Correlation to Hawaii Content and Performance Standards III

Foundations of Physics

Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
I.01.01 Science as Inquiry	Doing Scientific Inquiry	9 - 12	Develop and clarify questions and hypotheses that guide scientific investigations.	3	using life experiences and common sense	11	formulate a testable hypothesis
				3	inquiry starts with questions	33	formulate a testable hypothesis
				4	inquiry through observation	43	perform experiment
						43	test your prediction
				7	creating explanations through observation	48	formulate a hypothesis
				8	formulating a hypothesis	65	form a hypothesis
				8	forming hypotheses and testing with experiments	65	investigate motion on a roller coaster
				9	testing ideas against scientific evidence	65	where does the marble move the fastest?
				10	putting forth ideas and then testing them	67	investigate motion on a roller coaster
				242	finding a basic cycle of harmonic motion	79	write a hypothesis
						82	design an experiment
				323	using glow-in-the-dark plastic to demonstrate photon energy levels	82	plan three experiments to determine which variable affects the period of a pendulum
				423	charge by friction		
				432	making a simple capacitor	89	what is it that moves in the case of a wave?
				456	an experiment with a wire and compass	111	do your observations support this hypothesis?
				463	building an electromagnet with wire and a nail	147	how did A and B tapes acquire different charge?
				467	experiment demonstrating electromagnetic induction	201	design a procedure to separate a mixture

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
I.01.02 Science as Inquiry	Doing Scientific Inquiry	9 - 12	Design and conduct scientific investigations to test hypotheses.	9	testing ideas against scientific evidence	21	conduct the experiment
						21	plan the experiment
				242	finding a basic cycle of harmonic motion	28	set up the ultimate pulley
				293	demonstrating the Doppler effect	43	perform experiment
						65	investigate motion on a roller coaster
				432	making a simple capacitor	65	studying motion of ball on loop track
				456	an experiment with a wire and compass	67	investigate motion on a roller coaster
				463	building an electromagnet with wire and a nail	67	set up the straight track
				467	experiment demonstrating electromagnetic induction	82	plan three experiments to determine which variable affects the period of a pendulum
						82	design an experiment
						85	design and test a way to increase natural frequency
						85	select appropriate technology to make measurements
						129	choose circuit parts to light a bulb
						201	design a procedure to separate a mixture
						201	determine the equipment you will need
						202	conduct your experiment

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
I.01.03 Science as Inquiry	Doing Scientific Inquiry	9 - 12	Organize, analyze, validate and display data/information in ways appropriate to scientific investigations, using technology and mathematics.		data tables and graphs can be created on computer or graphing calculator	10	calculate percent difference
						13	is there a trend in measurements?
				11	Ptolemy model vs. Copernicus model of the solar system	13	create a graph
						13	find percent error
				25	why accuracy and precision are important	13	compare prediction to measurement
				40	making a good model	15	record data in a table
				43	constructing a graph	16	create a graph
				44	graphical models	16	describe the graph
				44	using a graphical model to make a prediction and checking the model's accuracy	17	use a data table
						18	record data
						21	record results in table
				54	constructing a graph	22	how do you measured positions compare to model?
				55	create a graph from a data table		
				60	creating the acceleration formula from experiments	22	create graphs
						22	compare calculation with graph estimate
				66	developing the formulas for a model of motion with constant acceleration	22	uniform acceleration model
				142	finding x and y components of velocity for model rocket	25	find the average time
						25	create an algebraic model
				282	write a formula relating velocity of wave to period and wavelength	27	record position and time data

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
				290	the process of digital sound reproduction	28	solve second law equation for string tension
				297	frequency spectrum	29	does experiment agree with prediction?
				312	light intensity follows an inverse square law	29	record mass and force
				411	the waveform of AC electricity	32	develop a model that predicts acceleration
				412	average voltage and current of AC power	37	make a graph
						37	calculate percent difference
						38	make a graph
						38	calculate percent difference
						43	create algebraic model
						43	how does the measurement compare to your prediction?
						43	sketch four graphs
						43	calculate percent difference
						49	write a formula
						56	create a graph
						58	find average of three trials
						63	as mechanical advantage increases what happens to length of pulled string?
						66	record data in table

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Student Text and Investigation Manual

Standard #: Strand / Content Standard / Grade Level / Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
		66 create a graph of speed vs. position 66 what does the graph tell you? 67 calculate average of three times 70 record data in table 71 calculate average work and power 76 compare predicted mass to actual mass 82 analyze data 82 make three different graphs 82 record your data in table 82 create data table for self-designed experiment 83 calculate percent error 87 sketch a graph 94 give an equation that describes your observations 114 are there differences between your prediction and measurement? 133 did battery voltage change? 135 graph voltage vs. current

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Student Text and Investigation Manual

Standard #: Strand / Content Standard / Grade Level / Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
		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 202 find percent composition 202 identify two sources of experimental error 208 calculating percent yield

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
I.01.04 Science as Inquiry	Doing Scientific Inquiry	9 - 12	Formulate scientific explanations and conclusions and models using logic and evidence.	11	Ptolemy model vs. Copernicus model of the solar system	10	calculate percent difference
				40	making a good model	13	compare prediction to measurement
				43	graphs are a way of representing data	13	find percent error
				43	constructing a graph	13	create a graph
				44	using a graphical model to make a prediction and checking the model's accuracy	16	create a graph
				44	graphical models	16	describe the graph
				45	recognizing patterns using graphs	16	what do the results tell you?
				54	understanding patterns in relationships between variables	18	are the accelerations different?
				54	constructing a graph	19	does the ball accelerate?
				55	create a graph from a data table	22	uniform acceleration model
				56	indicate relationships between variables in graphs	22	create graphs
				60	creating the acceleration formula from experiments	22	compare calculation with graph estimate
				66	developing the formulas for a model of motion with constant acceleration	22	how do you measured positions compare to model?
				246	understanding graphs of harmonic motion	25	create an algebraic model
						28	solve second law equation for string tension
						29	does experiment agree with prediction?
						32	develop a model that predicts acceleration

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
				282	write a formula relating velocity of wave to period and wavelength	37	calculate percent difference
						37	make a graph
				290	the process of digital sound reproduction	38	make a graph
				297	frequency spectrum	38	calculate percent difference
				304	comparison of wave forms from guitar sounds	43	create algebraic model
				306	explain why hearing can be damaged by loud sounds	43	calculate percent difference
						43	sketch four graphs
				307	decibel level vs. frequency graph for human hearing	43	how does the measurement compare to your prediction?
				312	light intensity follows an inverse square law	43	what would happen if...?
						49	write a formula
				411	the waveform of AC electricity	56	create a graph
				427	diagramming electric fields using field lines	58	explain why the angular acceleration is different
				443	diagramming magnetic fields using magnetic field lines	66	create a graph of speed vs. position
				479	current vs.voltage graph for a transistor	76	compare predicted mass to actual mass
						80	explain your observations
						82	make three different graphs
						83	calculate percent error

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
					87 explain how force applied causes the response 87 sketch a graph 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 114 are there differences between your prediction and measurement? 132 what conclusions can you draw? 133 analyze data and explain a rule 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

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
						169	make a current vs. voltage graph for the diode
						189	Bernoulli's equation
						202	find percent composition
						208	calculating percent yield
I.01.05 Science as Inquiry	Doing Scientific Inquiry	9 - 12	Communicate and defend scientific explanations and conclusions.	42	writing procedures in a lab notebook helps make sure your results are repeatable	122	present your findings
						122	communicate your findings
						175	display information you found for your element
						202	keep detailed notes as you work

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
I.01.06 Science as Inquiry	Doing Scientific Inquiry	9 - 12	Identify and analyze alternative explanations and conclusions and models.	4	inquiry through observation	12	do your results agree with hypothesis?
				7	creating explanations through observation	33	does your experiment confirm your hypothesis?
				8	forming hypotheses and testing with experiments	43	test your prediction
				10	putting forth ideas and then testing them	50	does your experiment provide confirmation?
				10	the usefulness of phlogiston theory despite being incorrect	65	where does the marble move the fastest?
				71	parachutes and air resistance	66	does this agree with your hypothesis?
				136	determining formula for acceleration on a ramp	111	do your observations support this hypothesis?
				188	perpetual motion machines	111	how does what you observed support the quantum theory?
				323	using glow-in-the-dark plastic to demonstrate photon energy levels	147	how did A and B tapes acquire different charge?
				367	speed of light did not behave as expected for Michelson and Morley	204	build models of Na and Cl and use them to explain bonding
				369	proof of time dilation		
				375	explain Thomas Young's demonstration of the wave nature of light		
				423	charge by friction		

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
I.01.07 Science as Inquiry	Doing Scientific Inquiry	9 - 12	Revise scientific explanations and conclusions based on additional information/data gathered.	7 8	revising explanations through observation refining theories based on observations	

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
I.02.01 Habits of Mind	Living the Values, Attitudes, and Commitments of the Inquiring Mind	9 - 12	Report findings accurately without alterations and draw conclusions from unaltered findings.	7	creating theories based on observations	13	predict speed of ball
				42	writing procedures in a lab notebook helps make sure your results are repeatable	15	record data in a table
						15	collect time data
						16	what do the results tell you?
				142	finding x and y components of velocity for model rocket	17	use a data table
						18	are the accelerations different?
				306	explain why hearing can be damaged by loud sounds	18	how would acceleration be different?
						18	record data
				498	since wood is created from other matter it must not be a fundamental substance	19	does the ball accelerate?
						21	record results in table
				498	listing different types of matter in your home	27	record position and time data
						29	record mass and force
						33	calculate the predicted speed
						37	use your graph to make a prediction
						38	use your graph to make a prediction
						42	predict exact landing location
						43	what would happen if...?
						58	explain why the angular acceleration is different

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
					65 predict where the ball moves fastest 66 record data in table 70 record data in table 78 observe what happens 80 explain your observations 82 create data table for self-designed experiment 82 record your data in table 87 observe what happens to the motion 87 explain how force applied causes the response 89 observe the wave pulse 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? 132 predict what the current will be 133 analyze data and explain a rule

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
						175	display information you found for your element
						202	keep detailed notes as you work
						206	record your observations
I.02.02 Habits of Mind	Living the Values, Attitudes, and Commitments of the Inquiring Mind	9 - 12	Acknowledge references, contributions, and work done by others.	42	writing procedures in a lab notebook helps make sure your results are repeatable	122	communicate your findings
						122	research types of electromagnetic waves
						175	display information you found for your element
						202	keep detailed notes as you work

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
I.02.03 Habits of Mind	Living the Values, Attitudes, and Commitments of the Inquiring Mind	9 - 12	Evaluate the logic and validity of evidence, conclusions, and explanations against current scientific knowledge.	11	Ptolemy model vs. Copernicus model of the solar system	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	12	do your results agree with hypothesis?
						13	compare prediction to measurement
				40	making a good model	13	create a graph
				43	constructing a graph	16	describe the graph
				44	checking a graphical model's accuracy	16	create a graph
				44	graphical models	22	how do you measured positions compare to model?
				44	using a graphical model to make a prediction and checking the model's accuracy	22	compare calculation with graph estimate
				54	constructing a graph	22	create graphs
				55	create a graph from a data table	29	does experiment agree with prediction?
				103	evaluating perpetual motion claims	33	does your experiment confirm your hypothesis?
				136	determining formula for acceleration on a ramp	37	make a graph
						38	make a graph
				188	perpetual motion machines	43	sketch four graphs
				290	the process of digital sound reproduction	43	how does the measurement compare to your prediction?
				297	frequency spectrum	50	does your experiment provide confirmation?

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
				367	speed of light did not behave as expected for Michelson and Morley	56	create a graph
						66	create a graph of speed vs. position
				369	proof of time dilation	66	does this agree with your hypothesis?
				375	explain Thomas Young's demonstration of the wave nature of light	76	compare predicted mass to actual mass
				411	the waveform of AC electricity	82	make three different graphs
						87	sketch a graph
						97	reliability of a double-blind test
						97	did the method give an accurate result?
						111	how does what you observed support the quantum theory?
						114	are there differences between your prediction and measurement?
						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

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
						169	make a current vs. voltage graph for the diode
I.02.04 Habits of Mind	Living the Values, Attitudes, and Commitments of the Inquiring Mind	9 - 12	Evaluate various perspectives and their implications before drawing conclusions.	8	testing hypotheses with experiments		
I.02.05 Habits of Mind	Living the Values, Attitudes, and Commitments of the Inquiring Mind	9 - 12	When appropriate, modify ideas, explanations, and hypotheses, based on empirical data or evidence.	7	revising explanations through observation	13	compare prediction to measurement
				8	refining theories based on observations	22	how do you measured positions compare to model?
				11	Ptolemy model vs. Copernicus model of the solar system	22	compare calculation with graph estimate
				40	making a good model	29	does experiment agree with prediction?
				44	using a graphical model to make a prediction and checking the model's accuracy	43	how does the measurement compare to your prediction?
				297	frequency spectrum	76	compare predicted mass to actual mass
						114	are there differences between your prediction and measurement?

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
I.02.06 Habits of Mind	Living the Values, Attitudes, and Commitments of the Inquiring Mind	9 - 12	Ask questions to clarify or validate purpose, perspective, assumptions, interpretations, and implications of a problem, situation, or solution.	3	inquiry starts with questions	89	what is it that moves in the case of a wave?
I.02.07 Habits of Mind	Living the Values, Attitudes, and Commitments of the Inquiring Mind	9 - 12	Use research techniques and a variety of resources to complete a report on a project of one's choice.	456 472 499 499	Hans Christian Oersted Dr. D. Bruce Montgomery Democritus Albert Einstein	122 175 202	research types of electromagnetic waves display information you found for your element keep detailed notes as you work
I.02.08 Habits of Mind	Living the Values, Attitudes, and Commitments of the Inquiring Mind	9 - 12	Ask questions, explain, and elaborate how science is a way of thinking and knowing the world around us.	7 560 644 645	in science inquiry is used to uncover truth deep water submarine Alvin application proof of Einstein's theory of general relativity astronomers find black holes by what is around them		

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
I.03.01 Habits of Mind	Using Unifying Concepts and Themes	9 - 12	Explain the function of a given system and its relationship to other systems in the natural world.	202	processes	28	system of Atwood's machine
				204	natural systems and efficiency		
				205	efficiency of plants		
				206	reversible and irreversible processes		
				210	power in natural systems		
				212	energy flow in systems		
				214	natural systems work in cycles		
				215	food webs and ecosystems		
				447	the magnetic field of Earth		
				449	shifting and reversal of Earth's magnetic poles		
				528	convection in the ocean		
				541	form and the strength of materials		
				566	knowing structure of atom		

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
I.03.02 Habits of Mind	Using Unifying Concepts and Themes	9 - 12	Explain the effect of large and small disturbances on systems in the natural world.	24	time scales in physics	28	system of Atwood's machine
				86	zero net force in equilibrium	44	forces in equilibrium
				99	weight in equilibrium problems		
				106	definition of equilibrium		
				108	applications of equilibrium		
				111	equilibrium and reaction or normal forces		
				115	understanding of equilibrium		
				119	drawing displacement vector using a scale		
				133	equilibrium of forces and balancing forces		
				163	rotational equilibrium		
				175	explain rotational equilibrium		
				202	processes		
				204	natural systems and efficiency		
				205	efficiency of plants		
				206	reversible and irreversible processes		
				210	power in natural systems		
				212	energy flow in systems		

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
				214	steady state energy balance of Earth	
				214	natural systems work in cycles	
				215	food webs and ecosystems	
				225	form changes in inelastic collisions	
				248	harmonic motion and equilibrium	
				250	stable and unstable equilibrium	
				251	restoring forces and inertia affect natural frequency	
				255	a system view of resonance	
				264	equilibrium level of waves	
				420	lightning and electric charge	
				447	the magnetic field of Earth	
				449	shifting and reversal of Earth's magnetic poles	
				499	scale and Brownian motion	
				522	thermal equilibrium	
				528	convection in the ocean	
				566	knowing structure of atom	

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
I.03.03 Habits of Mind	Using Unifying Concepts and Themes	9 - 12	Report how large changes in scale typically change the way things work in physical, biological, or social systems.	7	developing models to explain observations	22	model for uniform accelerated motion
				24	time scales in physics		
				40	creating useful models		
				101	a model for friction		
				102	a model for static friction		
				119	drawing displacement vector using a scale		
				330	optics and optical instruments		
				492	the binary number system and its use in computers		
				499	scale and Brownian motion		

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
I.03.04 Habits of Mind	Using Unifying Concepts and Themes	9 - 12	Design or create a model to represent a device, a plan, an equation, or a mental image.	7	developing models to explain observations	13	create a graph
				40	creating useful models	16	describe the graph
				43	constructing a graph	16	create a graph
				44	graphical models	22	model for uniform accelerated motion
				54	constructing a graph	22	create graphs
				55	create a graph from a data table	22	uniform acceleration model
				60	creating the acceleration formula from experiments	25	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	37	make a graph
				282	write a formula relating velocity of wave to period and wavelength	38	make a graph
				290	the process of digital sound reproduction	43	create algebraic model
				312	light intensity follows an inverse square law	43	sketch four graphs
				330	optics and optical instruments	49	write a formula
				411	the waveform of AC electricity	56	create a graph
				492	the binary number system and its use in computers	66	create a graph of speed vs. position
						82	make three different graphs
						87	sketch a graph
						94	give an equation that describes your observations

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
					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
I.04.01 Safety	Doing Safety	9 - 12	Apply school, classroom, laboratory, and field trip rules, as appropriate, to maintain a safe learning environment.	385 circuit breakers and fuses protect circuits from overloading 389 the danger of water and 120-volt electricity in terms of resistance and voltage and current 413 ground fault interrupt (GFI) outlets and ground wires 414 what happens if you plug too many things into a socket 432 safety precautions of capacitor 543 safety factors	79 safety note 129 electrical safety 129 safety precautions 131 electrical safety 131 safety precautions 150 safety note 159 battery safety 159 safety note 160 electromagnet safety 176 safety note 176 heat safety 185 safety tip 192 gas pressure safety note 206 acid safety

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
I.04.02 Safety	Doing Safety	9 - 12	Identify potentially unsafe conditions prior to the activity and explain how accidents can be prevented.	385	circuit breakers and fuses protect circuits from overloading	79	safety note
				389	the danger of water and 120-volt electricity in terms of resistance and voltage and current	129	electrical safety
				413	ground fault interrupt (GFI) outlets and ground wires	129	safety precautions
				414	what happens if you plug too many things into a socket	131	electrical safety
				432	safety precautions of capacitor	131	safety precautions
				543	safety factors	150	safety note
						159	battery safety
						159	safety note
						160	electromagnet safety
						176	safety note
						176	heat safety
						185	safety tip
						192	gas pressure safety note
						206	acid safety

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
I.04.03 Safety	Doing Safety	9 - 12	Follow most recent protocols established by the International Science and Engineering Fair when conducting any investigations on living and non-living organisms and under teacher/mentor supervision.	385 389 413 414 432 543	circuit breakers and fuses protect circuits from overloading the danger of water and 120-volt electricity in terms of resistance and voltage and current ground fault interrupt (GFI) outlets and ground wires what happens if you plug too many things into a socket safety precautions of capacitor safety factors	79 129 129 131 131 150 159 159 160 176 176 185 192 206	safety note electrical safety safety precautions electrical safety safety precautions safety note battery safety safety note electromagnet safety safety note heat safety safety tip gas pressure safety note acid safety
I.04.04 Safety	Doing Safety	9 - 12	Operate emergency equipment, such as eyewash, shower, and fire blanket when needed.		featured throughout CPO Science program		
I.04.05 Safety	Doing Safety	9 - 12	Assist teacher as requested in case of emergency.		featured throughout CPO Science program		

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
I.04.06 Safety	Doing Safety	9 - 12	Document and apply appropriate safety protocols when conducting scientific activities in and out of the classroom.	385	circuit breakers and fuses protect circuits from overloading	79	safety note
				389	the danger of water and 120-volt electricity in terms of resistance and voltage and current	129	electrical safety
				413	ground fault interrupt (GFI) outlets and ground wires	129	safety precautions
				414	what happens if you plug too many things into a socket	131	electrical safety
				432	safety precautions of capacitor	131	safety precautions
				543	safety factors	150	safety note
						159	battery safety
						159	safety note
						160	electromagnet safety
						176	safety note
						176	heat safety
						185	safety tip
						192	gas pressure safety note
						206	acid safety

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
I.05.01 Science and Technology in Society	Relating the Nature of Technology to Science	9 - 12	Identify and explain current issues or problems based on evidence found in available information.	52	Dr. Harold Edgerton and strobe photography	
				62	acceleration of cars	
				91	biomechanics application	
				92	applications of biomechanics	
				188	perpetual motion machines	
				292	sound in space	
				372	holograms and science fiction special effects	
				576	ôtransporter beamsö	

Correlation to Hawaii Content and Performance Standards III

Foundations of Physics

Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
I.05.02 Science and Technology in Society	Relating the Nature of Technology to Science	9 - 12	Collect, organize, and analyze information from reliable sources to identify alternative solutions.	412	average voltage and current of AC power	6	collecting data with precision
				498	listing different types of matter in your home	15	collect time data with precision
						15	collect time data
						18	collect time data with precision
						25	find the average time
						58	find average of three trials
						67	calculate average of three times
						71	calculate average work and power
						78	observe what happens
						87	observe what happens to the motion
						89	observe the wave pulse
						206	record your observations

Correlation to Hawaii Content and Performance Standards III

Foundations of Physics

Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
I.05.03 Science and Technology in Society	Relating the Nature of Technology to Science	9 - 12	Evaluate alternative solutions for effectiveness based on appropriate criteria.	11	Ptolemy model vs. Copernicus model of the solar system	13	create a graph
						13	compare prediction to measurement
				40	making a good model	16	describe the graph
				43	constructing a graph	16	create a graph
				44	using a graphical model to make a prediction and checking the model's accuracy	22	create graphs
						22	compare calculation with graph estimate
				44	graphical models	22	how do you measured positions compare to model?
				54	constructing a graph		
				55	create a graph from a data table	29	does experiment agree with prediction?
				290	the process of digital sound reproduction	37	make a graph
				297	frequency spectrum	38	make a graph
				411	the waveform of AC electricity	43	how does the measurement compare to your prediction?
						43	sketch four graphs
						56	create a graph
						66	create a graph of speed vs. position
						76	compare predicted mass to actual mass
						82	make three different graphs
						87	sketch a graph

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Foundations of Physics

Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
						114	are there differences between your prediction and measurement?
						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
I.05.04 Science and Technology in Society	Relating the Nature of Technology to Science	9 - 12	Predict consequences or implications of proposed decisions and related actions.	7	creating theories based on observations	13	predict speed of ball
				498	since wood is created from other matter it must not be a fundamental substance	18	how would acceleration be different?
						33	calculate the predicted speed
						37	use your graph to make a prediction
						38	use your graph to make a prediction
						42	predict exact landing location
						65	predict where the ball moves fastest
						132	predict what the current will be

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
I.05.05 Science and Technology in Society	Relating the Nature of Technology to Science	9 - 12	Select and carry out actions for the alternative solution selected.	9	testing ideas against scientific evidence	21	conduct the experiment
				242	finding a basic cycle of harmonic motion	21	plan the experiment
				293	demonstrating the Doppler effect	28	set up the ultimate pulley
				432	making a simple capacitor	43	perform experiment
				456	an experiment with a wire and compass	65	investigate motion on a roller coaster
				463	building an electromagnet with wire and a nail	65	studying motion of ball on loop track
				467	experiment demonstrating electromagnetic induction	67	investigate motion on a roller coaster
						67	set up the straight track
						82	plan three experiments to determine which variable affects the period of a pendulum
						82	design an experiment
						85	design and test a way to increase natural frequency
						85	select appropriate technology to make measurements
						129	choose circuit parts to light a bulb
						201	design a procedure to separate a mixture
						201	determine the equipment you will need
						202	conduct your experiment

Correlation to Hawaii Content and Performance Standards III

Foundations of Physics

Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
I.05.06 Science and Technology in Society	Relating the Nature of Technology to Science	9 - 12	Evaluate the effectiveness of the actions taken to resolve the problem or issue and its overall effect on self, others, and the environment.	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?
II.01.01 Historical Perspectives	Understanding Scientific Inquiry and the Character of Scientific Knowledge	9 - 12	Critique a scientific investigation for logic and validity based on evidence.	8	Comparing a theory and a natural law	43	follow the scientific method
				432	making a simple capacitor	82	design an experiment
						201	design a procedure to separate a mixture
II.01.02 Historical Perspectives	Understanding Scientific Inquiry and the Character of Scientific Knowledge	9 - 12	Examine and elaborate how ethics and integrity play important roles in scientific research.	499	development of atomic theory	75	the discovery of atom's nucleus
				614	Marie Curie	122	research types of electromagnetic waves
				615	Henri Bequerel and beta rays		

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Foundations of Physics

Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
II.01.03 Historical Perspectives	Understanding Scientific Inquiry and the Character of Scientific Knowledge	9 - 12	Explain how scientists prevent biases in research.	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	

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
				561	the Alvin research submarine	
				575	discovery of helium	
				625	turning lead into gold	
				641	research on future of the universe	

Correlation to Hawaii Content and Performance Standards III

Foundations of Physics

Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
II.01.04 Historical Perspectives	Understanding Scientific Inquiry and the Character of Scientific Knowledge	9 - 12	Compare and contrast the different science disciplines in terms of areas of study, techniques used, outcomes sought, purpose and philosophy.	13	medical and health professions use physics	80	explain the physics of a diver's somersaults
				16	the relation between physics and other fields of science	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
				52	strobe photography		
				73	antilock braking systems		
				80	applications of Newton's first law		
				90	examples of Newton's third law in the real world		
				91	biomechanics application		
				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		
				118	examples of scalars		
				130	kicked soccer ball acts as a projectile launched at an angle		
				131	hang time		

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
				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	
				155	satellite motion application	
				156	HEO and geostationary orbit	
				167	SUV rollovers and center of gravity	
				172	bicycle physics application	
				227	accident reconstruction	
				232	angular momentum of skater spinning and diver	
				234	gyroscopes and angular momentum	
				250	why airplanes have tails	
				262	examples of waves	
				290	stereo sound	
				299	understanding human hearing	

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
				323	glow-in-the-dark plastic	
				337	rainbows are an example of dispersion	
				347	the compound microscope	
				365	polarized sunglasses and LCD computer screens	
				390	breakdown voltage and lightning	
				398	holiday lights wired in series	
				401	why aren't birds electrocuted?	
				410	paying for electricity	
				413	wiring application	
				413	circuits in your house	
				418	charge of everyday objects	
				430	almost all electric appliances use capacitors	
				433	cameras use capacitors to supply energy for flash bulbs	
				448	how does a compass work?	
				449	Earth's magnetism	
				458	where coils are used	
				462	electromagnet in a toaster	

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
				498	search for answers in physics and chemistry	
				527	windchill factor	
				592	connections between biology and chemistry and physics	
				608	how engines work	
				621	exposure to UV radiation	

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
II.01.05 Historical Perspectives	Understanding Scientific Inquiry and the Character of Scientific Knowledge	9 - 12	Generalize that the human need to satisfy curiosity results in scientific knowledge and expanded ideas about the world.	4	learning about natural laws through inquiry and observation	80	explain the physics of a diver's somersaults
				7	in science inquiry is used to uncover truth	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
				52	strobe photography		
				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		
				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		

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
				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	
				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	
				243	examples of oscillators	
				250	why airplanes have tails	

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
				259	wing-beat cycle of a hummingbird	
				262	examples of waves	
				290	stereo sound	
				299	understanding human hearing	
				323	glow-in-the-dark plastic	
				337	rainbows are an example of dispersion	
				347	the compound microscope	
				365	polarized sunglasses and LCD computer screens	
				367	Einstein and theory of special relativity	
				390	breakdown voltage and lightning	
				398	holiday lights wired in series	
				401	why aren't birds electrocuted?	
				410	paying for electricity	
				413	circuits in your house	
				413	wiring application	
				418	charge of everyday objects	
				430	almost all electric appliances use capacitors	

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
				433	cameras use capacitors to supply energy for flash bulbs	
				448	how does a compass work?	
				458	where coils are used	
				462	electromagnet in a toaster	
				527	windchill factor	
				560	deep water submarine Alvin application	
				560	deep water submarine Alvin application	
				608	how engines work	
				614	Marie Curie	
				615	Henri Bequerel and beta rays	
				621	exposure to UV radiation	
				644	proof of Einstein's theory of general relativity	
				645	astronomers find black holes by what is around them	
				646	a standard model for particle physics	

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
II.02.01 Historical Perspectives	Interdependence of Science, Technology, and Society	9 - 12	Analyze, conclude, and defend how technology and science impacted the social, cultural, legal, political, economic, and / or ecological systems locally or globally and vice versa.	12	engineers design practical devices for solving problems	143	the cost of using electrical appliances
				14	using analysis and problem solving and an understanding of technology to make economic decisions		
				31	use of nanotechnology		
				72	antilock brakes application		
				112	designing a bridge		
				138	use of robots		
				155	geostationary satellites		
				196	hydroelectric power application		
				196	environmental impacts of hydroelectric power		
				209	range of power for common devices		
				216	energy from ocean tides		
				217	research into tidal power		
				217	advantages of tidal energy		
				228	seat belts and air bags		
				235	jet engines application		
				257	quartz crystals application		
				280	microwave ovens application		

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
				293	uses of Doppler radar	
				311	invention of electric light	
				325	the printing press	
				349	the telescope	
				378	importance of electricity	
				392	hybrid gas/electric cars application	
				392	environmental impact of auto pollution	
				413	wiring application	
				434	how television works application	
				451	MRI application	
				490	why computers are useful	
				534	energy-efficient building application	
				535	designing buildings to be energy efficient	
				585	economics of laser technology	
				602	hydrogen as a fuel	
				607	impact of combustion reaction of gasoline	
				608	alternate fuels to gasoline	
				618	power released by radioactive decay	

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
				621	sources of radiation in the environment	
				621	human technology contributes to radiation in environment	
				623	creation of CAT scans	
				628	nuclear waste	
				631	nuclear power application	
				632	nuclear waste	
				632	nuclear energy	
				634	comparison of fission and fusion	
II.02.02 Historical Perspectives	Interdependence of Science, Technology, and Society	9 - 12	Analyze and evaluate the uses and impact of technologies locally and / or globally and propose possible solutions to address negative issues.	219	using energy efficient products	
				392	hybrid cars combine advantages of gasoline fuel and electric power	
				392	environmental impact of auto pollution	
				534	energy-efficient building application	
				621	human technology contributes to radiation in environment	
				628	nuclear waste	

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
II.02.03 Historical Perspectives	Interdependence of Science, Technology, and Society	9 - 12	Analyze and evaluate the benefits, drawbacks, and trade-offs of issues raised by the application of biotechnology in the health field (i.e., moral, ethical, legal, economic, cultural, and/or social).	570 use of radioactive isotopes in medicine 622 x-ray machines 623 CAT scans 632 nuclear energy	
II.03.01 Historical Perspectives	"MALAMA I KA 'AINA": Sustainability	9 - 12	Assess the benefits and drawbacks of biotechnology on the enviroment and society.	570 use of radioactive isotopes in medicine 573 nuclear reactions 622 x-ray machines 623 CAT scans 625 nuclear reactions 632 nuclear energy	

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
II.03.02 Historical Perspectives	"MALAMA I KA 'AINA": Sustainability	9 - 12	Analyze, evaluate and propose possible solutions in sustaining life on Earth, considering the limited resources and fragile environmental conditions.	219	using energy efficient products	
				392	hybrid cars combine advantages of gasoline fuel and electric power	
				392	environmental impact of auto pollution	
				534	energy-efficient building application	
				594	water as the universal solvent	
				604	balancing chemical equation of acid rain	
				621	sources of radiation in the environment	
				621	human technology contributes to radiation in environment	
				628	nuclear waste	
				632	nuclear waste	

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
II.13.01 The Physical Environment	Nature of Matter	9 - 12	Describe and explain properties of elements and their relationships in the Periodic Table.	502	how the periodic table is organized	194	the periodic table
				569	periodic table is arranged by atomic number	204	build model of Na and Cl atoms and explain why they bond to form a molecule
				578	periodic table and quantum states		
				596	chemically similar elements and periodic table		
				596	alkali metals		
				598	groups in periodic table related to valence		
				598	arrangement of the periodic table		
				599	alkali metals tend to form ionic bonds		
				612	identifying groups on periodic table		

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
II.13.02 The Physical Environment	Nature of Matter	9 - 12	Analyze the interactions of molecules and their relationship to the physical properties of compounds in the context of biological, chemical, and / or physical systems.	30	relationship between states of matter and arrangement and motion of atoms and molecules	203	how many electrons are in the outermost level?
				33	describe movement of atoms in solids and gases	204	modeling a chemical bond
				508	phases of matter and arrangement of molecules		
				519	phases of matter		
				573	chemical reactions		
				593	chemical reactions involve rearrangement of atoms		
				594	definition of a solution		
				594	water as the universal solvent		
				595	electrons from chemical bonds		
				596	valence and chemical bonds		
				597	why chemical bonds form		
				598	use of noble gases to prevent chemical bonds in MIG welding		
				599	ionic vs. covalent		
				601	chemistry of carbon is organic chemistry		
				601	elements forming the human body		

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
				601	amino acids from proteins that are the building blocks of living things		
				604	balancing chemical equations in terms of atoms and molecules		
				606	photosynthesis		
				610	basis for carbon's importance to life		
II.14.02 The Physical Environment	Energy, Its Transformation and Matter	9 - 12	Describe waves as means of transmitting energy.	262	waves transmit energy	95	waves carry energy from one place to another
				263	waves are a form of traveling energy		
				272	waves transfer energy through absorption		
				277	energy of a wave		
				530	energy and radiation relationships		

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
II.14.03 The Physical Environment	Energy, Its Transformation and Matter	9 - 12	Apply the Laws of Conservation of Energy to describe the dynamics of a system.	194	conservation of energy explained	66	law of conservation of energy
				194	conservation of energy	68	find the total energy at each position
				194	the law of conservation of energy	74	investigating collisions and conservation of energy
				195	applying conservation of energy for a marble rolling on a hilly track		
				195	conservation of energy in a closed system		
				197	conservation of energy for Hoover Dam		
				203	efficiency and conservation of energy		
				204	efficiency in natural systems		
				206	connection between efficiency and time		
				212	universe is matter and energy organized in systems		
				215	energy flows in biological systems		
				227	kinetic energy conservation for elastic collisions		
				366	relationships between matter and energy in theory of special relativity		

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
				370	relationship and conservation of mass and energy	
				370	the equivalence of energy and matter	
				379	examples of circuits in nature	
				469	energy conservation and Faraday's law	
				515	thermodynamics and conservation of energy	
				522	heat transfer in living things	
				552	conservation of energy in fluids	
				553	energy conservation and Bernoulli's equation	
				582	matter and energy in quantum theory	
				616	matter and energy and radioactivity	
				629	conservation of energy in nuclear reactions	

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
II.14.04 The Physical Environment	Energy, Its Transformation and Matter	9 - 12	Explain what happens in the transformation of energy.	190	conversions of energy	67	friction as a source of energy dissipation
				194	energy transformations	72	potential to kinetic energy conversion in a pendulum
				194	energy transformations	72	draw an energy flow diagram
				195	friction can divert some energy	88	potential to kinetic energy conversions of a pendulum
				196	energy transformation hydroelectric plant	189	explore Bernoulli's equation
				196	energy transformation hydroelectric plant		
				199	kinetic and potential energy conversions while bouncing in a trampoline		
				199	trace the energy transformations from sun to a flashing taillight		
				202	efficiency and energy conversions		
				203	how friction affects machines		
				204	efficiency of Earth		
				205	efficiency in biological systems		
				205	calories in food		
				206	friction and the arrow of time		
				210	energy from the sun drives the weather on Earth		
				212	energy conversion		

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
				212	energy flow in a pendulum	
				213	the conversion process of energy flow	
				215	energy flows in biological systems	
				216	tidal energy represents frictional energy from the Earth-moon system	
				219	energy flow of a model solar car	
				245	friction causes damping in oscillators	
				245	kinetic to potential energy changes in motion of an oscillator	
				253	oscillators exchange energy back and forth between potential and kinetic	
				256	resonant systems accumulate energy	
				277	waves propagate by exchanging energy between two forms	
				320	photosynthesis converts light energy to chemical energy	
				324	light from chemical reactions	

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
				356	electromagnetic waves exchange energy between electricity and magnetic parts	
				393	conversion of energy in regenerative braking	
				400	energy conversions in a series circuit	
				451	MRI--energy exchange by a nucleus in a magnetic field	
				464	electric motor uses electromagnets to convert electrical energy to mechanical energy	
				467	electric generators transform mechanical energy into electric energy	
				553	Bernoulli's equation	
				554	applying Bernoulli's equation	
				564	Bernoulli's equation calculation	
				627	fusion reactions and the sun	

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
II.15.01 The Physical Environment	Forces, Motion, Sound, and Light	9 - 12	Analyze the forces and motions of moving objects and simple machines.	13	physics and bicycles	13	graph speed versus position
				13	biomechanics	23	investigate the effect of gravity
				13	physics applies to the internal working of the body	26	collect data on Newton's first law
				41	effect of friction on motion of a ball on a ramp	26	study Newton's first law
				48	graphs showing changes in speed	27	explain how Newton's first law applies
				50	graphs for motion of increasing speed and decreasing speed	27	were any forces acting on the ball?
				61	constant speed and constant acceleration	28	investigate Newton's second law
				61	any acceleration must come from a force	30	investigate Newton's third law
				63	calculating acceleration from a speed vs. time graph	30	Newton's third law and free body diagrams
				68	free fall and acceleration due to gravity	31	draw free body diagrams and identify action-reaction pairs
				69	motion formulas for free fall	34	investigate static and sliding friction
				70	solving problems with free fall	49	investigating centripetal force
				71	acceleration of gravity does not depend on mass	53	relationship between force and torque
				71	air resistance and terminal speed	59	investigate block and tackle machine

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
				72	friction and traction and antilock brakes	60	operate and study a block and tackle machine
				74	sketching speed vs. time graphs for different changes of motion	61	what effect does friction have on mechanical advantage?
				75	problem understanding acceleration due to gravity	61	find the mechanical advantage
				76	analyzing graph for changes in motion	62	investigate block and tackle machine
				78	force is an action that can change motion	77	relationship between force and motion and the second law
				78	changes in motion only occur through force	84	restoring forces and equilibrium
				79	what systems in a car overcome the law of inertia		
				79	all objects tend to resist changes in motion		
				80	seat belts and air bags and Newton's first law		
				80	Newton's laws and cup holders		
				81	force is related to acceleration		
				81	Newton's second law of motion		
				83	calculation using Newton's second law		
				84	Newton's second law and dynamics problems		

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
				85	finding force from acceleration	
				85	if there is acceleration there must be force	
				85	force problems	
				87	explaining Newton's third law in terms of an astronaut moving through space	
				87	forces always occur in action-reaction pairs	
				88	Newton's third law operates on pairs of objects	
				88	explaining Newton's third law in terms of moving a skateboard	
				89	solving problems with action-reaction forces	
				89	identifying which force is acting on which object	
				90	the natural jet engine in a squid	
				90	examples of Newton's third law	
				91	force platform used to analyze forces from running and walking	
				92	force from a vertical jump	

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
				93	problems using Newton's first law and second law	
				94	seat belt problem	
				97	strength of gravity on Earth and Jupiter	
				98	effects of g forces and zero gravity on the human body	
				98	gravity and acceleration and weightlessness	
				100	friction is a force that resists motion	
				100	the force of friction and the different types of friction	
				101	a model for friction	
				102	calculating the force of friction	
				102	the normal force as the reaction in an action-reaction pair	
				103	friction and motion	
				104	reducing friction force	
				105	friction applications	
				105	friction is the force that keeps nails and screws in place	
				106	Newton's second law and net force	

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
				107	forces on a free-body diagram	
				108	equilibrium and Newton's second law	
				108	use equilibrium to find an unknown force	
				109	restoring force of a spring	
				110	Hooke's law and restoring force of a spring	
				110	restoring force of a spring	
				111	understanding reaction forces in terms of springs and deformation	
				111	solid materials exert restoring force	
				112	analysis of forces on a bridge	
				115	friction of a pulled sled	
				116	calculate the acceleration of a toy	
				124	effects of friction on trajectories	
				124	projectiles and trajectories	
				128	gravity only accelerates vertical motion	
				129	vertical motion of a projectile	
				130	projectiles launched at an angle	

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
				131	range of projectiles	
				134	resolving force of gravity in ramp coordinates	
				134	forces on an inclined plane	
				135	frictional force on an inclined plane	
				135	acceleration down an inclined plane	
				135	normal force of an inclined plane	
				136	calculating acceleration on a ramp	
				136	calculating acceleration on a ramp accounting for friction	
				137	the vector form of Newton's second law	
				137	calculating acceleration from 3-D forces	
				137	predicting motion in three dimensions and controlling force and acceleration in space missions	
				139	determining position by triangulation and inertial navigation	
				141	effects of gravity on motion of a projectile	

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
				142	effects of friction on acceleration	
				148	direction of force determines linear or rotational motion	
				148	centripetal force causes circular motion	
				149	calculating centripetal force	
				149	calculating centripetal force	
				150	formula for centripetal acceleration	
				150	using centripetal acceleration to create the feeling of gravity by rotating the space station	
				151	banked turns	
				152	law of universal gravitation and orbital motion	
				154	orbits and gravitational force	
				155	satellite motion application	
				155	centripetal force and the law of universal gravitation combine to form the orbit equation	

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
				155	centripetal force and the law of universal gravitation combine to form the orbit equation	
				156	satellites in orbit	
				158	compare projectile motion to orbital motion	
				158	calculating centripetal force	
				160	how torque and force differ	
				160	using torque in household devices	
				161	line of action and the torque created by a force	
				161	force on a wrench	
				164	when force and lever arm are not perpendicular	
				165	the motion of a tossed object	
				166	centers of mass and gravity may differ	
				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	

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
				172	force and torque transformations in bicycles	
				173	force and torque transformations in bicycles	
				173	changing gears in a bicycle	
				174	compare force and torque	
				178	input and output for simple machines	
				178	how simple machines manipulate forces	
				179	how to calculate mechanical advantage	
				179	types of simple machines	
				180	mechanical advantage of human arm	
				180	the mechanical advantage of a lever	
				181	how a lever works	
				181	how a lever works	
				181	crowbar as an example of a lever	
				182	mechanical advantage of ropes and pulleys	
				183	small drills use gears	
				183	how wheels and gears work	

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
				183	friction and mechanical advantage of wheel and axle	
				184	ramps and screws	
				184	friction and mechanical advantage of ramps and screws	
				184	screw turns rotating motion into linear motion	
				187	work done against gravity	
				191	potential energy comes from gravity	
				200	calculate fulcrum point of a lever	
				209	estimating power requirements based on force	
				222	Newton's first law and momentum	
				224	momentum and Newton's third law	
				228	Newton's second law relating force and momentum	
				228	seat belts and air bags	
				228	car crash safety	
				229	momentum form of Newton's second law	

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
				234	gyroscopes and the space shuttle	
				238	cars that crumple in a collision	
				240	forces in a car stopping	
				245	friction causes damping in oscillators	
				249	harmonic motion in machines	
				252	Newton's second law and natural frequency	
				254	definition of periodic force	
				256	friction and steady state	
				425	electric forces always occur in pairs according to Newton's third law	
				440	the difference between magnetic poles and electric charge	
				442	torque between two magnets	
				448	biological compasses of animals	
				460	orbital motion of a charge	
				548	Newton's third law and pressure in a fluid	
				550	pressure and the third law	
				557	pressure of gases	

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
II.15.02 The Physical Environment	Forces, Motion, Sound, and Light	9 - 12	Describe and explain the effects of multiple forces acting on an object.	83	finding the net force	30	Newton's third law and free body diagrams
				84	calculating net force	31	draw free body diagrams and identify action-reaction pairs
				86	zero acceleration means net zero force	45	balancing a specified force
				89	solving problems with action-reaction forces	49	consider forces acting on the ball
				99	balanced force problems		
				103	net force includes the force of friction		
				106	net force must be zero in equilibrium		
				107	net force of zero and free-body diagram		
				107	forces on a free-body diagram		
				112	analysis of forces on a bridge		
				133	balancing forces in two dimensions		
				135	normal force of an inclined plane		
				141	calculate the net force		

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Student Text and Investigation Manual

Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
II.15.03 The Physical Environment	Forces, Motion, Sound, and Light	9 - 12	Analyze the nature of electromagnetic radiation.	281	microwaves	
				286	sound waves require matter to traverse	
				356	electricity and magnetism oscillations	
				359	waves of the electromagnetic spectrum	
				530	electromagnetic radiation	

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
II.15.04 The Physical Environment	Forces, Motion, Sound, and Light	9 - 12	Explain that the observed wavelength of a wave depends upon the relative motion of the source and the observer.	26	weight is a measure of the force of gravity pulling on mass	52	converting mass to weight
				27	understanding and measuring mass	128	relativity and frames of reference
				36	speed is relative		
				75	problem using frames of reference		
				82	English unit of force is the pound		
				92	measuring forces from a vertical jump		
				93	explain the difference between mass and weight		
				96	differences between mass and weight		
				98	weight and acceleration		
				99	weight is a force but mass is not		
				115	explain weight and mass		
				116	calculate mass from weight		
				127	calculating velocity vectors may require knowing frames of reference		
				152	attractive force between mass of person and mass of object is weight		

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
				366	special relativity and time dilation		
				367	relative motion and speed of light		
				369	frequency of light depends on relative motion		
				371	simultaneity depends on the relative motion of your frame of reference		
				643	frame of reference and the equivalence principle		
II.17.01 Earth Systems and the Universe	Forces of the Universe	9 - 12	Create an analogy showing the relationship between gravitational force, masses of objects, and the distance between them.	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		

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
II.17.02 Earth Systems and the Universe	Forces of the Universe	9 - 12	Explain the relationships between magnetic and electric forces.	412 average power in an electric motor 418 electric charge is a fundamental property of matter 419 electric forces are created between electric charges 420 explanation of coulomb 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 440 magnetism explained	146 build a simple electroscope 147 investigate the concept of electric charge 149 investigate charged balloons 152 investigate magnetic forces 154 draw magnetic field lines for a bar magnet 155 test materials to see if they are affected by magnets 161 experiment with pushes and pulls of permanent magnet in a rotor 161 investigate how an electric motor works 165 investigate electromagnetic induction

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page
				441	comparing magnetic and electric forces	
				442	force between two magnetics is not an inverse square law	
				443	understanding magnetic fields	
				445	alignment of domains responds to magnetic fields	
				446	creating permanent magnets	
				447	the magnetic field of Earth	
				448	a compass is a magnet that lines up with Earth's magnetic field	
				449	the strength of Earth's magnetic field	
				451	magnetic field of a nucleus	
				454	magnetic field between two unlike poles	
				458	the magnetic field of loops and coils	
				459	the magnetic field of coils and permanent magnets	
				460	magnetic force on a moving charge	
				461	calculating magnetic fields and forces	

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Standard #: Strand	Content Standard	Grade Level	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
				464 principle of the electric motor 465 commutation 466 battery-powered electric motors 467 concept of electromagnetic induction 471 transformers operate on electromagnetic induction	
II.18.01 Earth Systems and the Universe	Earth in the Solar System	9 - 12	Evaluate the consequences of human activities on an Earth system (e.g., driving cars increase CO2 emission, causing ozone depletion), and vice-versa.	196 environmental impacts of hydroelectric power 217 advantages of tidal energy 392 environmental impact of auto pollution 602 hydrogen as a fuel 607 impact of combustion reaction of gasoline 608 alternate fuels to gasoline 618 power released by radioactive decay 621 human technology contributes to radiation in environment 628 nuclear waste 632 nuclear energy 634 comparison of fission and fusion	143 the cost of using electrical appliances