

Correlation to District of Columbia Science Standards: Essential Skills

Foundations of Physics

Student Text and Investigation Manual

Standard #: Grade	Subject	Content Standard	Essential Skills	student text pg	detail	investigation pg	detail
PHI.3.01 High School	Physics I	Each student describes the structure of matter, the physical and chemical changes it undergoes, its energy sources and transformations; and applies fundamental principles of force and motion to explore the natural world.	The student generates and interprets graphs describing motion including the use of real-time technology		data tables and graphs can be created on computer or graphing calculator	13	create a graph
				24	making graphs of experimental results over time	13	graph speed versus position
				43	constructing a graph	16	create a graph
				43	graphs are a way of representing data	16	describe the graph
				43	constructing a graph	16	find the slope of the line
				43	draw a smooth curve; do NOT simply connect the dots	16	create a speed vs. time graph
				44	graphical models	16	create a position vs. time graph
				44	using a graph to make predictions	19	find the slope of the line
				45	recognizing patterns using graphs	19	make a speed vs. time graph
				45	recognizing relationships between variables from graphs	20	speed vs. time graph for uniform acceleration
				47	position vs. time graph	22	create a speed vs. time graph
				48	determining speed from the slope of a position vs. time graph	22	create graphs
				48	graphs showing changes in speed	22	create a position vs. time graph
				48	slope of a position vs. time graph	37	make a graph
						38	make a graph
						43	create four graphs
						43	sketch four graphs
		56	create a graph				
		66	create a graph of speed vs. position				

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				49	speed vs. time graph for constant speed	82	make three different graphs
				50	graphs for motion of increasing speed and decreasing speed	87	sketch a graph
				50	speed vs. time graph for downhill motion	135	graph voltage vs. current
				50	speed vs. time graph for downhill motion	136	graph voltage vs. current
				54	understanding patterns in relationships between variables	151	make a graph of voltage vs. time
				54	constructing a graph	160	create a graph
				54	graphing speed vs. time	167	make a graph of voltage vs. number of magnets
				55	analyzing distance vs. time graph	169	make a current vs. voltage graph for the diode
				55	create a graph from a data table		
				56	indicate relationships between variables in graphs		
				61	constant speed and constant acceleration		
				62	speed vs. time graph for accelerated motion		
				63	calculating acceleration from a speed vs. time graph		
				63	acceleration and slope of a speed vs. time graph		
				63	complex speed vs. time graphs		

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				65	calculating distance from speed vs. time graph		
				74	describing motion with speed vs. time graph		
				74	sketching speed vs. time graphs for different changes of motion		
				76	analyzing graph for changes in motion		
				246	understanding graphs of harmonic motion		
				246	understanding graphs of harmonic motion		
				260	velocity vs. time graph of harmonic motion		
				260	analyze graph of an oscillator		
				260	position vs. time graph of harmonic motion		
				290	the process of digital sound reproduction		
				304	comparison of wave forms from guitar sounds		
				307	decibel level vs. frequency graph for human hearing		
				411	the waveform of AC electricity		
				427	diagramming electric fields using field lines		

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				443	diagramming magnetic fields using magnetic field lines		
				479	current vs.voltage graph for a transistor		

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PHI.3.02 High School	Physics I	Each student describes the structure of matter, the physical and chemical changes it undergoes, its energy sources and transformations; and applies fundamental principles of force and motion to explore the natural world.	The student analyzes examples of uniform and accelerated motion including linear, projectile, and circular	36	the precise meaning of speed	9	calculate speed of rolling marble
				37	how to calculate speed	9	collect data and calculate speed of car
				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	find two speeds
				48	determining speed from the slope of a position vs. time graph	17	find the acceleration
				55	calculate the average speed and distance traveled	17	studying acceleration
				58	acceleration is the rate of change in the speed of an object	17	learn techniques for finding acceleration
				59	comparing speed and acceleration	20	understanding equation for uniform accelerated motion
				60	formula for acceleration	21	calculate speed of ball
				60	calculating acceleration from experiments	23	investigate the effect of gravity
				61	zero acceleration vs. constant acceleration vs. acceleration with zero speed	25	derive acceleration equation
						26	make ball roll at constant speed
		27	were any forces acting on the ball?				
		29	calculate the acceleration				

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				61	general definition of acceleration	33	calculate the predicted speed
				62	acceleration is total change of speed divided by total change in time	42	find initial speed of ball
				64	calculate speed in accelerated motion	46	investigating angular speed
				64	calculating the speed of an object that is accelerating	46	contrasting linear and angular motion
				64	calculate speed in accelerated motion	50	calculate the speed of the ball
				67	calculate time and distance from acceleration	58	rotational application of Newton's second law
				68	free fall and acceleration due to gravity	66	find the speed of the ball
				69	motion formulas for free fall	68	what is speed of the ball?
				70	calculating height and time of flight in free fall problems	76	calculate speeds of projectile and target balls
				70	solving problems with free fall	90	calculate the speed of the wave pulse
				71	acceleration of gravity does not depend on mass	191	calculate speed of air in homemade air-speed tester
				74	understanding average speed and instantaneous speed		
				75	calculations of speed		

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				75	problem understanding acceleration due to gravity		
				78	force is an action that can change motion		
				81	force is related to acceleration		
				84	direction of net force and acceleration and speed		
				97	strength of gravity on Earth and Jupiter		
				98	gravity and acceleration and weightlessness		
				100	friction is a force that resists motion		
				103	calculate the acceleration of a car including friction		
				124	projectiles and trajectories		
				128	constant velocity of horizontal component of projectile motion		
				128	gravity only accelerates vertical motion		
				129	vertical motion of a projectile		
				129	analyze a horizontally launched projectile		
				130	projectiles launched at an angle		

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				130	analyzing changing velocity in vertical component of projectile motion		
				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		
				142	calculating acceleration for sled on slope		
				144	rotation and revolution and angular speed		
				145	calculating angular speed in radians per second		
				146	calculating linear speed of a moving wheel		
				146	the relationship between linear and angular speed		
				146	angular speed of a moving wheel		
				147	the linear speed of a rolling wheel		
				147	speedometers and odometers		
				148	acceleration can be a change in the direction of motion		

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				148	centripetal force causes circular motion		
				150	centripetal acceleration		
				150	calculate the centripetal acceleration of a motorcycle		
				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		
				157	compare linear and angular speeds		
				158	compare projectile motion to orbital motion		
				160	translation and rotation		
				165	the motion of a tossed object		
				166	centers of mass and gravity may differ		
				169	relationship between angular acceleration and linear acceleration		
				171	rotational motion and linear motion		

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				171	angular acceleration of a wheel		
				187	work done against gravity		
				191	potential energy comes from gravity		
				231	linear and angular momentum		
				238	compare linear and angular momentum		
				254	definition of periodic force		

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PHI.3.03 High School	Physics I	Each student describes the structure of matter, the physical and chemical changes it undergoes, its energy sources and transformations; and applies fundamental principles of force and motion to explore the natural world.	The student demonstrates the effects of forces on the motion of objects	13	biomechanics	23	investigate the effect of gravity
				13	physics and bicycles	26	study Newton's first law
				41	effect of friction on motion of a ball on a ramp	27	collect data on Newton's first law
				61	any acceleration must come from a force	27	were any forces acting on the ball?
				68	free fall and acceleration due to gravity	27	explain how Newton's first law applies
				69	motion formulas for free fall	34	investigate static and sliding friction
				70	solving problems with free fall	49	investigating centripetal force
				71	air resistance and terminal speed	49	consider forces acting on the ball
				71	acceleration of gravity does not depend on mass	61	what effect does friction have on mechanical advantage?
				72	friction and traction and antilock brakes		
				75	problem understanding acceleration due to gravity		
				78	force is an action that can change motion		
				78	changes in motion only occur through force		
				79	all objects tend to resist changes in motion		
				81	force is related to acceleration		

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				85	if there is acceleration there must be force		
				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	calculating the force of friction		
				103	friction and motion		
				104	reducing friction force		
				105	friction applications		
				115	friction of a pulled sled		
				124	effects of friction on trajectories		
				124	projectiles and trajectories		
				128	gravity only accelerates vertical motion		
				129	vertical motion of a projectile		

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				130	projectiles launched at an angle		
				131	range of projectiles		
				133	balancing forces in two dimensions		
				134	resolving force of gravity in ramp coordinates		
				135	frictional force on an inclined plane		
				135	acceleration down an inclined plane		
				136	calculating acceleration on a ramp accounting for friction		
				141	effects of gravity on motion of a projectile		
				142	effects of friction on acceleration		
				148	direction of force determines linear or rotational motion		
				148	centripetal force causes circular motion		
				149	calculating centripetal force		
				152	law of universal gravitation and orbital motion		
				154	orbits and gravitational force		

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				155	centripetal force and the law of universal gravitation combine to form the orbit equation		
				155	centripetal force and the law of universal gravitation combine to form the orbit equation		
				158	compare projectile motion to orbital motion		
				158	calculating centripetal force		
				165	the motion of a tossed object		
				166	centers of mass and gravity may differ		
				168	Newton's first law and rotational inertia		
				172	force and torque transformations in bicycles		
				173	force and torque transformations in bicycles		
				180	mechanical advantage of human arm		
				183	friction and mechanical advantage of wheel and axle		

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				184	friction and mechanical advantage of ramps and screws		
				187	work done against gravity		
				191	potential energy comes from gravity		
				222	Newton's first law and momentum		
				228	car crash safety		
				245	friction causes damping in oscillators		
				254	definition of periodic force		
				256	friction and steady state		
				460	orbital motion of a charge		

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PHI.3.04 High School	Physics I	Each student describes the structure of matter, the physical and chemical changes it undergoes, its energy sources and transformations; and applies fundamental principles of force and motion to explore the natural world.	The student develops and interprets a free-body diagram for force analysis	83 84 86 89 103 106 107 107 112 135 141	finding the net force calculating net force zero acceleration means net zero force solving problems with action-reaction forces net force includes the force of friction net force must be zero in equilibrium net force of zero and free-body diagram forces on a free-body diagram analysis of forces on a bridge normal force of an inclined plane calculate the net force	30 31 45	Newton's third law and free body diagrams draw free body diagrams and identify action-reaction pairs balancing a specified force

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PHI.3.05 High School	Physics I	Each student describes the structure of matter, the physical and chemical changes it undergoes, its energy sources and transformations; and applies fundamental principles of force and motion to explore the natural world.	The student identifies and describes motion relative to different frames of reference	36 75 127 366 367 369 371 643	speed is relative problem using frames of reference calculating velocity vectors may require knowing frames of reference special relativity and time dilation relative motion and speed of light frequency of light depends on relative motion simultaneity depends on the relative motion of your frame of reference frame of reference and the equivalence principle	128	relativity and frames of reference

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PHI.3.06 High School	Physics I	Each student describes the structure of matter, the physical and chemical changes it undergoes, its energy sources and transformations; and applies fundamental principles of force and motion to explore the natural world.	The student interprets evidence for the work-energy theorem	185	work and energy	64	compare output and input work
				188	for all machines work out cannot exceed work in	64	relationship between work and energy
				189	relationship between work and energy	66	law of conservation of energy
				191	the symmetry between work and energy	68	find the total energy at each position
				194	the law of conservation of energy	74	investigating collisions and conservation of energy
				194	conservation of energy explained		
				195	applying conservation of energy for a marble rolling on a hilly track		
				195	conservation of energy in a closed system		
				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		

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				469	energy conservation and Faraday's law		
				515	thermodynamics and conservation of energy		
				552	conservation of energy in fluids		
				553	energy conservation and Bernoulli's equation		
				629	conservation of energy in nuclear reactions		

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PHI.3.07 High School	Physics I	Each student describes the structure of matter, the physical and chemical changes it undergoes, its energy sources and transformations; and applies fundamental principles of force and motion to explore the natural world.	The student observes and describes examples of kinetic and potential energy and their transformations	190	conversions of energy	66	law of conservation of energy
				191	the formula for potential energy	68	find the total energy at each position
				192	the formula for kinetic energy	68	calculate potential and kinetic energy
				193	deriving the formula for kinetic energy	72	potential to kinetic energy conversion in a pendulum
				194	energy transformations	72	draw an energy flow diagram
				194	energy transformations	74	investigating collisions and conservation of energy
				195	applying conservation of energy for a marble rolling on a hilly track	74	investigating collisions and conservation of energy
				196	energy transformation hydroelectric plant	88	potential to kinetic energy conversions of a pendulum
				196	energy transformation hydroelectric plant		
				197	conservation of energy for Hoover Dam		
				199	kinetic and potential energy conversions while bouncing in a trampoline		
				202	efficiency and energy conversions		
				205	efficiency in biological systems		
				212	energy flow in a pendulum		
				212	energy conversion		
				213	the conversion process of energy flow		

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				219	energy flow of a model solar car		
				245	kinetic to potential energy changes in motion of an oscillator		
				253	harmonic motion involves both potential and kinetic energy		
				253	oscillators exchange energy back and forth between potential and kinetic		
				256	resonant systems accumulate energy		
				277	waves propagate by exchanging energy between two forms		
				320	photosynthesis converts light energy to chemical energy		
				324	light from chemical reactions		
				356	electromagnetic waves exchange energy between electricity and magnetic parts		
				393	conversion of energy in regenerative braking		
				400	energy conversions in a series circuit		

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				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		
				552	potential energy of pressure		

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PHI.3.08 High School	Physics I	Each student describes the structure of matter, the physical and chemical changes it undergoes, its energy sources and transformations; and applies fundamental principles of force and motion to explore the natural world.	The student calculates the mechanical energy and momentum in a physical system	191	the formula for potential energy	68	calculate potential and kinetic energy
				191	calculate the potential energy of a cart	70	calculate person's power
				192	calculating kinetic energy depends on speed and mass	71	calculate power output for each climber
				192	the formula for kinetic energy	73	calculating momentum
				193	calculate the kinetic energy of a moving car	75	investigate collisions and conservation of momentum
				193	deriving the formula for kinetic energy	77	the momentum form of Newton's second law
				197	calculating energy supplied by Hoover Dam		
				207	power is the rate of doing work or using energy		
				207	calculate power in climbing stairs		
				208	units of power		
				208	power formulas		
				209	calculating power for common devices		
				210	estimating the power in wind		
				211	estimate average input power of a person		
				211	power in biological systems		

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				216	estimating the energy in tides		
				220	calculate energy and power for humans		
				220	calculate power rating		
				223	momentum formula and calculating momentum		
				226	solving elastic and inelastic collision problems		
				229	force on a rocket from change in momentum		
				230	calculate change in momentum for elastic vs. inelastic collisions		
				236	momentum conservation of turbofan engine		
				238	momentum in billiards		
				239	calculate momentum		
				253	harmonic motion involves both potential and kinetic energy		
				276	natural frequency and harmonics		
				409	power and efficiency of electric cars		

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PHI.3.09 High School	Physics I	Each student describes the structure of matter, the physical and chemical changes it undergoes, its energy sources and transformations; and applies fundamental principles of force and motion to explore the natural world.	The student demonstrates the conservation of energy and momentum	194	conservation of energy explained	66	law of conservation of energy
				194	the law of conservation of energy	68	find the total energy at each position
				195	applying conservation of energy for a marble rolling on a hilly track	74	investigating collisions and conservation of energy
				195	conservation of energy in a closed system	78	which ball had a greater change in momentum?
				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		
				224	law of conservation of momentum		
				225	conservation of momentum in collisions		
				226	applying conservation of momentum		
				227	kinetic energy conservation for elastic collisions		
				227	momentum conservation for collisions in two and three dimensions		

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				231	conservation of angular momentum examples		
				232	conservation of angular momentum		
				235	jet engines work because of conservation of momentum		
				370	relationship and conservation of mass and energy		
				370	Einstein's thinking about momentum of particles moving near the speed of light		
				469	energy conservation and Faraday's law		
				515	thermodynamics and conservation of energy		
				552	conservation of energy in fluids		
				553	energy conservation and Bernoulli's equation		
				629	conservation of energy in nuclear reactions		
				629	conservation of momentum in nuclear reactions		

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PHI.3.10 High School	Physics I	Each student describes the structure of matter, the physical and chemical changes it undergoes, its energy sources and transformations; and applies fundamental principles of force and motion to explore the natural world.	The student identifies the influence of mass and distance on gravitational forces	152	description of law of universal gravitation	51	calculate gravitational force of attraction
				153	formula and calculations for law of universal gravitation	51	investigate law of universal gravitation
				154	satellites and orbital motion		
				154	orbital motion		
				155	satellite motion application		
				156	HEO and geostationary orbit		
				158	calculate weight and acceleration due to gravity on Pluto		
				216	tides are due to force of gravity		
	243	orbit is a type of cycle					
	642	Newton's laws and gravity					

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PHI.3.11 High School	Physics I	Each student describes the structure of matter, the physical and chemical changes it undergoes, its energy sources and transformations; and applies fundamental principles of force and motion to explore the natural world.	The student researches, then interprets and shares the historical development of the concepts of gravitational, electrical, and magnetic force	41	Galileo and Newton conducted experiments with balls on ramps		
				52	Dr. Harold Edgerton and strobe photography		
				78	Newton's laws of motion		
				81	Newton's discovery of the connection between force and mass and acceleration		
				152	Sir Isaac Newton and law of universal gravitation		
				155	first artificial human-made Earth satellite was Sputnik		
				178	Great Pyramid of Giza and simple machines		
				257	Pierre and Jacques Curie and the piezoelectric effect		
				269	wave motion and equilibrium		
				290	technological breakthrough of sound recording		
				310	past theories of light		
				325	history of printing		
				348	the usefulness of recorded images		
				349	Galileo and telescopes		

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				349	the telescope		
				350	Newtonian reflecting telescope		
				361	Young's double-slit experiment		
				368	Einstein's thinking revolutionized physics		
				382	Ben Franklin and current		
				420	Charles-Augustin de Coulomb		
				440	magnetism		
				447	history of magnetism		
				447	discovering and using magnetism		
				501	search for elements and alchemy		
				501	ancient Greeks' ideas of elements		
				561	the Alvin research submarine		
				575	discovery of helium		
				580	Newton and classical physics		
				625	turning lead into gold		

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PHI.3.12 High School	Physics I	Each student describes the structure of matter, the physical and chemical changes it undergoes, its energy sources and transformations; and applies fundamental principles of force and motion to explore the natural world.	The student identifies and analyzes the influences of charge and distance on electric forces	418	electric charge is a fundamental property of matter	146	build a simple electroscope
				419	electric forces are created between electric charges	147	investigate the concept of electric charge
				419	differences between electric force and gravity	149	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	comparison between electric fields and gravitational fields		
				428	source charges and test charges		

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				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		

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PHI.3.13 High School	Physics I	Each student describes the structure of matter, the physical and chemical changes it undergoes, its energy sources and transformations; and applies fundamental principles of force and motion to explore the natural world.	The student demonstrates the relationship between electricity and magnetism	356	electricity and magnetism oscillations	159	build an electromagnet
				435	steering the electron beam on television screen	160	find out what happens to strength of electromagnet when current is increased
				441	comparing magnetic and electric forces	160	what happens to the strength of an electromagnet when you increase the current?
				442	force between two magnetics is not an inverse square law	165	investigate electromagnetic induction
				453	magnetic poles and electric charge		
				456	magnetic field of a wire		
				457	force on a current in a magnetic field		
				462	electromagnets		
				463	building an electromagnet		
				464	electric motor uses electromagnets to convert electrical energy to mechanical energy		
				465	how electromagnets are used in electric motors		
				467	concept of electromagnetic induction		
				471	transformers operate on electromagnetic induction		
				472	electromagnet-based maglev		
				475	diagram of electromagnet		

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PHI.3.14 High School	Physics I	Each student describes the structure of matter, the physical and chemical changes it undergoes, its energy sources and transformations; and applies fundamental principles of force and motion to explore the natural world.	The student designs and analyzes electric circuits	379	concept of a circuit	129	short circuit precautions
				380	circuit diagrams and electrical symbols	129	construct simple electric circuits
				380	understanding simple circuit and its diagram	130	understand the difference between open and closed circuits
				381	definition of short circuit	130	draw and interpret circuit diagrams
				381	open and closed circuits	131	short circuit precautions
				384	battery uses chemical energy to produce electrical charge	131	construct a simple circuit
				386	simple bulb and battery circuits to illustrate electrical resistance	137	parallel circuit and Ohm's law
				388	calculate the current flowing in a circuit	137	investigate series circuits
				398	parallel circuit defined	138	build a parallel circuit
				398	series circuit defined	139	compare series and parallel circuits
				399	current and resistance in a series circuit	139	analyze parallel circuits
				400	Kirchoff's voltage law	140	build and analyze network circuits
				400	voltage in a series circuit	150	short circuit precautions
				401	Kirchhoff's current law		
				401	parallel circuits		
				402	voltage and current in a parallel circuit		
				402	advantages of parallel circuits over series circuits		

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				402	short circuits		
				403	resistance in parallel circuits		
				404	using Kirchhoff's voltage law for circuit analysis		
				404	using Kirchhoff's current law for circuit analysis		
				405	analyzing a voltage divider circuit		
				405	voltage dividers		
				406	comparing series and parallel circuits		
				407	solving network circuits		
				407	solving network circuits		
				414	why series circuits are not used in homes and buildings		
				414	why parallel circuits are used in homes and buildings		
				415	compare current in a series and parallel circuit		
				415	explain short circuit		
				431	circuit symbol for a capacitor		

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PHI.3.15 High School	Physics I	Each student describes the structure of matter, the physical and chemical changes it undergoes, its energy sources and transformations; and applies fundamental principles of force and motion to explore the natural world.	The student identifies examples of electrical and magnetic forces in everyday life	4	learning about natural laws through inquiry and observation	80	explain the physics of a diver's somersaults
				19	problems in the real world use both metric and English units	92	how does sound get through tiny cracks?
				52	strobe photography	126	explain how polarizing sunglasses work
				73	antilock braking systems	157	study how a compass works
				80	applications of Newton's first law	161	investigate how an electric motor works
				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		
				138	robot navigation application		

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				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		
				259	wing-beat cycle of a hummingbird		

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				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		
				412	average power in an electric motor		
				413	circuits in your house		
				413	wiring application		
				418	charge of everyday objects		
				419	differences between electric force and gravity		
				424	the strength of electric forces		

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Standard #: Grade	Subject	Content Standard	Essential Skills	student text pg	detail	investigation pg	detail
				426	gravity is far weaker than electric forces		
				428	comparison between electric fields and gravitational fields		
				430	almost all electric appliances use capacitors		
				433	cameras use capacitors to supply energy for flash bulbs		
				441	comparing magnetic and electric forces		
				442	force between two magnetics is not an inverse square law		
				448	how does a compass work?		
				448	how does a compass work?		
				450	compensating for magnetic declination		
				453	how a compass is used		
				458	where coils are used		
				462	electromagnet in a toaster		
				464	principle of the electric motor		
				465	commutation		
				466	battery-powered electric motors		

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				527	windchill factor		
				608	how engines work		
				621	exposure to UV radiation		
				646	a standard model for particle physics		

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PHI.3.16 High School	Physics I	Each student describes the structure of matter, the physical and chemical changes it undergoes, its energy sources and transformations; and applies fundamental principles of force and motion to explore the natural world.	The student examines and describes a variety of waves propagated in various types of media and describe wave characteristics such as velocity, frequency, amplitude, refraction, and interference	242	what is a cycle?	81	investigate the motion of a pendulum
				244	concepts of period and frequency explained	85	investigate natural frequency
				245	concept of amplitude explained	88	if frequency is increased what happens to total energy?
				249	analyze the motion of the cycle of a pendulum	89	making wave pulses on a string
				251	concept of natural frequency	89	study characteristics of a wave pulse on a string
				251	systems tends to have a preferred frequency	89	study wave pulses on elastic cord
				252	changing natural frequency	90	study the speed of the wave pulse
				254	periodic force and natural frequency	90	measure speed of a wave pulse
				255	resonance occurs when periodic force matches natural frequency	91	make different types of waves in a ripple tank
				258	identify period and frequency and cycle and amplitude	91	making plane waves in a ripple tank
				260	calculate speed of an oscillator	91	is your water wave transverse or longitudinal?
				264	basic properties of frequency and wavelength and amplitude	91	making circular waves in a ripple tank
				264	frequency and amplitude and wavelength in waves	92	investigate diffraction in a ripple tank
				265	speed of a wave vs. speed of its medium	92	investigate reflection in a ripple tank

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Standard #: Grade	Subject	Content Standard	Essential Skills	student text pg	detail	investigation pg	detail
				265	concept of speed of a wave	92	observing reflection in water waves
				265	wave pulse	93	investigate frequency and wavelength
				266	speed of a wave is the speed at which a cycle moves	94	investigate the wavelength of standing waves
				266	formula for speed of a wave	94	investigate the frequency of standing waves
				267	water waves are transverse and Slinky is longitudinal	101	investigate interference with sound waves
				267	transverse and longitudinal waves	106	study refraction in a prism
				268	creating plane waves and circular waves	113	investigate Snell's law of refraction
				268	one- and two- and three-dimensional waves	113	study how refraction works
				269	propagation of waves through continuous materials	114	apply Snell's law of refraction
				270	waves and diffraction	123	study light interference
				270	waves and reflection	125	study the polarization of a transverse spring wave
				270	waves and refraction		
				270	concept of boundaries		
				271	waves and refraction and boundaries		
				271	curved boundaries		
				271	waves and reflection and boundaries		

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Standard #: Grade	Subject	Content Standard	Essential Skills	student text pg	detail	investigation pg	detail
				272	waves and diffraction and boundaries		
				273	constructive and destructive interference		
				273	concept of the superposition principle		
				274	resonance and reflection		
				274	natural frequency of waves		
				275	standing waves on a string		
				275	boundaries and natural frequency		
				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		
				282	describe relationship between wave characteristics		
				283	type of wave represented by a spring		

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Standard #: Grade	Subject	Content Standard	Essential Skills	student text pg	detail	investigation pg	detail
				283	analyze superimposed waves		
				284	which direction does a cork move on a water wave?		
				284	superimpose two waves		
				286	properties of sound waves		
				287	frequency and pitch of sound		
				287	the superposition of sound waves		
				288	relationship of loudness and amplitude and pressure in sound wave		
				291	pressure and amplitude of sound waves		
				292	importance of wavelength of sound waves		
				292	frequency and wavelengths of sound		
				292	sound is a longitudinal wave		
				294	speed of sound in different materials		
				295	standing wave patterns of sound		
				296	interference of sound waves		

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Standard #: Grade	Subject	Content Standard	Essential Skills	student text pg	detail	investigation pg	detail
				297	Fourier's theorem and superposition principle and frequency spectrum		
				300	pitch and frequency in music		
				301	consonance and dissonance and beats		
				303	design of a guitar		
				306	beats in a musical sound		
				307	applying superposition principle		
				308	wave amplitude and harmonics of tuning fork and musical instrument		
				315	light bends as it moves into a material		
				334	refraction is the bending of light rays		
				335	Snell's law of refraction		
				340	lenses follow Snell's law of refraction		
				340	design of a lens		
				354	using Snell's law		
				356	electromagnetic waves are oscillations of an energy field		
				361	interference of light waves and Young's double-slit experiment		

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Standard #: Grade	Subject	Content Standard	Essential Skills	student text pg	detail	investigation pg	detail
				373	holograms and the interference of light		
				452	MRI--each nucleus is a resonant oscillator		

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Standard #: Grade	Subject	Content Standard	Essential Skills	student text pg	detail	investigation pg	detail
PHI.3.17 High School	Physics I	Each student describes the structure of matter, the physical and chemical changes it undergoes, its energy sources and transformations; and applies fundamental principles of force and motion to explore the natural world.	The student identifies the characteristics and behaviors of sound and electromagnetic waves	267	transverse and longitudinal waves	91	is your water wave transverse or longitudinal?
				276	concept of harmonics	94	investigate harmonic wave patterns
				278	modes of a wave		
				279	modes of vibration	96	investigate range of frequencies the ear can detect
				281	microwaves		
				283	type of wave represented by a spring		
				286	sound waves require matter to traverse		
				286	sound is a wave of pressure		
				287	how we hear sound waves		
				287	frequency and pitch of sound		
				288	the decibel scale		
				288	loudness and decibels and the sensitivity of the ear		
				288	relationship of loudness and amplitude and pressure in sound wave		
				289	vibrations create sound		
				291	sound vibrates the eardrum		
				291	how we know sound is a wave		

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Standard #: Grade	Subject	Content Standard	Essential Skills	student text pg	detail	investigation pg	detail
				291	pressure and amplitude of sound waves		
				292	sound is a longitudinal wave		
				292	frequency and wavelengths of sound		
				294	effect of medium and temperature on speed of sound wave		
				298	constructing meaning from sound		
				299	how the ear works		
				300	music and sound		
				300	pitch and frequency in music		
				302	harmonics and frequency and the color of sound		
				306	list evidence that sound is a wave		
				359	waves of the electromagnetic spectrum		
				530	electromagnetic radiation		

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Standard #: Grade	Subject	Content Standard	Essential Skills	student text pg	detail	investigation pg	detail
PHI.3.18 High School	Physics I	Each student describes the structure of matter, the physical and chemical changes it undergoes, its energy sources and transformations; and applies fundamental principles of force and motion to explore the natural world.	The student interprets the role of wave characteristics and behaviors found in medical and industrial applications	262 277 279 281 289 295 296 298 301 302 303 359 360 452	waves are all around us standing waves are used to store energy vibration of a drum use of microwaves in microwave ovens acoustics designing a musical instrument design of a good concert hall sonograms echolocation and beats musical instruments sound from a guitar descriptions of radio waves and microwaves and infrared rays x-rays and gamma rays MRI uses radio waves	96	investigate human perception of sound

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Standard #: Grade	Subject	Content Standard	Essential Skills	student text pg	detail	investigation pg	detail
PHI.3.19 High School	Physics I	Each student describes the structure of matter, the physical and chemical changes it undergoes, its energy sources and transformations; and applies fundamental principles of force and motion to explore the natural world.	The student describes the photoelectric effect; explains the line spectra from different gas-discharge tubes	362 574 575 580 581 589 638	diffraction patterns and the spectrometer emission/absorption spectrum spectrum of hydrogen the photoelectric effect Einstein explains the photoelectric effect photoelectric effect spectral-line patterns and red shift	110 197	all light is produced by atoms absorption and emission of light by atomic electrons