

Correlation to NRC National Science Education Standards with Inquiry

Foundations of Physics

Student Text and Investigation Manual

Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
INQ01.1 Inquiry	Abilities Necessary to do Scientific Inquiry	Identify questions and concepts that guide scientific investigations	3	using life experiences and common sense	24	repeat investigation and apply ideas
			3	inquiry starts with questions	42	perform experiment
			242	finding a basic cycle of harmonic motion	64	investigate motion on a roller coaster
			432	making a simple capacitor	81	design an experiment
			456	an experiment with a wire and compass	88	what is it that moves in the case of a wave?
			463	building an electromagnet with wire and a nail	200	design a procedure to separate a mixture
			467	experiment demonstrating electromagnetic induction		

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
INQ01.2 Inquiry	Abilities Necessary to do Scientific Inquiry	Design and conduct scientific investigations	2	understanding natural laws	11	recognizing and controlling variables
			3	connecting cause and effect through observation	12	was this experiment better or worse than the first?
			4	inquiry through observation	12	cause and effect relationships
			7	creating explanations through observation	15	collect time data
			8	forming hypotheses and testing with experiments	21	conduct the experiment
			9	connecting cause and effect through analysis	21	plan the experiment
			9	testing ideas against scientific evidence	24	repeat investigation and apply ideas
			10	putting forth ideas and then testing them	27	set up the ultimate pulley
			10	the usefulness of phlogiston theory despite being incorrect	42	perform experiment
			11	acceptance of the Copernican model of the solar system on the basis of scientific evidence	42	test your prediction
			40	defining variables	64	where does the marble move the fastest?
			42	control and experimental variables	64	studying motion of ball on loop track
			43	dependent and independent variables in graphs	64	investigate motion on a roller coaster
					66	set up the straight track
					77	observe what happens
		78	safety note			
		81	design an experiment			
		81	determine which variable has the greatest effect			

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
			44	checking a graphical model's accuracy	81	plan three experiments to determine which variable affects the period of a pendulum
			45	recognizing patterns and cause and effect relationships	81	dependent and independent variables
			54	importance of changing one variable at a time in an experiment	84	select appropriate technology to make measurements
			71	parachutes and air resistance	84	design and test a way to increase natural frequency
			103	evaluating perpetual motion claims	86	observe what happens to the motion
			242	finding a basic cycle of harmonic motion	88	observe the wave pulse
			251	changing the natural frequency of a stretched rubber band	89	what effect does changing the tension have?
			293	demonstrating the Doppler effect	96	did the method give an accurate result?
			323	using glow-in-the-dark plastic to demonstrate photon energy levels	96	reliability of a double-blind test
			423	charge by friction	100	does the sound get louder or softer?
			432	making a simple capacitor	110	do your observations support this hypothesis?
			456	an experiment with a wire and compass	128	safety precautions
			463	building an electromagnet with wire and a nail	128	choose circuit parts to light a bulb
					130	safety precautions

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
			467	experiment demonstrating electromagnetic induction	146	how did A and B tapes acquire different charge?
			498	listing different types of matter in your home	149	safety note
			543	safety factors	158	safety note
					159	electromagnet safety
					165	variables that affect the performance of the generator
					175	safety note
					175	heat safety
					184	safety tip
					191	gas pressure safety note
					200	design a procedure to separate a mixture
					200	determine the equipment you will need
					201	conduct your experiment
					203	build models of Na and Cl and use them to explain bonding
					205	acid safety
					205	record your observations

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
INQ01.3 Inquiry	Abilities Necessary to do Scientific Inquiry	Use technology and mathematics to improve investigations and communications		data tables and graphs can be created on computer or graphing calculator		data tables and graphs can be created on computer or graphing calculator
			18	measuring distance	1	estimating length
			25	accuracy and precision of measurements	6	accuracy and resolution and printing
			25	why accuracy and precision are important	6	collecting data with precision
			42	controlling variables in experiments	10	calculate percent difference
			43	graphs are a way of representing data	13	find percent error
			45	recognizing patterns using graphs	13	is there a trend in measurements?
			48	slope of a position vs. time graph	15	collect time data with precision
			54	understanding patterns in relationships between variables	15	record data in a table
			56	indicate relationships between variables in graphs	16	find the slope of the line
			56	indicate relationships between variables in graphs	17	use a data table
			63	acceleration and slope of a speed vs. time graph	18	record data
			142	finding x and y components of velocity for model rocket	18	collect time data with precision
246	understanding graphs of harmonic motion	19	find the slope of the line			
		21	record results in table			
		24	calculate percent difference			
		24	find the average time			

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
			260	analyze graph of an oscillator	24	discuss sources of error
			304	comparison of wave forms from guitar sounds	26	record position and time data
			307	decibel level vs. frequency graph for human hearing	28	record mass and force
			412	average voltage and current of AC power	36	calculate percent difference
			427	diagramming electric fields using field lines	37	calculate percent difference
			443	diagramming magnetic fields using magnetic field lines	42	calculate percent difference
			479	current vs.voltage graph for a transistor	42	discuss sources of error
					42	measure and record the distance
					44	discuss sources of errors
					57	find average of three trials
					59	measure input and output forces
					62	as mechanical advantage increases what happens to length of pulled string?
					65	what does the graph tell you?
					65	record data in table
					66	measure vertical distance
					66	calculate average of three times
					69	record data in table

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
					70	calculate average work and power
					81	analyze data
					81	create data table for self-designed experiment
					81	measure the length of the string
					81	record your data in table
					82	calculate percent error
					132	did battery voltage change?
					201	identify two sources of experimental error
					201	find percent composition
					207	calculating percent yield

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
INQ01.4 Inquiry	Abilities Necessary to do Scientific Inquiry	Formulate and revise scientific explanations and models using logic and evidence	7	developing models to explain observations	12	do your results agree with hypothesis?
			7	revising explanations through observation	13	create a graph
			8	refining theories based on observations	13	compare prediction to measurement
			11	Ptolemy model vs. Copernicus model of the solar system	16	what do the results tell you?
			40	creating useful models	16	describe the graph
			40	making a good model	16	create a graph
			43	constructing a graph	18	are the accelerations different?
			44	graphical models	19	does the ball accelerate?
			44	using a graphical model to make a prediction and checking the model's accuracy	22	compare calculation with graph estimate
			54	constructing a graph	22	how do you measured positions compare to model?
			55	create a graph from a data table	22	create graphs
			60	creating the acceleration formula from experiments	22	model for uniform accelerated motion
			66	developing the formulas for a model of motion with constant acceleration	22	uniform acceleration model
			101	a model for friction	24	create an algebraic model
			102	a model for static friction	27	solve second law equation for string tension
			188	perpetual motion machines	28	does experiment agree with prediction?

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
			282	write a formula relating velocity of wave to period and wavelength	31	develop a model that predicts acceleration
			290	the process of digital sound reproduction	32	does your experiment confirm your hypothesis?
			297	frequency spectrum	36	make a graph
			306	explain why hearing can be damaged by loud sounds	37	make a graph
			312	light intensity follows an inverse square law	42	how does the measurement compare to your prediction?
			330	optics and optical instruments	42	sketch four graphs
			411	the waveform of AC electricity	42	create algebraic model
			492	the binary number system and its use in computers	42	what would happen if...?
					48	write a formula
					49	does your experiment provide confirmation?
					55	create a graph
					57	explain why the angular acceleration is different
					65	create a graph of speed vs. position
					65	does this agree with your hypothesis?
					75	compare predicted mass to actual mass
					79	explain your observations
					81	make three different graphs

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
					86	explain how force applied causes the response
					86	sketch a graph
					89	explain why higher tension makes waves move faster
					91	explain how wind might cause big waves in water
					93	give an equation that describes your observations
					100	explain what you hear
					108	explain how the colored filters work
					113	are there differences between your prediction and measurement?
					131	what conclusions can you draw?
					132	analyze data and explain a rule
					134	graph voltage vs. current
					135	graph voltage vs. current
					150	make a graph of voltage vs. time
					159	create a graph
					166	make a graph of voltage vs. number of magnets

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
					168	make a current vs. voltage graph for the diode
					188	Bernoulli's equation
INQ01.5 Inquiry	Abilities Necessary to do Scientific Inquiry	Recognize and analyze alternative explanations and models	8	Comparing a theory and a natural law	110	how does what you observed support the quantum theory?
			8	testing hypotheses with experiments		
			136	determining formula for acceleration on a ramp		
			367	speed of light did not behave as expected for Michelson and Morley		
			369	proof of time dilation		
			375	explain Thomas Young's demonstration of the wave nature of light		

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
INQ01.6 Inquiry	Abilities Necessary to do Scientific Inquiry	Communicate and defend a scientific argument	9	physics vocabulary is very specific	121	present your findings
			37	understanding the word "per"	174	display information you found for your element
			42	writing procedures in a lab notebook helps make sure your results are repeatable	201	keep detailed notes as you work
			44	using a graph to make predictions		
			45	recognizing relationships between variables from graphs		
			60	understanding the Greek letter delta		
			96	terms of mass and weight		
			97	understanding symbols		
			107	drawing free-body diagrams		
			116	draw a free-body diagram		
			125	drawing the velocity vector		
			212	making an energy flow diagram		
			246	understanding graphs of harmonic motion		
			333	drawing a ray diagram		
			342	drawing ray diagrams of lenses		

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
			380	circuit diagrams and electrical symbols		
			427	drawing the electric field using field lines		
			443	diagramming magnetic fields using magnetic field lines		

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
INQ02.1 Inquiry	Understandings About Scientific Inquiry	Scientists usually inquire about how physical, living, or designed systems function. Conceptual principles and knowledge guide scientific inquiries. Historical and current scientific knowledge influence the design and interpretation of investigations...	52	Dr. Harold Edgerton and strobe photography	121	research types of electromagnetic waves
			52	Dr. Harold Edgerton and strobe photography	146	Gilbert built the first electroscope
			112	impact of technology		
			155	first artificial human-made Earth satellite was Sputnik		
			178	Great Pyramid of Giza and simple machines		
			208	James Watt		
			257	Pierre and Jacques Curie and the piezoelectric effect		
			257	Pierre and Jacques Curie and the piezoelectric effect		
			269	wave motion and equilibrium		
			290	technological breakthrough of sound recording		
			310	past theories of light		
			311	Thomas Edison and the electric light		
			314	Einstein and the speed of light		
			316	Albert Einstein		
325	history of printing					

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
			348	the usefulness of recorded images		
			349	the telescope		
			361	Young's double-slit experiment		
			361	Thomas Young		
			366	Albert Einstein's theory of special relativity		
			367	Albert A. Michelson and Edward R. Morley		
			368	Einstein's thinking revolutionized physics		
			400	Gustav Robert Kirchhoff		
			440	magnetism		
			447	discovering and using magnetism		
			447	history of magnetism		
			456	Hans Christian Oersted		
			472	Dr. D. Bruce Montgomery		
			499	Albert Einstein		
			499	Democritus		
			501	search for elements and alchemy		
			501	ancient Greeks' ideas of elements		
			561	the Alvin research submarine		

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
			574	Niels Bohr		
			575	discovery of helium		
			575	Johann Balmer		
			578	Wolfgang Pauli		
			580	Max Planck and Albert Einstein		
			621	UV radiation and thinning of ozone layer		
			625	turning lead into gold		
			630	Wolfgang Pauli		
			641	research on future of the universe		
			644	proof of Einstein's theory of general relativity		
			647	Paul Dirac		

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INQ02.2 Inquiry	Understandings About Scientific Inquiry	Scientists conduct investigations for a wide variety of reasons. For example, they may wish to discover new aspects of the natural world, explain recently observed phenomena, or test the conclusions of prior investigations or the predictions of current...	4	learning about natural laws through inquiry and observation	79	explain the physics of a diver's somersaults
			7	in science inquiry is used to uncover truth	91	how does sound get through tiny cracks?
			19	problems in the real world use both metric and English units	125	explain how polarizing sunglasses work
			52	strobe photography		
			73	antilock braking systems		
			80	applications of Newton's first law		
			90	examples of Newton's third law in the real world		
			104	reducing friction and hovercraft and maglev trains		
			105	friction is useful for brakes and tires		
			109	jack-in-the-box uses a spring		
			112	design of structures		
			118	examples of scalars		
			130	kicked soccer ball acts as a projectile launched at an angle		
			131	hang time		
			133	example of gymnast for forces applied at an angle		

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
			138	robot navigation application		
			139	inertial navigation system		
			144	examples of objects moving in a circle		
			147	speedometers and odometers		
			149	centripetal force at the amusement park		
			154	the orbits of planets and comets		
			155	satellite motion application		
			156	HEO and geostationary orbit		
			167	SUV rollovers and center of gravity		
			172	bicycle physics application		
			211	output power from plants is input power for animals		
			227	accident reconstruction		
			232	angular momentum of skater spinning and diver		
			234	gyroscopes and angular momentum		
			243	examples of oscillators		
			250	why airplanes have tails		

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
			259	wing-beat cycle of a hummingbird		
			262	examples of waves		
			290	stereo sound		
			299	understanding human hearing		
			323	glow-in-the-dark plastic		
			337	rainbows are an example of dispersion		
			347	the compound microscope		
			365	polarized sunglasses and LCD computer screens		
			390	breakdown voltage and lightning		
			398	holiday lights wired in series		
			401	why aren't birds electrocuted?		
			410	paying for electricity		
			413	circuits in your house		
			413	wiring application		
			418	charge of everyday objects		
			430	almost all electric appliances use capacitors		
			433	cameras use capacitors to supply energy for flash bulbs		

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			448	how does a compass work?		
			458	where coils are used		
			462	electromagnet in a toaster		
			527	windchill factor		
			560	deep water submarine Alvin application		
			608	how engines work		
			621	exposure to UV radiation		
			644	proof of Einstein's theory of general relativity		
			645	astronomers find black holes by what is around them		
			646	a standard model for particle physics		

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INQ02.3 Inquiry	Understandings About Scientific Inquiry	Scientists rely on technology to enhance the gathering and manipulation of data. New techniques and tools provide new evidence to guide inquiry and new methods to gather data, thereby contributing to the advance of science. The accuracy and precision of..		data tables and graphs can be created on computer or graphing calculator		data tables and graphs can be created on computer or graphing calculator
			18	measuring distance	1	estimating length
			23	reading a digital timer	4	using a timer
			25	accuracy and precision of measurements	5	using photogates
			91	the force platform	6	collecting data with precision
			383	using a multimeter to measure voltage	6	accuracy and resolution and printing
			385	measuring current with an ammeter or multimeter	7	using devices to measure mass
			387	using a multimeter to measure resistance	9	using timer and photogates
			504	Celsius and Fahrenheit thermometers	11	using timer and photogates
			505	how thermometers work	14	using a timer and photogates
					15	collect time data with precision
					17	using a timer and photogates
					18	collect time data with precision
					18	use a timer and photogates
					21	use a timer and photogates

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
					23	use a timer and photogates
					25	use a timer and photogates
					28	use a spring scale
					28	find mass
					32	use a timer and photogate
					33	use a spring scale
					41	use a timer and photogates
					42	measure and record the distance
					43	use a spring scale
					46	use a timer and photogate
					49	use a timer and photogate
					57	use a timer and photogate
					59	measure input and output forces
					59	use a spring scale
					64	use a timer and photogate
					66	use a timer and photogate
					66	measure vertical distance
					74	use a timer and photogates
					81	use a timer and photogate

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
					81	measure the length of the string
					86	use photogate and timer to measure the period
					88	use a spring scale to measure tension of string
					89	use a timer and photogates
					92	use the timer to measure frequency
					111	use a laser and mirror to study law of reflection
					116	use a laser to locate images formed by a lens
					130	use a multimeter to measure current
					131	use a multimeter to measure voltage
					134	use a multimeter to measure current and voltage
					138	use a multimeter
					139	use the multimeter
					162	use a multimeter
					163	use a multimeter to measure voltage
					164	use a multimeter
					165	use a photogate and timer

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
					168 use a multimeter 170 use a multimeter 175 use a thermometer 177 measure the temperature 179 measure the temperature 191 use a digital balance	
INQ02.4 Inquiry	Understandings About Scientific Inquiry	Mathematics is essential in scientific inquiry. Mathematical tools and models guide and improve the posing of questions, gathering data, constructing explanations and communicating results.	60 66 282 312	creating the acceleration formula from experiments developing the formulas for a model of motion with constant acceleration write a formula relating velocity of wave to period and wavelength light intensity follows an inverse square law	22 24 27 31 42 48 93 188	uniform acceleration model create an algebraic model solve second law equation for string tension develop a model that predicts acceleration create algebraic model write a formula give an equation that describes your observations Bernoulli's equation

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INQ02.5 Inquiry	Understandings About Scientific Inquiry	Scientific explanations must adhere to criteria such as: a proposed explanation must be logically consistent; it must abide by the rules of evidence; it must be open to questions and possible modification; and it must be based on historical and current...	7	creating theories based on observations	12	was this experiment better or worse than the first?
			11	acceptance of the Copernican model of the solar system on the basis of scientific evidence	12	do your results agree with hypothesis?
			44	checking a graphical model's accuracy	13	predict speed of ball
			103	evaluating perpetual motion claims	16	what do the results tell you?
			188	perpetual motion machines	18	how would acceleration be different?
			306	explain why hearing can be damaged by loud sounds	18	are the accelerations different?
			498	since wood is created from other matter it must not be a fundamental substance	19	does the ball accelerate?
					32	calculate the predicted speed
					32	does your experiment confirm your hypothesis?
					36	use your graph to make a prediction
					37	use your graph to make a prediction
					41	predict exact landing location
					42	what would happen if...?
					49	does your experiment provide confirmation?
					57	explain why the angular acceleration is different

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					64	predict where the ball moves fastest
					65	does this agree with your hypothesis?
					79	explain your observations
					86	explain how force applied causes the response
					89	explain why higher tension makes waves move faster
					91	explain how wind might cause big waves in water
					96	did the method give an accurate result?
					96	reliability of a double-blind test
					100	explain what you hear
					108	explain how the colored filters work
					131	predict what the current will be
					131	what conclusions can you draw?
					132	analyze data and explain a rule

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INQ02.6 Inquiry	Understandings About Scientific Inquiry	Results of scientific inquiry- new knowledge and methods- emerge from different types of investigations and public communication among scientists. In communicating and defending the results of scientific inquiry, arguments must be logical and demonstrate...	7	developing models to explain observations	22	model for uniform accelerated motion
			40	creating useful models		
			101	a model for friction		
			102	a model for static friction		
			330	optics and optical instruments		
			440	scientists have never found single magnetic poles		
			492	the binary number system and its use in computers		
			568	understanding how gravity works inside atoms		
			583	the meaning of the uncertainty principle		
			637	areas of active research in physics		
			640	unresolved questions of history of universe		
			641	research on future of the universe		

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PS04.1 Physical Science	Motion and Forces	Objects change their motion only when a net force is applied. Laws of motion are used to calculate precisely the effects of forces on the motion of objects. The magnitude of the change in motion can be calculated using the...	36	the precise meaning of speed	9	collect data and calculate speed of car
			37	how to calculate speed	9	calculate speed of rolling marble
			37	calculating speed	10	make object move with speed of 1 m/sec
			38	the speed formula and calculating speed	12	finding speed of ball with one photogate
			41	speed of a ball on a ramp	14	find the speed of the ball
			46	speed is the rate of change of position	15	find speed of the ball
			47	average and instantaneous speed	17	studying acceleration
			48	determining speed from the slope of a position vs. time graph	17	find two speeds
			55	calculate the average speed and distance traveled	21	calculate speed of ball
			55	calculate the average speed and distance traveled	25	make ball roll at constant speed
			55	calculate the average speed and distance traveled	25	study Newton's first law
			58	acceleration is the rate of change in the speed of an object	26	were any forces acting on the ball?
			59	comparing speed and acceleration	26	collect data on Newton's first law
			61	any acceleration must come from a force	26	explain how Newton's first law applies
			62	acceleration is total change of speed divided by total change in time	27	investigate Newton's second law
62	acceleration is total change of speed divided by total change in time	29	investigate Newton's third law			
64	calculating the speed of an object that is accelerating	29	Newton's third law and free body diagrams			

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
			64	calculate speed in accelerated motion	30	draw free body diagrams and identify action-reaction pairs
			74	understanding average speed and instantaneous speed	32	calculate the predicted speed
			75	calculations of speed	41	find initial speed of ball
			78	force is an action that can change motion	48	consider forces acting on the ball
			78	changes in motion only occur through force	49	calculate the speed of the ball
			79	all objects tend to resist changes in motion	65	find the speed of the ball
			81	Newton's second law of motion	67	what is speed of the ball?
			81	force is related to acceleration	75	calculate speeds of projectile and target balls
			83	calculation using Newton's second law	76	relationship between force and motion and the second law
			84	Newton's second law and dynamics problems	89	calculate the speed of the wave pulse
			84	direction of net force and acceleration and speed	190	calculate speed of air in homemade air-speed tester
			85	if there is acceleration there must be force		
			85	force problems		
			85	finding force from acceleration		
			87	forces always occur in action-reaction pairs		

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
			88	Newton's third law operates on pairs of objects		
			89	identifying which force is acting on which object		
			89	solving problems with action-reaction forces		
			93	problems using Newton's first law and second law		
			94	force calculations in different units		
			94	seat belt problem		
			99	balanced force problems		
			100	friction is a force that resists motion		
			102	the normal force as the reaction in an action-reaction pair		
			106	Newton's second law and net force		
			107	forces on a free-body diagram		
			108	equilibrium and Newton's second law		
			108	use equilibrium to find an unknown force		
			111	understanding reaction forces in terms of springs and deformation		

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
			112	analysis of forces on a bridge		
			116	calculate the acceleration of a toy		
			133	balancing forces in two dimensions		
			135	normal force of an inclined plane		
			136	calculating acceleration on a ramp		
			137	the vector form of Newton's second law		
			137	calculating acceleration from 3-D forces		
			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	formula for centripetal acceleration		
			168	Newton's first law and rotational inertia		

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
			169	Newton's second law applies to rotational motion		
			171	Newton's second law for rotational motion variables		
			222	Newton's first law and momentum		
			224	momentum and Newton's third law		
			228	Newton's second law relating force and momentum		
			229	momentum form of Newton's second law		
			252	Newton's second law and natural frequency		
			254	definition of periodic force		
			425	electric forces always occur in pairs according to Newton's third law		
			548	Newton's third law and pressure in a fluid		
			550	pressure and the third law		
			557	pressure of gases		

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
PS04.2 Physical Science	Motion and Forces	Gravitation is a universal force that each mass exerts on any other mass. The strength of the gravitational attractive force between two masses is proportional to the masses and inversely proportional to the square of the distance between them.	68	free fall and acceleration due to gravity	23	investigate the effect of gravity
			69	motion formulas for free fall	41	predict where the ball will hit the floor
			70	solving problems with free fall	41	investigate projectile motion
			71	acceleration of gravity does not depend on mass	50	calculate gravitational force of attraction
			75	problem understanding acceleration due to gravity	50	investigate law of universal gravitation
			97	strength of gravity on Earth and Jupiter		
			98	gravity and acceleration and weightlessness		
			124	projectiles and trajectories		
			128	gravity only accelerates vertical motion		
			129	vertical motion of a projectile		
			130	projectiles launched at an angle		
			131	range of projectiles		
			134	resolving force of gravity in ramp coordinates		
			135	acceleration down an inclined plane		
			141	effects of gravity on motion of a projectile		

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
			152	description of law of universal gravitation		
			152	law of universal gravitation and orbital motion		
			153	formula and calculations for law of universal gravitation		
			154	orbits and gravitational force		
			154	orbital motion		
			155	centripetal force and the law of universal gravitation combine to form the orbit equation		
			158	calculate weight and acceleration due to gravity on Pluto		
			158	compare projectile motion to orbital motion		
			165	the motion of a tossed object		
			166	centers of mass and gravity may differ		
			187	work done against gravity		
			191	potential energy comes from gravity		
			216	tides are due to force of gravity		
			642	Newton's laws and gravity		

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Standard #:	Topic	Fundamental	student text	detail	investigation	detail
Content Area		Concept	pg		pg	

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
PS04.3 Physical Science	Motion and Forces	The electric force is a universal force that exists between any two charged objects. Opposite charges attract while like charges repel. The strength of the force is proportional to the charges, and, as with gravitation, inversely proportional...	418	electric charge is a fundamental property of matter	145	build a simple electroscope
			419	electric forces are created between electric charges	146	investigate the concept of electric charge
			419	differences between electric force and gravity	148	investigate charged balloons
			420	explanation of coulomb		
			421	current is the flow of charge		
			422	negative charge of electrons and current flow		
			423	static electricity and charge polarization and induction		
			424	the strength of electric forces		
			424	relationship of electric force and charge		
			425	the force between charges		
			426	charge creates an electric field		
			426	gravity is far weaker than electric forces		
			428	source charges and test charges		
			428	comparison between electric fields and gravitational fields		

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
			430	a capacitor stores charge		
			433	ability of a capacitor to store charge is capacitance		
			441	comparing magnetic and electric forces		
			442	force between two magnetics is not an inverse square law		
PS04.4 Physical Science	Motion and Forces	Between any two charged particles, electric force is vastly greater than the gravitational force. Most observable forces such as those exerted by a coiled spring or friction may be traced to electric forces acting between atoms and molecules.	419	differences between electric force and gravity		
			424	the strength of electric forces		
			426	gravity is far weaker than electric forces		
			428	comparison between electric fields and gravitational fields		

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Student Text and Investigation Manual

Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
PS04.5 Physical Science	Motion and Forces	Electricity and magnetism are two aspects of a single electromagnetic force. Moving electric charges produce magnetic forces, and moving magnets produce electric forces. These effects help students to understand electric motors and generators.	412	average power in an electric motor	158	build an electromagnet
			435	steering the electron beam on television screen	159	find out what happens to strength of electromagnet when current is increased
			441	comparing magnetic and electric forces	159	what happens to the strength of an electromagnet when you increase the current?
			442	force between two magnetics is not an inverse square law	160	investigate how an electric motor works
			456	magnetic field of a wire		
			457	force on a current in a magnetic field		
			462	electromagnets		
			463	building an electromagnet		
			464	principle of the electric motor		
			464	electric motor uses electromagnets to convert electrical energy to mechanical energy		
			465	commutation		
			465	how electromagnets are used in electric motors		
			466	battery-powered electric motors		
			472	electromagnet-based maglev		
			475	diagram of electromagnet		

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Student Text and Investigation Manual

Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
PS05.1 Physical Science	Conservation of Energy and the Increase in Disorder	The total energy of the universe is constant. Energy can be transferred by collisions in chemical and nuclear reactions, by light waves and other radiations, and in many other ways. However, it can never be destroyed. As these transfers...	189	energy appears in different forms	71	draw an energy flow diagram
			190	conversions of energy		
			190	different forms of energy		
			194	energy transformations		
			194	conservation of energy explained		
			194	the law of conservation of energy		
			195	conservation of energy in a closed system		
			196	energy transformation hydroelectric plant		
			202	efficiency and energy conversions		
			203	efficiency and conservation of energy		
			205	efficiency in biological systems		
			206	connection between efficiency and time		
			212	understand basic forms of energy		
			212	energy conversion		
			213	the conversion process of energy flow		
			215	energy flows in biological systems		

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
			219	energy flow of a model solar car		
			227	kinetic energy conservation for elastic collisions		
			256	resonant systems accumulate energy		
			277	waves propagate by exchanging energy between two forms		
			310	light is a form of energy		
			320	photosynthesis converts light energy to chemical energy		
			322	photons are bundles of light energy		
			324	light from chemical reactions		
			356	electromagnetic waves exchange energy between electricity and magnetic parts		
			370	relationship and conservation of mass and energy		
			378	electrical energy		
			384	batteries use chemical energy		
			393	conversion of energy in regenerative braking		

**Correlation to NRC National Science Education Standards with Inquiry
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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
			400	energy conversions in a series circuit		
			451	MRI--energy exchange by a nucleus in a magnetic field		
			464	electric motor uses electromagnets to convert electrical energy to mechanical energy		
			467	electric generators transform mechanical energy into electric energy		
			469	energy conservation and Faraday's law		
			509	temperature change and thermal energy		
			513	transfer of thermal energy		
			515	thermodynamics and conservation of energy		
			552	explanation of pressure and energy		
			552	conservation of energy in fluids		
			553	energy conservation and Bernoulli's equation		
			619	radiation as a flow of energy		
			622	energy of x-rays		
			629	conservation of energy in nuclear reactions		

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
			647	energy from antimatter		

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
PS05.2 Physical Science	Conservation of Energy and the Increase in Disorder	All energy can be considered to be either kinetic energy, which is the energy of motion; potential energy, which depends on relative position; or energy contained by a field, such as electromagnetic waves.	194	conservation of energy explained	65	law of conservation of energy
			194	the law of conservation of energy	67	find the total energy at each position
			195	conservation of energy in a closed system	73	investigating collisions and conservation of energy
			195	applying conservation of energy for a marble rolling on a hilly track		
			197	conservation of energy for Hoover Dam		
			203	efficiency and conservation of energy		
			206	connection between efficiency and time		
			215	energy flows in biological systems		
			227	kinetic energy conservation for elastic collisions		
			370	relationship and conservation of mass and energy		
			469	energy conservation and Faraday's law		
			515	thermodynamics and conservation of energy		
			552	conservation of energy in fluids		

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
			553	energy conservation and Bernoulli's equation		
			629	conservation of energy in nuclear reactions		
PS05.3 Physical Science	Conservation of Energy and the Increase in Disorder	Heat consists of random motion and the vibrations of atoms, molecules, and ions. The higher the temperature, the greater the atomic or molecular motion.	512	temperature and thermal energy and heat	177	explore the connection between temperature and heat and energy
PS05.4 Physical Science	Conservation of Energy and the Increase in Disorder	Everything tends to become less organized and less orderly over time. Thus, in all energy transfers, the overall effect is that the energy is spread out uniformly. Examples are the transfer of energy from hotter to cooler objects by ...	522	heat conduction	181	investigate convection in a liquid
			523	heat conduction		
			524	conduction in solids and liquids and gases		
			526	convection in liquids		
			527	convection depends on speed and surface area		
			528	convection and weather		
			530	radiation		
			535	sources of heat transfer in buildings		

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
PS06.1 Physical Science	Interactions of Energy and Matter	Waves, including sound and seismic waves, waves on water, and light waves, have energy and can transfer energy when they interact with matter.	254	concept of resonance	85	investigate resonance and its importance
			255	resonance occurs when periodic force matches natural frequency	87	if frequency is increased what happens to total energy?
			259	resonance and amplitude	88	study characteristics of a wave pulse on a string
			262	waves transmit energy	88	making wave pulses on a string
			263	waves are a form of traveling energy	88	study wave pulses on elastic cord
			264	basic properties of frequency and wavelength and amplitude	89	study the speed of the wave pulse
			264	frequency and amplitude and wavelength in waves	89	measure speed of a wave pulse
			265	concept of speed of a wave	90	making circular waves in a ripple tank
			265	wave pulse	90	make different types of waves in a ripple tank
			266	formula for speed of a wave	90	making plane waves in a ripple tank
			267	water waves are transverse and Slinky is longitudinal	90	is your water wave transverse or longitudinal?
			267	transverse and longitudinal waves	91	investigate diffraction in a ripple tank
			268	one- and two- and three- dimensional waves	91	observing reflection in water waves
			268	creating plane waves and circular waves	91	investigate reflection in a ripple tank
			270	waves and reflection		
			270	waves and refraction		

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
			270	waves and absorption	92	investigate frequency and wavelength
			270	waves and diffraction		
			271	waves and reflection and boundaries	93	investigate the wavelength of standing waves
			271	waves and refraction and boundaries	93	investigate the frequency of standing waves
			272	waves and absorption and boundaries	94	waves carry energy from one place to another
			272	waves and diffraction and boundaries	94	natural frequency and resonance of standing waves on a string
			272	waves transfer energy through absorption		
			273	sound and light waves and interference	99	investigate interference with sound waves
			273	constructive and destructive interference	99	investigate evidence for why sound is a wave
			274	resonance and reflection	100	sound waves and resonance
			274	how resonance is created	101	resonant frequencies of water glasses
			275	standing waves on a string	102	observe sound wave interference and beats
			275	standing waves and natural frequency and resonance	123	use a spectrometer to measure wavelength of different colors of light
			277	standing waves on a string	124	polarization of water waves
			277	energy of a wave		
			277	energy of a wave is proportional to frequency and amplitude	124	polarization of a spring wave

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
			278	modes of a wave	124	study the polarization of a transverse spring wave
			278	nodes and antinodes		
			278	wavelength of a standing wave	125	study the polarization of light
			279	modes of vibration	125	polarization of light
			280	microwaves and resonance		
			282	describe relationship between wave characteristics		
			283	type of wave represented by a spring		
			286	sound is a wave of pressure		
			286	properties of sound waves		
			286	sound waves require matter to traverse		
			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	importance of wavelength of sound waves		

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
			292	sound is a longitudinal wave		
			292	frequency and wavelengths of sound		
			294	effect of medium and temperature on speed of sound wave		
			295	standing wave patterns of sound		
			295	resonance of sound		
			296	interference of sound waves		
			300	pitch and frequency in music		
			301	consonance and dissonance and beats		
			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		
			310	light is a form of energy		
			312	the intensity of light		
			313	light carries information		
			314	the speed of light		

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
			328	how is light used for communication?		
			356	electromagnetic waves are oscillations of an energy field		
			356	light can be described in terms of waves		
			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		
			363	polarization		
			364	polarizers		
			365	applications of polarization		
			373	wave fronts of light		
			375	relate color to frequency for visible light		
			530	absorption of thermal radiation		
			530	energy and radiation relationships		
			530	electromagnetic radiation		

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
PS06.2 Physical Science	Interactions of Energy and Matter	Electromagnetic waves result when a charged object is accelerated or decelerated. Electromagnetic waves include radio waves (the longest wavelength), microwaves, infrared radiation (radiant heat), visible light, ultraviolet radiation...	262 277 281 281 311 320 320 356 359 359 359 360 360 360 452 531	waves are all around us standing waves are used to store energy microwaves use of microwaves in microwave ovens fluorescent bulbs create UV light visible light has just the right energy for life the energy of IR and UV light electricity and magnetism oscillations waves of the electromagnetic spectrum description and examples of infrared waves descriptions of radio waves and microwaves and infrared rays description and examples of ultraviolet waves x-rays and gamma rays visible light waves MRI uses radio waves thermal radiation and infrared light	121	study properties of the electromagnetic spectrum

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
			624	UV light is ionizing radiation		
PS06.3 Physical Science	Interactions of Energy and Matter	Each kind of atom or molecule can gain or lose energy only in particular discrete amounts and thus can absorb and emit light only at wavelengths corresponding to these amounts. These wavelengths can be used to identify the substance.	357	relationship between frequency and energy and color of light	109	all light is produced by atoms
			362	diffraction patterns and the spectrometer	123	use a spectrometer to measure wavelength of different colors of light
			375	relate color to frequency for visible light	196	absorption and emission of light by atomic electrons
			574	emission/absorption spectrum		
			575	spectral analysis of the sun		
			575	spectrum of hydrogen		
			638	spectral-line patterns and red shift		

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Standard #: Content Area	Topic	Fundamental Concept	student text pg	detail	investigation pg	detail
PS06.4 Physical Science	Interactions of Energy and Matter	In some materials, such as metals, electrons flow easily, whereas in insulating materials such as glass they can hardly flow at all. Semiconducting materials have intermediate behavior. At low temperatures some materials become superconductors...	390	classifying materials as conductor or insulator or semiconductor		
			395	classify conductivity of materials		
			421	negative charges move in a conductor		
			422	atomic structures of conductors and insulators and semiconductors		
			429	using a conductor as shielding from electric fields		
			480	conductivity and semiconductors		