

**Correlation to Alabama Course of Study: Science
 Foundations of Physics
 Student Text and Investigation Manual**

Standard #: Core	Strand	Benchmark		Volume One Student Text Page	Volume Two Investigation Manual Page	
INQ.01 Science	Process and Application	Understand fundamental assumptions about the universe upon which the scientific enterprise is based.	4	learning about natural laws through inquiry and observation	28	system of Atwood's machine
			7	in science inquiry is used to uncover truth	80	explain the physics of a diver's somersaults
			19	problems in the real world use both metric and English units	92	how does sound get through tiny cracks?
			52	strobe photography	126	explain how polarizing sunglasses work
			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		

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Standard #: Core	Strand	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	
			202 processes	
			204 natural systems and efficiency	
			205 efficiency of plants	
			206 reversible and irreversible processes	
			210 power in natural systems	
			211 output power from plants is input power for animals	
			212 energy flow in systems	

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			214	
				natural systems work in cycles
			215	
				food webs and ecosystems
			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
			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
			390	
				breakdown voltage and lightning
			398	
				holiday lights wired in series

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			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
			433	cameras use capacitors to supply energy for flash bulbs
			447	the magnetic field of Earth
			448	how does a compass work?
			449	shifting and reversal of Earth's magnetic poles
			458	where coils are used
			462	electromagnet in a toaster
			527	windchill factor
			528	convection in the ocean
			560	deep water submarine Alvin application
			566	knowing structure of atom
			608	how engines work
			621	exposure to UV radiation

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			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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INQ.02 Science	Process and Application	Discuss science as a body of knowledge and an investigative process.	4	learning about natural laws through inquiry and observation	13	predict speed of ball
			7	creating theories based on observations	16	what do the results tell you?
			7	in science inquiry is used to uncover truth	18	how would acceleration be different?
			154	the orbits of planets and comets	18	are the accelerations different?
			211	output power from plants is input power for animals	19	does the ball accelerate?
			243	examples of oscillators	33	calculate the predicted speed
			259	wing-beat cycle of a hummingbird	37	use your graph to make a prediction
			306	explain why hearing can be damaged by loud sounds	38	use your graph to make a prediction
			498	since wood is created from other matter it must not be a fundamental substance	42	predict exact landing location
			560	deep water submarine Alvin application	43	what would happen if...?
			644	proof of Einstein's theory of general relativity	58	explain why the angular acceleration is different
			645	astronomers find black holes by what is around them	65	predict where the ball moves fastest
			646	a standard model for particle physics	80	explain your observations
						87
			90	explain why higher tension makes waves move faster		
			92	explain how wind might cause big waves in water		

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
				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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INQ.03 Science	Process and Application	Conduct scientific investigations systematically.	2	understanding natural laws	11 formulate a testable hypothesis
			3	using life experiences and common sense	11 recognizing and controlling variables
			3	inquiry starts with questions	12 cause and effect relationships
			3	connecting cause and effect through observation	16 what do the results tell you?
			4	inquiry through observation	18 are the accelerations different?
			7	revising explanations through observation	19 does the ball accelerate?
			7	creating explanations through observation	33 formulate a testable hypothesis
			8	forming hypotheses and testing with experiments	43 perform experiment
			8	refining theories based on observations	43 what would happen if...?
			8	refining theories based on observations	43 test your prediction
			8	formulating a hypothesis	43 write a procedure
			9	testing ideas against scientific evidence	43 follow the scientific method
			9	connecting cause and effect through analysis	48 formulate a hypothesis
			10	putting forth ideas and then testing them	58 explain why the angular acceleration is different
			10	the usefulness of phlogiston theory despite being incorrect	65 form a hypothesis
			40	defining variables	65 where does the marble move the fastest? 65 studying motion of ball on loop track

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			42	67
			43	79
			45	80
			54	82
			71	82
			242	82
			251	87
			293	89
			306	90
			323	90
			423	92
			432	109
				111

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			456 an experiment with a wire and compass	132 what conclusions can you draw?
			463 building an electromagnet with wire and a nail	133 analyze data and explain a rule
			467 experiment demonstrating electromagnetic induction	147 how did A and B tapes acquire different charge?
				166 variables that affect the performance of the generator
				201 design a procedure to separate a mixture
				201 develop a procedure
				204 build models of Na and Cl and use them to explain bonding

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INQ.04 Science	Process and Application	Exhibit behaviors appropriate to the scientific enterprise consistently.	12	engineers design practical devices for solving problems	78	observe what happens
			13	medical and health professions use physics	87	observe what happens to the motion
			15	physics plays a role in nearly everything a person does	89	observe the wave pulse
			62	acceleration of cars	206	record your observations
			91	careers in biomechanics		
			188	perpetual motion machines		
			227	police forensic scientists		
			289	careers in acoustics		
			292	sound in space		
			296	ultrasound technology		
			367	Einstein and theory of special relativity		
			372	holograms and science fiction special effects		
			404	electrical engineers		
			440	scientists have never found single magnetic poles		
			498	listing different types of matter in your home		
			560	deep water submarine Alvin application		

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			568 understanding how gravity works inside atoms 576 transporter beams 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	
INQ.05 Science	Process and Application	Demonstrate correct care and safe use of instruments, equipment, and chemicals.	543 safety factors	79 safety note 129 safety precautions 131 safety precautions 150 safety note 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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INQ.06 Science	Process and Application	Demonstrate the ability to choose, construct, and/or assemble appropriate equipment for scientific investigations.	20 understanding metric rulers 23 reading a digital timer 91 the force platform 383 using a multimeter to measure voltage 385 measuring current with an ammeter or multimeter 387 using a multimeter to measure resistance	2 measuring a pencil 4 using a timer 5 using photogates 7 using devices to measure mass 9 using timer and photogates 11 using timer and photogates 14 using a timer and photogates 17 using a timer and photogates 18 use a timer and photogates 18 use a ruler 21 use a timer and photogates 23 use a timer and photogates 26 use a timer and photogates 28 set up the ultimate pulley 29 use a meter stick 29 find mass 29 use a spring scale 34 use a spring scale

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
				36 use a meter stick
				39 using a compass
				42 use a timer and photogates
				43 measure the distance
				44 use a spring scale
				47 use a timer and photogate
				50 use a timer and photogate
				58 use a timer and photogate
				60 use a spring scale
				65 use a timer and photogate
				67 use a timer and photogate
				67 set up the straight track
				75 use a timer and photogates
				78 use meter stick to measure height
				82 use a timer and photogate
				85 design and test a way to increase natural frequency
				87 use photogate and timer to measure the period
				89 use a spring scale to measure tension of string
				90 use a timer and photogates

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
				93 use the timer to measure frequency
				106 experiment with mirrors
				112 use a laser and mirror to study law of reflection
				112 study reflection with a mirror
				115 use mirrors and lenses to learn how images are formed
				117 use a laser to locate images formed by a lens
				131 use a multimeter to measure current
				132 use a multimeter to measure voltage
				135 use a multimeter to measure current and voltage
				139 use a multimeter
				140 use the multimeter
				157 reading a compass
				163 use a multimeter
				164 use a multimeter to measure voltage
				165 use a multimeter
				166 use a photogate and timer
				169 use a multimeter

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
				171 use a multimeter 192 use a digital balance 201 determine the equipment you will need 202 conduct your experiment

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INQ.07 Science	Process and Application	Apply critical and integrated science- thinking skills.	7	creating theories based on observations	2	significant digit practice
			8	formulating a hypothesis	2	practice length measurement
			9	physics vocabulary is very specific	4	measuring time
			18	measurements of distance in units of length	6	collecting data with precision
			19	description of length measured in English and metric systems	6	precision in measurement
			19	scientists use metric units	7	estimating mass
			21	calculating volume of simple shapes	9	make distance measurement
			22	time intervals	11	formulate a testable hypothesis
			23	units for measuring time	13	is there a trend in measurements?
			24	time intervals in physics	13	predict speed of ball
			25	understanding precision	15	collect time data with precision
			25	accuracy and precision of measurements	18	measure the length
			27	measuring mass in kg and grams	18	collect time data with precision
			33	commonly used units for measuring mass	18	how would acceleration be different?
			37	understanding the word "per"	23	measure the distance
			42	writing procedures in a lab notebook helps make sure your results are repeatable	26	find length in centimeters
					29	measure the force
		33	calculate the predicted speed			

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			43	graphs are a way of representing data	33	formulate a testable hypothesis
			44	using a graph to make predictions	34	measure the mass
			45	recognizing patterns using graphs	34	measure the force
			45	recognizing relationships between variables from graphs	36	measure the mass
			45	recognizing relationships between variables from graphs	36	measure the new position
			54	understanding patterns in relationships between variables	37	use your graph to make a prediction
			54	understanding patterns in relationships between variables	38	use your graph to make a prediction
			56	indicate relationships between variables in graphs	42	predict exact landing location
			60	understanding the Greek letter delta	46	working with radians
			60	understanding the Greek letter delta	48	formulate a hypothesis
			82	units of force are pounds and newtons	62	measure string length
			82	units of force are pounds and newtons	63	as mechanical advantage increases what happens to length of pulled string?
			83	understanding units for using Newton's second law	65	measure vertical distance
			83	understanding units for using Newton's second law	65	predict where the ball moves fastest
			96	terms of mass and weight	65	form a hypothesis
			97	understanding symbols	66	what does the graph tell you?
			107	drawing free-body diagrams	66	what does the graph tell you?
			116	draw a free-body diagram	68	convert grams to kilograms
			125	drawing the velocity vector	70	measure and mark height
			145	using radians per second to measure angular speed		

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			157	units of angular speed	78	make the string 70 cm long
			164	torque in English units	78	observe what happens
			212	making an energy flow diagram	78	measure mass of ball
			244	frequency is measured in hertz	79	write a hypothesis
			246	understanding graphs of harmonic motion	82	analyze data
			246	understanding graphs of harmonic motion	82	design an experiment
			246	understanding graphs of harmonic motion	87	observe what happens to the motion
			304	comparison of wave forms from guitar sounds	89	observe the wave pulse
			307	decibel level vs. frequency graph for human hearing	93	measure frequency
			307	decibel level vs. frequency graph for human hearing	96	measure frequency
			333	drawing a ray diagram	122	communicate your findings
			342	drawing ray diagrams of lenses	122	present your findings
			380	circuit diagrams and electrical symbols	131	measure current in a circuit
			382	unit of electric current is the ampere or amp (A)	132	predict what the current will be
			382	unit of electric current is the ampere or amp (A)	132	measure voltage in a circuit
			383	voltage is measured in volts (V)	133	did battery voltage change?
			387	electrical resistance is measured in ohms	137	measure voltage and current in series circuits
			408	measuring power in watts	148	investigate electrical forces in a penny

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			409 units of watts and horsepower used in electrical circuits	153 making measurements with precision
			410 electric companies charge for kilowatt-hours used	153 make measurement with precision
			420 coulomb is the unit of charge	163 measure direct current
			421 one ampere is the flow of one coulomb per second	164 measure voltage of battery pack
			427 diagramming electric fields using field lines	165 measure voltage
			427 drawing the electric field using field lines	169 measure current and voltage
			432 making a simple capacitor	171 measure current and voltage
			443 diagramming magnetic fields using magnetic field lines	178 measure 100 grams of water
			443 diagramming magnetic fields using magnetic field lines	192 find the mass of the bottle
			460 magnetic field strength	192 set the pressure to 10 psi
			475 units of magnetic field	193 convert psi to Pa
			479 current vs.voltage graph for a transistor	201 design a procedure to separate a mixture
			498 listing different types of matter in your home	202 find the mass
				202 find the mass to the nearest tenth of a gram
				206 record your observations

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			498	since wood is created from other matter it must not be a fundamental substance
			513	joules and calories and Btus
			542	units for stress
			548	units of pressure

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INQ.08 Science	Process and Application	Use mathematical models, simple statistical models, and graphical models to express patterns and relationships determined from sets of scientific data.		10 calculate percent difference
				13 compare prediction to measurement
			11 Ptolemy model vs. Copernicus model of the solar system	13 is there a trend in measurements?
			25 why accuracy and precision are important	13 create a graph
			40 making a good model	13 find percent error
			42 controlling variables in experiments	15 record data in a table
			43 constructing a graph	16 create a graph
			43 graphs are a way of representing data	16 describe the graph
			44 using a graphical model to make a prediction and checking the model's accuracy	17 use a data table
			44 graphical models	18 record data
			45 recognizing patterns using graphs	21 record results in table
			54 understanding patterns in relationships between variables	22 uniform acceleration model
			54 constructing a graph	22 compare calculation with graph estimate
			55 create a graph from a data table	22 how do you measured positions compare to model?
				22 create graphs
				24 create an algebraic model
				25 find the average time
	27 record position and time data			

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			56	indicate relationships between variables in graphs	28	solve second law equation for string tension
			60	creating the acceleration formula from experiments	29	does experiment agree with prediction?
			66	developing the formulas for a model of motion with constant acceleration	29	record mass and force
			142	finding x and y components of velocity for model rocket	32	develop a model that predicts acceleration
			246	understanding graphs of harmonic motion	37	calculate percent difference
			260	analyze graph of an oscillator	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	38	calculate percent difference
			297	frequency spectrum	43	sketch four graphs
			304	comparison of wave forms from guitar sounds	43	how does the measurement compare to your prediction?
			307	decibel level vs. frequency graph for human hearing	43	discuss sources of error
			312	light intensity follows an inverse square law	43	create algebraic model
			411	the waveform of AC electricity	43	calculate percent difference
					45	discuss sources of errors
					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?

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			412	average voltage and current of AC power	66	what does the graph tell you?
			427	diagramming electric fields using field lines	66	create a graph of speed vs. position
			443	diagramming magnetic fields using magnetic field lines	66	record data in table
			479	current vs.voltage graph for a transistor	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	create data table for self-designed experiment
					82	record your data in table
					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?		

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				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 202 identify two sources of experimental error 202 find percent composition 208 calculating percent yield
INQ.09 Science	Process and Application	Solve for unknown quantities by manipulating variables simultaneously.	60 creating the acceleration formula from experiments 66 developing the formulas for a model of motion with constant acceleration 282 write a formula relating velocity of wave to period and wavelength 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 43 create algebraic model 49 write a formula 94 give an equation that describes your observations 189 Bernoulli's equation

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INQ.10 Science	Process and Application	Use written and oral communication skills to present and explain scientific phenomena and concepts individually or in collaborative groups using technical and non-technical language.	9	physics vocabulary is very specific	122 communicate your findings
			37	understanding the word "per"	122 present your findings
			42	writing procedures in a lab notebook helps make sure your results are repeatable	175 display information you found for your element
			44	using a graph to make predictions	202 keep detailed notes as you work
			45	recognizing relationships between variables from graphs	
			60	understanding the Greek letter delta	
			96	terms of mass and weight	
			97	understanding symbols	
			107	drawing free-body diagrams	
			116	draw a free-body diagram	
			125	drawing the velocity vector	
			212	making an energy flow diagram	
			246	understanding graphs of harmonic motion	
			333	drawing a ray diagram	
			342	drawing ray diagrams of lenses	

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			380 circuit diagrams and electrical symbols 427 drawing the electric field using field lines 443 diagramming magnetic fields using magnetic field lines	
INQ.11 Science	Process and Application	Choose appropriate technology to retrieve relevant information from the Internet such as electronic encyclopedias, indices, and databases.	456 Hans Christian Oersted 472 Dr. D. Bruce Montgomery 499 Albert Einstein 499 Democritus	122 research types of electromagnetic waves

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INQ.12 Science	Process and Application	Analyze the advantages and disadvantages of widespread use of and reliance on technology.	<p>12 all technology is based on fundamental laws of physics</p> <p>12 engineers design practical devices for solving problems</p> <p>31 use of nanotechnology</p> <p>31 use of nanotechnology</p> <p>51 analyzing motion with video and strobe photography</p> <p>72 antilock brakes application</p> <p>72 antilock brakes application</p> <p>112 relationship between science and engineering and technology</p> <p>112 designing a bridge</p> <p>138 use of robots</p> <p>155 geostationary satellites</p> <p>172 bicycle physics application</p> <p>196 hydroelectric power application</p> <p>196 hydroelectric power application</p> <p>209 range of power for common devices</p> <p>216 energy from ocean tides</p> <p>217 research into tidal power</p>	

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			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	
			280 microwave ovens application	
			280 microwave ovens application	
			293 uses of Doppler radar	
			311 invention of electric light	
			325 the printing press	
			325 the printing press	
			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	

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			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	
			451 MRI application	
			451 MRI application	
			472 maglev train application	
			473 how magplanes levitate	
			490 why computers are useful	
			492 computers and electronic addition of numbers application	
			516 refrigerator application	
			534 energy-efficient building application	
			534 energy-efficient building application	
			560 deep water submarine Alvin application	
			585 laser application	
			604 balancing chemical equation of acid rain	

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			607 impact of combustion reaction of gasoline 615 smoke detectors 621 sources of radiation in the environment 623 creation of CAT scans 623 creation of CAT scans 631 nuclear power application 631 nuclear power application 632 nuclear waste	
INQ.13 Science	Process and Application	Practice responsible use of technology systems, information, and software such as following copyright laws.	data tables and graphs can be created on computer or graphing calculator	
INQ.14 Science	Process and Application	Evaluate technology-based options for lifelong learning.	456 Hans Christian Oersted 472 Dr. D. Bruce Montgomery 499 Albert Einstein 499 Democritus	122 research types of electromagnetic waves

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INQ.16 Science	Process and Application	Collect data and construct and analyze graphs, tables, and charts using tools such as computer-based or calculator-based probeware.	<p>data tables and graphs can be created on computer or graphing calculator</p> <p>18 measuring distance</p> <p>23 reading a digital timer</p> <p>25 accuracy and precision of measurements</p> <p>43 graphs are a way of representing data</p> <p>43 constructing a graph</p> <p>44 graphical models</p> <p>45 recognizing patterns using graphs</p> <p>54 understanding patterns in relationships between variables</p> <p>54 constructing a graph</p> <p>55 create a graph from a data table</p> <p>56 indicate relationships between variables in graphs</p> <p>60 creating the acceleration formula from experiments</p> <p>66 developing the formulas for a model of motion with constant acceleration</p>	<p>1 estimating length</p> <p>4 using a timer</p> <p>5 using photogates</p> <p>6 collecting data with precision</p> <p>6 accuracy and resolution and printing</p> <p>9 using timer and photogates</p> <p>11 using timer and photogates</p> <p>13 create a graph</p> <p>14 using a timer and photogates</p> <p>15 record data in a table</p> <p>15 collect time data with precision</p> <p>15 collect time data</p> <p>16 create a graph</p> <p>16 describe the graph</p> <p>17 using a timer and photogates</p> <p>17 use a data table</p> <p>18 use a timer and photogates</p> <p>18 collect time data with precision</p>

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			142 finding x and y components of velocity for model rocket	18 record data 21 record results in table
			246 understanding graphs of harmonic motion	21 use a timer and photogates 22 create graphs
			282 write a formula relating velocity of wave to period and wavelength	22 uniform acceleration model
			290 the process of digital sound reproduction	23 use a timer and photogates
			304 comparison of wave forms from guitar sounds	24 create an algebraic model
			307 decibel level vs. frequency graph for human hearing	26 use a timer and photogates 27 record position and time data
			312 light intensity follows an inverse square law	28 solve second law equation for string tension
			411 the waveform of AC electricity	29 record mass and force
			427 diagramming electric fields using field lines	32 develop a model that predicts acceleration
			443 diagramming magnetic fields using magnetic field lines	37 make a graph 38 make a graph
			479 current vs.voltage graph for a transistor	42 use a timer and photogates 43 measure and record the distance 43 create algebraic model 43 sketch four graphs

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
				47 use a timer and photogate
				49 write a formula
				50 use a timer and photogate
				56 create a graph
				58 use a timer and photogate
				60 measure input and output forces
				65 use a timer and photogate
				66 record data in table
				66 create a graph of speed vs. position
				67 measure vertical distance
				67 use a timer and photogate
				70 record data in table
				75 use a timer and photogates
				82 measure the length of the string
				82 create data table for self-designed experiment
				82 make three different graphs
				82 record your data in table
				82 use a timer and photogate
				87 sketch a graph
				87 use photogate and timer to measure the period

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
				90 use a timer and photogates 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 166 use a photogate and timer 167 make a graph of voltage vs. number of magnets 169 make a current vs. voltage graph for the diode 189 Bernoulli's equation

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
P.17 Physics	Forces and Motions	Describe the basic natural forces.	419 differences between electric force and gravity 424 the strength of electric forces 426 gravity is far weaker than electric forces 428 comparison between electric fields and gravitational fields 568 forces in the atom 626 strong force and electromagnetic force in the nucleus 649 four forces in nature	

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page			
P.18 Physics	Forces and Motions	Understand the interrelationships among mass, distance, force, velocity, acceleration, and time.	26	weight is a measure of the force of gravity pulling on mass	9	calculate speed of rolling marble	
			27	understanding and measuring mass	9	collect data and calculate speed of car	
			36	the precise meaning of speed	10	make object move with speed of 1 m/sec	
			37	calculating speed	12	finding speed of ball with one photogate	
			37	how to calculate speed	14	find the speed of the ball	
			38	the speed formula and calculating speed	15	find speed of the ball	
			38	compare and contrast speed and velocity	16	create a speed vs. time graph	
			41	speed of a ball on a ramp	16	create a position vs. time graph	
			41	effect of friction on motion of a ball on a ramp	17	find two speeds	
			46	speed is the rate of change of position	17	studying acceleration	
			47	position vs. time graph	17	find the acceleration	
			47	average and instantaneous speed	17	learn techniques for finding acceleration	
			48	determining speed from the slope of a position vs. time graph	19	make a speed vs. time graph	
			48	determining speed from the slope of a position vs. time graph	20	understanding equation for uniform accelerated motion	
			49	speed vs. time graph for constant speed	20	speed vs. time graph for uniform acceleration	
						21	calculate speed of ball

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page		
			50	speed vs. time graph for downhill motion	22	create a position vs. time graph
			54	graphing speed vs. time	22	create a speed vs. time graph
			55	calculate the average speed and distance traveled	23	investigate the effect of gravity
			55	analyzing distance vs. time graph	25	derive acceleration equation
			58	acceleration is the rate of change in the speed of an object	26	make ball roll at constant speed
			59	comparing speed and acceleration	26	study Newton's first law
			60	formula for acceleration	27	were any forces acting on the ball?
			61	general definition of acceleration	27	explain how Newton's first law applies
			61	zero acceleration vs. constant acceleration vs. acceleration with zero speed	27	collect data on Newton's first law
			61	any acceleration must come from a force	28	investigate Newton's second law
			62	acceleration is total change of speed divided by total change in time	29	calculate the acceleration
			62	speed vs. time graph for accelerated motion	30	Newton's third law and free body diagrams
			62	speed vs. time graph for accelerated motion	30	investigate Newton's third law
			63	complex speed vs. time graphs	31	draw free body diagrams and identify action-reaction pairs
					33	calculate the predicted speed

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page		
			64	calculating the speed of an object that is accelerating	34	investigate static and sliding friction
			64	calculate speed in accelerated motion	39	investigating vectors
			64	calculate speed in accelerated motion	42	find initial speed of ball
			65	calculating distance from speed vs. time graph	43	calculate the velocity vector
			67	calculate time and distance from acceleration	49	consider forces acting on the ball
			68	free fall and acceleration due to gravity	50	calculate the speed of the ball
			69	motion formulas for free fall	52	converting mass to weight
			70	solving problems with free fall	61	what effect does friction have on mechanical advantage?
			71	acceleration of gravity does not depend on mass	66	find the speed of the ball
			71	air resistance and terminal speed	68	what is speed of the ball?
			72	friction and traction and antilock brakes	76	calculate speeds of projectile and target balls
			74	describing motion with speed vs. time graph	77	relationship between force and motion and the second law
			74	understanding average speed and instantaneous speed	90	calculate the speed of the wave pulse
			75	calculations of speed	191	calculate speed of air in homemade air-speed tester

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			75	
				problem understanding acceleration due to gravity
			78	
				force is an action that can change motion
			78	
				changes in motion only occur through force
			79	
				all objects tend to resist changes in motion
			81	
				force is related to acceleration
			81	
				Newton's second law of motion
			82	
				English unit of force is the pound
			83	
				calculation using Newton's second law
			84	
				Newton's second law and dynamics problems
			84	
				direction of net force and acceleration and speed
			85	
				force problems
			85	
				if there is acceleration there must be force
			85	
				finding force from acceleration
			87	
				forces always occur in action-reaction pairs
			88	
				Newton's third law operates on pairs of objects

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			89	identifying which force is acting on which object
			89	solving problems with action-reaction forces
			92	measuring forces from a vertical jump
			93	problems using Newton's first law and second law
			93	explain the difference between mass and weight
			94	seat belt problem
			94	force calculations in different units
			96	differences between mass and weight
			97	strength of gravity on Earth and Jupiter
			98	weight and acceleration
			98	gravity and acceleration and weightlessness
			99	balanced force problems
			99	weight is a force but mass is not
			100	the force of friction and the different types of friction
			100	friction is a force that resists motion
			101	a model for friction

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			102	the normal force as the reaction in an action-reaction pair
			102	calculating the force of friction
			103	friction and motion
			104	reducing friction force
			105	friction applications
			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
			115	explain weight and mass
			115	friction of a pulled sled
			116	calculate mass from weight
			116	calculate the acceleration of a toy
			118	vectors have magnitude and direction

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			119	displacement vectors
			124	effects of friction on trajectories
			124	definition of the velocity vector
			124	projectiles and trajectories
			125	the velocity vector
			125	speed is the magnitude of the velocity vector
			126	components of the velocity vector
			127	adding velocity vectors
			128	gravity only accelerates vertical motion
			128	constant velocity of horizontal component of projectile motion
			129	vertical motion of a projectile
			130	analyzing changing velocity in vertical component of projectile motion
			130	projectiles launched at an angle
			131	range of projectiles
			133	balancing forces in two dimensions

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			134	resolving force of gravity in ramp coordinates
			135	normal force of an inclined plane
			135	acceleration down an inclined plane
			135	frictional force on 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
			141	effects of gravity on motion of a projectile
			142	effects of friction on acceleration
			146	calculating linear speed of a moving wheel
			147	the linear speed of a rolling wheel
			148	centripetal force causes circular motion
			148	direction of force determines linear or rotational motion

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			149	calculating centripetal force
			150	centripetal acceleration
			150	formula for centripetal acceleration
			152	law of universal gravitation and orbital motion
			152	attractive force between mass of person and mass of object is weight
			154	orbits and gravitational force
			155	centripetal force and the law of universal gravitation combine to form the orbit equation
			158	compare projectile motion to orbital motion
			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 #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			183	friction and mechanical advantage of wheel and axle
			184	friction and mechanical advantage of ramps and screws
			187	work done against gravity
			191	potential energy comes from gravity
			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
			245	friction causes damping in oscillators
			252	Newton's second law and natural frequency
			254	definition of periodic force
			256	friction and steady state
			260	position vs. time graph of harmonic motion
			260	velocity vs. time graph of harmonic motion

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			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

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page		
P.19 Physics	Forces and Motions	Explain the significance of slope and area under a curve when graphing motion data.	47	position vs. time graph	16	find the slope of the line
			48	slope of a 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	find the slope of the line
			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	acceleration and slope of a speed vs. time graph		
			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					

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
P.20 Physics	Forces and Motions	Analyze vector problems graphically and trigonometrically.	118 vectors have magnitude and direction 119 adding vectors 119 displacement vectors 120 adding vectors 121 adding and subtracting vectors 122 calculating vector components 123 finding magnitude and angle of a vector 124 definition of the velocity vector 125 the velocity vector 125 the velocity vector 126 components of the velocity vector 126 components of the velocity vector 127 adding velocity vectors 127 adding velocity vectors 128 independence of horizontal and vertical motion in a velocity vector 130 calculating velocity components of initial velocity	39 investigating vectors 41 calculate the resultant vector 43 calculate the velocity vector 44 investigating force vectors 45 calculate force components 49 draw a free body diagram and label forces

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			132 interpreting the x-y components of force	
			132 the force vector describes the strength and direction of a force	
			133 calculating components of a force vector	
			136 calculate the acceleration of a skier on a slope	
			186 work done by a force at an angle to the distance	

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
P.21 Physics	Forces and Motions	Use vectors to analyze the motion of an object acted upon by more than one force.	119 adding vectors 120 adding vectors 121 adding and subtracting vectors 122 calculating vector components 123 finding magnitude and angle of a vector 125 the velocity vector 126 components of the velocity vector 127 adding velocity vectors 128 independence of horizontal and vertical motion in a velocity vector 130 calculating velocity components of initial velocity 132 the force vector describes the strength and direction of a force 132 interpreting the x-y components of force 133 calculating components of a force vector 136 calculate the acceleration of a skier on a slope 186 work done by a force at an angle to the distance	41 calculate the resultant vector 44 investigating force vectors 45 calculate force components 49 draw a free body diagram and label forces

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page		
P.22 Physics	Forces and Motions	Demonstrate an understanding of momentum.	223	momentum formula and calculating momentum	73	calculating momentum
			224	law of conservation of momentum	75	investigate collisions and conservation of momentum
			225	conservation of momentum in collisions	77	the momentum form of Newton's second law
			226	applying conservation of momentum	78	which ball had a greater change in momentum?
			226	solving elastic and inelastic collision problems		
			227	momentum conservation for collisions in two and three dimensions		
			229	force on a rocket from change in momentum		
			230	calculate change in momentum for elastic vs. inelastic collisions		
			231	conservation of angular momentum examples		
			232	conservation of angular momentum		
			235	jet engines work because of conservation of momentum		
			236	momentum conservation of turbofan engine		
			238	momentum in billiards		
			239	calculate momentum		

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			276 natural frequency and harmonics 370 Einstein's thinking about momentum of particles moving near the speed of light 629 conservation of momentum in nuclear reactions	

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page		
P.23 Physics	Forces and Motions	Explain planetary motion and navigation in space in terms of Kepler's and Newton's laws.	87	forces always occur in action-reaction pairs	30	investigate Newton's third law
			88	Newton's third law operates on pairs of objects	46	investigating angular speed
			89	identifying which force is acting on which object	49	investigating centripetal force
			102	the normal force as the reaction in an action-reaction pair	51	calculate gravitational force of attraction
			111	understanding reaction forces in terms of springs and deformation	51	investigate law of universal gravitation
			144	rotation and revolution and angular speed		
			145	calculating angular speed in radians per second		
			146	angular speed of a moving wheel		
			149	calculating centripetal force		
			152	description of law of universal gravitation		
			153	formula and calculations for law of universal gravitation		
			154	orbital motion		
			154	satellites and orbital motion		

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Standard #: Core	Strand	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
			155	satellite motion application
			156	HEO and geostationary orbit
			158	calculate weight and acceleration due to gravity on Pluto
			158	calculating centripetal force
			160	translation and rotation
			216	tides are due to force of gravity
			224	momentum and Newton's third law
			243	orbit is a type of cycle
			425	electric forces always occur in pairs according to Newton's third law
			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
			642	Newton's laws and gravity

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
P.24 Physics	Forces and Motions	Apply quantitative relationships involving mass, weight, distance, work, power, gravitational potential energy, and kinetic energy.	13	physics and bicycles	34	calculate the weight
			13	biomechanics	52	converting mass to weight
			26	calculating weight from mass	59	investigate block and tackle machine
			26	weight is a measure of the force of gravity pulling on mass	60	operate and study a block and tackle machine
			27	understanding and measuring mass	61	find the mechanical advantage
			82	English unit of force is the pound	62	investigate block and tackle machine
			92	measuring forces from a vertical jump	64	relationship between work and energy
			93	explain the difference between mass and weight	64	compare output and input work
			96	differences between mass and weight	66	law of conservation of energy
			97	calculating weight with mass and gravity	68	find the total energy at each position
			98	weight and acceleration	68	calculate potential and kinetic energy
			99	weight calculations	70	calculate person's power
			99	weight is a force but mass is not	70	calculate work
			105	friction is the force that keeps nails and screws in place	71	calculate power output for each climber
			115	explain weight and mass	71	calculate work done
			116	calculate mass from weight	72	potential to kinetic energy conversion in a pendulum

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			134 forces on an inclined plane	74 investigating collisions and conservation of energy
			152 attractive force between mass of person and mass of object is weight	88 potential to kinetic energy conversions of a pendulum
			172 force and torque transformations in bicycles	
			173 force and torque transformations in bicycles	
			173 changing gears in a bicycle	
			178 input and output for simple machines	
			178 how simple machines manipulate forces	
			179 types of simple machines	
			179 how to calculate mechanical advantage	
			180 mechanical advantage of human arm	
			180 the mechanical advantage of a lever	
			181 how a lever works	
			181 how a lever works	
			182 mechanical advantage of ropes and pulleys	
			183 how wheels and gears work	
			184 ramps and screws	

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			185 work and energy	
			185 how to calculate work	
			187 calculating work done against gravity	
			188 for all machines work out cannot exceed work in	
			189 relationship between work and energy	
			191 the formula for potential energy	
			191 calculate the potential energy of a cart	
			191 the symmetry between work and energy	
			192 calculating kinetic energy depends on speed and mass	
			192 the formula for kinetic energy	
			193 calculate the kinetic energy of a moving car	
			193 deriving the formula for kinetic energy	
			194 energy transformations	
			195 applying conservation of energy for a marble rolling on a hilly track	
			196 energy transformation hydroelectric plant	

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			197 conservation of energy for Hoover Dam	
			197 calculating energy supplied by Hoover Dam	
			199 kinetic and potential energy conversions while bouncing in a trampoline	
			200 calculate fulcrum point of a lever	
			207 power is the rate of doing work or using energy	
			207 calculate power in climbing stairs	
			208 units of power	
			208 power formulas	
			209 calculating power for common devices	
			210 estimating the power in wind	
			211 power in biological systems	
			211 estimate average input power of a person	
			212 energy flow in a pendulum	
			216 estimating the energy in tides	
			220 calculate energy and power for humans	
			220 calculate power rating	

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			228 car crash safety	
			245 kinetic to potential energy changes in motion of an oscillator	
			253 harmonic motion involves both potential and kinetic energy	
			253 oscillators exchange energy back and forth between potential and kinetic	
			409 power and efficiency of electric cars	
			440 the difference between magnetic poles and electric charge	
			552 potential energy of pressure	
P.25 Physics	Forces and Motions	Explain the laws of thermodynamics.	188 for all machines work out cannot exceed work in	64 compare output and input work

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
P.26 Physics	Forces and Motions	Describe relationships qualitatively and quantitatively between changes in heat energy and changes in temperature.	504 temperature scales and Fahrenheit-Celsius conversions 505 measuring temperature 506 temperature measures average kinetic energy 507 the Kelvin scale and converting between Kelvin and Celsius 507 absolute zero and the limits of temperature 509 temperature change and thermal energy 512 temperature and thermal energy and heat 513 transfer of thermal energy 513 balance of thermal energy 513 definition of calorie 514 specific heat and the heat equation 514 the heat equation 516 refrigerator application 517 air conditioners 519 understanding Fahrenheit and Celsius and Kelvin 520 relationship between temp and average kinetic energy	176 investigate temperature and its effect on materials 178 explore the connection between temperature and heat and energy 179 specific heat

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			522 thermal equilibrium	
			523 thermal conductors and insulators	
			533 using Kelvin for radiation calculations	
			535 sources of heat transfer in buildings	
			537 heat flow between objects of different temperature	
			558 using temperature in Kelvins for Charles' law	

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
P.27 Physics	Interactions of Energy and Matter	Classify waves according to type.	264	basic properties of frequency and wavelength and amplitude	89	study characteristics of a wave pulse on a string
			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	90	measure speed of a wave pulse
			268	creating plane waves and circular waves	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	93	investigate frequency and wavelength
			279	modes of vibration	125	study the polarization of a transverse spring wave
			283	type of wave represented by a spring		
			286	properties of sound waves		
			292	sound is a longitudinal wave		
			303	design of a guitar		
			308	wave amplitude and harmonics of tuning fork and musical instrument		

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
P.28 Physics	Interactions of Energy and Matter	Explain wave behavior in terms of reflection, refraction, and diffraction.	270	waves and reflection	92	observing reflection in water waves
			270	waves and refraction	92	investigate reflection in a ripple tank
			270	waves and diffraction	92	investigate diffraction in a ripple tank
			271	waves and reflection and boundaries	106	study refraction in a prism
			271	waves and refraction and boundaries	106	use a mirror to study how light behaves
			272	waves and diffraction and boundaries	106	study reflection in a prism
			274	resonance and reflection	112	investigate law of reflection
			315	mirrors	113	study how refraction works
			315	light bends as it moves into a material	113	investigate Snell's law of refraction
			315	light rays bounce off a surface	114	study the critical angle of refraction in a prism
			324	the process of how light is reflected	114	study index of refraction
			331	mirrors reflect light	114	apply Snell's law of refraction
			331	lenses bend light	123	study light diffraction patterns
			332	specular and diffuse reflection		
			332	the image in a mirror		
			333	finding the normal line for reflection		
			333	the laws of reflection		
			334	refraction is the bending of light rays		

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			334	the index of refraction
			335	Snell's law of refraction
			335	refraction depends on index of refraction in both materials
			336	total internal reflection and the critical angle
			339	the image formed in a mirror
			340	lenses follow Snell's law of refraction
			340	design of a lens
			345	diffraction spot size image defect
			352	law of reflection
			353	explain index of refraction
			354	using Snell's law
			356	electromagnetic waves are oscillations of an energy field
			358	index of refraction is ratio of speed of light in material to speed of light in vacuum
			362	diffraction grating

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
P.29 Physics	Interactions of Energy and Matter	Differentiate between constructive and destructive wave interference.	247 the phase of an oscillator 273 sound and light waves and interference 273 constructive and destructive interference 278 nodes and antinodes 295 standing wave patterns of sound 296 interference of sound waves 301 consonance and dissonance and beats 306 beats in a musical sound 361 interference of light waves and Young's double-slit experiment 373 holograms and the interference of light	83 investigate oscillators in- phase and out-of-phase 101 investigate interference with sound waves 123 study light interference

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
P.30 Physics	Interactions of Energy and Matter	Relate physical properties of sound and light to wave characteristics.	251	concept of natural frequency	85	investigate natural frequency
			252	changing natural frequency	86	investigate resonance and its importance
			254	periodic force and natural frequency	88	if frequency is increased what happens to total energy?
			254	concept of resonance	90	study the speed of the wave pulse
			255	resonance occurs when periodic force matches natural frequency	94	investigate the frequency of standing waves
			255	resonance occurs when periodic force matches natural frequency	94	investigate the wavelength of standing waves
			259	resonance and amplitude	94	investigate harmonic wave patterns
			262	waves transmit energy	95	natural frequency and resonance of standing waves on a string
			263	waves are a form of traveling energy	95	waves carry energy from one place to another
			264	frequency and amplitude and wavelength in waves	96	investigate range of frequencies the ear can detect
			265	concept of speed of a wave	96	investigate human perception of sound
			266	formula for speed of a wave	101	investigate interference with sound waves
			272	waves transfer energy through absorption	106	use a mirror to study how light behaves
			273	constructive and destructive interference		
			274	how resonance is created		

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page		
			274	natural frequency of waves	108	investigate RGB and CMYK models of color
			275	standing waves and natural frequency and resonance	109	examining the spectrum of a light source
			275	boundaries and natural frequency	111	photons and quantum theory
			276	concept of harmonics	115	studying optical systems
			277	energy of a wave	119	analyze optical systems
			277	energy of a wave is proportional to frequency and amplitude	124	use a spectrometer to measure wavelength of different colors of light
			278	wavelength of a standing wave	125	polarization of water waves
			278	nodes and antinodes	125	polarization of a spring wave
			279	vibration of a drum	126	study the polarization of light
			280	microwaves and resonance	126	polarization of light
			281	microwaves		
			282	describe relationship between wave characteristics		
			286	sound is a wave of pressure		
			287	frequency and pitch of sound		
			287	how we hear sound waves		

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			288	
				loudness and decibels and the sensitivity of the ear
			288	
				relationship of loudness and amplitude and pressure in sound wave
			288	
				the decibel scale
			289	
				vibrations create sound
			289	
				acoustics
			291	
				how we know sound is a wave
			291	
				sound vibrates the eardrum
			291	
				pressure and amplitude of sound waves
			292	
				importance of wavelength of sound waves
			292	
				frequency and wavelengths of sound
			294	
				effect of medium and temperature on speed of sound wave
			295	
				resonance of sound
			295	
				standing wave patterns of sound
			295	
				designing a musical instrument
			296	
				design of a good concert hall

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			296	
				interference of sound waves
			298	constructing meaning from sound
			298	sonograms
			299	how the ear works
			300	music and sound
			300	pitch and frequency in music
			301	consonance and dissonance and beats
			301	echolocation and beats
			302	musical instruments
			302	harmonics and frequency and the color of sound
			303	sound from a guitar
			306	beats in a musical sound
			306	list evidence that sound is a wave
			310	how we see
			315	mirrors
			316	white light is the combination of all the colors
			316	light and energy
			317	how the human eye sees color

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			318	how we perceive color
			318	the additive color process
			319	the subtractive color process
			319	we see mostly reflected light
			321	the RGB and CMYK color processes are complementary
			322	the photon theory of light
			322	the photon theory of light
			323	photons and the intensity of light
			324	the process of how light is reflected
			324	when the photon theory of light is useful
			325	color separations in high quality printing
			326	the CMYK four-color printing process
			330	light rays indicate the path light travels
			331	lenses bend light
			331	mirrors reflect light
			331	prisms separate white light into its colors
			332	the image in a mirror

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			337	
				prisms and dispersion and rainbows
			338	
				how the human eye sees images
			344	
				the functions of an optical system
			346	
				calculating image and object distances for optical systems
			347	
				using image relay to analyze optical systems
			349	
				telescope as an optical system
			357	
				relationship between frequency and energy and color of light
			359	
				waves of the electromagnetic spectrum
			362	
				the diffraction pattern of laser light
			363	
				polarization
			364	
				polarizers
			365	
				applications of polarization
			372	
				three-dimensional images and the human eye
			375	
				relate color to frequency for visible light
			434	
				RGB process and how a television picture is made

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			530	energy and radiation relationships
			581	quantum or photon theory of light
			585	laser application
			586	how lasers make light

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
P.31 Physics	Interactions of Energy and Matter	Explain the impact of change in media upon the speed, frequency, and wavelength of a wave.	264 frequency and amplitude and wavelength in waves 265 concept of speed of a wave 266 formula for speed of a wave 277 energy of a wave is proportional to frequency and amplitude 278 wavelength of a standing wave 282 describe relationship between wave characteristics 292 importance of wavelength of sound waves 310 light is a form of energy 312 the intensity of light 313 light carries information 314 the speed of light 328 how is light used for communication? 356 light can be described in terms of waves 357 frequency and wavelength of light 357 relationship between frequency and energy and color of light	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

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			358 speed of light is frequency multiplied by length 373 wave fronts of light 375 relate color to frequency for visible light	

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
P.32 Physics	Interactions of Energy and Matter	Describe how different components of the electromagnetic spectrum are used for communication purposes.	262 waves are all around us 277 standing waves are used to store energy 281 use of microwaves in microwave ovens 281 microwaves 311 fluorescent bulbs create UV light 320 the energy of IR and UV light 320 visible light has just the right energy for life 359 waves of the electromagnetic spectrum 359 descriptions of radio waves and microwaves and infrared rays 359 description and examples of infrared waves 360 x-rays and gamma rays 360 visible light waves 360 description and examples of ultraviolet waves 452 MRI uses radio waves 531 thermal radiation and infrared light 624 UV light is ionizing radiation	122 study properties of the electromagnetic spectrum

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
P.33 Physics	Interactions of Energy and Matter	Demonstrate an understanding of reflection.	270 waves and reflection 271 waves and reflection and boundaries 274 resonance and reflection 315 mirrors 315 light rays bounce off a surface 324 the process of how light is reflected 331 mirrors reflect light 332 the image in a mirror 332 specular and diffuse reflection 333 the laws of reflection 333 finding the normal line for reflection 336 total internal reflection and the critical angle 339 the image formed in a mirror 352 law of reflection 356 electromagnetic waves are oscillations of an energy field	92 observing reflection in water waves 92 investigate reflection in a ripple tank 106 use a mirror to study how light behaves 106 study reflection in a prism 112 investigate law of reflection

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
P.34 Physics	Interactions of Energy and Matter	Demonstrate an understanding of refraction.	270 waves and refraction 271 waves and refraction and boundaries 315 light bends as it moves into a material 331 lenses bend light 334 the index of refraction 334 refraction is the bending of light rays 335 refraction depends on index of refraction in both materials 335 Snell's law of refraction 340 design of a lens 340 lenses follow Snell's law of refraction 353 explain index of refraction 354 using Snell's law 358 index of refraction is ratio of speed of light in material to speed of light in vacuum	106 study refraction in a prism 113 study how refraction works 113 investigate Snell's law of refraction 114 study the critical angle of refraction in a prism 114 study index of refraction 114 apply Snell's law of refraction
P.35 Physics	Interactions of Energy and Matter	Demonstrate an understanding of diffraction.	270 waves and diffraction 272 waves and diffraction and boundaries 345 diffraction spot size image defect 362 diffraction grating	92 investigate diffraction in a ripple tank 123 study light diffraction patterns

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
P.36 Physics	Interactions of Energy and Matter	Explain polarization.	363	polarization	125	polarization of water waves
			364	polarizers	125	polarization of a spring wave
			365	applications of polarization	126	study the polarization of light
					126	polarization of light

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page		
P.37 Physics	Interactions of Energy and Matter	Describe similarities in the calculation of electrical force, magnetic force, and gravitational force between objects.	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	154	how are magnetic field lines similar to electric field lines?
			158	calculate weight and acceleration due to gravity on Pluto		
			216	tides are due to force of gravity		
			426	fields and forces		
			427	an electric field exists around a charge		
			437	strength of an electric field		
			441	comparing magnetic and electric forces		
			442	force between two magnetics is not an inverse square law		
			443	magnets create a magnetic field around them		
			642	Newton's laws and gravity		
			649	every field has an associated particle		

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page		
P.38 Physics	Interactions of Energy and Matter	Explain the production of static charge in an electroscope through induction and conduction.	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		

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
P.39 Physics	Interactions of Energy and Matter	Identify methods by which an electric field can be created.	426 fields and forces 427 an electric field exists around a charge 435 steering the electron beam on television screen 437 strength of an electric field 443 magnets create a magnetic field around them 456 magnetic field of a wire 457 force on a current in a magnetic field 462 electromagnets 463 building an electromagnet 464 electric motor uses electromagnets to convert electrical energy to mechanical energy 465 how electromagnets are used in electric motors 467 concept of electromagnetic induction 471 transformers operate on electromagnetic induction 472 electromagnet-based maglev 475 diagram of electromagnet 649 every field has an associated particle	154 how are magnetic field lines similar to electric field lines? 159 build an electromagnet 160 find out what happens to strength of electromagnet when current is increased 160 what happens to the strength of an electromagnet when you increase the current? 165 investigate electromagnetic induction

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
P.40 Physics	Interactions of Energy and Matter	Apply quantitative relationships among charge, current, potential energy, potential difference, resistance, and electrical power for simple series, parallel, or combination DC circuits.	379	concept of a circuit	129	construct simple electric circuits
			380	understanding simple circuit and its diagram	131	construct a simple circuit
			382	voltage measures differences in energy	132	explore the concept of voltage
			382	electrical current explained	134	study the relationship between resistance and current
			383	voltage is a measure of electric potential energy	134	apply the concept of electrical resistance
			383	voltage and potential energy	134	Ohm's law
			383	voltage is a measure of electric potential energy	135	study the relationship between current and voltage
			384	battery uses chemical energy to produce electrical charge	135	derive Ohm's law from experiment
			386	concept of electrical resistance	136	use Ohm's law to calculate the resistance
			386	relationship between current and resistance	137	parallel circuit and Ohm's law
			386	simple bulb and battery circuits to illustrate electrical resistance	137	investigate series circuits
			387	measuring resistance	138	apply Ohm's law to series circuits
			388	calculate the current flowing in a circuit	138	build a parallel circuit
			388	Ohm's law	138	determining total resistance in a series circuit
			389	the resistance of electrical devices	139	analyze parallel circuits

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			390	resistance of conductors and insulators	139	compare series and parallel circuits
			390	classifying materials as conductor or insulator or semiconductor	140	build and analyze network circuits
			391	resistors	143	find the power rating of home appliances
			395	classify conductivity of materials	146	build a simple electroscope
			395	knowing difference between types of resistors	147	investigate the concept of electric charge
			396	calculation of voltage from resistance and current	149	investigate charged balloons
			398	parallel circuit defined	164	calculate the power consumed by the motor
			398	series circuit defined	171	use Ohm's law to calculate the resistance of the transistor
			399	calculating current in a series circuit using Ohm's law		
			399	current and resistance in a series circuit		
			399	adding resistance in a series circuit		
			400	Kirchoff's voltage law		
			400	voltage in a series circuit		
			401	Kirchhoff's current law		
			401	parallel circuits		
			402	advantages of parallel circuits over series circuits		

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			402	voltage and current in a parallel circuit
			403	using Ohm's law in parallel circuits
			403	resistance in parallel circuits
			404	using Ohm's law for circuit analysis
			404	using Kirchhoff's current law for circuit analysis
			404	using Kirchhoff's voltage law for circuit analysis
			405	voltage dividers
			405	analyzing a voltage divider circuit
			406	comparing series and parallel circuits
			407	solving network circuits
			407	calculate currents and voltages in a network circuit
			407	solving network circuits
			408	resistance definition
			408	voltage definition
			409	formula for calculating power in electric circuits
			414	why series circuits are not used in homes and buildings

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			414	
				why parallel circuits are used in homes and buildings
			415	
				compare current in a series and parallel circuit
			416	
				using Ohm's law to calculate current
			416	
				calculating resistance in a circuit
			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

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			431 voltage of a capacitor circuit	
			433 ability of a capacitor to store charge is capacitance	
			479 resistance of a transistor	
P.41 Physics	Interactions of Energy and Matter	Determine the force on charged particles using Coulomb's law.	424 Coulomb's law 425 calculate force using Coulomb's law 437 Coulomb's law is an inverse square law 438 calculating charge using Coulomb's law	148 investigate Coulomb's law

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page		
P.42 Physics	Interactions of Energy and Matter	Demonstrate an understanding of the scientific implications of the following as they relate to the nature of particles (atoms).	52	Dr. Harold Edgerton and strobe photography	75	the discovery of atom's nucleus
			208	James Watt	122	research types of electromagnetic waves
			257	Pierre and Jacques Curie and the piezoelectric effect	147	Gilbert built the first electroscope
			311	Thomas Edison and the electric light		
			314	Einstein and the speed of light		
			316	Albert Einstein		
			361	Thomas Young		
			366	Albert Einstein's theory of special relativity		
			367	Albert A. Michelson and Edward R. Morley		
			400	Gustav Robert Kirchhoff		
			440	magnetism		
			447	history of magnetism		
			499	development of atomic theory		
			501	ancient Greeks' ideas of elements		
			574	Niels Bohr		
			575	Johann Balmer		
			578	Wolfgang Pauli		
			580	Max Planck and Albert Einstein		

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Standard #: Core	Strand	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
			614 Marie Curie	
			615 Henri Bequerel and beta rays	
			630 Wolfgang Pauli	
			644 proof of Einstein's theory of general relativity	
			647 Paul Dirac	