

Correlation to Michigan Science Content Benchmarks: Summer, 2000

Foundations of Physics

Student Text and Investigation Manual

Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
HS.CI.1.1 Constructing New Scientific Knowledge	High School	All students will ask questions that help them learn about the world	Ask questions that can be investigated empirically.	3	using life experiences and common sense	24	repeat investigation and apply ideas
				3	inquiry starts with questions	81	design an experiment
				432	making a simple capacitor	88	what is it that moves in the case of a wave?
						200	design a procedure to separate a mixture

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HS.CI.1.2 Constructing New Scientific Knowledge	High School	All students will design and conduct investigations using appropriate methodology and technology	Design and conduct scientific investigations.	9	testing ideas against scientific evidence	11	recognizing and controlling variables
				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?
				40	defining variables	21	conduct the experiment
				42	control and experimental variables	21	plan the experiment
				43	dependent and independent variables in graphs	24	repeat investigation and apply ideas
				44	checking a graphical model's accuracy	27	set up the ultimate pulley
				54	importance of changing one variable at a time in an experiment	42	perform experiment
				103	evaluating perpetual motion claims	64	investigate motion on a roller coaster
				242	finding a basic cycle of harmonic motion	66	set up the straight track
				251	changing the natural frequency of a stretched rubber band	78	safety note
				432	making a simple capacitor	81	design an experiment
				456	an experiment with a wire and compass	81	dependent and independent variables
				463	building an electromagnet with wire and a nail	81	plan three experiments to determine which variable affects the period of a pendulum
						81	determine which variable has the greatest effect
						84	design and test a way to increase natural frequency

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				467	experiment demonstrating electromagnetic induction	84	select appropriate technology to make measurements
				543	safety factors	96	reliability of a double- blind test
						96	did the method give an accurate result?
						128	safety precautions
						128	choose circuit parts to light a bulb
						130	safety precautions
						149	safety note
						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	determine the equipment you will need
						200	design a procedure to separate a mixture
						201	conduct your experiment
						205	acid safety

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HS.CI.1.3 Constructing New Scientific Knowledge	High School	All students will design and conduct investigations using appropriate methodology and technology	Recognize and explain the limitations of measuring devices.	25	accuracy and precision of measurements	6 6 15 18 152 152 201	precision in measurement collecting data with precision collect time data with precision collect time data with precision making measurements with precision make measurement with precision find the mass to the nearest tenth of a gram
HS.CI.1.4 Constructing New Scientific Knowledge	High School	All students will learn from books and other sources of information	Gather and synthesize information from books and other sources of information.	456 472 499 499	Hans Christian Oersted Dr. D. Bruce Montgomery Albert Einstein Democritus	121	research types of electromagnetic waves
HS.CI.1.5 Constructing New Scientific Knowledge	High School	All students will communicate findings of investigations, using appropriate technology	Discuss topics in groups by making clear presentations, restating or summarizing what others have said, asking for clarifications or elaboration, taking alternative perspectives, and defending a position.	42	writing procedures in a lab notebook helps make sure your results are repeatable	121 121 174 201	communicate your findings present your findings display information you found for your element keep detailed notes as you work

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Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
HS.PMEIV.1. Matter and Energy	High School	All students will explain how electricity (and magnetism; see PMO) interact with matter	Explain how current is controlled in simple series and parallel circuits.	378	concept of electric current	130	explore the concept of electric current
				382	current flows through wires and carries energy	134	study the relationship between current and voltage
				382	electrical current explained		
				398	parallel circuit defined	136	parallel circuit and Ohm's law
				398	series circuit defined	136	investigate series circuits
				399	current and resistance in a series circuit	137	build a parallel circuit
				400	voltage in a series circuit	138	compare series and parallel circuits
				401	parallel circuits	138	analyze parallel circuits
				402	advantages of parallel circuits over series circuits	139	build and analyze network circuits
				402	voltage and current in a parallel circuit		
				403	resistance in parallel circuits		
				405	voltage dividers		
				406	comparing series and parallel circuits		
				407	solving network circuits		
				407	solving network circuits		
				408	current definition		
				414	why series circuits are not used in homes and buildings		

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Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
				414	why parallel circuits are used in homes and buildings		
				415	compare current in a series and parallel circuit		
				421	current is the flow of charge		
				422	negative charge of electrons and current flow		
				431	current into and out of capacitors		

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Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
HS.PMEIV.1. Matter and Energy	High School	All students will explain how electricity (and magnetism; see PMO) interact with matter	Describe how electric currents can be produced by interacting wires and magnets, and explain applications of this principle.	356	electricity and magnetism oscillations	158	build an electromagnet
				435	steering the electron beam on television screen	159	study the right-hand rule
				441	comparing magnetic and electric forces	159	find out what happens to strength of electromagnet when current is increased
				442	force between two magnetics is not an inverse square law	159	what happens to the strength of an electromagnet when you increase the current?
				456	magnetic field of a wire	164	investigate Faraday's law of induction
				457	force on a current in a magnetic field	164	investigate electromagnetic induction
				457	right-hand rule	165	build a generator
				462	electromagnets		
				462	finding the poles of an electromagnet using right-hand rule		
				463	building an electromagnet		
				464	electric motor uses electromagnets to convert electrical energy to mechanical energy		
				465	how electromagnets are used in electric motors		
				467	concept of electromagnetic induction		
				468	magnetic flux		
				469	Faraday's law of induction		

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Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
				470	generating electricity by induction		
				471	transformers operate on electromagnetic induction		
				472	electromagnet-based maglev		
				473	Eddy currents		
				475	using right-hand rule		
				475	diagram of electromagnet		

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Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
HS.PMOIV.3. Motion of Objects	High School	All students will describe how things around us move, explain why things move as they do, and demonstrate and explain how we control the motions of objects	Analyze patterns of force and motion in the operation of complex machines.	13	physics and bicycles	9	collect data and calculate speed of car
				36	the precise meaning of speed	9	calculate speed of rolling marble
				36	speed is relative	10	make object move with speed of 1 m/sec
				37	calculating speed	12	finding speed of ball with one photogate
				37	how to calculate speed	13	graph speed versus position
				38	compare and contrast speed and velocity	14	find the speed of the ball
				38	the speed formula and calculating speed	15	find speed of the ball
				41	speed of a ball on a ramp	16	create a speed vs. time graph
				41	effect of friction on motion of a ball on a ramp	16	create a position vs. time graph
				46	speed is the rate of change of position	17	find the acceleration
				47	average and instantaneous speed	17	studying acceleration
				47	position vs. time graph	17	find two speeds
				48	graphs showing changes in speed	17	learn techniques for finding acceleration
				48	determining speed from the slope of a position vs. time graph	19	make a speed vs. time graph
				48	determining speed from the slope of a position vs. time graph	20	speed vs. time graph for uniform acceleration
				49	speed vs. time graph for constant speed	20	understanding equation for uniform accelerated motion

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Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
				50	graphs for motion of increasing speed and decreasing speed	21	calculate speed of ball
				50	speed vs. time graph for downhill motion	22	create a speed vs. time graph
				54	graphing speed vs. time	22	create a position vs. time graph
				55	calculate the average speed and distance traveled	23	investigate the effect of gravity
				55	analyzing distance vs. time graph	24	derive acceleration equation
				58	acceleration is the rate of change in the speed of an object	25	make ball roll at constant speed
				59	comparing speed and acceleration	25	study Newton's first law
				60	formula for acceleration	26	explain how Newton's first law applies
				61	zero acceleration vs. constant acceleration vs. acceleration with zero speed	26	were any forces acting on the ball?
				61	constant speed and constant acceleration	26	collect data on Newton's first law
				61	any acceleration must come from a force	27	investigate Newton's second law
				61	general definition of acceleration	28	calculate the acceleration
				62	acceleration is total change of speed divided by total change in time	29	Newton's third law and free body diagrams
						29	investigate Newton's third law
						30	draw free body diagrams and identify action-reaction pairs

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Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
				62	speed vs. time graph for accelerated motion	32	calculate the predicted speed
				63	complex speed vs. time graphs	33	investigate static and sliding friction
				63	calculating acceleration from a speed vs. time graph	41	predict where the ball will hit the floor
				64	calculate speed in accelerated motion	41	investigate projectile motion
				64	calculating the speed of an object that is accelerating	41	find initial speed of ball
				64	calculate speed in accelerated motion	43	investigating force vectors
				64	calculate speed in accelerated motion	44	balancing a specified force
				65	calculating distance from speed vs. time graph	48	consider forces acting on the ball
				67	calculate time and distance from acceleration	48	draw a free body diagram and label forces
				68	free fall and acceleration due to gravity	48	investigating centripetal force
				69	motion formulas for free fall	49	calculate the speed of the ball
				70	solving problems with free fall	52	calculating torque
				71	acceleration of gravity does not depend on mass	58	investigate block and tackle machine
				71	air resistance and terminal speed	60	find the mechanical advantage
				72	friction and traction and antilock brakes	60	what effect does friction have on mechanical advantage?

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Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
				74	sketching speed vs. time graphs for different changes of motion	61	investigate block and tackle machine
				74	understanding average speed and instantaneous speed	65	find the speed of the ball
				74	describing motion with speed vs. time graph	67	what is speed of the ball?
				75	calculations of speed	75	calculate speeds of projectile and target balls
				75	problem understanding acceleration due to gravity	76	relationship between force and motion and the second law
				75	problem using frames of reference	79	torque changes the direction of angular momentum vector
				76	analyzing graph for changes in motion	89	calculate the speed of the wave pulse
				78	force is an action that can change motion	127	relativity and frames of reference
				78	changes in motion only occur through force	186	the stress formula
				79	all objects tend to resist changes in motion	187	measure tensile strength of a soft material
				79	what systems in a car overcome the law of inertia	190	calculate speed of air in homemade air-speed tester
				80	Newton's laws and cup holders		
				80	seat belts and air bags and Newton's first law		
				81	Newton's second law of motion		

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				81	force is related to acceleration		
				83	calculation using Newton's second law		
				83	finding the net force		
				84	Newton's second law and dynamics problems		
				84	direction of net force and acceleration and speed		
				84	calculating net force		
				85	if there is acceleration there must be force		
				85	finding force from acceleration		
				85	force problems		
				86	zero acceleration means net zero force		
				87	forces always occur in action-reaction pairs		
				87	explaining Newton's third law in terms of an astronaut moving through space		
				88	Newton's third law operates on pairs of objects		
				88	explaining Newton's third law in terms of moving a skateboard		

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Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
				89	identifying which force is acting on which object		
				89	solving problems with action-reaction forces		
				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	friction is a force that resists motion		
				100	the force of friction and the different types of friction		
				101	a model for friction		
				102	the normal force as the reaction in an action-reaction pair		
				102	calculating the force of friction		
				103	net force includes the force of friction		
				103	friction and motion		
				104	reducing friction force		

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				105	friction is the force that keeps nails and screws in place		
				105	friction applications		
				106	Newton's second law and net force		
				106	net force must be zero in equilibrium		
				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		
				109	the force from a spring		
				110	Hooke's law		
				111	understanding reaction forces in terms of springs and deformation		
				111	solid materials act like springs		
				112	analysis of forces on a bridge		
				115	friction of a pulled sled		
				116	calculate the acceleration of a toy		
				124	projectiles and trajectories		

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Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
				124	effects of friction on trajectories		
				125	speed is the magnitude of the velocity vector		
				127	calculating velocity vectors may require knowing frames of reference		
				128	constant velocity of horizontal component of projectile motion		
				128	gravity only accelerates vertical motion		
				129	vertical motion of a projectile		
				130	projectiles launched at an angle		
				130	analyzing changing velocity in vertical component of projectile motion		
				131	range of projectiles		
				133	balancing forces in two dimensions		
				134	resolving force of gravity in ramp coordinates		
				134	forces on an inclined plane		
				135	normal force of an inclined plane		

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Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
				135	frictional force on an inclined plane		
				135	acceleration down an inclined plane		
				136	calculate the acceleration of a skier on a slope		
				136	calculating acceleration on a ramp		
				136	calculating acceleration on a ramp accounting for friction		
				137	calculating acceleration from 3-D forces		
				137	the vector form of Newton's second law		
				137	predicting motion in three dimensions and controlling force and acceleration in space missions		
				139	determining position by triangulation and inertial navigation		
				141	effects of gravity on motion of a projectile		
				141	calculate the net force		
				142	effects of friction on acceleration		
				146	calculating linear speed of a moving wheel		

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Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
				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		
				149	calculating centripetal force		
				150	using centripetal acceleration to create the feeling of gravity by rotating the space station		
				150	centripetal acceleration		
				150	formula for centripetal acceleration		
				151	banked turns		
				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		

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Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
				155	centripetal force and the law of universal gravitation combine to form the orbit equation		
				155	satellite motion application		
				156	satellites in orbit		
				158	calculating centripetal force		
				158	compare projectile motion to orbital motion		
				160	using torque in household devices		
				160	center of rotation		
				161	force on a wrench		
				161	calculating torque using torque equation		
				162	calculating torque		
				163	solve a rotational equilibrium problem		
				164	calculate a torque from an angled force		
				165	the motion of a tossed object		
				166	centers of mass and gravity may differ		
				168	Newton's first law and rotational inertia		

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Standard #: Strand	Level	Content Standard	Benchmark	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		
				172	force and torque transformations in bicycles		
				173	force and torque transformations in bicycles		
				173	changing gears in a bicycle		
				174	calculating torque		
				178	input and output for simple machines		
				179	types of simple machines		
				181	how a lever works		
				181	torque and mechanical advantage of a lever		
				181	crowbar as an example of a lever		
				183	friction and mechanical advantage of wheel and axle		
				183	mechanical advantage of gears		
				183	small drills use gears		

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				184	screw turns rotating motion into linear motion		
				184	friction and mechanical advantage of ramps and screws		
				186	work done by a force at an angle to the distance		
				187	work done against gravity		
				191	potential energy comes from gravity		
				200	calculate fulcrum point of a lever		
				209	estimating power requirements based on force		
				222	Newton's first law and momentum		
				224	momentum and Newton's third law		
				228	car crash safety		
				228	seat belts and air bags		
				228	Newton's second law relating force and momentum		
				229	momentum form of Newton's second law		
				234	torque resists change in angular momentum		

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Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
				234	gyroscopes and the space shuttle		
				238	cars that crumple in a collision		
				240	forces in a car stopping		
				245	friction causes damping in oscillators		
				249	harmonic motion in machines		
				252	Newton's second law and natural frequency		
				254	definition of periodic force		
				256	friction and steady state		
				260	position vs. time graph of harmonic motion		
				260	velocity vs. time graph of harmonic motion		
				366	special relativity and time dilation		
				367	relative motion and speed of light		
				369	frequency of light depends on relative motion		
				371	simultaneity depends on the relative motion of your frame of reference		

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				425	electric forces always occur in pairs according to Newton's third law		
				460	orbital motion of a charge		
				541	force and stress		
				542	stress and breaking		
				548	Newton's third law and pressure in a fluid		
				550	pressure and the third law		
				557	pressure of gases		
				560	stress in the hull of Alvin		
				563	stress vs. pressure		
				564	calculating breaking stress		
				643	frame of reference and the equivalence principle		

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HS.PMOIV.3. Motion of Objects	High School	All students will relate motion to energy and energy conversions	Explain energy conversions in moving objects and machines.	189	energy appears in different forms	65	investigate potential and kinetic energy of ball
				190	conversions of energy	65	law of conservation of energy
				190	different forms of energy	67	calculate potential and kinetic energy
				191	the formula for potential energy	67	find the total energy at each position
				192	the formula for kinetic energy	71	potential to kinetic energy conversion in a pendulum
				193	deriving the formula for kinetic energy	71	draw an energy flow diagram
				194	energy transformations	73	investigating collisions and conservation of energy
				194	the law of conservation of energy	87	potential to kinetic energy conversions of a pendulum
				194	conservation of energy explained		
				194	energy transformations		
				195	applying conservation of energy for a marble rolling on a hilly track		
				195	conservation of energy in a closed system		
				196	energy transformation hydroelectric plant		
				196	energy transformation hydroelectric plant		
				197	conservation of energy for Hoover Dam		

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				199	trace the energy transformations from sun to a flashing taillight		
				199	kinetic and potential energy conversions while bouncing in a trampoline		
				202	efficiency and energy conversions		
				203	efficiency and conservation of energy		
				204	efficiency of Earth		
				205	efficiency in biological systems		
				205	calories in food		
				206	connection between efficiency and time		
				210	energy from the sun drives the weather on Earth		
				212	understand basic forms of energy		
				212	energy conversion		
				212	energy flow in a pendulum		
				213	the conversion process of energy flow		
				215	energy flows in biological systems		
				215	energy flows in biological systems		

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				219	energy flow of a model solar car		
				227	kinetic energy conservation for elastic collisions		
				245	kinetic to potential energy changes in motion of an oscillator		
				253	oscillators exchange energy back and forth between potential and kinetic		
				253	harmonic motion involves both potential and kinetic energy		
				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		

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				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		
				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		
				515	thermodynamics and conservation of energy		
				552	explanation of pressure and energy		

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				552	conservation of energy in fluids		
				553	energy conservation and Bernoulli's equation		
				597	the energy of chemical bonds is described		
				619	radiation as a flow of energy		
				622	energy of x-rays		
				625	energy changes in nuclear reactions		
				626	source of energy in nuclear reactions		
				627	energy of fusion reactions		
				627	fusion reactions and the sun		
				628	energy of fission reactions		
				629	conservation of energy in nuclear reactions		
				647	energy from antimatter		

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HS.PWVIV.4 Waves and Vibrations	High School	All students will describe sounds and sound waves	Relate characteristics of sounds that we hear to properties of sound waves.	276	concept of harmonics	93	investigate harmonic wave patterns
				279	vibration of a drum	95	investigate range of frequencies the ear can detect
				286	sound is a wave of pressure	95	investigate human perception of sound
				287	frequency and pitch of sound	99	investigate evidence for why sound is a wave
				287	how we hear sound waves	103	musical instruments and harmonics
				288	the decibel scale	104	music and chords and octaves
				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	pressure and amplitude of sound waves		
				291	how we know sound is a wave		
				291	sound vibrates the eardrum		
				292	frequency and wavelengths of sound		
				294	effect of medium and temperature on speed of sound wave		
				295	designing a musical instrument		

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				296	design of a good concert hall		
				298	sonograms		
				298	constructing meaning from sound		
				299	how the ear works		
				300	pitch and frequency in music		
				300	music and sound		
				301	echolocation and beats		
				302	musical instruments		
				302	harmonics and frequency and the color of sound		
				303	sound from a guitar		
				306	list evidence that sound is a wave		

Correlation to Michigan Science Content Benchmarks: Summer, 2000

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Student Text and Investigation Manual

Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
HS.PWVIV.4 Waves and Vibrations	High School	All students will explain shadows, color, and other light phenomena	Explain how we see colors of objects.	310	how we see	107	investigate RGB model of color
				316	white light is the combination of all the colors	107	investigate RGB and CMYK models of color
				317	how the human eye sees color	108	examining the spectrum of a light source
				318	how we perceive color	123	use a spectrometer to measure wavelength of different colors of light
				318	the additive color process		
				319	we see mostly reflected light		
				319	the subtractive color process		
				321	the RGB and CMYK color processes are complementary		
				324	the process of how light is reflected		
				325	color separations in high quality printing		
				326	the CMYK four-color printing process		
				331	prisms separate white light into its colors		
				337	prisms and dispersion and rainbows		
				357	relationship between frequency and energy and color of light		

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Student Text and Investigation Manual

Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
				375	relate color to frequency for visible light		
				434	RGB process and how a television picture is made		

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Student Text and Investigation Manual

Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
HS.PWVIV.4 Waves and Vibrations	High School	All students will measure and describe vibrations and waves	Describe waves in terms of their properties.	242	what is a cycle?	80	investigate the motion of a pendulum
				244	concepts of period and frequency explained	85	investigate resonance and its importance
				245	concept of amplitude explained	87	if frequency is increased what happens to total energy?
				249	analyze the motion of the cycle of a pendulum	88	study wave pulses on elastic cord
				251	systems tends to have a preferred frequency	88	making wave pulses on a string
				254	concept of resonance	89	study the speed of the wave pulse
				255	resonance occurs when periodic force matches natural frequency	90	is your water wave transverse or longitudinal?
				258	identify period and frequency and cycle and amplitude	90	making plane waves in a ripple tank
				259	resonance and amplitude	90	make different types of waves in a ripple tank
				260	calculate speed of an oscillator	90	making circular waves in a ripple tank
				264	frequency and amplitude and wavelength in waves	91	observing reflection in water waves
				265	wave pulse	91	investigate diffraction in a ripple tank
				265	concept of speed of a wave	91	investigate reflection in a ripple tank
				266	speed of a wave is the speed at which a cycle moves	93	investigate the wavelength of standing waves
				266	formula for speed of a wave		

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Student Text and Investigation Manual

Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
				267	transverse and longitudinal waves	93	investigate the frequency of standing waves
				267	water waves are transverse and Slinky is longitudinal	94	natural frequency and resonance of standing waves on a string
				268	one- and two- and three-dimensional waves	99	investigate interference with sound waves
				270	waves and reflection	100	sound waves and resonance
				270	waves and diffraction	101	resonant frequencies of water glasses
				270	waves and refraction	102	observe sound wave interference and beats
				270	waves and absorption	102	observe sound wave interference and beats
				271	waves and reflection and boundaries	124	polarization of water waves
				271	waves and refraction and boundaries	124	polarization of a spring wave
				272	waves and diffraction and boundaries	125	study the polarization of light
				272	waves and absorption and boundaries	125	polarization of light
				273	constructive and destructive interference		
				273	sound and light waves and interference		
				274	how resonance is created		
				274	resonance and reflection		
				275	standing waves and natural frequency and resonance		

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Student Text and Investigation Manual

Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
				275	standing waves on a string		
				277	energy of a wave is proportional to frequency and amplitude		
				277	standing waves on a string		
				278	wavelength of a standing wave		
				278	modes of a wave		
				278	nodes and antinodes		
				279	modes of vibration		
				280	microwaves and resonance		
				282	describe relationship between wave characteristics		
				283	type of wave represented by a spring		
				287	frequency and pitch of sound		
				288	relationship of loudness and amplitude and pressure in sound wave		
				291	pressure and amplitude of sound waves		
				292	sound is a longitudinal wave		

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Student Text and Investigation Manual

Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
				292	frequency and wavelengths of sound		
				292	importance of wavelength of sound waves		
				295	resonance of sound		
				295	standing wave patterns of sound		
				296	interference of sound waves		
				300	pitch and frequency in music		
				301	consonance and dissonance and beats		
				306	beats in a musical sound		
				356	electromagnetic waves are oscillations of an energy field		
				363	polarization		
				364	polarizers		
				365	applications of polarization		
				452	MRI--each nucleus is a resonant oscillator		
				530	absorption of thermal radiation		

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Student Text and Investigation Manual

Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
HS.PWVIV.4 Waves and Vibrations	High School	All students will measure and describe vibrations and waves	Describe different types of waves and their technological applications.	262	waves are all around us	121	study properties of the electromagnetic spectrum
				277	standing waves are used to store energy		
				281	microwaves		
				281	use of microwaves in microwave ovens		
				311	fluorescent bulbs create UV light		
				320	visible light has just the right energy for life		
				320	the energy of IR and UV light		
				359	descriptions of radio waves and microwaves and infrared rays		
				359	waves of the electromagnetic spectrum		
				359	description and examples of infrared waves		
				360	description and examples of ultraviolet waves		
				360	x-rays and gamma rays		
				360	visible light waves		
				452	MRI uses radio waves		
				531	thermal radiation and infrared light		
				624	UV light is ionizing radiation		

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Student Text and Investigation Manual

Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
HS.RII.1.1 Reflecting on Scientific Knowledge	High School	All students will analyze claims for their scientific merit and explain how scientists decide what constitutes scientific knowledge	Justify plans or explanations on a theoretical or empirical basis.	11	acceptance of the Copernican model of the solar system on the basis of scientific evidence	10	calculate percent difference
				11	Ptolemy model vs. Copernicus model of the solar system	12	was this experiment better or worse than the first?
				40	making a good model	13	find percent error
				43	constructing a graph	13	compare prediction to measurement
				44	checking a graphical model's accuracy	13	create a graph
				44	using a graphical model to make a prediction and checking the model's accuracy	16	create a graph
				44	graphical models	16	describe the graph
				54	constructing a graph	16	what do the results tell you?
				55	create a graph from a data table	18	are the accelerations different?
				103	evaluating perpetual motion claims	19	does the ball accelerate?
				290	the process of digital sound reproduction	22	create graphs
				297	frequency spectrum	22	how do you measured positions compare to model?
				306	explain why hearing can be damaged by loud sounds	22	compare calculation with graph estimate
				411	the waveform of AC electricity	24	calculate percent difference
						24	find the average time
						28	does experiment agree with prediction?
						36	make a graph

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Student Text and Investigation Manual

Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
				412	average voltage and current of AC power	36	calculate percent difference
						37	calculate percent difference
						37	make a graph
						42	sketch four graphs
						42	calculate percent difference
						42	what would happen if...?
						42	how does the measurement compare to your prediction?
						55	create a graph
						57	find average of three trials
						57	explain why the angular acceleration is different
						65	create a graph of speed vs. position
						66	calculate average of three times
						70	calculate average work and power
						75	compare predicted mass to actual mass
						79	explain your observations
						81	make three different graphs
						82	calculate percent error

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Student Text and Investigation Manual

Standard #: Strand	Level	Content Standard	Benchmark	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
						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
						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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Student Text and Investigation Manual

Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
						168	make a current vs. voltage graph for the diode
						201	find percent composition
						207	calculating percent yield
HS.RII.1.2 Reflecting on Scientific Knowledge	High School	All students will analyze claims for their scientific merit and explain how scientists decide what constitutes scientific knowledge	Describe some general limitations of scientific knowledge.	440	scientists have never found single magnetic poles		
				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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Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
HS.RII.1.3 Reflecting on Scientific Knowledge	High School	All students will show how science is related to other ways of knowing	Show how common themes of science, mathematics, and technology apply in real-world contexts.	4	learning about natural laws through inquiry and observation	22	model for uniform accelerated motion
				7	developing models to explain observations	79	explain the physics of a diver's somersaults
				12	engineers design practical devices for solving problems	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
				31	use of nanotechnology		
				40	creating useful models		
				52	strobe photography		
				72	antilock brakes application		
				73	antilock braking systems		
				80	applications of Newton's first law		
				90	examples of Newton's third law in the real world		
				101	a model for friction		
				102	a model for static friction		
				104	reducing friction and hovercraft and maglev trains		
				105	friction is useful for brakes and tires		
				109	jack-in-the-box uses a spring		

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Student Text and Investigation Manual

Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
				112	designing a bridge		
				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		
				138	use of robots		
				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		
				155	geostationary satellites		
				156	HEO and geostationary orbit		
				167	SUV rollovers and center of gravity		

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Student Text and Investigation Manual

Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
				172	bicycle physics application		
				196	hydroelectric power application		
				209	range of power for common devices		
				211	output power from plants is input power for animals		
				216	energy from ocean tides		
				217	research into tidal power		
				227	accident reconstruction		
				228	seat belts and air bags		
				232	angular momentum of skater spinning and diver		
				234	gyroscopes and angular momentum		
				235	jet engines application		
				243	examples of oscillators		
				250	why airplanes have tails		
				257	quartz crystals application		
				259	wing-beat cycle of a hummingbird		
				262	examples of waves		
				280	microwave ovens application		
				290	stereo sound		
				293	uses of Doppler radar		

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Student Text and Investigation Manual

Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
				299	understanding human hearing		
				311	invention of electric light		
				323	glow-in-the-dark plastic		
				325	the printing press		
				330	optics and optical instruments		
				337	rainbows are an example of dispersion		
				347	the compound microscope		
				349	the telescope		
				365	polarized sunglasses and LCD computer screens		
				378	importance of electricity		
				390	breakdown voltage and lightning		
				392	hybrid gas/electric cars application		
				398	holiday lights wired in series		
				401	why aren't birds electrocuted?		
				410	paying for electricity		
				413	wiring application		
				413	circuits in your house		
				413	wiring application		

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Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
				418	charge of everyday objects		
				430	almost all electric appliances use capacitors		
				433	cameras use capacitors to supply energy for flash bulbs		
				434	how television works application		
				448	how does a compass work?		
				451	MRI application		
				458	where coils are used		
				462	electromagnet in a toaster		
				490	why computers are useful		
				492	the binary number system and its use in computers		
				527	windchill factor		
				534	energy-efficient building application		
				608	how engines work		
				621	exposure to UV radiation		
				623	creation of CAT scans		
				631	nuclear power application		
				646	a standard model for particle physics		

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Student Text and Investigation Manual

Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
HS.RII.1.4 Reflecting on Scientific Knowledge	High School	All students will show how science is related to other ways of knowing	Discuss the historical development of key scientific concepts and principles.	41	Galileo and Newton conducted experiments with balls on ramps	74	the discovery of atom's nucleus
				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		
				499	development of atomic theory		
				580	Newton and classical physics		
				614	Marie Curie		
				615	Henri Bequerel and beta rays		

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Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
HS.RII.1.5 Reflecting on Scientific Knowledge	High School	All students will show how science and technology affect our society	Explain the social and economic advantages and risks of new technology.	13	x-ray and ultrasound technology are used in medicine	142	the cost of using electrical appliances
				197	efficiency of the Hoover Dam		
				217	advantages of tidal energy		
				263	medical technology using waves		
				289	stethoscopes used to hear sound vibrations		
				296	ultrasound technology		
				336	fiber optics are used for surgical inspections		
				443	magnetic resonance imaging		
				451	MRI application		
				531	infrared thermometers		
				570	use of radioactive isotopes in medicine		
				622	x-ray machines		
				622	x-ray machines		
				623	CAT scans		
				623	CAT scans		
				631	nuclear power application		
632	nuclear energy						

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Student Text and Investigation Manual

Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
HS.RII.1.6 Reflecting on Scientific Knowledge	High School	All students will show how science and technology affect our society	Develop an awareness of and sensitivity to the natural world.	7	in science inquiry is used to uncover truth		
				560	deep water submarine Alvin application		
				644	proof of Einstein's theory of general relativity		
				645	astronomers find black holes by what is around them		

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Student Text and Investigation Manual

Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
HS.RII.1.7 Reflecting on Scientific Knowledge	High School	All students will show how people of diverse cultures have contributed to and influenced developments in science	Describe the historical, political, and social factors affecting developments in science.	52	Dr. Harold Edgerton and strobe photography		
				52	Dr. Harold Edgerton and strobe photography		
				91	biomechanics application		
				92	applications of biomechanics		
				155	first artificial human-made Earth satellite was Sputnik		
				178	Great Pyramid of Giza and simple machines		
				257	Pierre and Jacques Curie and the piezoelectric effect		
				269	wave motion and equilibrium		
				290	technological breakthrough of sound recording		
				310	past theories of light		
				325	history of printing		
				348	the usefulness of recorded images		
				349	the telescope		
				361	Young's double-slit experiment		
368	Einstein's thinking revolutionized physics						

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Student Text and Investigation Manual

Standard #: Strand	Level	Content Standard	Benchmark	student text pg	detail	investigation pg	detail
				447	discovering and using magnetism		
				501	search for elements and alchemy		
				561	the Alvin research submarine		
				575	discovery of helium		
				625	turning lead into gold		