

Correlation to Indiana's Science Academic Standards

Foundations of Physics

Student Text and Investigation Manual

Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
P.1.01 Physics I	Standard 1: Principles of Physics	The Properties of Matter	Describe matter in terms of its fundamental constituents and be able to differentiate among those constituents.	29	all matter is made of atoms	174	matter is composed of atoms
				420	electric charge is a property of the particles that make up the atom	175	record atomic number
				420	electric charge is a property of the particles that make up the atom	194	basic properties of subatomic particles
				420	electric charge is a property of the particles that make up the atom	194	subatomic particles
				422	movement of electrons in current	203	how many electrons are in the outermost level?
				437	draw a model of an atom	203	electrons and energy levels
				444	magnetism is a property of particles that make up the atom	203	review subatomic particles
				444	electrons and magnetism	204	modeling a chemical bond
				459	atomic currents		
				480	electrons in a semiconductor		
				499	idea that matter is made of atoms proved through Brownian motion		
				500	smallest piece of matter is the atom		
				501	atoms and elements		
				566	charge and mass of electrons and protons and neutrons		
				566	three particles make up the atom		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				567	mass and the nucleus		
				567	structure of the atom		
				569	elements and atoms and atomic number		
				570	chemical properties of isotopes due to atomic structure		
				572	stability of nucleus and balance of protons and neutrons		
				574	Neils Bohr's theory		
				576	Neils Bohr		
				577	energy levels explain spectral lines		
				588	properties of subatomic particles		
				595	electrons from chemical bonds		
				596	valence and chemical bonds		
				597	why chemical bonds form		
				598	use of noble gases to prevent chemical bonds in MIG welding		

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P.1.02 Physics I	Standard 1: Principles of Physics	The Properties of Matter	Measure or determine the physical quantities including mass, charge, pressure, volume, temperature, and density of an object or unknown sample.	41	size and mass and shape are variables that affect motion	175	find the density
				503	molecules and properties of matter	176	investigate temperature and its effect on materials
				504	temperature scales and Fahrenheit-Celsius conversions	177	the density of ice vs. water
				505	measuring temperature	192	investigate the mass of a volume of gas at different pressures
				507	the Kelvin scale and converting between Kelvin and Celsius	193	investigate the effect of temperature on pressure
				519	understanding Fahrenheit and Celsius and Kelvin		
				533	using Kelvin for radiation calculations		
				540	densities of common materials		
				541	strength of materials depends on form and material		
				542	breaking strength of materials under stress		
				547	relationship between mass and volume and density		
				558	pressure and temperature of gases		
				558	using temperature in Kelvins for Charles' law		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
P.1.03 Physics I	Standard 1: Principles of Physics	The Properties of Matter	Describe and apply the kinetic molecular theory to the states of matter.	30	relationship between states of matter and arrangement and motion of atoms and molecules	176	investigate temperature and its effect on materials
				33	describe movement of atoms in solids and gases	179	specific heat
				504	temperature scales and Fahrenheit-Celsius conversions	182	investigate convection in a liquid
				505	measuring temperature		
				506	temperature measures average kinetic energy		
				507	the Kelvin scale and converting between Kelvin and Celsius		
				508	phases of matter and arrangement of molecules		
				509	temperature change and thermal energy		
				509	heat of fusion		
				510	heat of vaporization		
				511	evaporation and condensation		
				513	transfer of thermal energy		
				514	specific heat and the heat equation		
				516	refrigerator application		
				519	understanding Fahrenheit and Celsius and Kelvin		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				519	phases of matter		
				520	relationship between temp and average kinetic energy		
				522	heat conduction		
				523	heat conduction		
				524	conduction in solids and liquids and gases		
				526	convection in liquids		
				527	convection depends on speed and surface area		
				528	convection and weather		
				530	radiation		
				533	using Kelvin for radiation calculations		
				535	sources of heat transfer in buildings		
				535	sources of heat transfer in buildings		
				558	using temperature in Kelvins for Charles' law		
				606	energy from sunlight stored through photosynthesis		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
P.1.04 Physics I	Standard 1: Principles of Physics	The Properties of Matter	Employ correct units in describing common physical quantities.	18	measurements of distance in units of length	2	practice length measurement
				19	description of length measured in English and metric systems	2	significant digit practice
				4	measuring time	6	precision in measurement
				19	scientists use metric units	7	estimating mass
				21	calculating volume of simple shapes	9	make distance measurement
				22	time intervals	18	measure the length
				23	units for measuring time	23	measure the distance
				24	time intervals in physics	26	find length in centimeters
				25	understanding precision	29	measure the force
				25	accuracy and precision of measurements	34	measure the force
				27	measuring mass in kg and grams	34	measure the mass
				33	commonly used units for measuring mass	36	measure the mass
				36	measure the new position	46	working with radians
				37	units for speed	62	measure string length
				58	units of acceleration	65	measure vertical distance
				60	understanding units of acceleration	68	convert grams to kilograms
				82	units of force are pounds and newtons	70	measure and mark height
				82	unit of force is derived	78	make the string 70 cm long
				83	understanding units for using Newton's second law	78	measure mass of ball

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				110	units for spring constant	93	measure frequency
				144	units of angular speed	96	measure frequency
				145	using radians per second to measure angular speed	131	measure current in a circuit
				157	units of angular speed	132	measure voltage in a circuit
				164	torque in English units	137	measure voltage and current in series circuits
				186	units of work are joules	148	investigate electrical forces in a penny
				244	frequency is measured in hertz	153	making measurements with precision
				382	unit of electric current is the ampere or amp (A)	153	make measurement with precision
				383	voltage is measured in volts (V)	163	measure direct current
				387	electrical resistance is measured in ohms	164	measure voltage of battery pack
				408	measuring power in watts	165	measure voltage
				409	units of watts and horsepower used in electrical circuits	169	measure current and voltage
				410	electric companies charge for kilowatt-hours used	171	measure current and voltage
				420	coulomb is the unit of charge	178	measure 100 grams of water
				421	one ampere is the flow of one coulomb per second	192	set the pressure to 10 psi
				428	deriving units for measuring electric fields	192	find the mass of the bottle
						193	convert psi to Pa

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				460	magnetic field strength	202	find the mass to the nearest tenth of a gram
				475	units of magnetic field		
				513	joules and calories and Btus	202	find the mass
				542	units for stress		
				548	units of pressure		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
P.1.05 Physics I	Standard 1: Principles of Physics	Relationships between Motion and Force	Use appropriate vector and scalar quantities to solve kinematics and dynamics problems in one and two dimensions.	36	the precise meaning of speed	9	calculate speed of rolling marble
				37	calculating speed	9	collect data and calculate speed of car
				37	how to calculate 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	21	calculate speed of ball
				55	calculate the average speed and distance traveled	26	make ball roll at constant speed
				64	calculate speed in accelerated motion	33	calculate the predicted speed
				74	understanding average speed and instantaneous speed	39	investigating vectors
				75	calculations of speed	41	calculate the resultant vector
				118	vectors have magnitude and direction	42	find initial speed of ball
				119	adding vectors	43	calculate the velocity vector
				119	displacement vectors	44	investigating force vectors
				120	adding vectors	49	draw a free body diagram and label forces
				50	calculate the speed of the ball		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				121	adding and subtracting vectors	66	find the speed of the ball
				124	definition of the velocity vector	68	what is speed of the ball?
				125	the velocity vector	76	calculate speeds of projectile and target balls
				126	components of the velocity vector	90	calculate the speed of the wave pulse
				127	adding velocity vectors	191	calculate speed of air in homemade air-speed tester
				127	adding velocity vectors		
				132	the force vector describes the strength and direction of a force		
				136	calculate the acceleration of a skier on a slope		
				146	calculating linear speed of a moving wheel		
				147	the linear speed of a rolling wheel		
				186	work done by a force at an angle to the distance		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
P.1.06 Physics I	Standard 1: Principles of Physics	Relationships between Motion and Force	Describe and measure motion in terms of position, time, and the derived quantities of velocity and acceleration.	38	compare and contrast speed and velocity	13	graph speed versus position
				47	position vs. time graph	16	create a speed vs. time graph
				48	graphs showing changes in speed	16	create a position vs. time graph
				48	determining speed from the slope of a position vs. time graph	17	learn techniques for finding acceleration
				49	speed vs. time graph for constant speed	17	find the acceleration
				50	speed vs. time graph for downhill motion	17	studying acceleration
				50	graphs for motion of increasing speed and decreasing speed	19	make a speed vs. time graph
				54	graphing speed vs. time	20	speed vs. time graph for uniform acceleration
				55	analyzing distance vs. time graph	20	understanding equation for uniform accelerated motion
				58	acceleration is the rate of change in the speed of an object	22	create a speed vs. time graph
				59	comparing speed and acceleration	22	create a position vs. time graph
				60	formula for acceleration	25	derive acceleration equation
				60	calculating acceleration from experiments	29	calculate the acceleration
				61	general definition of acceleration	49	consider forces acting on the ball

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				61	zero acceleration vs. constant acceleration vs. acceleration with zero speed		
				61	constant speed and constant acceleration		
				62	speed vs. time graph for accelerated motion		
				62	acceleration is total change of speed divided by total change in time		
				63	complex speed vs. time graphs		
				63	calculating acceleration from a speed vs. time graph		
				64	calculating the speed of an object that is accelerating		
				64	calculate speed in accelerated motion		
				65	calculating distance from speed vs. time graph		
				67	calculate time and distance from acceleration		
				70	calculating height and time of flight in free fall problems		
				74	describing motion with speed vs. time graph		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				74	sketching speed vs. time graphs for different changes of motion		
				76	analyzing graph for changes in motion		
				84	direction of net force and acceleration and speed		
				99	balanced force problems		
				103	calculate the acceleration of a car including friction		
				125	speed is the magnitude of the velocity vector		
				128	constant velocity of horizontal component of projectile motion		
				129	analyze a horizontally launched projectile		
				130	analyzing changing velocity in vertical component of projectile motion		
				133	balancing forces in two dimensions		
				142	calculating acceleration for sled on slope		
				150	centripetal acceleration		
				150	calculate the centripetal acceleration of a motorcycle		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				260	position vs. time graph of harmonic motion		
				260	velocity vs. time graph of harmonic motion		

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P.1.07 Physics I	Standard 1: Principles of Physics	Relationships between Motion and Force	Use Newton's Laws (e.g., $F = ma$) together with the kinematic equations to predict the motion of an object.	61	any acceleration must come from a force	26	study Newton's first law
				78	changes in motion only occur through force	27	collect data on Newton's first law
				79	all objects tend to resist changes in motion	27	explain how Newton's first law applies
				80	Newton's laws and cup holders	28	investigate Newton's second law
				81	Newton's second law of motion	30	Newton's third law and free body diagrams
				83	calculation using Newton's second law	30	investigate Newton's third law
				84	Newton's second law and dynamics problems	31	draw free body diagrams and identify action- reaction pairs
				85	force problems	77	relationship between force and motion and the second law
				85	if there is acceleration there must be force		
				85	finding force from acceleration		
				87	forces always occur in action-reaction pairs		
				88	Newton's third law operates on pairs of objects		
				89	solving problems with action-reaction forces		
				89	identifying which force is acting on which object		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				93	problems using Newton's first law and second law		
				94	seat belt problem		
				102	the normal force as the reaction in an action-reaction pair		
				106	Newton's second law and net force		
				107	forces on a free-body diagram		
				108	use equilibrium to find an unknown force		
				108	equilibrium and Newton's second law		
				111	understanding reaction forces in terms of springs and deformation		
				112	analysis of forces on a bridge		
				116	calculate the acceleration of a toy		
				135	normal force of an inclined plane		
				136	calculating acceleration on a ramp		
				137	the vector form of Newton's second law		
				137	calculating acceleration from 3-D forces		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				148	direction of force determines linear or rotational motion		
				149	calculating centripetal force		
				150	formula for centripetal acceleration		
				155	satellite motion application		
				168	Newton's first law and rotational inertia		
				169	Newton's second law applies to rotational motion		
				171	Newton's second law for rotational motion variables		
				222	Newton's first law and momentum		
				224	momentum and Newton's third law		
				228	Newton's second law relating force and momentum		
				229	momentum form of Newton's second law		
				240	forces in a car stopping		
				252	Newton's second law and natural frequency		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				425	electric forces always occur in pairs according to Newton's third law		
				548	Newton's third law and pressure in a fluid		
				550	pressure and the third law		
				557	pressure of gases		
P.1.08 Physics I	Standard 1: Principles of Physics	Relationships between Motion and Force	Describe the nature of centripetal force and centripetal acceleration	149	calculating centripetal force	49	investigating centripetal force
				155	centripetal force and the law of universal gravitation combine to form the orbit equation		
				158	calculating centripetal force		
				460	orbital motion of a charge		

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P.1.09 Physics I	Standard 1: Principles of Physics	Relationships between Motion and Force	Use the conservation of energy and conservation of momentum laws to predict, both conceptually and quantitatively, the results of the interactions between objects.	191	the formula for potential energy	66	law of conservation of energy
				192	the formula for kinetic energy	68	calculate potential and kinetic energy
				193	deriving the formula for kinetic energy	68	find the total energy at each position
				194	conservation of energy explained	72	potential to kinetic energy conversion in a pendulum
				194	the law of conservation of energy	73	calculating momentum
				194	energy transformations	73	momentum is a vector
				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	75	investigate collisions and conservation of momentum
				196	energy transformation hydroelectric plant	77	the momentum form of Newton's second law
				197	conservation of energy for Hoover Dam	78	which ball had a greater change in momentum?
				199	kinetic and potential energy conversions while bouncing in a trampoline	80	angular momentum behaves like a vector
				203	efficiency and conservation of energy	88	potential to kinetic energy conversions of a pendulum
				206	connection between efficiency and time		
212	energy flow in a pendulum						

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				215	energy flows in biological systems		
				222	comparison of kinetic energy and momentum		
				223	momentum formula and calculating momentum		
				223	momentum is a vector		
				224	law of conservation of momentum		
				225	conservation of momentum in collisions		
				226	solving elastic and inelastic collision problems		
				226	applying conservation of momentum		
				227	momentum conservation for collisions in two and three dimensions		
				227	kinetic energy conservation for elastic collisions		
				229	force on a rocket from change in momentum		
				230	calculate change in momentum for elastic vs. inelastic collisions		
				231	conservation of angular momentum examples		

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				232	conservation of angular momentum		
				235	jet engines work because of conservation of momentum		
				236	momentum conservation of turbofan engine		
				237	why is momentum a vector		
				238	momentum in billiards		
				239	calculate momentum		
				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		
				276	natural frequency and harmonics		
				370	relationship and conservation of mass and energy		
				370	Einstein's thinking about momentum of particles moving near the speed of light		

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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 momentum in nuclear reactions		
				629	conservation of energy in nuclear reactions		

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P.1.10 Physics I	Standard 1: Principles of Physics	Relationships between Motion and Force	Demonstrate an understanding of the inverse square nature of gravitational and electrostatic 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	orbital motion	154	how are magnetic field lines similar to electric field lines?
				158	calculate weight and acceleration due to gravity on Pluto		
				216	tides are due to force of gravity		
				426	fields and forces		
				427	an electric field exists around a charge		
				437	strength of an electric field		
				443	magnets create a magnetic field around them		
				642	Newton's laws and gravity		
				649	every field has an associated particle		

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P.1.11 Physics I	Standard 1: Principles of Physics	The Nature of Energy	Recognize energy in its different manifestations, such as kinetic, gravitational potential, thermal, chemical, nuclear, electromagnetic, or mechanical.	189	energy appears in different forms		
				190	different forms of energy		
				199	trace the energy transformations from sun to a flashing taillight		
				204	efficiency of Earth		
				205	calories in food		
				210	energy from the sun drives the weather on Earth		
				212	understand basic forms of energy		
				215	energy flows in biological systems		
				310	light is a form of energy		
				322	photons are bundles of light energy		
				378	electrical energy		
				384	batteries use chemical energy		
				552	explanation of pressure and energy		
				597	the energy of chemical bonds is described		
				619	radiation as a flow of energy		
				622	energy of x-rays		

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				625	energy changes in nuclear reactions		
				626	source of energy in nuclear reactions		
				627	fusion reactions and the sun		
				627	energy of fusion reactions		
				628	energy of fission reactions		
				647	energy from antimatter		

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P.1.12 Physics I	Standard 1: Principles of Physics	The Nature of Energy	Use the law of conservation of energy to predict the outcome(s) of an energy transformation.	191	the formula for potential energy	68	calculate potential and kinetic energy
				192	the formula for kinetic energy	72	potential to kinetic energy conversion in a pendulum
				193	deriving the formula for kinetic energy	88	potential to kinetic energy conversions of a pendulum
				194	energy transformations		
				196	energy transformation hydroelectric plant		
				199	kinetic and potential energy conversions while bouncing in a trampoline		
				212	energy flow in a pendulum		
				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		

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P.1.13 Physics I	Standard 1: Principles of Physics	The Nature of Energy	Use the concepts of temperature, thermal energy, transfer of thermal energy, and the mechanical equivalent of heat to predict the results of an energy transfer.	506	temperature measures average kinetic energy	179	specific heat
				513	definition of calorie	180	investigate the thermal conductivity of various materials
				514	specific heat and the heat equation	182	observe free and forced convection
				514	the heat equation	182	investigate convection in a liquid
				517	air conditioners	186	observing the blackbody spectrum
				520	relationship between temp and average kinetic energy		
				522	heat conduction		
				523	heat conduction		
				524	thermal conductivity		
				524	conduction in solids and liquids and gases		
				525	the heat conduction equation		
				526	convection in liquids		
				526	free and forced convection		
				527	convection depends on speed and surface area		
				528	convection and weather		
				529	heat transfer coefficient and the convection equation		
				530	radiation		

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				532	blackbody spectrum and stars		
				533	thermal radiation power given off by a blackbody		
				535	sources of heat transfer in buildings		
				538	using heat conduction equation to calculate R-value		
				538	convection equation problem		
				557	Boyle's law		
				558	Charles' law		
				564	using Boyle's law		

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P.1.14 Physics I	Standard 1: Principles of Physics	The Nature of Energy	Explain the relation between energy (E) and power (P). Explain the definition of the unit of power, the watt.	191	calculate the potential energy of a cart		
				192	calculating kinetic energy depends on speed and mass		
				193	calculate the kinetic energy of a moving car		
				197	calculating energy supplied by Hoover Dam		
				207	power is the rate of doing work or using energy		
				208	units of power		
				209	calculating power for common devices		
				211	estimate average input power of a person		
				216	estimating the energy in tides		
				220	calculate energy and power for humans		
				408	measuring power in watts		
				409	units of watts and horsepower used in electrical circuits		
				410	electric companies charge for kilowatt-hours used		
				513	joules and calories and Btus		

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P.1.15 Physics I	Standard 1: Principles of Physics	Momentum and Energy	Distinguish between the concepts of momentum (using the formula $p = mv$) and energy.	223	momentum formula and calculating momentum	73	calculating momentum
				224	law of conservation of momentum	75	investigate collisions and conservation of momentum
				225	conservation of momentum in collisions	77	the momentum form of Newton's second law
				226	applying conservation of momentum	78	which ball had a greater change in momentum?
				226	solving elastic and inelastic collision problems		
				227	momentum conservation for collisions in two and three dimensions		
				229	force on a rocket from change in momentum		
				230	calculate change in momentum for elastic vs. inelastic collisions		
				231	conservation of angular momentum examples		
				232	conservation of angular momentum		
				235	jet engines work because of conservation of momentum		
				236	momentum conservation of turbofan engine		
				238	momentum in billiards		
				239	calculate momentum		

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				276	natural frequency and harmonics		
				370	Einstein's thinking about momentum of particles moving near the speed of light		
				629	conservation of momentum in nuclear reactions		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
P.1.16 Physics I	Standard 1: Principles of Physics	Momentum and Energy	Describe circumstances under which each conservation law may be used.	194	the law of conservation of energy	78	which ball had a greater change in momentum?
				194	conservation of energy explained		
				195	conservation of energy in a closed system		
				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		
				231	conservation of angular momentum examples		
				232	conservation of angular momentum		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				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 momentum in nuclear reactions		
				629	conservation of energy in nuclear reactions		
P.1.17 Physics I	Standard 1: Principles of Physics	The Nature of Electricity and Magnetism	Describe the interaction between stationary charges using Coulomb's Law.	424	Coulomb's law	148	investigate Coulomb's law
				425	calculate force using Coulomb's law		
				437	Coulomb's law is an inverse square law		
				438	calculating charge using Coulomb's law		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
P.1.18 Physics I	Standard 1: Principles of Physics	The Nature of Electricity and Magnetism	Explain the concepts of electrical charge, electrical current, electrical potential, electric field, and magnetic field. Use the definitions of the coulomb, the ampere, the volt, the volt/meter, and the tesla.	378	concept of electric current	131	explore the concept of electric current
				382	current flows through wires and carries energy	132	explore the concept of voltage
				382	voltage measures differences in energy	134	study the relationship between resistance and current
				382	electrical current explained	134	apply the concept of electrical resistance
				383	voltage is a measure of electric potential energy	134	Ohm's law
				383	voltage is a measure of electric potential energy	135	study the relationship between current and voltage
				383	voltage and potential energy	135	derive Ohm's law from experiment
				386	concept of electrical resistance	136	use Ohm's law to calculate the resistance
				386	relationship between current and resistance	138	apply Ohm's law to series circuits
				387	measuring resistance	138	determining total resistance in a series circuit
				388	Ohm's law	146	build a simple electroscope
				389	the resistance of electrical devices	147	investigate the concept of electric charge
				390	resistance of conductors and insulators	149	investigate charged balloons
				391	resistors	152	investigate magnetic forces
				395	knowing difference between types of resistors		
				396	calculation of voltage from resistance and current		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				399	calculating current in a series circuit using Ohm's law	154	draw magnetic field lines for a bar magnet
				399	adding resistance in a series circuit	155	test materials to see if they are affected by magnets
				403	using Ohm's law in parallel circuits	159	build an electromagnet
				404	using Ohm's law for circuit analysis	160	find out what happens to strength of electromagnet when current is increased
				407	calculate currents and voltages in a network circuit	160	what happens to the strength of an electromagnet when you increase the current?
				408	voltage definition		
				408	current definition	161	experiment with pushes and pulls of permanent magnet in a rotor
				408	resistance definition		
				416	calculating resistance in a circuit	171	use Ohm's law to calculate the resistance of the transistor
				416	using Ohm's law to calculate current		
				418	electric charge is a fundamental property of matter		
				419	electric forces are created between electric charges		
				420	explanation of coulomb		
				421	current is the flow of charge		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				421	current is the flow of charge		
				422	negative charge of electrons and current flow		
				422	negative charge of electrons and current flow		
				423	static electricity and charge polarization and induction		
				424	relationship of electric force and charge		
				425	the force between charges		
				426	charge creates an electric field		
				428	source charges and test charges		
				430	a capacitor stores charge		
				431	current into and out of capacitors		
				431	voltage of a capacitor circuit		
				433	ability of a capacitor to store charge is capacitance		
				435	steering the electron beam on television screen		
				440	magnetism explained		
				443	understanding magnetic fields		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				445	alignment of domains responds to magnetic fields		
				446	creating permanent magnets		
				447	the magnetic field of Earth		
				448	a compass is a magnet that lines up with Earth's magnetic field		
				449	the strength of Earth's magnetic field		
				451	magnetic field of a nucleus		
				454	magnetic field between two unlike poles		
				456	magnetic field of a wire		
				457	force on a current in a magnetic field		
				458	the magnetic field of loops and coils		
				459	the magnetic field of coils and permanent magnets		
				460	magnetic force on a moving charge		
				461	calculating magnetic fields and forces		
				462	electromagnets		
				463	building an electromagnet		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				464	electric motor uses electromagnets to convert electrical energy to mechanical energy		
				465	how electromagnets are used in electric motors		
				472	electromagnet-based maglev		
				475	diagram of electromagnet		
				479	resistance of a transistor		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
P.1.19 Physics I	Standard 1: Principles of Physics	The Nature of Electricity and Magnetism	Analyze simple arrangements of electrical components in series and parallel circuits. Know that any resistive element in a DC circuit dissipates energy, which heats the resistor.	379	concept of a circuit	129	construct simple electric circuits
				380	understanding simple circuit and its diagram	131	construct a simple circuit
				384	battery uses chemical energy to produce electrical charge	137	parallel circuit and Ohm's law
				386	simple bulb and battery circuits to illustrate electrical resistance	137	investigate series circuits
				388	calculate the current flowing in a circuit	138	build a parallel circuit
				398	series circuit defined	139	compare series and parallel circuits
				398	parallel circuit defined	139	analyze parallel circuits
				399	current and resistance in a series circuit	140	build and analyze network circuits
				400	voltage in a series circuit		
				401	parallel circuits		
				402	voltage and current in a parallel circuit		
				402	advantages of parallel circuits over series circuits		
				403	resistance in parallel circuits		
				405	voltage dividers		
				406	comparing series and parallel circuits		
				407	solving network circuits		
				407	solving network circuits		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				414	why parallel circuits are used in homes and buildings		
				414	why series circuits are not used in homes and buildings		
				415	compare current in a series and parallel circuit		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
P.1.20 Physics I	Standard 1: Principles of Physics	The Nature of Electricity and Magnetism	Describe electric and magnetic forces in terms of the field concept and the relationship between moving charges and magnetic fields.	356	electricity and magnetism oscillations	146	build a simple electroscope
				418	electric charge is a fundamental property of matter	147	investigate the concept of electric charge
				419	electric forces are created between electric charges	149	investigate charged balloons
				420	explanation of coulomb	152	investigate magnetic forces
				421	current is the flow of charge	154	draw magnetic field lines for a bar magnet
				422	negative charge of electrons and current flow	155	test materials to see if they are affected by magnets
				423	static electricity and charge polarization and induction	159	build an electromagnet
				424	relationship of electric force and charge	160	study the right-hand rule
				425	the force between charges	160	find out what happens to strength of electromagnet when current is increased
				426	charge creates an electric field	160	what happens to the strength of an electromagnet when you increase the current?
				428	source charges and test charges	161	experiment with pushes and pulls of permanent magnet in a rotor
				430	a capacitor stores charge	165	investigate electromagnetic induction
				433	ability of a capacitor to store charge is capacitance		
				435	steering the electron beam on television screen		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				440	magnetism explained		
				441	comparing magnetic and electric forces		
				442	force between two magnetics is not an inverse square law		
				443	understanding magnetic fields		
				445	alignment of domains responds to magnetic fields		
				446	creating permanent magnets		
				447	the magnetic field of Earth		
				448	a compass is a magnet that lines up with Earth's magnetic field		
				449	the strength of Earth's magnetic field		
				451	magnetic field of a nucleus		
				453	magnetic poles and electric charge		
				454	magnetic field between two unlike poles		
				456	magnetic field of a wire		
				457	right-hand rule		
				457	force on a current in a magnetic field		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				458	the magnetic field of loops and coils		
				459	the magnetic field of coils and permanent magnets		
				460	magnetic force on a moving charge		
				461	calculating magnetic fields and forces		
				462	finding the poles of an electromagnet using right-hand rule		
				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		
				475	using right-hand rule		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
P.1.21 Physics I	Standard 1: Principles of Physics	The Nature of Electricity and Magnetism	Explain the operation of electric generators and motors in terms of Ampere's law and Faraday's law.	421	negative charges move in a conductor	165	investigate Faraday's law of induction
				422	atomic structures of conductors and insulators and semiconductors	166	build a generator
				429	using a conductor as shielding from electric fields		
				468	magnetic flux		
				469	Faraday's law of induction		
				470	generating electricity by induction		
				473	Eddy currents		
				480	conductivity and semiconductors		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
P.1.22 Physics I	Standard 1: Principles of Physics	The Behavior of Waves	Describe waves in terms of their fundamental characteristics of velocity, wavelength, frequency or period, and amplitude. Know that radio waves, light, and X-rays are different wavelength bands in the spectrum of electromagnetic waves	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	86	investigate resonance and its importance
				249	analyze the motion of the cycle of a pendulum	88	if frequency is increased what happens to total energy?
				251	concept of natural frequency	89	making wave pulses on a string
				251	systems tends to have a preferred frequency	89	study characteristics of a wave pulse on a string
				252	changing natural frequency	89	study wave pulses on elastic cord
				254	periodic force and natural frequency	90	study the speed of the wave pulse
				254	concept of resonance	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
				255	resonance occurs when periodic force matches natural frequency	91	making circular waves in a ripple tank
				258	identify period and frequency and cycle and amplitude	91	making plane waves in a ripple tank
				259	resonance and amplitude	93	investigate frequency and wavelength
				260	calculate speed of an oscillator	94	investigate the wavelength of standing waves
				262	waves transmit energy		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				262	waves are all around us	94	investigate the frequency of standing waves
				263	waves are a form of traveling energy	95	natural frequency and resonance of standing waves on a string
				264	frequency and amplitude and wavelength in waves	95	waves carry energy from one place to another
				264	basic properties of frequency and wavelength and amplitude	125	study the polarization of a transverse spring wave
				265	wave pulse		
				265	concept of speed of a wave		
				266	formula for speed of a wave		
				266	speed of a wave is the speed at which a cycle moves		
				267	water waves are transverse and Slinky is longitudinal		
				268	one- and two- and three-dimensional waves		
				268	creating plane waves and circular waves		
				272	waves transfer energy through absorption		
				274	natural frequency of waves		
				274	how resonance is created		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				275	standing waves on a string		
				275	standing waves and natural frequency and resonance		
				275	boundaries and natural frequency		
				277	energy of a wave		
				277	standing waves on a string		
				277	standing waves are used to store energy		
				277	energy of a wave is proportional to frequency and amplitude		
				278	wavelength of a standing wave		
				280	microwaves and resonance		
				281	microwaves		
				281	use of microwaves in microwave ovens		
				282	describe relationship between wave characteristics		
				286	sound waves require matter to traverse		
				286	sound is a wave of pressure		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				286	properties of sound waves		
				287	frequency and pitch of sound		
				288	relationship of loudness and amplitude and pressure in sound wave		
				289	vibrations create sound		
				291	pressure and amplitude of sound waves		
				291	how we know sound is a wave		
				292	frequency and wavelengths of sound		
				292	importance of wavelength of sound waves		
				294	effect of medium and temperature on speed of sound wave		
				295	resonance of sound		
				300	pitch and frequency in music		
				303	design of a guitar		
				306	list evidence that sound is a wave		
				308	wave amplitude and harmonics of tuning fork and musical instrument		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				359	descriptions of radio waves and microwaves and infrared rays		
				359	waves of the electromagnetic spectrum		
				360	x-rays and gamma rays		
				452	MRI uses radio waves		
				452	MRI--each nucleus is a resonant oscillator		
				530	energy and radiation relationships		
				530	electromagnetic radiation		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
P.1.23 Physics I	Standard 1: Principles of Physics	The Behavior of Waves	Use the principle of superposition to describe the interference effects arising from propagation of several waves through the same medium.	247	the phase of an oscillator	83	investigate oscillators in-phase and out-of-phase
				273	concept of the superposition principle	101	investigate interference with sound waves
				273	sound and light waves and interference		
				273	constructive and destructive interference		
				278	nodes and antinodes		
				283	analyze superimposed waves		
				284	superimpose two waves		
				287	the superposition of sound waves		
				295	standing wave patterns of sound		
				296	interference of sound waves		
				297	Fourier's theorem and superposition principle and frequency spectrum		
				301	consonance and dissonance and beats		
				306	beats in a musical sound		
				307	applying superposition principle		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
P.1.24 Physics I	Standard 1: Principles of Physics	The Behavior of Waves	Use the concepts of reflection, refraction, polarization, transmission, and absorption to predict the motion of waves moving through space and matter.	267	transverse and longitudinal waves	91	is your water wave transverse or longitudinal?
				270	waves and absorption	92	observing reflection in water waves
				270	waves and refraction	92	investigate reflection in a ripple tank
				270	waves and reflection	92	investigate diffraction in a ripple tank
				270	waves and diffraction	92	investigate diffraction in a ripple tank
				271	waves and refraction and boundaries	125	polarization of water waves
				271	waves and reflection and boundaries	125	polarization of a spring wave
				272	waves and diffraction and boundaries	126	study the polarization of light
				272	waves and absorption and boundaries	126	polarization of light
				274	resonance and reflection		
				278	modes of a wave		
				279	modes of vibration		
				283	type of wave represented by a spring		
				292	sound is a longitudinal wave		
				356	electromagnetic waves are oscillations of an energy field		
				363	polarization		
				364	polarizers		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				365	applications of polarization		
				530	absorption of thermal radiation		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
P.1.25 Physics I	Standard 1: Principles of Physics	The Behavior of Waves	Use the concepts of wave motion to predict conceptually and quantitatively the various properties of a simple optical system.	315	mirrors	106	use a mirror to study how light behaves
				331	mirrors reflect light	115	studying optical systems
				331	lenses bend light	115	investigating the difference between an object and an image
				332	the image in a mirror	116	investigate how focal length is related to focal point
				336	how fiber optics work	116	trace ray diagrams through a double convex lens
				338	how the human eye sees images	117	sketch the image formed by a lens
				338	optics in terms of objects and images	117	compare the image of the arrow to the original arrow
				339	mirrors form virtual images	119	analyze optical systems
				339	finding an image in a ray diagram	120	apply the concept of chromatic aberration
				340	focal point and focal length	124	use a spectrometer to measure wavelength of different colors of light
				341	the image formed by a lens		
				341	focus and focal plane of a lens		
				342	finding the image in a ray diagram		
				342	drawing ray diagrams of lenses		
				343	ray diagram for a converging lens		
				343	the images formed by a lens		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				344	the brightness of an image formed by a lens		
				344	the functions of an optical system		
				345	chromatic aberration and spherical aberration		
				346	calculating image and object distances for optical systems		
				347	using multiple images allows an optical system to change the size of an image		
				347	using image relay to analyze optical systems		
				349	telescope as an optical system		
				353	identifying rays from a ray diagram		
				353	explain fiber optic cables		
				357	relationship between frequency and energy and color of light		
				372	three-dimensional images and the human eye		
				375	relate color to frequency for visible light		
				376	fiber optic cable calculation		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
P.1.26 Physics I	Standard 1: Principles of Physics	The Behavior of Waves	Identify electromagnetic radiation as a wave phenomenon after observing refraction, reflection, and polarization of such radiation.	315	light bends as it moves into a material	106	study refraction in a prism
				315	light rays bounce off a surface	106	study reflection in a prism
				324	the process of how light is reflected	112	investigate law of reflection
				332	specular and diffuse reflection	113	study how refraction works
				333	the laws of reflection	113	investigate Snell's law of refraction
				333	finding the normal line for reflection	114	study the critical angle of refraction in a prism
				334	the index of refraction	114	study index of refraction
				334	refraction is the bending of light rays	114	apply Snell's law of refraction
				335	Snell's law of refraction	123	study light interference
				335	refraction depends on index of refraction in both materials	123	study light diffraction patterns
				336	total internal reflection and the critical angle		
				339	the image formed in a mirror		
				340	lenses follow Snell's law of refraction		
				340	design of a lens		
				345	diffraction spot size image defect		
				352	law of reflection		

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				353	explain index of refraction		
				354	using Snell's law		
				358	index of refraction is ratio of speed of light in material to speed of light in vacuum		
				361	interference of light waves and Young's double-slit experiment		
				362	diffraction grating		
				364	transmission of light through two polarizers		
				373	holograms and the interference of light		
				530	absorption of thermal radiation		
				531	blackbody and perfect absorption of light		
				574	absorption of light		
				586	emission and absorption of photons in laser light		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
P.1.27 Physics I	Standard 1: Principles of Physics	The Laws of Thermodynamics	Understand that the temperature of an object is proportional to the average kinetic energy of the molecules in it and that the thermal energy is the sum of all the microscopic potential and kinetic energies.	506 513 520 522 523 537	temperature measures average kinetic energy balance of thermal energy relationship between temp and average kinetic energy thermal equilibrium thermal conductors and insulators heat flow between objects of different temperature		

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P.1.28 Physics I	Standard 1: Principles of Physics	The Laws of Thermodynamics	Describe the Laws of Thermodynamics, understanding that energy is conserved, heat does not move from a cooler object to a hotter one without the application of external energy, and that there is a lowest temperature, called absolute zero.	507	absolute zero and the limits of temperature	180	investigate the thermal conductivity of various materials
				522	heat conduction		
				523	heat conduction	182	investigate convection in a liquid
				524	conduction in solids and liquids and gases		
				524	thermal conductivity		
				525	the heat conduction equation		
				526	convection in liquids		
				527	convection depends on speed and surface area		
				528	convection and weather		
				530	radiation		
				535	sources of heat transfer in buildings		
				538	using heat conduction equation to calculate R- value		

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P.1.29 Physics I	Standard 1: Principles of Physics	The Nature of Atomic and Subatomic Physics	Describe the nuclear model of the atom in terms of mass and spatial relationships of the electrons, protons, and neutrons.	420	electric charge is a property of the particles that make up the atom	175	record atomic number
				420	electric charge is a property of the particles that make up the atom	194	basic properties of subatomic particles
				422	movement of electrons in current	194	subatomic particles
				437	draw a model of an atom	203	electrons and energy levels
				444	magnetism is a property of particles that make up the atom	203	review subatomic particles
				444	electrons and magnetism		
				459	atomic currents		
				480	electrons in a semiconductor		
				500	smallest piece of matter is the atom		
				566	charge and mass of electrons and protons and neutrons		
				566	three particles make up the atom		
				567	mass and the nucleus		
				567	structure of the atom		
				569	elements and atoms and atomic number		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				570	chemical properties of isotopes due to atomic structure		
				572	stability of nucleus and balance of protons and neutrons		
				574	Neils Bohr's theory		
				576	Neils Bohr		
				577	energy levels explain spectral lines		
				588	properties of subatomic particles		
P.1.30 Physics I	Standard 1: Principles of Physics	The Nature of Atomic and Subatomic Physics	Explain that the nucleus, although it contains nearly all of the mass of the atom, occupies less than the proportion of the solar system occupied by the sun.	420	electric charge is a property of the particles that make up the atom	175	record atomic number
				437	draw a model of an atom	194	subatomic particles
				444	electrons and magnetism	203	review subatomic particles
				566	three particles make up the atom		
				567	structure of the atom		
				569	elements and atoms and atomic number		
				570	chemical properties of isotopes due to atomic structure		
				572	stability of nucleus and balance of protons and neutrons		

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P.1.31 Physics I	Standard 1: Principles of Physics	The Nature of Atomic and Subatomic Physics	Explain the role of the strong nuclear force in binding matter together.	568 626 649	forces in the atom strong force and electromagnetic force in the nucleus four forces in nature		
P.1.32 Physics I	Standard 1: Principles of Physics	The Nature of Atomic and Subatomic Physics	Using the concept of binding energy per nucleon, explain why a massive nucleus that fissions into two medium-mass nuclei emits energy in the process.	573 627 628 635	fusion fusion reactions fission reactions differences between fission and fusion	213	fusion and fission
P.1.33 Physics I	Standard 1: Principles of Physics	The Nature of Atomic and Subatomic Physics	Using the same concept, explain why two light nuclei that fuse into a more massive nucleus emit energy in the process.	573 627 628 635	fusion fusion reactions fission reactions differences between fission and fusion	213	fusion and fission

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
P.1.34 Physics I	Standard 1: Principles of Physics	The Nature of Atomic and Subatomic Physics	Understand and explain the properties of radioactive materials, including half-life, types of emissions, and the relative penetrative powers of each type.	502	elements past #92 are radioactive and decay	209	radioactive decay and half life
				570	radioactive isotopes	210	simulate radioactive decay
				570	use of radioactive isotopes in medicine	211	types of radiation
				614	three kinds of radioactivity		
				614	radioactive decay		
				615	alpha and beta and gamma radiation		
				616	energy and radioactivity		
				617	half-life		
				618	carbon dating		
				618	half-life calculation		
				620	danger of gamma rays and alpha particles		
				620	ionizing and nonionizing radiation		
				622	x-ray machines		
				623	CAT scans		
				624	danger of ionizing radiation		
				632	nuclear energy		
				634	three kinds of radioactive decay		
				636	half-life of nitrogen-13		

Correlation to Indiana's Science Academic Standards

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
P.1.35 Physics I	Standard 1: Principles of Physics	The Nature of Atomic and Subatomic Physics	Describe sources and uses of radioactivity and nuclear energy.	570 618 621 622 623 624 632 632	use of radioactive isotopes in medicine carbon dating sources of radiation in the environment x-ray machines CAT scans measuring radiation with Geiger counter nuclear waste nuclear energy		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
P.2.01 Physics I	Standard 2: Historical Perspectives of Physics		Explain that Isaac Newton created a unified view of force and motion in which motion everywhere in the universe can be explained by the same few rules.	52	Dr. Harold Edgerton and strobe photography	26	study Newton's first law
				61	any acceleration must come from a force	27	explain how Newton's first law applies
				78	changes in motion only occur through force	28	investigate Newton's second law
				79	all objects tend to resist changes in motion	30	investigate Newton's third law
				80	Newton's laws and cup holders	51	calculate gravitational force of attraction
				81	Newton's second law of motion	51	investigate law of universal gravitation
				84	Newton's second law and dynamics problems	147	Gilbert built the first electroscope
				85	if there is acceleration there must be force		
				85	finding force from acceleration		
				87	forces always occur in action-reaction pairs		
				88	Newton's third law operates on pairs of objects		
				89	identifying which force is acting on which object		
				93	problems using Newton's first law and second law		
				102	the normal force as the reaction in an action-reaction pair		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				106	Newton's second law and net force		
				108	equilibrium and Newton's second law		
				111	understanding reaction forces in terms of springs and deformation		
				137	the vector form of Newton's second law		
				148	direction of force determines linear or rotational motion		
				152	description of law of universal gravitation		
				153	formula and calculations for law of universal gravitation		
				154	orbital motion		
				155	satellite motion application		
				158	calculate weight and acceleration due to gravity on Pluto		
				168	Newton's first law and rotational inertia		
				208	James Watt		
				216	tides are due to force of gravity		
				222	Newton's first law and momentum		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				224	momentum and Newton's third law		
				228	Newton's second law relating force and momentum		
				240	forces in a car stopping		
				257	Pierre and Jacques Curie and the piezoelectric effect		
				311	Thomas Edison and the electric light		
				314	Einstein and the speed of light		
				316	Albert Einstein		
				361	Thomas Young		
				366	Albert Einstein's theory of special relativity		
				367	Albert A. Michelson and Edward R. Morley		
				400	Gustav Robert Kirchhoff		
				425	electric forces always occur in pairs according to Newton's third law		
				548	Newton's third law and pressure in a fluid		
				550	pressure and the third law		
				557	pressure of gases		
				574	Niels Bohr		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				575	Johann Balmer		
				578	Wolfgang Pauli		
				580	Max Planck and Albert Einstein		
				630	Wolfgang Pauli		
				642	Newton's laws and gravity		
				644	proof of Einstein's theory of general relativity		
				647	Paul Dirac		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
P.2.02 Physics I	Standard 2: Historical Perspectives of Physics		Describe how Newton's system was based on the concepts of mass, force, and acceleration; his three laws of motion relating to them; and a physical law stating that the force of gravity...	61	any acceleration must come from a force	26	study Newton's first law
				78	changes in motion only occur through force	27	explain how Newton's first law applies
				79	all objects tend to resist changes in motion	28	investigate Newton's second law
				80	Newton's laws and cup holders	30	investigate Newton's third law
				81	Newton's second law of motion	51	calculate gravitational force of attraction
				84	Newton's second law and dynamics problems	51	investigate law of universal gravitation
				85	if there is acceleration there must be force		
				85	finding force from acceleration		
				87	forces always occur in action-reaction pairs		
				88	Newton's third law operates on pairs of objects		
				89	identifying which force is acting on which object		
				93	problems using Newton's first law and second law		
				102	the normal force as the reaction in an action-reaction pair		
				106	Newton's second law and net force		

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Student Text and Investigation Manual

Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				108	equilibrium and Newton's second law		
				111	understanding reaction forces in terms of springs and deformation		
				137	the vector form of Newton's second law		
				148	direction of force determines linear or rotational motion		
				152	description of law of universal gravitation		
				153	formula and calculations for law of universal gravitation		
				154	orbital motion		
				155	satellite motion application		
				158	calculate weight and acceleration due to gravity on Pluto		
				168	Newton's first law and rotational inertia		
				216	tides are due to force of gravity		
				222	Newton's first law and momentum		
				224	momentum and Newton's third law		

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Student Text and Investigation Manual

Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				228	Newton's second law relating force and momentum		
				240	forces in a car stopping		
				425	electric forces always occur in pairs according to Newton's third law		
				548	Newton's third law and pressure in a fluid		
				550	pressure and the third law		
				557	pressure of gases		
				642	Newton's laws and gravity		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
P.2.03 Physics I	Standard 2: Historical Perspectives of Physics		Explain that the Newtonian model made it possible to account for such diverse phenomena as tides, the orbits of the planets and moons, the motion of falling objects, and Earth's equatorial bulge.	68	free fall and acceleration due to gravity	23	investigate the effect of gravity
				69	motion formulas for free fall	51	calculate gravitational force of attraction
				70	solving problems with free fall	51	investigate law of universal gravitation
				71	acceleration of gravity does not depend on mass		
				75	problem understanding acceleration due to gravity		
				97	strength of gravity on Earth and Jupiter		
				98	gravity and acceleration and weightlessness		
				124	projectiles and trajectories		
				128	gravity only accelerates vertical motion		
				129	vertical motion of a projectile		
				130	projectiles launched at an angle		
				131	range of projectiles		
				134	resolving force of gravity in ramp coordinates		
				135	acceleration down an inclined plane		
				141	effects of gravity on motion of a projectile		

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

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Student Text and Investigation Manual

Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
P.2.04 Physics I	Standard 2: Historical Perspectives of Physics		Describe how the Scottish physicist James Clerk Maxwell used Ampere's law and Faraday's law to predict the existence of electromagnetic waves and predict that light was just such a wave.	52	Dr. Harold Edgerton and strobe photography	147	Gilbert built the first electroscope
				208	James Watt	197	quantum physics
				257	Pierre and Jacques Curie and the piezoelectric effect	200	explore how a vibrating string has similar properties to a quantum system
				311	Thomas Edison and the electric light		
				314	Einstein and the speed of light		
				316	Albert Einstein		
				361	Thomas Young		
				366	Albert Einstein's theory of special relativity		
				367	Albert A. Michelson and Edward R. Morley		
				400	Gustav Robert Kirchhoff		
				574	Niels Bohr		
				575	Johann Balmer		
				578	Wolfgang Pauli		
				580	comparing classical and quantum physics		
				580	Max Planck and Albert Einstein		
				581	classical vs. quantum theory of light		
				582	classical vs. quantum concept of electron		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				583	how the uncertainty principle differs from classical theory		
				589	electrons in classical vs. quantum physics		
				629	conservation of particles in nuclear reactions		
				630	antimatter and neutrinos and other particles		
				630	Wolfgang Pauli		
				644	proof of Einstein's theory of general relativity		
				646	standard model of particle physics		
				647	matter and antimatter		
				647	Paul Dirac		
				648	standard model of particles		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
P.2.05 Physics I	Standard 2: Historical Perspectives of Physics		Describe how among the surprising ideas of Albert Einstein's special relativity is that nothing can travel faster than the speed of light, which is the same for all observers...	310	light is a form of energy	127	when does special relativity become important?
				312	the intensity of light		
				313	light carries information		
				314	the speed of light		
				314	Einstein's theory of relativity		
				328	how is light used for communication?		
				356	light can be described in terms of waves		
				357	frequency and wavelength of light		
				358	speed of light is frequency multiplied by length		
				366	relationship between matter and energy and time and space		
				367	speed of light paradox		
				368	speed and time and clocks		
				369	consequences of time dilation		
				371	simultaneity depends on the relative motion of your frame of reference		
				373	wave fronts of light		
				642	Einstein's theory and gravity and inertial mass		

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Student Text and Investigation Manual

Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
				644	general relativity and curved space-time		
				645	black holes and general relativity		
P.2.06 Physics I	Standard 2: Historical Perspectives of Physics		Explain that the special theory of relativity ($E=mc^2$) is best known for stating that any form of energy has mass and that matter itself is a form of energy.	314	Einstein's theory of relativity	127	when does special relativity become important?
				366	relationship between matter and energy and time and space		
				367	speed of light paradox		
				368	speed and time and clocks		
				369	consequences of time dilation		
				371	simultaneity depends on the relative motion of your frame of reference		
				642	Einstein's theory and gravity and inertial mass		
				644	general relativity and curved space-time		
				645	black holes and general relativity		

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Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
P.2.07 Physics I	Standard 2: Historical Perspectives of Physics		Describe how general relativity theory pictures Newton's gravitational force as a distortion of space and time.	152 153 154 158 216 642	description of law of universal gravitation formula and calculations for law of universal gravitation orbital motion calculate weight and acceleration due to gravity on Pluto tides are due to force of gravity Newton's laws and gravity	51 51	calculate gravitational force of attraction investigate law of universal gravitation
P.2.08 Physics I	Standard 2: Historical Perspectives of Physics		Explain that Marie and Pierre Curie made radium available to researchers all over the world, increasing the study of radioactivity and leading to the realization that one kind of atom may change into another kind...	614 615	Marie Curie Henri Bequerel and beta rays		

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Foundations of Physics

Student Text and Investigation Manual

Standard #: Course	Standard	Topic	Objective	student text pg	detail	investigation pg	detail
P.2.09 Physics I	Standard 2: Historical Perspectives of Physics		Explain that Ernest Rutherford and his colleagues discovered that the radioactive element radon spontaneously splits itself into a slightly lighter nucleus and a very light helium nucleus.	499	development of atomic theory	75	the discovery of atom's nucleus
P.2.10 Physics I	Standard 2: Historical Perspectives of Physics		Describe how later, Austrian and German scientists showed that when uranium is struck by neutrons, it splits into two nearly equal parts plus two or three extra neutrons.	573 627 628 635	fusion fusion reactions fission reactions differences between fission and fusion	213	fusion and fission