

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
3.2.10.A1	Inquiry and Design	Apply knowledge and understanding about the nature of scientific and technological knowledge.	Compare and contrast scientific theories and beliefs.	8	Comparing a theory and a natural law	111	how does what you observed support the quantum theory?
				8	testing hypotheses with experiments		
				41	Galileo and Newton conducted experiments with balls on ramps		
				52	Dr. Harold Edgerton and strobe photography		
				78	Newton's laws of motion		
				81	Newton's discovery of the connection between force and mass and acceleration		
				136	determining formula for acceleration on a ramp		
				152	Sir Isaac Newton and law of universal gravitation		
				155	first artificial human-made Earth satellite was Sputnik		
				178	Great Pyramid of Giza and simple machines		
				257	Pierre and Jacques Curie and the piezoelectric effect		
				269	wave motion and equilibrium		

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Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				290	technological breakthrough of sound recording		
				310	past theories of light		
				325	history of printing		
				348	the usefulness of recorded images		
				349	the telescope		
				349	Galileo and telescopes		
				350	Newtonian reflecting telescope		
				361	Young's double-slit experiment		
				367	speed of light did not behave as expected for Michelson and Morley		
				368	Einstein's thinking revolutionized physics		
				369	proof of time dilation		
				375	explain Thomas Young's demonstration of the wave nature of light		
				382	Ben Franklin and current		
				420	Charles-Augustin de Coulomb		
				447	discovering and using magnetism		
				501	search for elements and alchemy		

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Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				561	the Alvin research submarine		
				575	discovery of helium		
				580	Newton and classical physics		
				625	turning lead into gold		
				641	research on future of the universe		
3.2.10.A2	Inquiry and Design	Apply knowledge and understanding about the nature of scientific and technological knowledge.	Know that science uses both direct and indirect observation means to study the world and the universe.	10	the usefulness of phlogiston theory despite being incorrect	15	collect time data
				71	parachutes and air resistance	78	observe what happens
				498	listing different types of matter in your home	87	observe what happens to the motion
						89	observe the wave pulse
						109	record observations
						110	examine the effects of glow-in-the-dark material
						204	build models of Na and Cl and use them to explain bonding
						206	record your observations

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Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
3.2.10.A3	Inquiry and Design	Apply knowledge and understanding about the nature of scientific and technological knowledge.	Integrate new information into existing theories and explain implied results.	7	revising explanations through observation	16	what do the results tell you?
				8	refining theories based on observations	18	are the accelerations different?
				306	explain why hearing can be damaged by loud sounds	19	does the ball accelerate?
						43	what would happen if...?
						58	explain why the angular acceleration is different
						80	explain your observations
						87	explain how force applied causes the response
						90	explain why higher tension makes waves move faster
						92	explain how wind might cause big waves in water
						109	explain how the colored filters work
						132	what conclusions can you draw?
						133	analyze data and explain a rule

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Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
3.2.10.B1	Inquiry and Design	Apply process knowledge and organize scientific and technological phenomena in varied ways.	Describe materials using precise quantitative and qualitative skills based on observations.	498	listing different types of matter in your home	6 6 15 15 18 78 87 89 153 153 202 206	precision in measurement collecting data with precision collect time data collect time data with precision collect time data with precision observe what happens observe what happens to the motion observe the wave pulse make measurement with precision making measurements with precision find the mass to the nearest tenth of a gram record your observations

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Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
3.2.10.B2	Inquiry and Design	Apply process knowledge and organize scientific and technological phenomena in varied ways.	Develop appropriate scientific experiments: raising questions, formulating hypotheses, testing, controlled experiments, recognizing variables, manipulating variables, interpreting data, and producing solutions.	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	28	set up the ultimate pulley
				4	inquiry through observation	33	formulate a testable hypothesis
				7	revising explanations through observation	43	perform experiment
				7	creating explanations through observation	43	write a procedure
				7	creating explanations through observation	43	test your prediction
				7	creating explanations through observation	43	follow the scientific method
				8	forming hypotheses and testing with experiments	43	follow the scientific method
				8	refining theories based on observations	48	formulate a hypothesis
				8	refining theories based on observations	65	where does the marble move the fastest?
				8	formulating a hypothesis	65	form a hypothesis
				9	testing ideas against scientific evidence	65	investigate motion on a roller coaster
				9	connecting cause and effect through analysis	65	investigate motion on a roller coaster
10	the usefulness of phlogiston theory despite being incorrect	67	investigate motion on a roller coaster				
10	putting forth ideas and then testing them	67	set up the straight track				
10	putting forth ideas and then testing them	79	write a hypothesis				
10	putting forth ideas and then testing them	82	design an experiment				
40	defining variables	82	determine which variable has the greatest effect				

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Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				42	writing lab procedures	82	dependent and independent variables
				42	control and experimental variables	82	plan three experiments to determine which variable affects the period of a pendulum
				43	dependent and independent variables in graphs	85	design and test a way to increase natural frequency
				45	recognizing patterns and cause and effect relationships	89	what is it that moves in the case of a wave?
				54	importance of changing one variable at a time in an experiment	90	what effect does changing the tension have?
				71	parachutes and air resistance	111	do your observations support this hypothesis?
				242	finding a basic cycle of harmonic motion	147	how did A and B tapes acquire different charge?
				251	changing the natural frequency of a stretched rubber band	166	variables that affect the performance of the generator
				323	using glow-in-the-dark plastic to demonstrate photon energy levels	201	design a procedure to separate a mixture
				423	charge by friction	201	determine the equipment you will need
				432	making a simple capacitor	201	develop a procedure
				456	an experiment with a wire and compass	202	conduct your experiment
				463	building an electromagnet with wire and a nail	204	build models of Na and Cl and use them to explain bonding

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Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				467	experiment demonstrating electromagnetic induction		

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Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
3.2.10.B3	Inquiry and Design	Apply process knowledge and organize scientific and technological phenomena in varied ways.	Use process skills to make inferences and predictions using collected information and to communicate, using space / time relationships, defining operationally.	7	creating theories based on observations	13	predict speed of ball
				11	Ptolemy model vs. Copernicus model of the solar system	13	compare prediction to measurement
				40	making a good model	18	how would acceleration be different?
				44	using a graphical model to make a prediction and checking the model's accuracy	22	compare calculation with graph estimate
				60	creating the acceleration formula from experiments	22	how do you measured positions compare to model?
				66	developing the formulas for a model of motion with constant acceleration	22	uniform acceleration model
				282	write a formula relating velocity of wave to period and wavelength	24	create an algebraic model
				297	frequency spectrum	28	solve second law equation for string tension
				312	light intensity follows an inverse square law	28	does experiment agree with prediction?
				498	since wood is created from other matter it must not be a fundamental substance	29	develop a model that predicts acceleration
						32	calculate the predicted speed
						37	use your graph to make a prediction
						38	use your graph to make a prediction
						42	predict exact landing location

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Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
						43	how does the measurement compare to your prediction?
						43	create algebraic model
						49	write a formula
						65	predict where the ball moves fastest
						76	compare predicted mass to actual mass
						94	give an equation that describes your observations
						114	are there differences between your prediction and measurement?
						132	predict what the current will be
						189	Bernoulli's equation
3.2.10.C1	Inquiry and Design	Apply the elements of scientific inquiry to solve problems.	Generate questions about objects, organisms and/or events that can be answered through scientific investigations.	3	inquiry starts with questions	89	what is it that moves in the case of a wave?
3.2.10.C2	Inquiry and Design	Apply the elements of scientific inquiry to solve problems.	Evaluate the appropriateness of questions.	3	inquiry starts with questions	89	what is it that moves in the case of a wave?

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Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
3.2.10.C3	Inquiry and Design	Apply the elements of scientific inquiry to solve problems.	Design an investigation with adequate control and limited variables to investigate a question.	40 42 43 54 251	defining variables control and experimental variables dependent and independent variables in graphs importance of changing one variable at a time in an experiment changing the natural frequency of a stretched rubber band	11 82 82 166	recognizing and controlling variables determine which variable has the greatest effect dependent and independent variables variables that affect the performance of the generator
3.2.10.C4	Inquiry and Design	Apply the elements of scientific inquiry to solve problems.	Conduct a multiple step experiment.	42	writing lab procedures	28 43 67 85 201 202	set up the ultimate pulley write a procedure set up the straight track design and test a way to increase natural frequency develop a procedure conduct your experiment

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Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
3.2.10.C5	Inquiry and Design	Apply the elements of scientific inquiry to solve problems.	Organize experimental information using a variety of analytic methods.	43	constructing a graph	13	create a graph
				44	graphical models	15	record data in a table
				54	constructing a graph	16	create a graph
				55	create a graph from a data table	16	describe the graph
				60	creating the acceleration formula from experiments	17	use a data table
				66	developing the formulas for a model of motion with constant acceleration	18	record data
				142	finding x and y components of velocity for model rocket	21	record results in table
				282	write a formula relating velocity of wave to period and wavelength	22	uniform acceleration model
				290	the process of digital sound reproduction	22	create graphs
				312	light intensity follows an inverse square law	24	create an algebraic model
				411	the waveform of AC electricity	27	record position and time data
						28	solve second law equation for string tension
						29	record mass and force
						32	develop a model that predicts acceleration
		37	make a graph				
		38	make a graph				
		43	sketch four graphs				
		43	create algebraic model				
		49	write a formula				
		56	create a graph				
		66	record data in table				

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

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Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
3.2.10.C6	Inquiry and Design	Apply the elements of scientific inquiry to solve problems.	Judge the significance of experimental information in answering the question.	11	acceptance of the Copernican model of the solar system on the basis of scientific evidence	12	was this experiment better or worse than the first?
				44	checking a graphical model's accuracy	16	what do the results tell you?
				103	evaluating perpetual motion claims	18	are the accelerations different?
				306	explain why hearing can be damaged by loud sounds	19	does the ball accelerate?
						43	what would happen if...?
						58	explain why the angular acceleration is different
						80	explain your observations
						87	explain how force applied causes the response
						90	explain why higher tension makes waves move faster
						92	explain how wind might cause big waves in water
						97	reliability of a double-blind test
						97	did the method give an accurate result?
						109	explain how the colored filters work
						132	what conclusions can you draw?
						133	analyze data and explain a rule

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Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
3.2.10.C7	Inquiry and Design	Apply the elements of scientific inquiry to solve problems.	Suggest additional steps that might be done experimentally.	42	writing lab procedures	18 43 201 202	propose one way to increase acceleration write a procedure develop a procedure would you modify your procedure further?
3.2.10.D1	Inquiry and Design	Identify and apply the technological design process to solve problems.	Examine the problem, rank all necessary information and all questions that must be answered.	113 113 113 543	build and test a prototype structure out of toothpicks conceptual design for a bridge the engineering design cycle failure analysis in the design process	83 85 163 163 163 173 191	design and construct a pendulum create a system that oscillates design and test different electric motors propose solutions that will work for each disk apply steps of the design cycle to building different electric motors designing and building logic circuits build an air-speed tester
3.2.10.D2	Inquiry and Design	Identify and apply the technological design process to solve problems.	Propose and analyze a solution	113	conceptual design for a bridge	163	propose solutions that will work for each disk

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Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
3.2.10.D3	Inquiry and Design	Identify and apply the technological design process to solve problems.	Implement the solution.	113	build and test a prototype structure out of toothpicks	83	design and construct a pendulum
						85	create a system that oscillates
						163	design and test different electric motors
						191	build an air-speed tester
3.2.10.D4	Inquiry and Design	Identify and apply the technological design process to solve problems.	Evaluate the solution, test, redesign and improve as necessary.	113	build and test a prototype structure out of toothpicks	83	design and construct a pendulum
				113	conceptual design for a bridge	85	create a system that oscillates
				113	test and evaluate the prototype structure design	163	design and test different electric motors
				389	electrical devices are designed to operate at a certain voltage	163	propose solutions that will work for each disk
				543	evaluate three designs for a bridge	164	evaluate the performance of motor designs
						167	suggest improvements you could make to the generator design
						191	build an air-speed tester
3.2.10.D5	Inquiry and Design	Identify and apply the technological design process to solve problems.	Communicate the process and evaluate and present the impacts of the solution.	42	writing procedures in a lab notebook helps make sure your results are repeatable	122	communicate your findings
						122	present your findings
						175	display information you found for your element
						202	keep detailed notes as you work

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Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
3.4.10.A1	Physical Science, Chemistry and Physics	Explain concepts about the structure and properties of matter.	Know that atoms are composed of even smaller sub-atomic structures whose properties are measurable.	29	all matter is made of atoms	174	matter is composed of atoms
				420	electric charge is a property of the particles that make up the atom	175	identify symbol and atomic number and average atomic mass
				420	electric charge is a property of the particles that make up the atom	175	record atomic number
				422	movement of electrons in current	194	isotopes
				437	draw a model of an atom	194	identify symbol and atomic number and mass number
				444	electrons and magnetism	194	basic properties of subatomic particles
				444	magnetism is a property of particles that make up the atom	194	subatomic particles
				459	atomic currents	203	electrons and energy levels
				480	electrons in a semiconductor	203	review subatomic particles
				499	idea that matter is made of atoms proved through Brownian motion	213	explore radioactive isotopes
				500	smallest piece of matter is the atom		
				501	atoms and elements		
				502	the periodic table		
				566	three particles make up the atom		

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Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				566	charge and mass of electrons and protons and neutrons		
				567	structure of the atom		
				567	mass and the nucleus		
				569	elements and atoms and atomic number		
				570	chemical properties of isotopes due to atomic structure		
				570	isotopes explained		
				571	atomic mass of stable isotopes		
				572	stability of nucleus and balance of protons and neutrons		
				572	chart of stable isotopes		
				574	Neils Bohr's theory		
				576	Neils Bohr		
				577	energy levels explain spectral lines		
				588	carbon isotopes		
				588	properties of subatomic particles		

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Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
3.4.10.A3	Physical Science, Chemistry and Physics	Explain concepts about the structure and properties of matter.	Predict the behavior of gases through the use of Boyle's, Charles' or the ideal gas law, in everyday situations.	557 558 558 564	Boyle's law pressure and temperature of gases Charles' law using Boyle's law	192 193	investigate the mass of a volume of gas at different pressures investigate the effect of temperature on pressure
3.4.10.A4	Physical Science, Chemistry and Physics	Explain concepts about the structure and properties of matter.	Describe phases of matter according to the Kinetic Molecular Theory.	30 30 33 508 508 509 510 511 519 595	physical differences between solids and liquids and gases relationship between states of matter and arrangement and motion of atoms and molecules describe movement of atoms in solids and gases characteristics of matter related to its phase phases of matter and arrangement of molecules melting boiling evaporation and condensation phases of matter chemical bonds determine properties of materials	177	observe a common phase change

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Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
3.4.10.B4	Physical Science, Chemistry and Physics	Analyze energy sources and transfers of heat.	Use knowledge of conservation of energy and momentum to explain common phenomena (e.g., refrigeration system, rocket propulsion).	87	forces always occur in action-reaction pairs	30	investigate Newton's third law
				88	Newton's third law operates on pairs of objects	30	Newton's third law and free body diagrams
				89	solving problems with action-reaction forces	31	draw free body diagrams and identify action-reaction pairs
				89	identifying which force is acting on which object	73	calculating momentum
				102	the normal force as the reaction in an action-reaction pair	75	investigate collisions and conservation of momentum
				107	forces on a free-body diagram	77	the momentum form of Newton's second law
				111	understanding reaction forces in terms of springs and deformation	78	which ball had a greater change in momentum?
				112	analysis of forces on a bridge		
				135	normal force of an inclined plane		
				223	momentum formula and calculating momentum		
				224	law of conservation of momentum		
				224	momentum and Newton's third law		
				225	conservation of momentum in collisions		

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Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				226	applying conservation of 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		
				276	natural frequency and harmonics		
				370	Einstein's thinking about momentum of particles moving near the speed of light		

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Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				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		
				629	conservation of momentum in nuclear reactions		

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Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
3.4.10.B5	Physical Science, Chemistry and Physics	Analyze energy sources and transfers of heat.	Explain resistance, current and electro-motive force (Ohm's Law).	378	concept of electric current	131	explore the concept of electric current
				382	current flows through wires and carries energy	132	explore the concept of voltage
				382	electrical current explained	134	study the relationship between resistance and current
				382	voltage measures differences in energy	134	apply the concept of electrical resistance
				383	voltage is a measure of electric potential energy	134	Ohm's law
				383	voltage and potential energy	135	study the relationship between current and voltage
				386	concept of electrical resistance	135	derive Ohm's law from experiment
				386	relationship between current and resistance	136	use Ohm's law to calculate the resistance
				387	measuring resistance	137	investigate series circuits
				388	Ohm's law	137	parallel circuit and Ohm's law
				389	the resistance of electrical devices	138	build a parallel circuit
				390	resistance of conductors and insulators	138	determining total resistance in a series circuit
				391	resistors	138	apply Ohm's law to series circuits
				395	knowing difference between types of resistors	139	compare series and parallel circuits
				396	calculation of voltage from resistance and current	139	analyze parallel circuits
				398	parallel circuit defined		

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				398	series circuit defined	140	build and analyze network circuits
				399	calculating current in a series circuit using Ohm's law	171	use Ohm's law to calculate the resistance of the transistor
				399	current and resistance in a series circuit		
				399	adding resistance in a series circuit		
				400	voltage in a series circuit		
				401	parallel circuits		
				402	advantages of parallel circuits over series circuits		
				402	voltage and current in a parallel circuit		
				403	resistance in parallel circuits		
				403	using Ohm's law in parallel circuits		
				404	using Ohm's law for circuit analysis		
				405	voltage dividers		
				406	comparing series and parallel circuits		
				407	solving network circuits		
				407	calculate currents and voltages in a network circuit		
				407	solving network circuits		

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				408	resistance definition		
				408	voltage definition		
				408	current definition		
				414	why parallel circuits are used in homes and buildings		
				414	why series circuits are not used in homes and buildings		
				415	compare current in a series and parallel circuit		
				416	calculating resistance in a circuit		
				416	using Ohm's law to calculate current		
				421	current is the flow of charge		
				422	negative charge of electrons and current flow		
				431	current into and out of capacitors		
				431	voltage of a capacitor circuit		
				479	resistance of a transistor		

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3.4.10.C1	Physical Science, Chemistry and Physics	Distinguish among the principles of force and motion.	Identify the relationship of electricity and magnetism as two aspects of a single electromagnetic force.	412	average power in an electric motor	146	build a simple electroscope
				418	electric charge is a fundamental property of matter	147	investigate the concept of electric charge
				419	electric forces are created between electric charges	149	investigate charged balloons
				420	explanation of coulomb	152	investigate magnetic forces
				421	current is the flow of charge	154	draw magnetic field lines for a bar magnet
				422	negative charge of electrons and current flow	155	test materials to see if they are affected by magnets
				423	static electricity and charge polarization and induction	159	build an electromagnet
				424	relationship of electric force and charge	160	study the right-hand rule
				425	the force between charges	160	find out what happens to strength of electromagnet when current is increased
				426	charge creates an electric field	160	what happens to the strength of an electromagnet when you increase the current?
				428	source charges and test charges	161	experiment with pushes and pulls of permanent magnet in a rotor
				430	a capacitor stores charge	161	investigate how an electric motor works
				433	ability of a capacitor to store charge is capacitance	165	investigate Faraday's law of induction
				435	steering the electron beam on television screen		

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				440	magnetism explained	165	investigate electromagnetic induction
				441	comparing magnetic and electric forces		
				442	force between two magnetics is not an inverse square law		
				443	understanding magnetic fields		
				445	alignment of domains responds to magnetic fields		
				446	creating permanent magnets		
				447	the magnetic field of Earth		
				448	a compass is a magnet that lines up with Earth's magnetic field		
				449	the strength of Earth's magnetic field		
				451	magnetic field of a nucleus		
				454	magnetic field between two unlike poles		
				456	magnetic field of a wire		
				457	force on a current in a magnetic field		
				457	right-hand rule		
				458	coils and solenoids		

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				458	the magnetic field of loops and coils		
				459	the magnetic field of coils and permanent magnets		
				459	the magnetic field of coils and permanent magnets		
				460	magnetic force on a moving charge		
				461	calculating magnetic fields and forces		
				461	calculate magnetic field at the center of a coil		
				462	finding the poles of an electromagnet using right-hand rule		
				462	electromagnets		
				462	coils used in electromagnets		
				463	adding turns increases an electromagnet's strength		
				463	building an electromagnet		
				464	principle of the electric motor		
				464	electric motor uses electromagnets to convert electrical energy to mechanical energy		
				465	how electromagnets are used in electric motors		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				465	commutation		
				466	battery-powered electric motors		
				467	concept of electromagnetic induction		
				468	magnetic flux		
				469	Faraday's law of induction		
				471	transformers operate on electromagnetic induction		
				472	electromagnet-based maglev		
				473	Eddy currents		
				475	using right-hand rule		
				475	diagram of electromagnet		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
3.4.10.C2	Physical Science, Chemistry and Physics	Distinguish among the principles of force and motion.	Identify elements of simple machines in compound machines.	13	biomechanics	59	investigate block and tackle machine
				105	friction is the force that keeps nails and screws in place		
				134	forces on an inclined plane		
				160	using torque in household devices		
				161	force on a wrench		
				173	changing gears in a bicycle		
				178	how simple machines manipulate forces		
				178	input and output for simple machines		
				179	how to calculate mechanical advantage		
				179	types of simple machines		
				180	the mechanical advantage of a lever		
				180	mechanical advantage of human arm		
				181	how a lever works		
				181	how a lever works		
				181	crowbar as an example of a lever		
182	mechanical advantage of ropes and pulleys						

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				183	small drills use gears		
				183	how wheels and gears work		
				184	screw turns rotating motion into linear motion		
				184	ramps and screws		
				200	calculate fulcrum point of a lever		
				209	estimating power requirements based on force		
				249	harmonic motion in machines		
				440	the difference between magnetic poles and electric charge		
3.4.10.C3	Physical Science, Chemistry and Physics	Distinguish among the principles of force and motion.	Explain fluid power systems through the design and construction of appropriate models.	561	buoyancy of Alvin	175	find the density
				622	x-rays are photons	177	the density of ice vs. water

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
3.4.10.C4	Physical Science, Chemistry and Physics	Distinguish among the principles of force and motion.	Describe sound effects (e.g., Doppler effect, amplitude, frequency, reflection, refraction, absorption, sonar, seismic).	254	concept of resonance	86	investigate resonance and its importance
				255	resonance occurs when periodic force matches natural frequency	89	study characteristics of a wave pulse on a string
				259	resonance and amplitude	89	study wave pulses on elastic cord
				264	basic properties of frequency and wavelength and amplitude	89	making wave pulses on a string
				265	wave pulse	90	measure speed of a wave pulse
				267	water waves are transverse and Slinky is longitudinal	91	is your water wave transverse or longitudinal?
				267	transverse and longitudinal waves	91	making plane waves in a ripple tank
				268	creating plane waves and circular waves	91	making circular waves in a ripple tank
				268	one- and two- and three-dimensional waves	91	make different types of waves in a ripple tank
				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
				270	waves and absorption	92	investigate diffraction in a ripple tank
				271	waves and refraction and boundaries	93	investigate frequency and wavelength
				271	waves and reflection and boundaries	95	natural frequency and resonance of standing waves on a string
				272	waves and diffraction and boundaries		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				272	waves and absorption and boundaries	96	investigate range of frequencies the ear can detect
				273	constructive and destructive interference	96	investigate human perception of sound
				273	sound and light waves and interference	101	investigate interference with sound waves
				274	resonance and reflection	125	study the polarization of a transverse spring wave
				274	how resonance is created		
				275	standing waves and natural frequency and resonance		
				275	standing waves on a string		
				277	standing waves on a string		
				278	modes of a wave		
				278	nodes and antinodes		
				279	vibration of a drum		
				279	modes of vibration		
				280	microwaves and resonance		
				283	type of wave represented by a spring		
				286	sound is a wave of pressure		
				286	properties of sound waves		
				287	frequency and pitch of sound		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				287	how we hear sound waves		
				288	relationship of loudness and amplitude and pressure in sound wave		
				288	loudness and decibels and the sensitivity of the ear		
				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	frequency and wavelengths of sound		
				292	sound is a longitudinal wave		
				294	effect of medium and temperature on speed of sound wave		
				295	standing wave patterns of sound		
				295	designing a musical instrument		
				295	resonance of sound		
				296	interference of sound waves		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				296	design of a good concert hall		
				298	sonograms		
				298	constructing meaning from sound		
				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		
				303	sound from a guitar		
				303	design of a guitar		
				306	beats in a musical sound		
				306	list evidence that sound is a wave		
				308	wave amplitude and harmonics of tuning fork and musical instrument		
				356	electromagnetic waves are oscillations of an energy field		
				530	absorption of thermal radiation		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
3.4.10.C5	Physical Science, Chemistry and Physics	Distinguish among the principles of force and motion.	Describe light effects (e.g., Doppler effect, dispersion, absorption, emission spectra, polarization, interference).	262	waves are all around us	106	use a mirror to study how light behaves
				277	standing waves are used to store energy	106	study reflection in a prism
				281	use of microwaves in microwave ovens	106	study refraction in a prism
				281	microwaves	108	investigate RGB and CMYK models of color
				310	light is a form of energy	109	examining the spectrum of a light source
				310	how we see		
				311	fluorescent bulbs create UV light	112	investigate law of reflection
				312	the intensity of light	113	investigate Snell's law of refraction
				313	light carries information	113	study how refraction works
				314	the speed of light		
				315	light rays bounce off a surface	114	apply Snell's law of refraction
				315	light bends as it moves into a material	122	study properties of the electromagnetic spectrum
				315	mirrors	123	study light interference
				316	light and energy	123	study light diffraction patterns
				316	white light is the combination of all the colors	124	use a spectrometer to measure wavelength of different colors of light
				317	how the human eye sees color	125	polarization of a spring wave
				318	how we perceive color		
				318	the additive color process	125	polarization of water waves

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				319	the subtractive color process	126	study the polarization of light
				319	we see mostly reflected light	126	polarization of light
				320	visible light has just the right energy for life		
				320	the energy of IR and UV light		
				321	the RGB and CMYK color processes are complementary		
				322	the photon theory of light		
				324	the process of how light is reflected		
				324	the process of how light is reflected		
				325	color separations in high quality printing		
				326	the CMYK four-color printing process		
				328	how is light used for communication?		
				330	light rays indicate the path light travels		
				331	mirrors reflect light		
				331	lenses bend light		
				331	prisms separate white light into its colors		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				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		
				335	Snell's law of refraction		
				336	total internal reflection and the critical angle		
				337	prisms and dispersion and rainbows		
				338	how the human eye sees images		
				339	the image formed in a mirror		
				340	design of a lens		
				340	lenses follow Snell's law of refraction		
				345	diffraction spot size image defect		
				352	law of reflection		
				354	using Snell's law		
				356	light can be described in terms of waves		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				357	relationship between frequency and energy and color of light		
				357	frequency and wavelength of light		
				358	speed of light is frequency multiplied by length		
				359	description and examples of infrared waves		
				359	waves of the electromagnetic spectrum		
				359	descriptions of radio waves and microwaves and infrared rays		
				360	x-rays and gamma rays		
				360	description and examples of ultraviolet waves		
				360	visible light waves		
				361	interference of light waves and Young's double-slit experiment		
				362	diffraction grating		
				363	polarization		
				364	polarizers		
				364	transmission of light through two polarizers		
				365	applications of polarization		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				372	three-dimensional images and the human eye		
				373	holograms and the interference of light		
				373	wave fronts of light		
				375	relate color to frequency for visible light		
				434	RGB process and how a television picture is made		
				452	MRI uses radio waves		
				530	absorption of thermal radiation		
				531	thermal radiation and infrared light		
				531	blackbody and perfect absorption of light		
				574	absorption of light		
				586	emission and absorption of photons in laser light		
				624	UV light is ionizing radiation		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
3.4.10.C6	Physical Science, Chemistry and Physics	Distinguish among the principles of force and motion.	Describe and measure the motion of sound, light and other objects.	36	the precise meaning of speed	9	collect data and calculate speed of car
				37	calculating speed	9	calculate speed of rolling marble
				37	how to calculate speed	10	make object move with speed of 1 m/sec
				38	compare and contrast speed and velocity	12	finding speed of ball with one photogate
				38	the speed formula and calculating speed	13	graph speed versus position
				41	speed of a ball on a ramp	14	find the speed of the ball
				41	effect of friction on motion of a ball on a ramp	15	find speed of the ball
				46	speed is the rate of change of position	16	create a speed vs. time graph
				47	position vs. time graph	16	create a position vs. time graph
				47	average and instantaneous speed	17	find two speeds
				48	determining speed from the slope of a position vs. time graph	17	find the acceleration
				48	determining speed from the slope of a position vs. time graph	17	learn techniques for finding acceleration
				48	graphs showing changes in speed	17	studying acceleration
				48	graphs showing changes in speed	19	make a speed vs. time graph
				49	speed vs. time graph for constant speed	20	speed vs. time graph for uniform acceleration
				50	graphs for motion of increasing speed and decreasing speed	20	understanding equation for uniform accelerated motion

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				50	speed vs. time graph for downhill motion	21	calculate speed of ball
				54	graphing speed vs. time	22	create a position vs. time graph
				55	calculate the average speed and distance traveled	22	create a speed vs. time graph
				55	analyzing distance vs. time graph	23	investigate the effect of gravity
				58	acceleration is the rate of change in the speed of an object	25	derive acceleration equation
				59	comparing speed and acceleration	26	make ball roll at constant speed
				60	formula for acceleration	29	calculate the acceleration
				61	constant speed and constant acceleration	33	calculate the predicted speed
				61	general definition of acceleration	34	investigate static and sliding friction
				61	zero acceleration vs. constant acceleration vs. acceleration with zero speed	42	find initial speed of ball
				62	acceleration is total change of speed divided by total change in time	50	calculate the speed of the ball
				62	speed vs. time graph for accelerated motion	61	what effect does friction have on mechanical advantage?
				63	complex speed vs. time graphs	66	find the speed of the ball
						68	what is speed of the ball?
						76	calculate speeds of projectile and target balls
						81	investigate the motion of a pendulum

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				63	calculating acceleration from a speed vs. time graph	88	if frequency is increased what happens to total energy?
				64	calculate speed in accelerated motion	90	calculate the speed of the wave pulse
				64	calculating the speed of an object that is accelerating	90	study the speed of the wave pulse
				64	calculate speed in accelerated motion	94	investigate the wavelength of standing waves
				65	calculating distance from speed vs. time graph	94	investigate the frequency of standing waves
				67	calculate time and distance from acceleration	95	waves carry energy from one place to another
				68	free fall and acceleration due to gravity	191	calculate speed of air in homemade air-speed tester
				69	motion formulas for free fall		
				70	solving problems with free fall		
				71	air resistance and terminal speed		
				71	acceleration of gravity does not depend on mass		
				72	friction and traction and antilock brakes		
				74	understanding average speed and instantaneous speed		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				74	sketching speed vs. time graphs for different changes of motion		
				74	describing motion with speed vs. time graph		
				75	calculations of speed		
				75	problem understanding acceleration due to gravity		
				76	analyzing graph for changes in motion		
				84	direction of net force and acceleration and speed		
				97	strength of gravity on Earth and Jupiter		
				98	gravity and acceleration and weightlessness		
				100	the force of friction and the different types of friction		
				101	a model for friction		
				102	calculating the force of friction		
				103	friction and motion		
				104	reducing friction force		
				105	friction applications		
				115	friction of a pulled sled		
				124	projectiles and trajectories		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				124	effects of friction on trajectories		
				125	speed is the magnitude of the velocity vector		
				128	constant velocity of horizontal component of projectile motion		
				128	gravity only accelerates vertical 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		
				134	resolving force of gravity in ramp coordinates		
				135	frictional force on an inclined plane		
				135	acceleration down an inclined plane		
				136	calculating acceleration on a ramp accounting for friction		
				141	effects of gravity on motion of a projectile		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				142	effects of friction on acceleration		
				146	calculating linear speed of a moving wheel		
				147	the linear speed of a rolling wheel		
				150	centripetal acceleration		
				152	law of universal gravitation and orbital motion		
				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		
				183	friction and mechanical advantage of wheel and axle		
				184	friction and mechanical advantage of ramps and screws		
				187	work done against gravity		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				191	potential energy comes from gravity		
				242	what is a cycle?		
				244	concepts of period and frequency explained		
				245	concept of amplitude explained		
				245	friction causes damping in oscillators		
				249	analyze the motion of the cycle of a pendulum		
				251	systems tends to have a preferred frequency		
				256	friction and steady state		
				258	identify period and frequency and cycle and amplitude		
				260	velocity vs. time graph of harmonic motion		
				260	calculate speed of an oscillator		
				260	position vs. time graph of harmonic motion		
				262	waves transmit energy		
				263	waves are a form of traveling energy		
				264	frequency and amplitude and wavelength in waves		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				265	concept of speed of a wave		
				266	speed of a wave is the speed at which a cycle moves		
				266	formula for speed of a wave		
				272	waves transfer energy through absorption		
				277	energy of a wave is proportional to frequency and amplitude		
				277	energy of a wave		
				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		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				357	frequency and wavelength of light		
				358	speed of light is frequency multiplied by length		
				373	wave fronts of light		
				452	MRI--each nucleus is a resonant oscillator		
				530	energy and radiation relationships		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
3.4.10.C7	Physical Science, Chemistry and Physics	Distinguish among the principles of force and motion.	Know Newton's laws of motion (including inertia, action, and reaction) and gravity and apply them to solve problems related to forces and mass.	41	effect of friction on motion of a ball on a ramp	23	investigate the effect of gravity
				61	any acceleration must come from a force	26	study Newton's first law
				68	free fall and acceleration due to gravity	27	collect data on Newton's first law
				69	motion formulas for free fall	27	were any forces acting on the ball?
				70	solving problems with free fall	27	explain how Newton's first law applies
				71	air resistance and terminal speed	28	investigate Newton's second law
				71	acceleration of gravity does not depend on mass	30	Newton's third law and free body diagrams
				72	friction and traction and antilock brakes	30	investigate Newton's third law
				75	problem understanding acceleration due to gravity	31	draw free body diagrams and identify action-reaction pairs
				78	force is an action that can change motion	34	investigate static and sliding friction
				78	changes in motion only occur through force	49	consider forces acting on the ball
				79	what systems in a car overcome the law of inertia	61	what effect does friction have on mechanical advantage?
				79	all objects tend to resist changes in motion	77	relationship between force and motion and the second law
				80	seat belts and air bags and Newton's first law		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				80	Newton's laws and cup holders		
				81	Newton's second law of motion		
				81	force is related to acceleration		
				83	calculation using Newton's second law		
				84	Newton's second law and dynamics problems		
				85	if there is acceleration there must be force		
				85	force problems		
				85	finding force from acceleration		
				87	explaining Newton's third law in terms of an astronaut moving through space		
				87	forces always occur in action-reaction pairs		
				88	Newton's third law operates on pairs of objects		
				88	explaining Newton's third law in terms of moving a skateboard		
				89	solving problems with action-reaction forces		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				89	identifying which force is acting on which object		
				90	examples of Newton's third law		
				93	problems using Newton's first law and second law		
				94	seat belt problem		
				97	strength of gravity on Earth and Jupiter		
				98	gravity and acceleration and weightlessness		
				99	balanced force problems		
				100	the force of friction and the different types of friction		
				100	friction is a force that resists motion		
				101	a model for friction		
				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		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				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	friction of a pulled sled		
				116	calculate the acceleration of a toy		
				124	projectiles and trajectories		
				124	effects of friction on trajectories		
				128	gravity only accelerates vertical motion		
				129	vertical motion of a projectile		
				130	projectiles launched at an angle		
				131	range of projectiles		
				133	balancing forces in two dimensions		
				134	resolving force of gravity in ramp coordinates		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				135	frictional force on an inclined plane		
				135	acceleration down an inclined plane		
				135	normal force of an inclined plane		
				136	calculating acceleration on a ramp accounting for friction		
				136	calculating acceleration on a ramp		
				137	predicting motion in three dimensions and controlling force and acceleration in space missions		
				137	calculating acceleration from 3-D forces		
				137	the vector form of Newton's second law		
				139	determining position by triangulation and inertial navigation		
				141	effects of gravity on motion of a projectile		
				142	effects of friction on acceleration		
				148	centripetal force causes circular motion		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				148	direction of force determines linear or rotational motion		
				149	calculating centripetal force		
				150	using centripetal acceleration to create the feeling of gravity by rotating the space station		
				150	formula for centripetal acceleration		
				151	banked turns		
				152	law of universal gravitation and orbital motion		
				154	orbits and gravitational force		
				155	satellite motion application		
				155	centripetal force and the law of universal gravitation combine to form the orbit equation		
				156	satellites in orbit		
				158	compare projectile motion to orbital motion		
				165	the motion of a tossed object		
				166	centers of mass and gravity may differ		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				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		
				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		
				228	seat belts and air bags		
				229	momentum form of Newton's second law		
				234	gyroscopes and the space shuttle		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				238	cars that crumple in a collision		
				240	forces in a car stopping		
				245	friction causes damping in oscillators		
				252	Newton's second law and natural frequency		
				254	definition of periodic force		
				256	friction and steady state		
				425	electric forces always occur in pairs according to Newton's third law		
				548	Newton's third law and pressure in a fluid		
				550	pressure and the third law		
				557	pressure of gases		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
3.4.10.C8	Physical Science, Chemistry and Physics	Distinguish among the principles of force and motion.	Determine the efficiency of mechanical systems by applying mathematical formulas.	202	definition of efficiency	69	calculate efficiency for each ball
				203	efficiency explained		
				213	efficiency of an energy flow process		
				219	ideal vs. real machine		
				220	calculate efficiency of model solar car		
				236	fuel efficiency of turbofan engines		
				311	efficiency of electric vs. fluorescent light bulbs		
				393	efficiency of hybrid cars		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
3.4.10.D6	Physical Science, Chemistry and Physics	Explain essential ideas about the composition and structure of the universe.	Explain the impact of the Copernican and Newtonian thinking on man's view of the universe.	41	Galileo and Newton conducted experiments with balls on ramps		
				78	Newton's laws of motion		
				81	Newton's discovery of the connection between force and mass and acceleration		
				152	Sir Isaac Newton and law of universal gravitation		
				349	Galileo and telescopes		
				350	Newtonian reflecting telescope		
				382	Ben Franklin and current		
				420	Charles-Augustin de Coulomb		
				580	Newton and classical physics		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
3.4.12.C1	Physical Science, Chemistry and Physics	Apply the principles of motion and force.	Evaluate wave properties of frequency, wavelength, and speed as applied to sound and light through different media.	251	concept of natural frequency	85	investigate natural frequency
				252	changing natural frequency	88	if frequency is increased what happens to total energy?
				254	periodic force and natural frequency	89	study wave pulses on elastic cord
				255	resonance occurs when periodic force matches natural frequency	89	study characteristics of a wave pulse on a string
				264	frequency and amplitude and wavelength in waves	89	making wave pulses on a string
				264	basic properties of frequency and wavelength and amplitude	90	study the speed of the wave pulse
				265	wave pulse	90	measure speed of a wave pulse
				265	concept of speed of a wave	91	making circular waves in a ripple tank
				265	speed of a wave vs. speed of its medium	91	make different types of waves in a ripple tank
				266	formula for speed of a wave	91	is your water wave transverse or longitudinal?
				267	transverse and longitudinal waves	91	making plane waves in a ripple tank
				267	water waves are transverse and Slinky is longitudinal	93	investigate frequency and wavelength
				268	creating plane waves and circular waves	94	investigate the wavelength of standing waves
				268	one- and two- and three-dimensional waves	94	investigate the frequency of standing waves

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				269	propagation of waves through continuous materials	124	use a spectrometer to measure wavelength of different colors of light
				274	natural frequency of waves	125	study the polarization of a transverse spring wave
				275	standing waves on a string		
				275	boundaries and natural frequency		
				277	standing waves on a string		
				277	energy of a wave is proportional to frequency and amplitude		
				278	wavelength of a standing wave		
				278	modes of a wave		
				279	modes of vibration		
				281	microwaves		
				282	describe relationship between wave characteristics		
				283	type of wave represented by a spring		
				284	which direction does a cork move on a water wave?		
				286	properties of sound waves		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				286	sound is a wave of pressure		
				287	frequency and pitch of sound		
				288	relationship of loudness and amplitude and pressure in sound wave		
				289	vibrations create sound		
				291	how we know sound is a wave		
				291	pressure and amplitude of sound waves		
				292	sound is a longitudinal wave		
				292	importance of wavelength of sound waves		
				292	frequency and wavelengths of sound		
				294	speed of sound in different materials		
				294	effect of medium and temperature on speed of sound wave		
				300	pitch and frequency in music		
				303	design of a guitar		
				306	list evidence that sound is a wave		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				308	wave amplitude and harmonics of tuning fork and musical instrument		
				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		
				358	speed of light is frequency multiplied by length		
				359	waves of the electromagnetic spectrum		
				373	wave fronts of light		
				375	relate color to frequency for visible light		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
3.4.12.C2	Physical Science, Chemistry and Physics	Apply the principles of motion and force.	Propose and produce modifications of specific mechanical power systems that will improve their efficiency.	202	definition of efficiency	69	calculate efficiency for each ball
				203	efficiency explained		
				213	efficiency of an energy flow process		
				219	ideal vs. real machine		
				220	calculate efficiency of model solar car		
				236	fuel efficiency of turbofan engines		
				311	efficiency of electric vs. fluorescent light bulbs		
				393	efficiency of hybrid cars		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
3.4.12.C3	Physical Science, Chemistry and Physics	Apply the principles of motion and force.	Analyze the principles of translational motion, velocity and acceleration as they relate to free fall and projectile motion	68	free fall and acceleration due to gravity	23	investigate the effect of gravity
				69	motion formulas for free fall	45	calculate force components
				70	solving problems with free fall		
				71	acceleration of gravity does not depend on mass		
				75	problem understanding acceleration due to gravity		
				97	strength of gravity on Earth and Jupiter		
				98	gravity and acceleration and weightlessness		
				122	calculating vector components		
				123	finding magnitude and angle of a vector		
				124	projectiles and trajectories		
				125	the velocity vector		
				126	components of the velocity vector		
				128	gravity only accelerates vertical motion		
				128	independence of horizontal and vertical motion in a velocity vector		
				129	vertical motion of a projectile		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				130	calculating velocity components of initial velocity		
				130	projectiles launched at an angle		
				131	range of projectiles		
				132	interpreting the x-y components of force		
				133	calculating components of a force vector		
				134	resolving force of gravity in ramp coordinates		
				135	acceleration down an inclined plane		
				141	effects of gravity on motion of a projectile		
				152	law of universal gravitation and orbital motion		
				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		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				166	centers of mass and gravity may differ		
				187	work done against gravity		
				191	potential energy comes from gravity		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
3.4.12.C4	Physical Science, Chemistry and Physics	Apply the principles of motion and force.	Analyze the principles of rotational motion to solve problems relating to angular momentum, and torque.	144	rotation and revolution and angular speed	46	contrasting linear and angular motion
				145	calculating angular speed in radians per second	46	investigating angular speed
				146	angular speed of a moving wheel	53	relationship between force and torque
				146	the relationship between linear and angular speed	53	calculating torque
				147	speedometers and odometers	54	explore rotational equilibrium and net torque
				157	compare linear and angular speeds	79	investigate angular momentum
				160	how torque and force differ	80	explain life application of conservation of momentum
				160	translation and rotation	80	torque changes the direction of angular momentum vector
				160	center of rotation		
				161	calculating torque using torque equation		
				161	line of action and the torque created by a force		
				162	combining torques to find the net torque		
				162	calculating torque		
				163	in rotational equilibrium the net torque is zero		
				163	solve a rotational equilibrium problem		
				164	calculate a torque from an angled force		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				164	when force and lever arm are not perpendicular		
				171	rotational motion and linear motion		
				174	compare force and torque		
				174	calculating torque		
				181	torque and mechanical advantage of a lever		
				183	mechanical advantage of gears		
				231	linear and angular momentum		
				231	what is angular momentum		
				232	angular momentum depends on speed and mass and shape		
				233	formula for angular momentum		
				234	torque resists change in angular momentum		
				238	compare linear and angular momentum		
				442	torque between two magnets		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
3.4.12.C5	Physical Science, Chemistry and Physics	Apply the principles of motion and force.	Intepret a model that illustrates circular motion and acceleration.	146	the relationship between linear and angular speed	46	contrasting linear and angular motion
				147	speedometers and odometers	49	investigating centripetal force
				148	acceleration can be a change in the direction of motion	57	investigating rotational inertia
				149	calculating centripetal force	58	rotational application of Newton's second law
				155	centripetal force and the law of universal gravitation combine to form the orbit equation		
				157	compare linear and angular speeds		
				158	calculating centripetal force		
				168	rotational inertia and mass distribution		
				169	rotational inertia		
				169	relationship between angular acceleration and linear acceleration		
				170	moment of inertia		
				171	angular acceleration of a wheel		
				171	rotational motion and linear motion		
				231	linear and angular momentum		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				233	moment of inertia examples		
				238	compare linear and angular momentum		
				460	orbital motion of a charge		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
3.4.12.C6	Physical Science, Chemistry and Physics	Apply the principles of motion and force.	Describe inertia, motion, equilibrium, and action/reaction concepts through words, models and mathematical symbols.	26	inertia is an effect of mass	9	collect data and calculate speed of car
				37	how to calculate speed	10	make object move with speed of 1 m/sec
				41	effect of friction on motion of a ball on a ramp	12	finding speed of ball with one photogate
				48	determining speed from the slope of a position vs. time graph	14	find the speed of the ball
				55	calculate the average speed and distance traveled	15	find speed of the ball
				60	formula for acceleration	17	find two speeds
				60	calculating acceleration from experiments	17	learn techniques for finding acceleration
				61	any acceleration must come from a force	20	understanding equation for uniform accelerated motion
				61	general definition of acceleration	21	calculate speed of ball
				64	calculate speed in accelerated motion	23	investigate the effect of gravity
				68	free fall and acceleration due to gravity	26	study Newton's first law
				69	motion formulas for free fall	26	make ball roll at constant speed
				70	solving problems with free fall	27	explain how Newton's first law applies
				70	calculating height and time of flight in free fall problems	27	were any forces acting on the ball?
						27	collect data on Newton's first law
						28	investigate Newton's second law

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				71	air resistance and terminal speed	30	investigate Newton's third law
				71	acceleration of gravity does not depend on mass	30	Newton's third law and free body diagrams
				72	friction and traction and antilock brakes	31	draw free body diagrams and identify action-reaction pairs
				75	calculations of speed	33	calculate the predicted speed
				75	problem understanding acceleration due to gravity	34	investigate static and sliding friction
				78	force is an action that can change motion	39	investigating vectors
				78	changes in motion only occur through force	42	find initial speed of ball
				79	descriptions of inertia and Newton's first law	43	calculate the velocity vector
				79	all objects tend to resist changes in motion	45	balancing a specified force
				80	Newton's laws and cup holders	49	consider forces acting on the ball
				81	force is related to acceleration	50	calculate the speed of the ball
				81	Newton's second law of motion	61	what effect does friction have on mechanical advantage?
				83	finding the net force	66	find the speed of the ball
				83	calculation using Newton's second law	68	what is speed of the ball?
				84	calculating net force	73	calculating momentum
				84	Newton's second law and dynamics problems		

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Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				85	force problems	75	investigate collisions and conservation of momentum
				85	if there is acceleration there must be force		
				85	finding force from acceleration	76	calculate speeds of projectile and target balls
				86	zero acceleration means net zero force	77	the momentum form of Newton's second law
				87	forces always come in pairs	77	relationship between force and motion and the second law
				87	forces always occur in action-reaction pairs	85	where is the mass that provides inertia?
				88	Newton's third law operates on pairs of objects	90	calculate the speed of the wave pulse
				89	solving problems with action-reaction forces	191	calculate speed of air in homemade air-speed tester
				89	identifying which force is acting on which object		
				93	problems using Newton's first law and second law		
				94	seat belt problem		
				94	inertia problem		
				97	strength of gravity on Earth and Jupiter		
				98	gravity and acceleration and weightlessness		
				99	balanced force problems		
				100	friction is a force that resists motion		

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Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				100	the force of friction and the different types of friction		
				101	a model for friction		
				102	calculating the force of friction		
				102	the normal force as the reaction in an action-reaction pair		
				103	net force includes the force of friction		
				103	friction and motion		
				103	calculate the acceleration of a car including friction		
				104	reducing friction force		
				105	friction applications		
				106	net force must be zero in equilibrium		
				106	Newton's second law and net force		
				107	forces on a free-body diagram		
				107	net force of zero and free-body diagram		
				108	equilibrium and Newton's second law		
				108	use equilibrium to find an unknown force		

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Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				111	understanding reaction forces in terms of springs and deformation		
				112	analysis of forces on a bridge		
				115	friction of a pulled sled		
				116	calculate the acceleration of a toy		
				118	vectors have magnitude and direction		
				119	displacement vectors		
				124	projectiles and trajectories		
				124	definition of the velocity vector		
				124	effects of friction on trajectories		
				125	the velocity vector		
				126	components of the velocity vector		
				127	adding velocity vectors		
				128	gravity only accelerates vertical motion		
				129	analyze a horizontally launched projectile		
				129	vertical motion of a projectile		
				130	projectiles launched at an angle		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				131	range of projectiles		
				132	the force vector describes the strength and direction of a force		
				133	balancing forces in two dimensions		
				134	resolving force of gravity in ramp coordinates		
				135	frictional force on an inclined plane		
				135	normal force of an inclined plane		
				135	acceleration down 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	calculate the net force		
				141	effects of gravity on motion of a projectile		
				142	effects of friction on acceleration		

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Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				142	calculating acceleration for sled on slope		
				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		
				149	calculating centripetal force		
				150	centripetal acceleration		
				150	formula for centripetal acceleration		
				150	calculate the centripetal acceleration of a motorcycle		
				151	centrifugal force is actually an example of inertia		
				152	law of universal gravitation and orbital motion		
				154	orbits and gravitational force		
				155	satellite motion application		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				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		
				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		

Correlation to Pennsylvania Academic Standards for Science

Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				223	momentum formula and calculating momentum		
				224	momentum and Newton's third law		
				226	solving elastic and inelastic collision problems		
				228	Newton's second law relating force and momentum		
				229	momentum form of Newton's second law		
				229	force on a rocket from change in momentum		
				230	calculate change in momentum for elastic vs. inelastic collisions		
				236	momentum conservation of turbofan engine		
				238	momentum in billiards		
				239	calculate momentum		
				240	forces in a car stopping		
				245	friction causes damping in oscillators		
				249	inertia and restoring force cause harmonic motion		
				252	Newton's second law and natural frequency		
				254	definition of periodic force		

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Foundations of Physics

Student Text and Investigation Manual

Standard #:	Category	Standard Statement	Standard Descriptors	student text pg	detail	investigation pg	detail
				256	friction and steady state		
				276	natural frequency and harmonics		
				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		
				642	inertial mass		