam accelerators		
				434	how television works application		
				434	how television works application		
				443	magnetic resonance imaging		
				451	MRI application		
				451	MRI application		
				451	MRI application		
				472	maglev train application		
				473	how magplanes levitate		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
				490	why computers are useful		
				492	computers and electronic addition of numbers application		
				516	refrigerator application		
				531	infrared thermometers		
				534	energy-efficient building application		
				534	energy-efficient building application		
				560	deep water submarine Alvin application		
				585	laser application		
				615	smoke detectors		
				622	x-ray machines		
				623	CAT scans		
				623	creation of CAT scans		
				623	creation of CAT scans		
				631	nuclear power application		
				631	nuclear power application		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
INQI.G.4 Inquiry	Understandings about Scientific Inquiry	Historical and current scientific knowledge, current research, technology, mathematics, and logic should be the basis for conducting investigations and drawing conclusions.	Discuss how mathematics is important to scientific inquiry.	60	creating the acceleration formula from experiments	15	collect time data
				66	developing the formulas for a model of motion with constant acceleration	22	uniform acceleration model
				282	write a formula relating velocity of wave to period and wavelength	24	create an algebraic model
				312	light intensity follows an inverse square law	25	find the average time
				412	average voltage and current of AC power	28	solve second law equation for string tension
						32	develop a model that predicts acceleration
						43	create algebraic model
						49	write a formula
						58	find average of three trials
						67	calculate average of three times
						71	calculate average work and power
						94	give an equation that describes your observations
						189	Bernoulli's equation

**Correlation to South Carolina Science Standards
Foundations of Physics
 Student Text and Investigation Manual**

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
INQI.G.5 Inquiry	Understandings about Scientific Inquiry	Historical and current scientific knowledge, current research, technology, mathematics, and logic should be the basis for conducting investigations and drawing conclusions.	Discuss why scientific models and explanations need to be based on the available body of scientific knowledge.	7	developing models to explain observations	22	uniform acceleration model
				40	creating useful models	22	model for uniform accelerated motion
				60	creating the acceleration formula from experiments	24	create an algebraic model
				66	developing the formulas for a model of motion with constant acceleration	28	solve second law equation for string tension
				101	a model for friction	32	develop a model that predicts acceleration
				102	a model for static friction	43	create algebraic model
				282	write a formula relating velocity of wave to period and wavelength	49	write a formula
				312	light intensity follows an inverse square law	94	give an equation that describes your observations
				330	optics and optical instruments	189	Bernoulli's equation
				440	scientists have never found single magnetic poles		
				492	the binary number system and its use in computers		
				568	understanding how gravity works inside atoms		
				583	the meaning of the uncertainty principle		
				637	areas of active research in physics		

Correlation to South Carolina Science Standards

Foundations of Physics

Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
				640	unresolved questions of history of universe		
				641	research on future of the universe		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
INQI.G.6 Inquiry	Understandings about Scientific Inquiry	Historical and current scientific knowledge, current research, technology, mathematics, and logic should be the basis for conducting investigations and drawing conclusions.	Understand that scientific explanations must be logical, supported by the evidence, and open to revision.	8	Comparing a theory and a natural law	12	do your results agree with hypothesis?
				8	testing hypotheses with experiments	13	compare prediction to measurement
				11	Ptolemy model vs. Copernicus model of the solar system	16	what do the results tell you?
				40	making a good model	18	are the accelerations different?
				44	using a graphical model to make a prediction and checking the model's accuracy	19	does the ball accelerate?
						22	compare calculation with graph estimate
				136	determining formula for acceleration on a ramp	22	how do you measured positions compare to model?
				188	perpetual motion machines	29	does experiment agree with prediction?
				297	frequency spectrum	33	does your experiment confirm your hypothesis?
				306	explain why hearing can be damaged by loud sounds	43	what would happen if...?
				367	speed of light did not behave as expected for Michelson and Morley	43	how does the measurement compare to your prediction?
				369	proof of time dilation	50	does your experiment provide confirmation?
				375	explain Thomas Young's demonstration of the wave nature of light	58	explain why the angular acceleration is different
						66	does this agree with your hypothesis?

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
						76	compare predicted mass to actual mass
						80	explain your observations
						87	explain how force applied causes the response
						90	explain why higher tension makes waves move faster
						92	explain how wind might cause big waves in water
						109	explain how the colored filters work
						111	how does what you observed support the quantum theory?
						114	are there differences between your prediction and measurement?
						132	what conclusions can you draw?
						133	analyze data and explain a rule

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.A.1.a Physics	Motions and Forces	Objects change their motion only when a net force is applied. Laws of motion are used to calculate precisely the effects of forces on the motion of objects. The magnitude of the change in motion can be calculated using the relationship $F=ma,...$	Trace the historical development of the understanding of forces including the contributions of Galileo, Isaac Newton, Benjamin Franklin, and Charles-Augustin de Coulomb.	41	Galileo and Newton conducted experiments with balls on ramps		
				78	Newton's laws of motion		
				81	Newton's discovery of the connection between force and mass and acceleration		
				152	Sir Isaac Newton and law of universal gravitation		
				349	Galileo and telescopes		
				350	Newtonian reflecting telescope		
				382	Ben Franklin and current		
				420	Charles-Augustin de Coulomb		
				580	Newton and classical physics		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.A.1.b Physics	Motions and Forces	Objects change their motion only when a net force is applied. Laws of motion are used to calculate precisely the effects of forces on the motion of objects. The magnitude of the change in motion can be calculated using the relationship $F=ma, \dots$	Predict the motion of an object in terms of Newton's three laws of motion.	61	any acceleration must come from a force	26	study Newton's first law
				78	changes in motion only occur through force	27	collect data on Newton's first law
				79	all objects tend to resist changes in motion	27	explain how Newton's first law applies
				81	Newton's second law of motion	28	investigate Newton's second law
				83	calculation using Newton's second law	30	Newton's third law and free body diagrams
				84	Newton's second law and dynamics problems	30	investigate Newton's third law
				85	if there is acceleration there must be force	31	draw free body diagrams and identify action-reaction pairs
				85	finding force from acceleration	77	relationship between force and motion and the second law
				85	force problems		
				87	forces always occur in action-reaction pairs		
				88	Newton's third law operates on pairs of objects		
				89	solving problems with action-reaction forces		
				89	identifying which force is acting on which object		
				93	problems using Newton's first law and second law		
				94	seat belt problem		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
				102	the normal force as the reaction in an action-reaction pair		
				106	Newton's second law and net force		
				107	forces on a free-body diagram		
				108	use equilibrium to find an unknown force		
				108	equilibrium and Newton's second law		
				111	understanding reaction forces in terms of springs and deformation		
				112	analysis of forces on a bridge		
				116	calculate the acceleration of a toy		
				135	normal force of an inclined plane		
				136	calculating acceleration on a ramp		
				137	calculating acceleration from 3-D forces		
				137	the vector form of Newton's second law		
				148	direction of force determines linear or rotational motion		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
				149	calculating centripetal force		
				150	formula for centripetal acceleration		
				168	Newton's first law and rotational inertia		
				169	Newton's second law applies to rotational motion		
				171	Newton's second law for rotational motion variables		
				222	Newton's first law and momentum		
				224	momentum and Newton's third law		
				228	Newton's second law relating force and momentum		
				229	momentum form of Newton's second law		
				252	Newton's second law and natural frequency		
				425	electric forces always occur in pairs according to Newton's third law		
				548	Newton's third law and pressure in a fluid		
				550	pressure and the third law		
				557	pressure of gases		

Correlation to South Carolina Science Standards

Foundations of Physics

Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
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Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.A.1.c Physics	Motions and Forces	Objects change their motion only when a net force is applied. Laws of motion are used to calculate precisely the effects of forces on the motion of objects. The magnitude of the change in motion can be calculated using the relationship $F=ma, \dots$	Solve uniformly accelerated, linear motion problems quantitatively and graphically.	36	the precise meaning of speed	9	calculate speed of rolling marble
				37	calculating speed	9	collect data and calculate speed of car
				37	how to calculate speed	10	make object move with speed of 1 m/sec
				38	the speed formula and calculating speed	12	finding speed of ball with one photogate
				41	speed of a ball on a ramp	13	graph speed versus position
				46	speed is the rate of change of position	14	find the speed of the ball
				47	average and instantaneous speed	15	find speed of the ball
				47	position vs. time graph	16	create a position vs. time graph
				48	graphs showing changes in speed	16	create a speed vs. time graph
				48	determining speed from the slope of a position vs. time graph	17	find the acceleration
				48	determining speed from the slope of a position vs. time graph	17	studying acceleration
				48	determining speed from the slope of a position vs. time graph	17	find two speeds
				49	speed vs. time graph for constant speed	17	learn techniques for finding acceleration
				50	graphs for motion of increasing speed and decreasing speed	19	make a speed vs. time graph
				50	speed vs. time graph for downhill motion	20	understanding equation for uniform accelerated motion
				54	graphing speed vs. time	20	speed vs. time graph for uniform acceleration

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
				55	calculate the average speed and distance traveled	21	calculate speed of ball
				55	analyzing distance vs. time graph	22	create a speed vs. time graph
				58	acceleration is the rate of change in the speed of an object	22	create a position vs. time graph
				58	acceleration is the rate of change in the speed of an object	25	derive acceleration equation
				59	comparing speed and acceleration	26	make ball roll at constant speed
				60	formula for acceleration	29	calculate the acceleration
				61	constant speed and constant acceleration	33	calculate the predicted speed
				61	general definition of acceleration	42	find initial speed of ball
				62	acceleration is total change of speed divided by total change in time	50	calculate the speed of the ball
				62	acceleration is total change of speed divided by total change in time	66	find the speed of the ball
				62	speed vs. time graph for accelerated motion	68	what is speed of the ball?
				62	speed vs. time graph for accelerated motion	76	calculate speeds of projectile and target balls
				63	complex speed vs. time graphs	77	relationship between force and motion and the second law
				63	calculating acceleration from a speed vs. time graph	90	calculate the speed of the wave pulse
				64	calculate speed in accelerated motion	191	calculate speed of air in homemade air-speed tester
				64	calculating the speed of an object that is accelerating		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
				64	calculate speed in accelerated motion		
				65	calculating distance from speed vs. time graph		
				67	calculate time and distance from acceleration		
				74	understanding average speed and instantaneous speed		
				74	describing motion with speed vs. time graph		
				74	sketching speed vs. time graphs for different changes of motion		
				75	calculations of speed		
				76	analyzing graph for changes in motion		
				83	calculation using Newton's second law		
				84	direction of net force and acceleration and speed		
				85	force problems		
				108	use equilibrium to find an unknown force		
				116	calculate the acceleration of a toy		
				136	calculating acceleration on a ramp		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
				137	calculating acceleration from 3-D forces		
				146	calculating linear speed of a moving wheel		
				147	the linear speed of a rolling wheel		
				149	calculating centripetal force		
				150	centripetal acceleration		
				150	formula for centripetal acceleration		
				169	Newton's second law applies to rotational motion		
				171	Newton's second law for rotational motion variables		
				229	momentum form of Newton's second law		
				252	Newton's second law and natural frequency		
				260	position vs. time graph of harmonic motion		
				260	velocity vs. time graph of harmonic motion		

**Correlation to South Carolina Science Standards
Foundations of Physics
 Student Text and Investigation Manual**

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.A.1.d Physics	Motions and Forces	Objects change their motion only when a net force is applied. Laws of motion are used to calculate precisely the effects of forces on the motion of objects. The magnitude of the change in motion can be calculated using the relationship $F=ma,...$	Generate and interpret graphs of linear motion.	47	position vs. time graph	16	create a speed vs. time graph
				48	determining speed from the slope of a position vs. time graph	16	create a position vs. time graph
				49	speed vs. time graph for constant speed	19	make a speed vs. time graph
				50	speed vs. time graph for downhill motion	20	speed vs. time graph for uniform acceleration
				54	graphing speed vs. time	22	create a speed vs. time graph
				55	analyzing distance vs. time graph	22	create a position vs. time graph
				62	speed vs. time graph for accelerated motion		
				63	complex speed vs. time graphs		
				65	calculating distance from speed vs. time graph		
				74	describing motion with speed vs. time graph		
				260	velocity vs. time graph of harmonic motion		
				260	position vs. time graph of harmonic motion		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.A.1.e Physics	Motions and Forces	Objects change their motion only when a net force is applied. Laws of motion are used to calculate precisely the effects of forces on the motion of objects. The magnitude of the change in motion can be calculated using the relationship $F=ma,...$	Cite evidence to justify the use of auto safety devices, including seat belts, air bags, bumpers and head rests, in terms of Newton's laws.	79	what systems in a car overcome the law of inertia		
				80	seat belts and air bags and Newton's first law		
				87	explaining Newton's third law in terms of an astronaut moving through space		
				88	explaining Newton's third law in terms of moving a skateboard		
				90	examples of Newton's third law		
				137	predicting motion in three dimensions and controlling force and acceleration in space missions		
				139	determining position by triangulation and inertial navigation		
				150	using centripetal acceleration to create the feeling of gravity by rotating the space station		
				151	banked turns		
				156	satellites in orbit		
				228	seat belts and air bags		
				234	gyroscopes and the space shuttle		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
				238	cars that crumple in a collision		
PSIV.A.2.A Physics	Motions and Forces	Gravitation is a universal force that each mass exerts on any other mass. The strength of the gravitational attractive force between two masses is proportional to the masses and inversely proportional to the square of the distance between them.	Describe quantitative changes in gravitational attraction in terms of changes in distances between masses.	152	description of law of universal gravitation	51	calculate gravitational force of attraction
				153	formula and calculations for law of universal gravitation	51	investigate law of universal gravitation
				154	orbital motion		
				158	calculate weight and acceleration due to gravity on Pluto		
				216	tides are due to force of gravity		
				642	Newton's laws and gravity		
PSIV.A.2.b Physics	Motions and Forces	Gravitation is a universal force that each mass exerts on any other mass. The strength of the gravitational attractive force between two masses is proportional to the masses and inversely proportional to the square of the distance between them.	Describe quantitative changes in gravitational attraction in terms of changes in the masses.	152	description of law of universal gravitation	51	calculate gravitational force of attraction
				153	formula and calculations for law of universal gravitation	51	investigate law of universal gravitation
				154	orbital motion		
				158	calculate weight and acceleration due to gravity on Pluto		
				216	tides are due to force of gravity		
				642	Newton's laws and gravity		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.A.3.a Physics	Motions and Forces	The electric force is a universal force that exists between any two charged objects. Opposite charges attract while like charges repel. The strength of the force is proportional to the charges, and, as with gravitation, ...	Demonstrate the interactions of like and unlike charges.	418	electric charge is a fundamental property of matter	146	build a simple electroscope
				419	observing forces between charges using an electroscope	147	investigate and understand how an electroscope works
				419	electric forces are created between electric charges	147	investigate the concept of electric charge
				420	explanation of coulomb	149	investigate charged balloons
				421	current is the flow of charge		
				422	negative charge of electrons and current flow		
				423	charging an electroscope by induction		
				423	static electricity and charge polarization and induction		
				424	relationship of electric force and charge		
				425	the force between charges		
				426	charge creates an electric field		
				428	source charges and test charges		
				430	a capacitor stores charge		
				433	ability of a capacitor to store charge is capacitance		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.A.3.b Physics	Motions and Forces	The electric force is a universal force that exists between any two charged objects. Opposite charges attract while like charges repel. The strength of the force is proportional to the charges, and, as with gravitation, ...	Examine changes in electrostatic attraction in terms of changes in distances between two point charges.	418	electric charge is a fundamental property of matter	146	build a simple electroscope
				419	electric forces are created between electric charges	147	investigate the concept of electric charge
				420	explanation of coulomb	149	investigate charged balloons
				421	current is the flow of charge		
				422	negative charge of electrons and current flow		
				423	static electricity and charge polarization and induction		
				424	relationship of electric force and charge		
				425	the force between charges		
				426	charge creates an electric field		
				428	source charges and test charges		
				430	a capacitor stores charge		
				433	ability of a capacitor to store charge is capacitance		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.A.3.c Physics	Motions and Forces	The electric force is a universal force that exists between any two charged objects. Opposite charges attract while like charges repel. The strength of the force is proportional to the charges, and, as with gravitation, ...	Examine changes in electrostatic attraction in terms of changes in the quantities of the charges.	418	electric charge is a fundamental property of matter	146	build a simple electroscope
				419	electric forces are created between electric charges	147	investigate the concept of electric charge
				420	explanation of coulomb	149	investigate charged balloons
				421	current is the flow of charge		
				422	negative charge of electrons and current flow		
				423	static electricity and charge polarization and induction		
				424	relationship of electric force and charge		
				425	the force between charges		
				426	charge creates an electric field		
				428	source charges and test charges		
				430	a capacitor stores charge		
				433	ability of a capacitor to store charge is capacitance		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.A.3.d Physics	Motions and Forces	The electric force is a universal force that exists between any two charged objects. Opposite charges attract while like charges repel. The strength of the force is proportional to the charges, and, as with gravitation, ...	Compare the magnitudes of electrical and gravitational forces.	419 424 426 426 427 428 437 443 649	differences between electric force and gravity the strength of electric forces fields and forces gravity is far weaker than electric forces an electric field exists around a charge comparison between electric fields and gravitational fields strength of an electric field magnets create a magnetic field around them every field has an associated particle	154	how are magnetic field lines similar to electric field lines?

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.A.3.e Physics	Motions and Forces	The electric force is a universal force that exists between any two charged objects. Opposite charges attract while like charges repel. The strength of the force is proportional to the charges, and, as with gravitation, ...	Discuss the role of static electricity in disruptions and damage to electrical devices.	418	electric charge is a fundamental property of matter	146	build a simple electroscope
				419	electric forces are created between electric charges	147	investigate the concept of electric charge
				420	explanation of coulomb	149	investigate charged balloons
				421	current is the flow of charge		
				422	negative charge of electrons and current flow		
				423	static electricity and charge polarization and induction		
				424	relationship of electric force and charge		
				425	the force between charges		
				426	charge creates an electric field		
				428	source charges and test charges		
				430	a capacitor stores charge		
				433	ability of a capacitor to store charge is capacitance		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.A.4.a Physics	Motions and Forces	Electricity and magnetism are two aspects of a single electromagnetic force. Moving electric charges produce magnetic forces, and moving magnets produce electric forces. These effects help students to understand electric motors and generators.	Describe how moving electrical charges produce magnetic fields.	356 467 471	electricity and magnetism oscillations concept of electromagnetic induction transformers operate on electromagnetic induction	165	investigate electromagnetic induction
PSIV.A.4.b Physics	Motions and Forces	Electricity and magnetism are two aspects of a single electromagnetic force. Moving electric charges produce magnetic forces, and moving magnets produce electric forces. These effects help students to understand electric motors and generators.	Describe how moving magnets produce electrical fields.	470	generating electricity by induction	166	build a generator

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.A.4.c Physics	Motions and Forces	Electricity and magnetism are two aspects of a single electromagnetic force. Moving electric charges produce magnetic forces, and moving magnets produce electric forces. These effects help students to understand electric motors and generators.	Compare and contrast electrical motors and electrical generators in terms of energy transfers.	412 464 465 466 470	average power in an electric motor principle of the electric motor commutation battery-powered electric motors generating electricity by induction	161 166	investigate how an electric motor works build a generator
PSIV.A.4.d Physics	Motions and Forces	Electricity and magnetism are two aspects of a single electromagnetic force. Moving electric charges produce magnetic forces, and moving magnets produce electric forces. These effects help students to understand electric motors and generators.	Examine the effects of the advent of electricity on individuals and society.	196 197 217 602 608 618 631 632 634	environmental impacts of hydroelectric power efficiency of the Hoover Dam advantages of tidal energy hydrogen as a fuel alternate fuels to gasoline power released by radioactive decay nuclear power application nuclear energy comparison of fission and fusion	143	the cost of using electrical appliances

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.A.5.a Physics	Motions and Forces	Analyze electrical circuits that obey Ohm's Law.	Construct and schematically diagram simple series circuits and parallel circuits.	398	parallel circuit defined	137	parallel circuit and Ohm's law
				398	series circuit defined		
				399	current and resistance in a series circuit		
				400	voltage in a series circuit		
				401	parallel circuits		
				402	voltage and current in a parallel circuit		
				403	resistance in parallel circuits		
				405	voltage dividers		
				407	solving network circuits		
				407	solving network circuits		
				414	why parallel circuits are used in homes and buildings		
				414	why series circuits are not used in homes and buildings		

**Correlation to South Carolina Science Standards
Foundations of Physics
 Student Text and Investigation Manual**

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.A.5.b Physics	Motions and Forces	Analyze electrical circuits that obey Ohm's Law.	Use an electric meter to measure the voltage and resistance.	382	electrical current explained	131	use a multimeter to measure current
				382	voltage measures differences in energy	132	explore the concept of voltage
				383	voltage and potential energy	132	use a multimeter to measure voltage
				383	voltage is a measure of electric potential energy	135	study the relationship between current and voltage
				383	using a multimeter to measure voltage	135	use a multimeter to measure current and voltage
				385	measuring current with an ammeter or multimeter	139	use a multimeter
				387	using a multimeter to measure resistance	140	use the multimeter
				408	voltage definition	163	use a multimeter
				431	voltage of a capacitor circuit	164	use a multimeter to measure voltage
						165	use a multimeter
						169	use a multimeter
						171	use a multimeter

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.A.5.c Physics	Motions and Forces	Analyze electrical circuits that obey Ohm's Law.	Compare and contrast series and parallel circuits.	400	Kirchoff's voltage law	139	compare series and parallel circuits
				401	Kirchhoff's current law		
				402	advantages of parallel circuits over series circuits	140	build and analyze network circuits
				404	using Kirchoff's current law for circuit analysis		
				404	using Kirchoff's voltage law for circuit analysis		
				405	analyzing a voltage divider circuit		
				406	comparing series and parallel circuits		
				415	compare current in a series and parallel circuit		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.A.5.d Physics	Motions and Forces	Analyze electrical circuits that obey Ohm's Law.	Perform calculations using Ohm's Law.	386	relationship between current and resistance	134	Ohm's law
				388	Ohm's law	135	derive Ohm's law from experiment
				396	calculation of voltage from resistance and current	136	use Ohm's law to calculate the resistance
				399	calculating current in a series circuit using Ohm's law	138	apply Ohm's law to series circuits
				403	using Ohm's law in parallel circuits	171	use Ohm's law to calculate the resistance of the transistor
				404	using Ohm's law for circuit analysis		
				407	calculate currents and voltages in a network circuit		
				416	using Ohm's law to calculate current		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.A.5.e Physics	Motions and Forces	Analyze electrical circuits that obey Ohm's Law.	Explain how fuses, surge protectors, and breakers function.	381	definition of short circuit	129	short circuit precautions
				385	circuit breakers and fuses protect circuits from overloading	129	electrical safety
				389	the danger of water and 120-volt electricity in terms of resistance and voltage and current	131	short circuit precautions
						131	electrical safety
						150	short circuit precautions
						159	battery safety
				402	short circuits		
				413	ground fault interrupt (GFI) outlets and ground wires		
				414	what happens if you plug too many things into a socket		
				415	explain short circuit		
				432	safety precautions of capacitor		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.B.1.a Physics	Conservation of Energy and the Increase in Disorder	The total energy of the universe is constant. Energy can be transferred by collisions in chemical and nuclear reactions, by light waves and other radiations, and in many other ways. However, it can never be destroyed....	Evaluate transformations between potential and kinetic energies and other forms of energy.	191	the formula for potential energy	66	law of conservation of energy
				192	the formula for kinetic energy	68	calculate potential and kinetic energy
				193	deriving the formula for kinetic energy	68	find the total energy at each position
				195	applying conservation of energy for a marble rolling on a hilly track	74	investigating collisions and conservation of energy
				197	conservation of energy for Hoover Dam		
				253	harmonic motion involves both potential and kinetic energy		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.B.1.b Physics	Conservation of Energy and the Increase in Disorder	The total energy of the universe is constant. Energy can be transferred by collisions in chemical and nuclear reactions, by light waves and other radiations, and in many other ways. However, it can never be destroyed....	State and apply quantitative relationships between energy, work, power, and efficiency.	185	work and energy	63	studying the concept of work
				185	physics definition of work	64	relationship between work and energy
				185	how to calculate work	69	calculate efficiency for each ball
				186	the work done by a force	70	calculate work
				187	work done against gravity	70	calculate person's power
				187	calculating work done against gravity	71	calculate work done
				189	relationship between work and energy	71	calculate power output for each climber
				191	the symmetry between work and energy		
				191	calculate the potential energy of a cart		
				192	calculating kinetic energy depends on speed and mass		
				193	calculate the kinetic energy of a moving car		
				193	deriving the formula for kinetic energy		
				197	calculating energy supplied by Hoover Dam		
				199	concept of work		
				200	calculate work done		
				202	definition of efficiency		
				203	efficiency explained		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
				207	power is the rate of doing work or using energy		
				207	calculate power in climbing stairs		
				208	power formulas		
				208	units of power		
				209	calculating power for common devices		
				210	estimating the power in wind		
				211	estimate average input power of a person		
				211	power in biological systems		
				213	efficiency of an energy flow process		
				216	estimating the energy in tides		
				219	ideal vs. real machine		
				220	calculate power rating		
				220	calculate efficiency of model solar car		
				220	calculate energy and power for humans		
				236	fuel efficiency of turbofan engines		
				311	efficiency of electric vs. fluorescent light bulbs		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
				393	efficiency of hybrid cars		
				409	power and efficiency of electric cars		
PSIV.B.1.c Physics	Conservation of Energy and the Increase in Disorder	The total energy of the universe is constant. Energy can be transferred by collisions in chemical and nuclear reactions, by light waves and other radiations, and in many other ways. However, it can never be destroyed....	Cite or identify examples of how the disorder of matter changes with energy changes.	188	for all machines work out cannot exceed work in	64	compare output and input work
				195	friction can divert some energy	67	friction as a source of energy dissipation
				203	how friction affects machines		
				206	friction and the arrow of time		
				216	tidal energy represents frictional energy from the Earth-moon system		
				245	friction causes damping in oscillators		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.B.2.a Physics	Conservation of Energy and the Increase in Disorder	All energy can be considered to be either kinetic energy, which is the energy of motion; potential energy, which depends on relative position; or energy contained by a field, such as electromagnetic waves.	Classify energy types as potential, kinetic, or electromagnetic.	189	energy appears in different forms	66	law of conservation of energy
				190	different forms of energy	68	find the total energy at each position
				194	energy transformations	72	potential to kinetic energy conversion in a pendulum
				195	applying conservation of energy for a marble rolling on a hilly track	74	investigating collisions and conservation of energy
				196	energy transformation hydroelectric plant	88	potential to kinetic energy conversions of a pendulum
				197	conservation of energy for Hoover Dam		
				199	kinetic and potential energy conversions while bouncing in a trampoline		
				212	energy flow in a pendulum		
				212	understand basic forms of energy		
				245	kinetic to potential energy changes in motion of an oscillator		
				253	oscillators exchange energy back and forth between potential and kinetic		
				310	light is a form of energy		
				322	photons are bundles of light energy		
				378	electrical energy		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
				384	batteries use chemical energy		
				552	explanation of pressure and energy		
				619	radiation as a flow of energy		
				622	energy of x-rays		
				647	energy from antimatter		
PSIV.B.3.a Physics	Conservation of Energy and the Increase in Disorder	Heat consists of random motion and the vibrations of atoms, molecules, and ions. The higher the temperature, the greater the atomic or molecular motion.	Predict and measure the effects of varying the temperature, pressure, and volume of gases.	557	Boyle's law	192	investigate the mass of a volume of gas at different pressures
				558	pressure and temperature of gases	193	investigate the effect of temperature on pressure
				558	Charles' law		
				559	the combined gas law		
				564	using Boyle's law		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.B.3.b Physics	Conservation of Energy and the Increase in Disorder	Heat consists of random motion and the vibrations of atoms, molecules, and ions. The higher the temperature, the greater the atomic or molecular motion.	Assess particle motion and distance as they relate to temperature and phase changes.	30	relationship between states of matter and arrangement and motion of atoms and molecules	177	observe a common phase change
				33	describe movement of atoms in solids and gases		
				506	temperature and addition of heat energy		
				506	temperature measures average kinetic energy		
				508	phases of matter and arrangement of molecules		
				509	melting		
				509	temp vs. time graph for phase change of ice to water		
				510	boiling		
				511	evaporation and condensation		
				519	phases of matter		
				519	temp vs. time graphs for various materials		
				520	relationship between temp and average kinetic energy		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.B.3.c Physics	Conservation of Energy and the Increase in Disorder	Heat consists of random motion and the vibrations of atoms, molecules, and ions. The higher the temperature, the greater the atomic or molecular motion.	Assess the hazards of handling and storing pressurized gases.	191	gas pressure safety note		
				545	thermal expansion formula		
				549	formula for pressure in a liquid caused by gravity		
				550	pressure and force formula		
				551	applying the laws of motion to fluids		
				560	pressure force on Alvin		
				563	thermal expansion		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.B.4.a Physics	Conservation of Energy and the Increase in Disorder	Everything tends to become less organized and less orderly over time. Thus, in all energy transfers, the overall effect is that the energy is spread out uniformly. Examples are the transfer of energy from hotter to cooler objects by conduction,...	Compare and contrast the environmental impact of power plants that use fossil fuels, water, or nuclear energy to produce electricity.	196	environmental impacts of hydroelectric power	143	the cost of using electrical appliances
				196	hydroelectric power system		
				197	efficiency of the Hoover Dam		
				217	advantages of tidal energy		
				217	extracting tidal power		
				470	energy for generators		
				602	hydrogen as a fuel		
				608	alternate fuels to gasoline		
				618	power released by radioactive decay		
				631	nuclear power application		
				631	nuclear power application		
				632	nuclear energy		
				634	comparison of fission and fusion		

**Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual**

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.C.1.a Physics	Interactions of Energy and Matter	Waves, including sound and seismic waves, waves on water, and light waves, have energy and can transfer energy when they interact with matter.	Identify and show relationships among wave characteristics such as velocity, period, frequency, amplitude, phase, and wavelength.	242	what is a cycle?	81	investigate the motion of a pendulum
				244	concepts of period and frequency explained	88	if frequency is increased what happens to total energy?
				245	concept of amplitude explained	90	study the speed of the wave pulse
				249	analyze the motion of the cycle of a pendulum	94	investigate the wavelength of standing waves
				251	systems tends to have a preferred frequency	94	investigate the frequency of standing waves
				258	identify period and frequency and cycle and amplitude		
				260	calculate speed of an oscillator		
				264	frequency and amplitude and wavelength in waves		
				265	concept of speed of a wave		
				266	speed of a wave is the speed at which a cycle moves		
				266	formula for speed of a wave		
				277	energy of a wave is proportional to frequency and amplitude		
				278	wavelength of a standing wave		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
				282	describe relationship between wave characteristics		
				287	frequency and pitch of sound		
				288	relationship of loudness and amplitude and pressure in sound wave		
				291	pressure and amplitude of sound waves		
				292	importance of wavelength of sound waves		
				292	frequency and wavelengths of sound		
				300	pitch and frequency in music		
				452	MRI--each nucleus is a resonant oscillator		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.C.1.b Physics	Interactions of Energy and Matter	Waves, including sound and seismic waves, waves on water, and light waves, have energy and can transfer energy when they interact with matter.	Compare and contrast models of longitudinal and transverse waves.	265	wave pulse	89	making wave pulses on a string
				267	transverse and longitudinal waves	89	study wave pulses on elastic cord
				267	water waves are transverse and Slinky is longitudinal	91	is your water wave transverse or longitudinal?
				268	one- and two- and three- dimensional waves	91	making circular waves in a ripple tank
				275	standing waves on a string	91	make different types of waves in a ripple tank
				277	standing waves on a string	91	making plane waves in a ripple tank
				278	modes of a wave		
				279	modes of vibration		
				283	type of wave represented by a spring		
				292	sound is a longitudinal wave		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.C.1.c Physics	Interactions of Energy and Matter	Waves, including sound and seismic waves, waves on water, and light waves, have energy and can transfer energy when they interact with matter.	Give examples of the wave behaviors of reflection, refraction, diffraction, interference, polarization, and Doppler effect.	270	waves and refraction	92	observing reflection in water waves
				270	waves and absorption	92	investigate reflection in a ripple tank
				270	waves and reflection	92	investigate diffraction in a ripple tank
				270	waves and diffraction	101	investigate interference with sound waves
				271	waves and refraction and boundaries	106	study refraction in a prism
				271	waves and reflection and boundaries	106	use a mirror to study how light behaves
				272	waves and diffraction and boundaries	106	study reflection in a prism
				272	waves and absorption and boundaries	113	study how refraction works
				273	sound and light waves and interference	123	study light interference
				273	constructive and destructive interference	123	study light diffraction patterns
				274	resonance and reflection		
				278	nodes and antinodes		
				293	definition of the Doppler effect		
				294	Doppler effect and supersonic and subsonic motion		
				295	standing wave patterns of sound		
				296	interference of sound waves		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
				301	consonance and dissonance and beats		
				306	beats in a musical sound		
				307	understanding of Doppler effect		
				315	light rays bounce off a surface		
				315	light bends as it moves into a material		
				315	mirrors		
				324	the process of how light is reflected		
				331	lenses bend light		
				331	mirrors reflect light		
				332	specular and diffuse reflection		
				332	the image in a mirror		
				333	finding the normal line for reflection		
				334	refraction is the bending of light rays		
				336	total internal reflection and the critical angle		
				339	the image formed in a mirror		
				340	design of a lens		
				345	diffraction spot size image defect		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
				356	electromagnetic waves are oscillations of an energy field		
				361	interference of light waves and Young's double-slit experiment		
				362	diffraction grating		
				364	transmission of light through two polarizers		
				373	holograms and the interference of light		
				530	absorption of thermal radiation		
				530	absorption of thermal radiation		
				531	blackbody and perfect absorption of light		
				574	absorption of light		
				586	emission and absorption of photons in laser light		
				638	Doppler effect and red shift		

**Correlation to South Carolina Science Standards
Foundations of Physics
 Student Text and Investigation Manual**

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.C.1.d Physics	Interactions of Energy and Matter	Waves, including sound and seismic waves, waves on water, and light waves, have energy and can transfer energy when they interact with matter.	Compare light and sound in terms of wave models.	286	sound is a wave of pressure	197	quantum physics
				289	vibrations create sound	200	explore how a vibrating string has similar properties to a quantum system
				291	how we know sound is a wave		
				294	effect of medium and temperature on speed of sound wave		
				306	list evidence that sound is a wave		
				310	light is a form of energy		
				312	the intensity of light		
				313	light carries information		
				314	the speed of light		
				316	light and energy		
				322	the photon theory of light		
				328	how is light used for communication?		
				330	light rays indicate the path light travels		
				356	light can be described in terms of waves		
				357	frequency and wavelength of light		
				358	speed of light is frequency multiplied by length		
				373	wave fronts of light		

Correlation to South Carolina Science Standards

Foundations of Physics

Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
				580	comparing classical and quantum physics		
				581	classical vs. quantum theory of light		
				582	classical vs. quantum concept of electron		
				583	how the uncertainty principle differs from classical theory		
				589	electrons in classical vs. quantum physics		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.C.1.e Physics	Interactions of Energy and Matter	Waves, including sound and seismic waves, waves on water, and light waves, have energy and can transfer energy when they interact with matter.	Distinguish between the electromagnetic spectrum, seismic waves, water waves and sound waves based on their properties and behaviors.	262	waves are all around us	89	making wave pulses on a string
				262	waves transmit energy	89	study wave pulses on elastic cord
				263	waves are a form of traveling energy	91	making circular waves in a ripple tank
				265	wave pulse	91	make different types of waves in a ripple tank
				267	water waves are transverse and Slinky is longitudinal	91	making plane waves in a ripple tank
				268	one- and two- and three- dimensional waves	95	waves carry energy from one place to another
				272	waves transfer energy through absorption	122	study properties of the electromagnetic spectrum
				275	standing waves on a string		
				277	energy of a wave		
				277	standing waves are used to store energy		
				277	standing waves on a string		
				281	use of microwaves in microwave ovens		
				281	microwaves		
				286	sound waves require matter to traverse		
				320	visible light has just the right energy for life		
				359	descriptions of radio waves and microwaves and infrared rays		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
				359	waves of the electromagnetic spectrum		
				360	visible light waves		
				360	x-rays and gamma rays		
				452	MRI uses radio waves		
				530	electromagnetic radiation		
				530	energy and radiation relationships		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.C.1.f Physics	Interactions of Energy and Matter	Waves, including sound and seismic waves, waves on water, and light waves, have energy and can transfer energy when they interact with matter.	Describe the energy of a wave in terms of amplitude and frequency.	242	what is a cycle?	81	investigate the motion of a pendulum
				244	concepts of period and frequency explained		
				245	concept of amplitude explained		
				249	analyze the motion of the cycle of a pendulum		
				251	systems tends to have a preferred frequency		
				258	identify period and frequency and cycle and amplitude		
				260	calculate speed of an oscillator		
				264	frequency and amplitude and wavelength in waves		
				265	concept of speed of a wave		
				266	formula for speed of a wave		
				266	speed of a wave is the speed at which a cycle moves		
				277	energy of a wave is proportional to frequency and amplitude		
				278	wavelength of a standing wave		
				88	if frequency is increased what happens to total energy?		
90	study the speed of the wave pulse						
94	investigate the wavelength of standing waves						
94	investigate the frequency of standing waves						
124	use a spectrometer to measure wavelength of different colors of light						

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
				282	describe relationship between wave characteristics		
				292	importance of wavelength of sound waves		
				357	relationship between frequency and energy and color of light		
				375	relate color to frequency for visible light		
				452	MRI--each nucleus is a resonant oscillator		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.C.1.g Physics	Interactions of Energy and Matter	Waves, including sound and seismic waves, waves on water, and light waves, have energy and can transfer energy when they interact with matter.	Relate wave behavior to health issues such as skin cancer, cataracts, medical diagnostics, and treatment.	13	x-ray and ultrasound technology are used in medicine		
				263	medical technology using waves		
				289	stethoscopes used to hear sound vibrations		
				296	ultrasound technology		
				336	fiber optics are used for surgical inspections		
				443	magnetic resonance imaging		
				451	MRI application		
				531	infrared thermometers		
				570	use of radioactive isotopes in medicine		
				622	x-ray machines		
				622	x-ray machines		
				623	CAT scans		
				623	CAT scans		
				632	nuclear energy		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.C.1.h Physics	Interactions of Energy and Matter	Waves, including sound and seismic waves, waves on water, and light waves, have energy and can transfer energy when they interact with matter.	Relate wave behavior to communication issues such as cellular phones, satellites, and animal communication.	262	waves are all around us	96	investigate human perception of sound
				277	standing waves are used to store energy		
				279	vibration of a drum		
				281	use of microwaves in microwave ovens		
				289	acoustics		
				295	designing a musical instrument		
				296	design of a good concert hall		
				298	sonograms		
				301	echolocation and beats		
				302	musical instruments		
				303	sound from a guitar		
				311	fluorescent bulbs create UV light		
				320	the energy of IR and UV light		
				359	description and examples of infrared waves		
				359	descriptions of radio waves and microwaves and infrared rays		
				360	x-rays and gamma rays		
				360	description and examples of ultraviolet waves		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
				452	MRI uses radio waves		
				531	thermal radiation and infrared light		
				624	UV light is ionizing radiation		
PSIV.C.1.i Physics	Interactions of Energy and Matter	Waves, including sound and seismic waves, waves on water, and light waves, have energy and can transfer energy when they interact with matter.	Relate wave behavior to optical and sonic devices such as optic fibers and motion detectors.	262	waves are all around us		
				277	standing waves are used to store energy		
				281	use of microwaves in microwave ovens		
				336	how fiber optics work		
				353	explain fiber optic cables		
				359	descriptions of radio waves and microwaves and infrared rays		
				360	x-rays and gamma rays		
				376	fiber optic cable calculation		
				452	MRI uses radio waves		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.C.2.a Physics	Interactions of Energy and Matter	Electromagnetic waves result when a charged object is accelerated or decelerated. Electromagnetic waves include radio waves (the longest wavelength), microwaves, infrared radiation (radiant heat), visible light, ultraviolet radiation,...	Compare and contrast the parts of the electromagnetic spectrum in terms of energy.	281 311 320 320 359 359 360 360 531 624	microwaves fluorescent bulbs create UV light the energy of IR and UV light visible light has just the right energy for life description and examples of infrared waves waves of the electromagnetic spectrum description and examples of ultraviolet waves visible light waves thermal radiation and infrared light UV light is ionizing radiation	122	study properties of the electromagnetic spectrum

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.C.3.a Physics	Interactions of Energy and Matter	Each kind of atom or molecule can gain or lose energy only in particular discrete amounts and thus can absorb and emit light only at wavelengths corresponding to these amounts. These wavelengths can be used to identify the substance.	Describe how the absorbing and releasing of energy by electrons produces light.	316	light and energy	110	all light is produced by atoms
				322	the photon theory of light	111	photons and quantum theory
				322	the photon theory of light		
				323	photons and the intensity of light	197	absorption and emission of light by atomic electrons
				324	when the photon theory of light is useful		
				330	light rays indicate the path light travels		
				362	diffraction patterns and the spectrometer		
				574	emission/absorption spectrum		
				575	spectrum of hydrogen		
				581	quantum or photon theory of light		
				638	spectral-line patterns and red shift		

Correlation to South Carolina Science Standards
Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.C.3.b Physics	Interactions of Energy and Matter	Each kind of atom or molecule can gain or lose energy only in particular discrete amounts and thus can absorb and emit light only at wavelengths corresponding to these amounts. These wavelengths can be used to identify the substance.	Explain that each element has its own configuration of electrons and has a unique line spectrum that can be used to identify that element.	316 331 337 575	white light is the combination of all the colors prisms separate white light into its colors prisms and dispersion and rainbows spectral analysis of the sun	109	examining the spectrum of a light source
PSIV.C.3.c Physics	Interactions of Energy and Matter	Each kind of atom or molecule can gain or lose energy only in particular discrete amounts and thus can absorb and emit light only at wavelengths corresponding to these amounts. These wavelengths can be used to identify the substance.	Discuss the application of emitted colors by certain substances in such areas as fireworks and light sources.	575	spectral analysis of the sun		

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Foundations of Physics
Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.C.4.a Physics	Interactions of Energy and Matter	In some materials, such as metals, electrons flow easily, whereas in insulating materials such as glass they can hardly flow at all. Semiconducting materials have intermediate behavior....	Compare insulators, conductors, and semiconductors.	421 422 429 480	negative charges move in a conductor atomic structures of conductors and insulators and semiconductors using a conductor as shielding from electric fields conductivity and semiconductors		
PSIV.C.4.b Physics	Interactions of Energy and Matter	In some materials, such as metals, electrons flow easily, whereas in insulating materials such as glass they can hardly flow at all. Semiconducting materials have intermediate behavior....	Describe the conditions under which superconductivity exists.	390	will be featured in final physics text with material on conductors		

Correlation to South Carolina Science Standards

Foundations of Physics

Student Text and Investigation Manual

Standard #: Area	Strand	Standard	Benchmark	student text pg	detail	investigation pg	detail
PSIV.C.4.c Physics	Interactions of Energy and Matter	In some materials, such as metals, electrons flow easily, whereas in insulating materials such as glass they can hardly flow at all. Semiconducting materials have intermediate behavior....	Evaluate the impact of miniaturization of electric circuits upon individuals and society.	31 73	nanotechnology application use of control computers in cars	168	electronic devices are part of our daily lives