Correlation to California Science Content Standards

Physics: A First Course

Student Text and Investigation Manual

Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
InqHS.01.a Investigation and Experimentation	Standard	Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop questions and perform investigations.	Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.	11	measurement		computer spreadsheets and graphing software can be used throughout the curriculum for data analysis and presentation
				12	metric system	1	collect accurate, precise data with electronic timer
				13	measuring time	2	using timers and photogates
						7	collect precise data
						27	how can photogate ensure consistent results?
						44	using a timer and photogates
						46	using a timer and photogates
						61	collect and record resistance data
						78	estimate the precision of measurements
						86	use a timer and photogate to measure speed of rotor
						93	use a timer and photogate to measure the period of a pendulum
						96	use a timer and photogate to measure the natural frequency of an oscillator

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						150	using computer spreadsheets
InqHS.01.b Investigation and Experimentation	Standard	Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop questions and perform investigations.	Identify and communicate sources of unavoidable experimental error.	11 11 11 12 13	importance of units communicating via measurement measurement metric system measuring time	1 3 4 7 21 26 27 27 52 78	collect accurate, precise data with electronic timer car launching technique is a possible source of error car launching technique is a possible source of error collect precise data how close is your prediction to the actual measurement? spotting the landing point of the marble is tricky marble launching technique is a possible source of error how can photogate ensure consistent results? find a percentage estimate the precision of measurements

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InqHS.01.c Investigation and Experimentation	Standard	Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop questions and perform investigations.	Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.	6	what is a variable	3	car launching technique is a possible source of error
				8	cause and effect relationships	4	use photogate A to monitor repeatability
				8	control and experimental variables	4	car launching technique is a possible source of error
				8	dependent variables	6	reflecting on the experiment
				8	independent variables	6	recognize and control variables
				16	graphs and dependent variables	7	construct explanations supported by evidence
				16	graphs and independent variables	9	how do your observations support your answer?
				24	importance of changing one variable at a time in an experiment	11	what experimental data support answer?
						21	how close is your prediction to the actual measurement?
						26	spotting the landing point of the marble is tricky
						27	practice your technique until it is repeatable
						27	identify and control variables
						27	marble launching technique is a possible source of error
						47	construct a reasonable explanation

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
					52 find a percentage 60 propose a relationship between power and voltage 94 investigate variables and how they affect the period of a pendulum

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Student Text and Investigation Manual

Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
InqHS.01.d Investigation and Experimentation	Standard	Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop questions and perform investigations.	Formulate explanations by using logic and evidence.	8	cause and effect relationships	6 6 6 7 7 9 9 11 11 47 47 52 60 60 67	reflecting on the experiment do results agree with hypothesis? reflecting on the experiment construct explanations supported by evidence construct explanations supported by evidence how do your observations support your answer? how do your observations support your answer? what experimental data support answer? what experimental data support answer? construct a reasonable explanation construct a reasonable explanation find a percentage propose a relationship between power and voltage propose a relationship between power and voltage explain what happened

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Student Text and Investigation Manual

Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
InqHS.01.e Investigation and Experimentation	Standard	Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop questions and perform investigations.	Solve scientific problems by using quadratic equations and simple trigonometric, exponential, and logarithmic functions.	19	mathematical descriptions	11	find formula for acceleration
				26	interpreting distance/time graph	13	derive a formula
				34	mathematical model of acceleration	17	calculate mechanical advantage
				35	Newton's second law equation	17	derive a formula to use with ropes and pulleys
				41	average speed equation	29	find a mathematical name for the steepness ratio
				43	calculating weight	29	calculate the ratio
				61	momentum equation	31	calculate temperature of mixture
				62	relating impulse and momentum conservation	69	calculate power used by the bulb
				68	kinetic energy formula	75	derive a formula to calculate the charge
				86	the work equation	76	calculate the number of electrons
				89	the power equation	99	calculate natural frequency and period
				96	calculating mechanical advantage	154	calculate gear ratio
				118	Hooke's law equation		
				141	projectile motion problems		
				143	calculating angular speed		
				144	finding the circumference of a circle		
				145	linear speed equation		
				153	equation for law of universal gravitation		
				179	the heat equation		
				193	density formula		

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				208	pressure and temperature relationship		
				308	equation for Ohm's law		
				342	equation for Coulomb's law		
				438	calculating wave speeds		
				439	equation for the speed of a wave		
				525	equation for the speed of light		
InqHS.01.f Investigation and Experimentation	Standard	Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop questions and perform investigations.	Distinguish between hypothesis and theory as scientific terms.	8	scientific method	6	form a hypothesis
				8	formulating a hypothesis	30	state a hypothesis about the water's energy
				22	scientific method in action	31	did result agree with hypothesis?
						94	state a hypothesis about period of pendulum
						96	state a hypothesis about the natural frequency of the oscillator

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
InqHS.01.g Investigation and Experimentation	Standard	Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop questions and perform investigations.	Recognize the usefulness and limitations of models and theories as scientific representations of reality.	10	what is a model	4	construct a graph
				16	constructing graphs	11	find formula for acceleration
				16	steps to follow for graph construction	11	create a graph
				19	mathematical models	13	derive a formula
				19	mathematical descriptions	15	graph speed vs. height
				25	constructing a graph	17	derive a formula to use with ropes and pulleys
				26	interpreting distance/time graph	17	calculate mechanical advantage
				34	mathematical model of acceleration	20	graph work done vs. deflection of rubber band
				35	Newton's second law equation	21	graph speed vs. rubber band deflection
				41	average speed equation	25	graph friction vs. mass
				43	calculating weight	27	graph launch angle vs. range
				46	motion graphs	29	calculate the ratio
				48	motion graphs	29	find a mathematical name for the steepness ratio
				61	momentum equation	29	graph acceleration vs. steepness ratio
				62	relating impulse and momentum conservation	31	calculate temperature of mixture
				68	kinetic energy formula	45	make a graph of efficiency vs. speed
				86	the work equation	50	graph time vs. temperature
				89	the power equation		
				96	calculating mechanical advantage		
				112	using a graph to find force vector components		

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
				118	Hooke's law equation	52	construct a graph
				141	projectile motion problems	69	calculate power used by the bulb
				143	calculating angular speed	75	graph current vs. time for the capacitor
				144	finding the circumference of a circle	75	derive a formula to calculate the charge
				145	linear speed equation	76	calculate the number of electrons
				153	equation for law of universal gravitation	86	graph voltage vs. speed
				179	the heat equation	94	sketch harmonic motion graphs
				193	density formula	99	calculate natural frequency and period
				208	pressure and temperature relationship	154	calculate gear ratio
				308	equation for Ohm's law		
				342	equation for Coulomb's law		
				419	harmonic motion graphs		
				420	finding the amplitude on a harmonic motion graph		
				438	calculating wave speeds		
				439	equation for the speed of a wave		
				525	equation for the speed of light		

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
InqHS.01.j Investigation and Experimentation	Standard	Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop questions and perform investigations.	Recognize the issues of statistical variability and the need for controlled tests.	4 6 8 8 8 16 16 24	what is analysis what is a variable control and experimental variables dependent variables independent variables graphs and dependent variables graphs and independent variables importance of changing one variable at a time in an experiment	6 27 71 94	recognize and control variables identify and control variables find the average of the three times investigate variables and how they affect the period of a pendulum

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
InqHS.01.k Investigation and Experimentation	Standard	Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop questions and perform investigations.	Recognize the cumulative nature of scientific evidence.	23	science helps us learn about natural world	6	predict fastest car
				23	science helps us learn about natural world	15	predict speed of car
				28	Newton's idea of force	21	predict speed of car
				167	history of atomic theory	30	predict temperature of mixture
				218	contributions of John Dalton	45	predict how many bounces the car will make
				218	atomic theory	47	suggest a design modification
				219	contributions of Rutherford	96	make predictions about natural frequency
				219	contributions of J. J. Thomson		
				219	development of atom models		
				230	contributions of Bohr		
				231	Pauli's contributions		
				231	contributions of Schrödinger		
				232	contributions of Heisenberg		

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
InqHS.01.I Investigation and Experimentation	Standard	Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop questions and perform investigations.	Analyze situations and solve problems that require combining and applying concepts from more than one area of science.	104	connection to life science: prosthetic legs and technology	48	connection to chemistry
				186	connection to chemistry: extraordinary materials	89	connection to earth science: gravitational fields
				212	connection to life science: deep water submarine	111	connection to life science: photoreceptors in the eye
				234	indirect evidence and archaeology	167	building a sundial: earth science connection
				254	energy in the ocean		
				274	cook or chemist?		
				312	electric circuits in your body		
				354	connection to earth science: lightning		
				374	What is an MRI scanner?		
				408	space weather is magnetic		
				492	northern lights		
				516	retinal implants		

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
InqHS.01.m Investigation and Experimentation	Standard	Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop questions and perform investigations.	Investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings. Examples of issues include irradiation of food, cloning of animals by somatic cell nuclear transfer, choice of energy sources…	104 122 247 247 254 255 255 335	prosthetic legs and technology maglev train technology burning gasoline and low efficiency sources of electrical power in the United States generating electricity from the ocean's energy energy in the ocean impact of generating electricity on the environment using hybrid cars	112 157 157 161	research how computer monitors and televsions make colros research electricity generation methods compare economic and environmental impact of using different energy sources making a model maglev train

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page	Volume Two Investigation Manual Page
InqHS.01.n Investigation and Experimentation	Standard	Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop questions and perform investigations.	Know that when an observation does not agree with an accepted scientific theory, the observation is sometimes mistaken or fraudulent and that the theory is sometimes wrong.		3 car launching technique is a possible source of error 4 use photogate A to monitor repeatability 4 car launching technique is a possible source of error 6 do results agree with hypothesis? 21 how close is your prediction to the actual measurement? 26 spotting the landing point of the marble is tricky 27 practice your technique until it is repeatable 27 marble launching technique is a possible source of error 31 did result agree with hypothesis?

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PhysHS.01.a Physics	Motion and Forces	Newton's law predicts the motion of most objects.	Students know how to solve problems that involve constant speed and average speed.	18 56	speed units calculate speed from distance/time graph	3 7 9 10 21 25 44 46	find the speed of the car measure the speed why did the speed change? find speed of car measure speed of car calculate speed of car experiment and find average speed measure speed of car

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
PhysHS.01.b Physics	Motion and Force	Newton's law predicts the motion of most objects.	Students know that when forces are balanced, no acceleration occurs; thus an object continues to move at a constant speed or stays at rest Newton's first law).	16	constructing graphs	4	construct a graph
				16	steps to follow for graph construction	8	investigate Newton's first law of motion
				25	constructing a graph	11	create a graph
				29	Newton’s first law	11	speed vs. time graph
				32	acceleration defined	15	graph speed vs. height
				36	balanced and unbalanced forces	20	graph work done vs. deflection of rubber band
				46	motion graphs	21	graph speed vs. rubber band deflection
				48	speed vs. time graph	25	graph friction vs. mass
				48	motion graphs	27	graph launch angle vs. range
				49	speed vs. time graph for accelerating motion	29	graph acceleration vs. steepness ratio
				51	finding distance from a speed vs. time graph	45	make a graph of efficiency vs. speed
				112	using a graph to find force vector components	50	graph time vs. temperature
				419	harmonic motion graphs	52	construct a graph
				420	finding the amplitude on a harmonic motion graph	61	collect and record resistance data
						75	graph current vs. time for the capacitor
						86	graph voltage vs. speed
						94	sketch harmonic motion graphs

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
PhysHS.01.c Physics	Motion and Force	Newton's law predicts the motion of most objects.	Students know how to apply the law F=ma to solve one-dimensional motion problems that involve constant forces Newton's second law).	35	quantitative understanding of second law	10	investigate Newton's second law of motion
				35	Newton’s second law	23	Newton's second law of motion
				36	applying Newton’s second law properly	25	apply Newton's second law of motion
				37	using second law formula	29	apply Newton's second law of motion
				424	Newton’s second law and oscillators	95	Newton's 2nd law of motion and natural frequency
PhysHS.01.d Physics	Motion and Force	Newton's law predicts the motion of most objects.	Students know that when one object exerts a force on a second object, the second object always exerts a force of equal magnitude and in the opposite direction Newton's third law).	52	action-reaction pairs	12	investigate Newton's 3rd law of motion
				59	Newton’s third law	13	relate Newton's 3rd law of motion to car collisions
				60	sorting out force pairs		
				78	third law and rockets		
				117	Newton’s third law and springs		
				128	the third law and physics of walls		
				158	Newton’s third law and helicopters		

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
PhysHS.01.e Physics	Motion and Force	Newton's law predicts the motion of most objects.	Students know the relationship between the universal law of gravitation and the effect of gravity on an object at the surface of the Earth.	39	calculations pertaining to free fall	26	investigate projectile motion
				39	effect of gravity on motion		
				52	acceleration shown through strobe photography		
				88	work and gravity		
				137	projectile explained		
				138	free fall component of a trajectory		
				153	Newton’s law of universal gravitation explained		
				402	gravitational field		

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
PhysHS.01.f Physics	Motion and Force	Newton's law predicts the motion of most objects.	Students know applying a force to an object perpendicular to the direction of its motion causes the object to change direction but not speed(e.g.,Earth's gravitational force causes a satellite in a circular orbit to change direction but not speed).	39	effect of gravity on motion	23	draw a free body diagram
				39	calculations pertaining to free fall	23	use force vectors
				52	acceleration shown through strobe photography	26	investigate projectile motion
				88	work and gravity		
				111	force vectors		
				113	using a free-body diagram		
				115	finding resultant vector		
				137	projectile explained		
				138	free fall component of a trajectory		
				142	angular speed vs. linear speed		
				143	angular speed formula		
				145	calculating linear speed for a rotating object		
				147	centripetal force		
				148	centripetal force		
				149	Newton's second law and circular motion		
				153	Newton’s law of universal gravitation explained		
				154	understanding orbital motion		
				402	gravitational field		

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
PhysHS.01.g Physics	Motion and Force	Newton's law predicts the motion of most objects.	Students know circular motion requires the application of a constant force directed towards the center of the circle.	142 143 145 147 148 149 154	angular speed vs. linear speed angular speed formula calculating linear speed for a rotating object centripetal force centripetal force Newton's second law and circular motion understanding orbital motion		
PhysHS.01.h Physics	Motion and Force	Newton's law predicts the motion of most objects.	Students know Newton's laws are not exact but provide very good approximations unless an object is moving close to the speed of light or is small enough that quantum effects are important.	280 284	meaning of Einstein’s formula theory of special relativity	53 55	explore the concept of relativity a thought experiment on Einstein's theories

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PhysHS.01.I Physics	Motion and Force	Newton's law predicts the motion of most objects.	Students know how to solve two-dimensional trajectory problems.	17	speed of light	6	how can speed be measured?
				17	speed defined	8	investigate Newton's first law of motion
				18	calculating speed	24	investigate effect of friction
				29	Newton’s first law	26	investigate projectile motion
				39	calculations pertaining to free fall		
				39	effect of gravity on motion		
				45	skydiving and terminal speed		
				45	terminal speed		
				45	effects of air resistance		
				52	acceleration shown through strobe photography		
				88	work and gravity		
				94	friction and machines		
				101	friction explained		
				119	cause of friction		
				119	friction explained		
				120	static and sliding friction		
				122	reducing friction		
				123	useful friction		
				136	working with velocity vector		
				137	projectile explained		

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				138	free fall component of a trajectory		
				143	angular speed		
				402	gravitational field		
				418	friction and damping		
PhysHS.01.j Physics	Motion and Force	Newton's law predicts the motion of most objects.	Students know how to resolve two-dimensional vectors into their components and calculate the magnitude and direction of a vector from its components.	61	momentum is calculated with velocity – not speed	23	draw a free body diagram
				61	momentum is calculated with velocity – not speed	23	use force vectors
				111	force vectors		
				112	resolving vectors		
				113	using a free-body diagram		
				115	finding resultant vector		
PhysHS.01.k Physics	Motion and Force	Newton's law predicts the motion of most objects.	Students know how to solve two-dimensional problems involving balanced forces(statics).	36	balanced and unbalanced forces	24	investigate effect of friction
				45	effects of air resistance		
				94	friction and machines		
				101	friction explained		
				119	cause of friction		
				119	friction explained		
				120	static and sliding friction		
				122	reducing friction		
				123	useful friction		
				418	friction and damping		

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PhysHS.01.l Physics	Motion and Force	Newton's law predicts the motion of most objects.	Students know how to solve problems in circular motion by using the formula for centripetal acceleration in the following form: a=v2/r.	143 145 149	angular speed formula calculating linear speed for a rotating object Newton's second law and circular motion		
PhysHS.01.m Physics	Motion and Force	Newton's law predicts the motion of most objects.	Students know how to solve problems involving the forces between two electric charges at a distance (Coulomb's law) or the forces between two masses at a distance (universal gravitation).	153 340 342 342 404	Newton’s law of universal gravitation explained understanding coulombs electric forces are very strong understanding Coulomb’s law the electric field	89	understand and investigate electric and gravitational fields

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PhysHS.02.a Physics	Conservation of Energy and Momentum	The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects.	Students know how to calculate kinetic energy by using the formula E=(1/2)mv2.	67	potential energy explained	14	investigate exchange of energy in car and track system
				67	calculating potential energy	15	apply law of energy conservation
				68	potential to kinetic energy conversions	15	calculate potential energy of car
				68	kinetic energy explained	24	calculate kinetic energy of sled
				68	calculating kinetic energy	47	calculate energy
				69	kinetic energy and stopping distance of a car		
				70	potential to kinetic energy conversions		
				70	law of conservation of energy		
				71	using energy conservation to solve problems		
				117	potential and kinetic energy in a spring		
				249	mechanical systems and energy		
				249	energy flow diagram for mechanical systems		

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PhysHS.02.b Physics	Conservation of Energy and Momentum	The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects.	Students know how to calculate changes in gravitational potential energy near Earth by using the formula (change in potential energy) = mgh (h is the change in the elevation).	67 68 69	calculating potential energy calculating kinetic energy kinetic energy and stopping distance of a car	15 24 47	calculate potential energy of car calculate kinetic energy of sled calculate energy
PhysHS.02.c Physics	Conservation of Energy and Momentum	The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects.	Students know how to solve problems involving conservation of energy in simple systems, such as falling objects.	10 67 68 70 71 249	conservation of energy potential energy explained kinetic energy explained law of conservation of energy using energy conservation to solve problems energy flow diagram for mechanical systems	14 15 42 47	investigate exchange of energy in car and track system apply law of energy conservation model how atoms exchange energy draw an energy flow diagram
PhysHS.02.d Physics	Conservation of Energy and Momentum	The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects.	Students know how to calculate momentum as the product mv.	61 61	calculating momentum momentum is calculated with velocity – not speed	12 13 13	investigate momentum calculate momentum of two cars analyze collision data

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PhysHS.02.e Physics	Conservation of Energy and Momentum	The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects.	Students know momentum is separately conserved quantity different from energy.	63 64 74 77	law of conservation of momentum using momentum conservation to solve problems momentum and collisions momentum and car safety	13	apply the law of conservation of momentum
PhysHS.02.f Physics	Conservation of Energy and Momentum	The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects.	Students know an unbalanced force on an object produces a change in its momentum.	36 61	balanced and unbalanced forces calculating momentum	12 13 13	investigate momentum calculate momentum of two cars analyze collision data

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
PhysHS.02.g Physics	Conservation of Energy and Momentum	The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects.	Students know how to solve problems involving elastic and inelastic collisions in one-dimension by using the principles of conservation of momentum and energy.	10	conservation of energy	11	investigate net force
				31	net force explained	13	apply the law of conservation of momentum
				36	balanced and unbalanced forces	22	when net force is zero
				37	net force and second law calculating	42	model how atoms exchange energy
				63	law of conservation of momentum	44	friction and energy dissipation
				64	using momentum conservation to solve problems	45	describe energy changes
				74	momentum and collisions	46	investigate energy flow in a system
				77	momentum and car safety	47	investigate friction as a part of energy flow
				116	when net force is zero	47	draw an energy flow diagram
				240	energy and systems	57	draw energy flow diagram of the circuit
				243	energy flow diagrams		
				251	energy flow in natural systems		

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
PhysHS.02.h Physics	Conservation of Energy and Momentum	The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects.	Students know how to solve problems involving conservation of energy in simple systems with various sources of potential energy, such as capacitors and springs.	10 67 68 70 71 249	conservation of energy potential energy explained kinetic energy explained law of conservation of energy using energy conservation to solve problems energy flow diagram for mechanical systems	14 15 42 47	investigate exchange of energy in car and track system apply law of energy conservation model how atoms exchange energy draw an energy flow diagram
PhysHS.03.a Physics	Heat and Thermodynamics	Energy cannot be created or destroyed although in many processes energy is transferred to the environment as heat.	Students know heat flow and work are two forms of energy transfer between systems.	94 101 177 181 183 184 240 243 251	work and simple machines output work is always less than input work heat and work heat conduction natural and forced convection thermal radiation energy and systems energy flow diagrams energy flow in natural systems	18 30 44 45 46 47 57	compare and contrast input and output work investigating heat transfer friction and energy dissipation describe energy changes investigate energy flow in a system investigate friction as a part of energy flow draw energy flow diagram of the circuit

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
PhysHS.03.b Physics	Heat and Thermodynamics	Energy cannot be created or destroyed although in many processes energy is transferred to the environment as heat.	Students know that the work done by a heat engine that is working in a cycle is the difference between the heat flow into the engine at high temperature and the heat flow out at a lower temperature and that this is in an example of the law of conservation	68	potential to kinetic energy conversions	48	investigate energy changes in chemical reactions
				70	potential to kinetic energy conversions	157	research electricity generation methods
				86	calculating work		
				88	calculating work		
				117	potential and kinetic energy in a spring		
				176	flow of thermal energy is heat		
				177	heat and work		
				185	heat transfer is everywhere		
				247	burning gasoline and low efficiency		
				247	sources of electrical power in the United States		
				249	mechanical systems and energy		
				254	generating electricity from the ocean's energy		
				255	energy in the ocean		

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
PhysHS.03.c Physics	Heat and Thermodynamics	Energy cannot be created or destroyed although in many processes energy is transferred to the environment as heat.	Students know the internal energy of an object includes the energy of random motion of the object's atoms and molecules, often referred to as thermal energy.	176	understanding the difference between heat and temperature	30	investigate difference between temperature and heat
				176	flow of thermal energy is heat	32	investiate concept of specific heat
				177	heat and work		
				178	specific heat explained		
				185	heat transfer is everywhere		

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
PhysHS.03.d Physics	Heat and Thermodynamics	Energy cannot be created or destroyed although in many processes energy is transferred to the environment as heat.	Students know that most processes tend to decrease the order of a system over time and that energy levels are eventually distributed uniformly.	68	potential to kinetic energy conversions	45	calculate efficiency of the experimental system
				70	potential to kinetic energy conversions	45	graph efficiency vs. speed
				102	efficiency explained	45	investigate efficiency
				117	potential and kinetic energy in a spring		
				172	kinetic theory and temperature		
				176	flow of thermal energy is heat		
				177	calories explained		
				177	heat and work		
				179	the heat equation		
				181	thermal equilibrium		
				185	heat transfer is everywhere		
				246	efficiency explained		
				247	efficiency of a heat engine		
				248	efficiency of living things		
				249	mechanical systems and energy		
				334	efficiency of gasoline engine		
				334	efficiency of electric motors		

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
PhysHS.03.e Physics	Heat and Thermodynamics	Energy cannot be created or destroyed although in many processes energy is transferred to the environment as heat.	Students know that entropy is a quantity that measures the order or disorder of a system and that quantity is larger for a more disordered system.	240 251 253	system interactions energy flow in natural systems energy flow and food chains	7	examine energy in the system
PhysHS.03.f Physics	Heat and Thermodynamics	Energy cannot be created or destroyed although in many processes energy is transferred to the environment as heat.	Students know that statement "Entropy tends to increase" is a law of statistical probability that governs all closed systems (second law of thermodynamics).	9 9 114 128 178 240 243 251 253 423 423	energy in a system stability of systems systems in equilibrium equilibrium and architecture specific heat explained system interactions energy conservation and closed systems energy flow in natural systems energy flow and food chains restoring forces and equilibrium equilibrium and harmonic motion	7 22 32	examine energy in the system investigate equilibrium investiate concept of specific heat

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
PhysHS.03.g Physics	Heat and Thermodynamics	Energy cannot be created or destroyed although in many processes energy is transferred to the environment as heat.	Students know how to solve problems involving heat flow, work, and efficiency in heat engine and know that all real engines lose some heat to their surroundings.	86	calculating work	18	compare and contrast input and output work
				88	calculating work	45	calculate efficiency of the experimental system
				89	calculating power	45	graph efficiency vs. speed
				90	maximum power output of a person	45	investigate efficiency
				94	work and simple machines		
				101	output work is always less than input work		
				102	efficiency explained		
				244	power explained		
				245	three ways to look at power		
				246	efficiency explained		
				247	efficiency of a heat engine		
				248	efficiency of living things		
				250	power in human technology		
				252	power in natural systems		
				254	wave power		
				254	tidal power		
				334	efficiency of gasoline engine		
				334	efficiency of electric motors		

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
PhysHS.04.a Physics	Waves	Waves have characteristic properties that do not depend on the type of wave.	Students know waves carry energy from one place to another.	434 435 447 455 461 462 467	waves transmit energy waves and technology waves and energy acoustics how a French horn works acoustics of concert halls how the ear works		
PhysHS.04.b Physics	Waves	Waves have characteristic properties that do not depend on the type of wave.	Students know how to identify transverse and longitudinal waves in mechanical media, such as springs and ropes, and on the earth (seismic waves).	436 436 440	longitudinal waves transverse waves standing waves on a vibrating string	98 99 100 124	study waves on a string explore transverse waves study water waves relating transverse waves on a spring to light waves
PhysHS.04.c Physics	Waves	Waves have characteristic properties that do not depend on the type of wave.	Students know how to solve problems involving wavelength, frequency, and wave speed.	437 438 461	frequency and amplitude and wavelength of waves the speed of waves wavelength of sound	101	investigate standing waves and frequency

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
PhysHS.04.d Physics	Waves	Waves have characteristic properties that do not depend on the type of wave.	Students know sound is a longitudinal wave whose speed depends on the properties of the medium in which it propagates.	415 435 454 456 458 459 459 468	sound is a wave how to recognize waves sound is a wave speed of sound how sound is recorded sound is a wave sound waves and different media pitch and the musical scale	104 105	properties of sound waves investigate sound wave interference
PhysHS.04.e Physics	Waves	Waves have characteristic properties that do not depend on the type of wave.	Students know radio waves, light, and X-rays are different wavelength bands in the spectrum of electromagnetic waves whose speed in a vacuum is approximately 3 x 10^8m/s (186,000 miles/second).	481 523 524 526 527 536 537	speed of light electromagnetic spectrum wavelength and frequency of visible light low-energy electromagnetic waves high-energy electromagnetic waves the electromagnetic spectrum infrared telescopes	111 123	mixing primary colors of light investigate visible light wavelengths

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
PhysHS.04.f Physics	Waves	Waves have characteristic properties that do not depend on the type of wave.	Students know how to identify the characteristic properties of waves: interference (beats), diffraction, refraction, Doppler effect, and polarization.	442 442 443 443 445 445 457 469 531	refracted waves reflected waves absorption explained diffraction explained destructive interference constructive interference understanding the Doppler effect frequency of sound and beats polarization	106 125 126	investigate interference and beats explore polarization of light explore the concept of polarization of light

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
PhysHS.05.a Physics	Electric and Magnetic Phenomena	Electric and magnetic phenomena are related and have many practical applications.	Students know how to predict the voltage or current in simple direct current(DC) electric circuits constructed from batteries, wires, resistors, and capacitors.	299	examples of electric circuits in nature	57	build circuits
				299	electric circuits	57	open and closed circuits
				300	circuit diagrams	58	measure voltage
				301	battery circuits	59	draw and interpret circuit diagrams
				301	open and closed circuits	60	a circuit with a dimmer switch
				303	understanding voltage	60	measure voltage
				304	how batteries work	64	investigating voltage drops
				318	series circuits	65	measure the voltage
				320	voltage in a series circuit	65	investigate series circuits
				323	parallel circuits	65	build a circuit with three bulbs and a switch
				324	voltage in a parallel circuit	66	investigate series circuits
				325	comparing series and parallel circuits	67	investigate short circuits and learn how to avoid
				326	parallel circuits in homes	67	understand why short circuits are dangerous
				326	understanding short circuits	68	investigate parallel circuits
				349	voltage and charge	68	compare series and parallel circuits
				350	how capacitors work	69	construct a simple circuit
				351	voltage and capacitors	70	investigate capacitors
				351	charging a capacitor	75	calculate charge stored in capacitor
				351	capacitors and current		
				352	measuring capacitance		

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
PhysHS.05.b Physics	Electric and Magnetic Phenomena	Electric and magnetic phenomena are related and have many practical applications.	Students know how to solve problems involving Ohm's law.	308 321	Ohm’s law Ohm’s law and voltage drops	62 63 67 75	investigate Ohm's law use Ohm's law Ohm's law and short circuits work with Ohm's law
PhysHS.05.c Physics	Electric and Magnetic Phenomena	Electric and magnetic phenomena are related and have many practical applications.	Students know any resistive element in a DC circuit dissipates energy, which heats the resistor. Students can calculate the power (rate of energy dissipation) in any resistive circuit element by using the formula Power = IR.	300 306 307 309 311 319 328 330	resistors understanding electrical resistance measuring resistance resistance of common objects resistors resistance in a series circuit calculating power in a circuit direct current	61 63 69 70 71	investigate resistance investigate resistance and potentiometers finding power used by a circuit explain what you observed in terms of energy and power calculate energy and power
PhysHS.05.e Physics	Electric and Magnetic Phenomena	Electric and magnetic phenomena are related and have many practical applications.	Students know charged particles are sources of electric fields and are subject to the forces of the electric fields from other charges.	340 341 341 354 404	understanding electric charge what causes shocks charged objects and static electricity understanding lightning the electric field	72 89	investigate the nature of electric charge understand and investigate electric and gravitational fields

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
PhysHS.05.f Physics	Electric and Magnetic Phenomena	Electric and magnetic phenomena are related and have many practical applications.	Students know magnetic materials and electric currents (moving electric charges) are sources of magnetic fields and are subject to forces arising from the magnetic fields of other sources.	360	what is a magnet	77	investigate the strength of magnetic force
				362	magnetic fields	79	investigate interactions of different materials with magnets
				363	magnetic field lines	80	compare magnetic force and electric current in an electromagnet
				374	magnets and MRI scanners	80	explore properties of electromagnets
				381	magnetic field of a wire	81	find relationship between current and magnetic field
				388	Faraday's law of induction	81	compare electromagnet and permanent magnet
				404	the electric field	88	investigate magnetic fields
						89	understand and investigate electric and gravitational fields
						90	use magnetic fields to solve a puzzle

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
PhysHS.05.g Physics	Electric and Magnetic Phenomena	Electric and magnetic phenomena are related and have many practical applications.	Students know how to determine the direction of a magnetic field produced by current flowing in a straight wire or in a coil.	298	electric current	59	measure current
				302	current in simple circuits	59	work with volts and amps
				302	measuring electric current	66	current in a series circuit
				303	measuring voltage	74	investigate the flow of electric charge
				305	measuring current with a multimeter	77	investigate the strength of magnetic force
				319	current in a series circuit	79	investigate interactions of different materials with magnets
				323	current in a parallel circuit	81	compare electromagnet and permanent magnet
				346	charge and current	88	investigate magnetic fields
				360	what is a magnet	90	use magnetic fields to solve a puzzle
				361	using magnetic forces		
				362	magnetic fields		
				363	magnetic field lines		
				364	right-hand rule		
				374	magnets and MRI scanners		
				381	magnetic field of a wire		
PhysHS.05.h Physics	Electric and Magnetic Phenomena	Electric and magnetic phenomena are related and have many practical applications.	Students know changing magnetic fields produce electric fields, thereby inducing currents in nearby conductors.	364	electromagnets	85	investigate electromagentic induction
				365	building an electromagnet		
				387	electromagnetic induction explained		

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
PhysHS.05.I Physics	Electric and Magnetic Phenomena	Electric and magnetic phenomena are related and have many practical applications.	Students know plasmas, the fourth state of matter, contains ions or free electrons or both and conduct electricity.	173 174 175	phases of matter heat energy and molecular motion plasma	34 35 36	arrangement of solid, liquid, gas particles comparing equal masses of gas, solid, and liquid solid, liquid, gas density differences
PhysHS.05.j Physics	Electric and Magnetic Phenomena	Electric and magnetic phenomena are related and have many practical applications.	Students know electric and magnetic fields contain energy and act as vector force fields.	360 362 363 374 381 404	what is a magnet magnetic fields magnetic field lines magnets and MRI scanners magnetic field of a wire the electric field	77 79 81 88 89 90	investigate the strength of magnetic force investigate interactions of different materials with magnets compare electromagnet and permanent magnet investigate magnetic fields understand and investigate electric and gravitational fields use magnetic fields to solve a puzzle
PhysHS.05.k Physics	Electric and Magnetic Phenomena	Electric and magnetic phenomena are related and have many practical applications.	Students know the force on a charged particle in an electric field is qE, where E is the electric field at the position of the particle and q is the charge of the particle.	340 341 341 354	understanding electric charge what causes shocks charged objects and static electricity understanding lightning	72	investigate the nature of electric charge

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
PhysHS.05.l Physics	Electric and Magnetic Phenomena	Electric and magnetic phenomena are related and have many practical applications.	Students know how to calculate the electric field resulting from a point charge.	340 341 341 354 404	understanding electric charge what causes shocks charged objects and static electricity understanding lightning the electric field	72 89	investigate the nature of electric charge understand and investigate electric and gravitational fields
PhysHS.05.m Physics	Electric and Magnetic Phenomena	Electric and magnetic phenomena are related and have many practical applications.	Students know static electric fields have as their source some arrangement of electric charges.	340 341 341 354 404	understanding electric charge what causes shocks charged objects and static electricity understanding lightning the electric field	72 89	investigate the nature of electric charge understand and investigate electric and gravitational fields
PhysHS.05.n Physics	Electric and Magnetic Phenomena	Electric and magnetic phenomena are related and have many practical applications.	Students know the magnitude of the force on a moving particle in a magnetic field is qvB sin(a), where a is the angle between v and B, and the students use the right-hand rule to find the direction of this force.	360 362 363 364 374 381	what is a magnet magnetic fields magnetic field lines right-hand rule magnets and MRI scanners magnetic field of a wire	77 79 81 88 90	investigate the strength of magnetic force investigate interactions of different materials with magnets compare electromagnet and permanent magnet investigate magnetic fields use magnetic fields to solve a puzzle

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Standard #: Subject	Topic	Standard	Benchmark	Volume One Student Text Page		Volume Two Investigation Manual Page	
PhysHS.05.o Physics	Electric and Magnetic Phenomena	Electric and magnetic phenomena are related and have many practical applications.	Students know how to apply the concepts of electrical and gravitational potential energy to solve problems involving conservation of energy.	10	conservation of energy	14	investigate exchange of energy in car and track system
				67	potential energy explained	15	apply law of energy conservation
				68	kinetic energy explained	42	model how atoms exchange energy
				68	potential to kinetic energy conversions	45	describe energy changes
				70	law of conservation of energy	46	investigate energy flow in a system
				70	potential to kinetic energy conversions	47	draw an energy flow diagram
				71	using energy conservation to solve problems	57	draw energy flow diagram of the circuit
				117	potential and kinetic energy in a spring		
				240	energy and systems		
				243	energy flow diagrams		
				249	energy flow diagram for mechanical systems		
				249	mechanical systems and energy		
				251	energy flow in natural systems		