

Correlation to Tennessee Science Learning Expectations

CPO Science Physics: A First Course

Student Text and Investigation Manual

Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.1.01 Physics	Mechanics	Laws of mechanics are the foundations of classical physics.	Explore displacement, velocity, and acceleration.	17	comparing speeds	10	find speed of car
				17	nothing in the universe stays still	11	investigating net force and acceleration
				17	speed defined	21	measure speed of car
				17	constant speed	25	calculate speed of car
				17	speed of light	3	find the speed of the car
				18	calculating speed	44	experiment and find average speed
				18	speed units	46	measure speed of car
				19	velocity defined	53	investigate frames of reference
				32	acceleration defined	54	identify frame of reference
				33	acceleration and velocity	6	how can speed be measured?
				35	changes in speed or direction always involve acceleration	7	measure the speed
				36	zero acceleration explained	9	why did the speed change?
				40	velocity defined		
				45	terminal speed		
				45	skydiving and terminal speed		
				56	calculate speed from distance/time graph		
				110	compare and contrast scalars and vectors		
				134	understanding displacement		
136	speed vs. velocity						

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
				136	working with velocity vector		
				143	angular speed		
3231.1.02 Physics	Mechanics	Laws of mechanics are the foundations of classical physics.	Analyze vector diagrams and solve composition and resolution problems for force and momentum.	28	force defined	11	investigate net force
				30	units of force	22	when net force is zero
				31	net force explained	23	draw a free body diagram
				36	balanced and unbalanced forces	23	use force vectors
				37	net force and second law calculating		
				61	momentum is calculated with velocity – not speed		
				110	compare and contrast scalars and vectors		
				111	force vectors		
				112	resolving vectors		
				113	using a free-body diagram		
				115	finding resultant vector		
				116	when net force is zero		
				136	working with velocity vector		

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.1.03 Physics	Mechanics	Laws of mechanics are the foundations of classical physics.	Explore characteristics of rectilinear motion and create displacement-time graphs (velocity), velocity-time graphs (acceleration and distance).	46 47 48 49 51	position vs. time graphs position vs. time graph for accelerating motion speed vs. time graph speed vs. time graph for accelerating motion finding distance from a speed vs. time graph	11 4	speed vs. time graph position vs. time graph

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.1.04 Physics	Mechanics	Laws of mechanics are the foundations of classical physics.	Investigate the characteristics of centripetal motion and centripetal acceleration.	124	torque causes objects to rotate		
				124	torque explained		
				124	comparing torque and force		
				125	torque is not work		
				125	calculating torque		
				126	solving problems with torque		
				127	rotational equilibrium		
				142	angular speed vs. linear speed		
				143	angular speed formula		
				143	calculating angular speed		
				143	rotations and degrees		
				145	calculating linear speed for a rotating object		
				149	Newton's second law and circular motion		
				154	understanding orbital motion		

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.1.05 Physics	Mechanics	Laws of mechanics are the foundations of classical physics.	Evaluate the dynamics of systems in motion including friction, gravity, impulse and momentum, change in momentum, and conservation of momentum.	39	effect of gravity on motion	12	investigate momentum
				39	calculations pertaining to free fall	13	apply the law of conservation of momentum
				45	effects of air resistance	13	analyze collision data
				52	acceleration shown through strobe photography	13	calculate momentum of two cars
				61	calculating momentum	24	investigate effect of friction
				61	momentum is calculated with velocity – not speed	26	investigate projectile motion
				62	understanding impulse		
				63	law of conservation of momentum		
				64	using momentum conservation to solve problems		
				74	momentum and collisions		
				76	impulse and practical problem solving		
				77	momentum and car safety		
				88	work and gravity		
				94	friction and machines		
				101	friction explained		
				119	friction explained		
				119	cause of friction		
				120	static and sliding friction		
				122	reducing friction		

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				123	useful friction		
				137	projectile explained		
				138	free fall component of a trajectory		
				402	gravitational field		
				418	friction and damping		
3231.1.06 Physics	Mechanics	Laws of mechanics are the foundations of classical physics.	Investigate projectile motion.	39	calculations pertaining to free fall	26	investigate projectile motion
				39	effect of gravity on motion		
				52	acceleration shown through strobe photography		
				88	work and gravity		
				137	projectile explained		
				138	free fall component of a trajectory		
				402	gravitational field		

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.1.07 Physics	Mechanics	Laws of mechanics are the foundations of classical physics.	Apply mathematics to solve motion problems.	19	mathematical descriptions	11	find formula for acceleration
				26	interpreting distance/time graph	13	derive a formula
				34	mathematical model of acceleration	154	calculate gear ratio
				35	Newton's second law equation	17	calculate mechanical advantage
				41	average speed equation	17	derive a formula to use with ropes and pulleys
				43	calculating weight	29	find a mathematical name for the steepness ratio
				61	momentum equation		
				62	relating impulse and momentum conservation	29	calculate the ratio
				68	kinetic energy formula	31	calculate temperature of mixture
				86	the work equation	69	calculate power used by the bulb
				89	the power equation		
				96	calculating mechanical advantage	75	derive a formula to calculate the charge
				118	Hooke's law equation	76	calculate the number of electrons
				141	projectile motion problems		
				143	calculating angular speed	99	calculate natural frequency and period
				144	finding the circumference of a circle		
				145	linear speed equation		
				153	equation for law of universal gravitation		
				179	the heat equation		

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
				193	density formula		
				208	pressure and temperature relationship		
				308	equation for Ohm's law		
				342	equation for Coulomb's law		
				438	calculating wave speeds		
				439	equation for the speed of a wave		
				525	equation for the speed of light		
3231.1.08 Physics	Mechanics	Laws of mechanics are the foundations of classical physics.	Experiment with elastic and inelastic collisions.	61	calculating momentum	12	investigate momentum
				63	law of conservation of momentum	13	apply the law of conservation of momentum
				64	using momentum conservation to solve problems	13	analyze collision data
				74	momentum and collisions	13	calculate momentum of two cars
				77	momentum and car safety	13	investigate collisions with the energy car

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.1.09 Physics	Mechanics	Laws of mechanics are the foundations of classical physics.	Experiment with pendulums.	414 414 416 416 417 418 430	a pendulum's cycle understanding a cycle frequency explained period is the time for one cycle frequency is the inverse of period amplitude explained identify period and frequency and cycle and amplitude	92 92 92 93 94	explore harmonic motion using a pendulum explore the meaning of cycle explore the meaning of amplitude measure the period of a pendulum investigate harmonic motion with a pendulum
3231.1.10 Physics	Mechanics	Laws of mechanics are the foundations of classical physics.	Utilize trigonometry and vector analysis to solve force and momentum problems.	31 37 61 111 112 113 115 116	net force explained net force and second law calculating momentum is calculated with velocity – not speed force vectors resolving vectors using a free-body diagram finding resultant vector when net force is zero	11 22 23 23	investigate net force when net force is zero draw a free body diagram use force vectors

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.1.11 Physics	Mechanics	Laws of mechanics are the foundations of classical physics.	Apply elementary calculus to solve motion problems.	19	mathematical descriptions	11	find formula for acceleration
				26	interpreting distance/time graph	13	derive a formula
				34	mathematical model of acceleration	154	calculate gear ratio
				35	Newton's second law equation	17	calculate mechanical advantage
				41	average speed equation	17	derive a formula to use with ropes and pulleys
				43	calculating weight	29	find a mathematical name for the steepness ratio
				61	momentum equation		
				62	relating impulse and momentum conservation	29	calculate the ratio
				68	kinetic energy formula	31	calculate temperature of mixture
				86	the work equation	69	calculate power used by the bulb
				89	the power equation		
				96	calculating mechanical advantage	75	derive a formula to calculate the charge
				118	Hooke's law equation	76	calculate the number of electrons
				141	projectile motion problems		
				143	calculating angular speed	99	calculate natural frequency and period
				144	finding the circumference of a circle		
				145	linear speed equation		
				153	equation for law of universal gravitation		
				179	the heat equation		

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
				193	density formula		
				208	pressure and temperature relationship		
				308	equation for Ohm's law		
				342	equation for Coulomb's law		
				438	calculating wave speeds		
				439	equation for the speed of a wave		
				525	equation for the speed of light		
3231.1.12 Physics	Mechanics	Laws of mechanics are the foundations of classical physics.	Experiment with elastic and inelastic collisions.	61	calculating momentum	12	investigate momentum
				63	law of conservation of momentum	13	apply the law of conservation of momentum
				64	using momentum conservation to solve problems	13	analyze collision data
				74	momentum and collisions	13	calculate momentum of two cars
				77	momentum and car safety	13	investigate collisions with the energy car
3231.1.13 Physics	Mechanics	Laws of mechanics are the foundations of classical physics.	Distinguish between mass and weight using base units in the SI system.	29	mass and inertia	9	research and define inertia and weight and mass
				43	calculating weight from mass		
				43	weight vs. mass		
				44	weight vs. mass		

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.1.14 Physics	Mechanics	Laws of mechanics are the foundations of classical physics.	Associate time with the independent variable in most experiments.	6	what is a variable	11	create a graph
				8	independent variables	15	graph speed vs. height
				8	dependent variables	20	graph work done vs. deflection of rubber band
				8	control and experimental variables	21	graph speed vs. rubber band deflection
				16	constructing graphs	25	graph friction vs. mass
				16	steps to follow for graph construction	27	identify and control variables
				16	graphs and independent variables	27	graph launch angle vs. range
				16	graphs and dependent variables	29	graph acceleration vs. steepness ratio
				24	importance of changing one variable at a time in an experiment	4	construct a graph
				25	constructing a graph	45	make a graph of efficiency vs. speed
				46	motion graphs	50	graph time vs. temperature
				48	motion graphs	52	construct a graph
				112	using a graph to find force vector components	6	recognize and control variables
				419	harmonic motion graphs	75	graph current vs. time for the capacitor
				420	finding the amplitude on a harmonic motion graph	86	graph voltage vs. speed
						94	investigate variables and how they affect the period of a pendulum

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
						94	sketch harmonic motion graphs
3231.1.15 Physics	Mechanics	Laws of mechanics are the foundations of classical physics.	Relate inertia, force, or action-reaction forces to Newton's three laws of motion.	29	Newton's first law	10	investigate Newton's second law of motion
				35	quantitative understanding of second law	12	investigate Newton's 3rd law of motion
				35	Newton's second law	13	relate Newton's 3rd law of motion to car collisions
				36	applying Newton's second law properly	23	Newton's second law of motion
				37	using second law formula	25	apply Newton's second law of motion
				52	action-reaction pairs	29	apply Newton's second law of motion
				59	Newton's third law	8	investigate Newton's first law of motion
				60	sorting out force pairs	95	Newton's 2nd law of motion and natural frequency
				78	third law and rockets		
				117	Newton's third law and springs		
				128	the third law and physics of walls		
				158	Newton's third law and helicopters		
				424	Newton's second law and oscillators		

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.1.16 Physics	Mechanics	Laws of mechanics are the foundations of classical physics.	Compare, contrast, and apply characteristic properties of scalar and vector quantities.	110	compare and contrast scalars and vectors	23	use force vectors
				111	force vectors		
				115	finding resultant vector		
				136	working with velocity vector		

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.1.17 Physics	Mechanics	Laws of mechanics are the foundations of classical physics.	Investigate the definitions of force, work, power, kinetic energy, and potential energy.	28	force defined	15	calculate potential energy of car
				36	balanced and unbalanced forces	154	identify force and distance trade-off
				66	calculating work done on objects	18	calculate work
				66	energy is stored work	18	investigate concept of work
				66	work defined		
				67	calculating potential energy	19	investigate concept of energy as stored work
				68	calculating kinetic energy	20	graph force vs. distance
				69	kinetic energy and stopping distance of a car	24	calculate kinetic energy of sled
				86	calculating work	47	calculate energy
				87	work results from force and distance that are in same distance		
				88	calculating work		
				88	work done by or against gravity		
				89	calculating power		
				90	maximum power output of a person		
				244	power explained		
				245	three ways to look at power		
				250	power in human technology		

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
				252	power in natural systems		
				254	wave power		
				254	tidal power		

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.1.18 Physics	Mechanics	Laws of mechanics are the foundations of classical physics.	Analyze the characteristics of energy, conservation of energy including friction, and gravitational potential energy.	9	basic forms of energy	14	investigate exchange of energy in car and track system
				10	conservation of energy		
				66	energy is stored work	15	calculate potential energy of car
				67	calculating potential energy		
				67	potential energy explained	15	apply law of energy conservation
				68	calculating kinetic energy	18	compare and contrast input and output work
				68	kinetic energy explained		
				69	kinetic energy and stopping distance of a car	19	investigate concept of energy as stored work
				70	law of conservation of energy	24	calculate kinetic energy of sled
				71	using energy conservation to solve problems	42	model how atoms exchange energy
				94	work and simple machines	44	friction and energy dissipation
				101	output work is always less than input work	45	describe energy changes
				240	energy and systems	46	investigate energy flow in a system
				241	energy exists in many different forms	47	calculate energy
				243	energy flow diagrams	47	investigate friction as a part of energy flow
				249	energy flow diagram for mechanical systems	47	identify forms of energy in an experimental system
				251	energy flow in natural systems	47	draw an energy flow diagram
						57	draw energy flow diagram of the circuit

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.1.19 Physics	Mechanics	Laws of mechanics are the foundations of classical physics.	Relate work and power to various simple machines, mechanical advantage of different machines, and recognize simple machines that are combined to form compound machines.	91	simple machines	16	investigate simple machines
				92	simple machines and forces	17	investigate mechanical advantage
				93	simple machines and mechanical advantage	17	calculate mechanical advantage
				95	solving mechanical advantage problems	45	calculate efficiency of the experimental system
				96	how a lever works	45	investigate efficiency
				97	simple machines and the human body	45	graph efficiency vs. speed
				98	how a rope and pulley system works		
				99	how gears and ramps work		
				102	efficiency explained		
				104	simple machines and the human body		
				246	efficiency explained		
				247	efficiency of a heat engine		
				248	efficiency of living things		
				334	efficiency of electric motors		
				334	efficiency of gasoline engine		

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.1.20 Physics	Mechanics	Laws of mechanics are the foundations of classical physics.	Describe rotational equilibrium and relate this factor to torque.	124 124 124 125 125 126 127 142	torque causes objects to rotate torque explained comparing torque and force torque is not work calculating torque solving problems with torque rotational equilibrium angular speed vs. linear speed		
3231.1.21 Physics	Mechanics	Laws of mechanics are the foundations of classical physics.	Determine the magnitude of the buoyant force exerted on a floating object or a submerged object.	202	buoyancy explained		
3231.1.22 Physics	Mechanics	Laws of mechanics are the foundations of classical physics.	Investigate the apparent weight of an object submerged in a fluid.	202	buoyancy explained		

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.1.23 Physics	Mechanics	Laws of mechanics are the foundations of classical physics.	Explain, in terms of force and/or density, why some objects float and some objects sink.	200 201 201 202 213	density of fluids comparing liquid and solid densities comparing density of ice and water buoyancy explained submarines and density	35	investigate density
3231.1.24 Physics	Mechanics	Laws of mechanics are the foundations of classical physics.	Calculate the pressure exerted by a fluid according to Pascal's Principle.	204	pressure and fluids		
3231.1.25 Physics	Mechanics	Laws of mechanics are the foundations of classical physics.	Calculate how pressure varies with water depth.	203 204 204 205 212	concept of pressure atomic level explanation of pressure pressure and fluids Bernoulli's principle and the airfoil pressure and deep water	35	investigating air pressure
3231.1.26 Physics	Mechanics	Laws of mechanics are the foundations of classical physics.	Examine the motion of a fluid using the continuity equation.	205 205	Bernoulli's principle Bernoulli's principle and fluids	37 38	investigate Bernoulli's principle applying Bernoulli's equation
3231.1.27 Physics	Mechanics	Laws of mechanics are the foundations of classical physics.	Recognize the effects of Bernoulli's principle on fluid motion and its applications.	205 205	Bernoulli's principle Bernoulli's principle and fluids	37 38	investigate Bernoulli's principle applying Bernoulli's equation

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3231.2.01 Physics	Thermodynamics	The principles and laws of thermodynamics are essential for understanding the concept of energy.	Investigate temperature in relationship to kinetic energy.	172 176 177 178 242	kinetic theory and temperature understanding the difference between heat and temperature heat and work specific heat explained generation of heat from frictional motion	30 32	investigate difference between temperature and heat investiate concept of specific heat
3231.2.02 Physics	Thermodynamics	The principles and laws of thermodynamics are essential for understanding the concept of energy.	Identify the characteristics of internal energy and temperature/heat (joules/calories).	176	understanding the difference between heat and temperature	30	investigate difference between temperature and heat
3231.2.03 Physics	Thermodynamics	The principles and laws of thermodynamics are essential for understanding the concept of energy.	Experiment with change in heat content (quantity of thermal energy) and relate to kinetic energy and specific heat.	177 179	calories explained the heat equation	31 32	investigating and using the heat equation challenge: heat problem
3231.2.04 Physics	Thermodynamics	The principles and laws of thermodynamics are essential for understanding the concept of energy.	Investigate phase changes of heat of fusion, heat of vaporization, and heat of sublimation.	174 174 176 185	interpreting a heating curve diagram heat energy and molecular motion flow of thermal energy is heat heat transfer is everywhere	33 34	investigate energy and phase changes apply concept of energy and phase changes

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.2.05 Physics	Thermodynamics	The principles and laws of thermodynamics are essential for understanding the concept of energy.	Explore thermal expansion and contraction.	182	thermal conductivity		
3231.2.06 Physics	Thermodynamics	The principles and laws of thermodynamics are essential for understanding the concept of energy.	Apply the second law of thermodynamics to the Carnot engine.	94 101	work and simple machines output work is always less than input work	18	compare and contrast input and output work
3231.2.07 Physics	Thermodynamics	The principles and laws of thermodynamics are essential for understanding the concept of energy.	Apply the Laws of Thermodynamics to the atmospheric levels of the earth.	94 101	work and simple machines output work is always less than input work	18	compare and contrast input and output work
3231.2.08 Physics	Thermodynamics	The principles and laws of thermodynamics are essential for understanding the concept of energy.	Recognize that absolute zero is the absence of molecular kinetic energy.	175	absolute zero		

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3231.2.09 Physics	Thermodynamics	The principles and laws of thermodynamics are essential for understanding the concept of energy.	Relate the First Law of Thermodynamics as an application of the Law of Conservation of Energy and heat transfer through conduction, convection, and radiation.	9 94 101 181 183 184 240 241 243 251	basic forms of energy work and simple machines output work is always less than input work heat conduction natural and forced convection thermal radiation energy and systems energy exists in many different forms energy flow diagrams energy flow in natural systems	18 30 45 46 47 57	compare and contrast input and output work investigating heat transfer describe energy changes investigate energy flow in a system identify forms of energy in an experimental system draw energy flow diagram of the circuit
3231.2.10 Physics	Thermodynamics	The principles and laws of thermodynamics are essential for understanding the concept of energy.	Investigate calorimetry, kinetic energy, and specific heat.	172 176 177 178 179	kinetic theory and temperature understanding the difference between heat and temperature calories explained specific heat explained the heat equation	30 31 32 32	investigate difference between temperature and heat investigating and using the heat equation challenge: heat problem investiate concept of specific heat

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3231.3.01 Physics	Waves and Sound	Understanding sound and light is accomplished by investigating wave behavior.	Investigate simple harmonic motion.	414	a pendulum's cycle	102	harmonics and standing wave patterns
				414	understanding a cycle	109	harmonics and musical instruments
				416	frequency explained	92	explore harmonic motion using a pendulum
				416	period is the time for one cycle	92	explore the meaning of cycle
				417	frequency is the inverse of period	92	explore the meaning of amplitude
				418	amplitude explained	93	measure the period of a pendulum
				419	understanding graphs of harmonic motion	94	understanding graphs of harmonic motion
				430	identify period and frequency and cycle and amplitude	94	investigate harmonic motion with a pendulum
				471	harmonics and instruments		

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3231.3.02 Physics	Waves and Sound	Understanding sound and light is accomplished by investigating wave behavior.	Investigate and analyze wavelength, frequency, period, and amplitude of longitudinal and transverse waves.	434	waves transmit energy	100	study water waves
				436	longitudinal waves	101	investigate standing waves and frequency
				436	transverse waves		
				437	frequency and amplitude and wavelength of waves	123	how colors of light relate to frequency and wavelength
				438	the speed of waves		
				440	standing waves on a vibrating string	123	measure wavelengths of visible light using a spectrometer
				447	waves and energy	124	relating transverse waves on a spring to light waves
				456	speed of sound		
				461	wavelength of sound	98	study waves on a string
				468	pitch and the musical scale	99	explore transverse waves
				481	speed of light		
				483	color and light		
				524	energy and color of light		

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3231.3.03 Physics	Waves and Sound	Understanding sound and light is accomplished by investigating wave behavior.	Describe a wave interaction as reflection, refraction, diffraction, or interference.	442	reflected waves	111	colors of light
				442	refracted waves	113	investigate law of reflection
				443	diffraction explained	113	use a mirror to observe reflected light
				478	seeing and reflected light	114	use results to derive law of reflection
				482	refraction of light	114	use a prism to investigate light rays
				482	reflection of light	115	investigate refraction
				485	how the human eye sees color	119	investigate lenses and magnification
				499	mirrors reflect light	120	using a mirror to reflect light
				501	reflection explained	120	investigate reflection of light
				502	the law of reflection	121	investigate refraction of light
				503	understanding refraction	121	investigate refraction of light
				504	angles of incidence and refraction	121	use a lens to refract light
				512	magnification	122	investigate diffraction of light
				528	diffraction and light		
				529	interference of light waves		
				530	diffraction gratings and spectrometers		
3231.3.04 Physics	Waves and Sound	Understanding sound and light is accomplished by investigating wave behavior.	Explore Hooke's Law.	118	Hooke's law		

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3231.3.05 Physics	Waves and Sound	Understanding sound and light is accomplished by investigating wave behavior.	Investigate reflection, refraction, diffraction, and interference of sound waves.	421 422 442 442 443 445 445 469	circular motion and phase harmonic motion that is out of phase refracted waves reflected waves diffraction explained destructive interference constructive interference frequency of sound and beats	106	investigate interference and beats
3231.3.06 Physics	Waves and Sound	Understanding sound and light is accomplished by investigating wave behavior.	Compare mechanical and electromagnetic waves.	434 435 435 436 436 440 447 459 523 524 536	waves transmit energy waves and technology how to recognize waves longitudinal waves transverse waves standing waves on a vibrating string waves and energy sound waves and different media electromagnetic spectrum wavelength and frequency of visible light the electromagnetic spectrum	100 111 123 124 98 99	study water waves mixing primary colors of light investigate visible light wavelengths relating transverse waves on a spring to light waves study waves on a string explore transverse waves

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.3.07 Physics	Waves and Sound	Understanding sound and light is accomplished by investigating wave behavior.	Explain the Doppler Effect.	457	understanding the Doppler effect		
3231.3.08 Physics	Waves and Sound	Understanding sound and light is accomplished by investigating wave behavior.	Determine the speed of sound experimentally and describe the effects various materials and temperatures on sound transmission.	456 467 468	speed of sound how the ear works pitch and the musical scale		
3231.3.09 Physics	Waves and Sound	Understanding sound and light is accomplished by investigating wave behavior.	Measure spring constants.	118	Hooke's law		

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.3.10 Physics	Waves and Sound	Understanding sound and light is accomplished by investigating wave behavior.	Solve problems related to wave length, frequency, period, and speed.	414 414 416 416 417 418 430 437 438 456 461 468	a pendulum's cycle understanding a cycle frequency explained period is the time for one cycle frequency is the inverse of period amplitude explained identify period and frequency and cycle and amplitude frequency and amplitude and wavelength of waves the speed of waves speed of sound wavelength of sound pitch and the musical scale	101 92 92 92 93 94	investigate standing waves and frequency explore harmonic motion using a pendulum explore the meaning of cycle explore the meaning of amplitude measure the period of a pendulum investigate harmonic motion with a pendulum
3231.3.11 Physics	Waves and Sound	Understanding sound and light is accomplished by investigating wave behavior.	Determine the speed of sound experimentally using various materials and temperatures.	456 468	speed of sound pitch and the musical scale		

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.3.12 Physics	Waves and Sound	Understanding sound and light is accomplished by investigating wave behavior.	Describe simple harmonic motion.	414 414 416 416 417 418 430	a pendulum's cycle understanding a cycle frequency explained period is the time for one cycle frequency is the inverse of period amplitude explained identify period and frequency and cycle and amplitude	92 92 92 93 94	explore harmonic motion using a pendulum explore the meaning of cycle explore the meaning of amplitude measure the period of a pendulum investigate harmonic motion with a pendulum
3231.3.13 Physics	Waves and Sound	Understanding sound and light is accomplished by investigating wave behavior.	Compare the wave characteristics of natural auditory phenomena.	415 454 455 455 458 459 461 462 467	sound is a wave sound is a wave the decibel scale acoustics how sound is recorded sound is a wave how a French horn works acoustics of concert halls how the ear works	104 105	properties of sound waves investigate sound wave interference

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.4.01 Physics	Light and Optics	Understanding optics is accomplished by investigating the behavior and laws of light.	Explore properties of electromagnetic radiation.	483	white light is a mixture of colors	111	mixing primary colors of light
				483	color and light	122	observe white light through diffraction glasses
				523	electromagnetic spectrum	123	investigate visible light wavelengths
				524	wavelength and frequency of visible light	123	how colors of light relate to frequency and wavelength
				524	energy and color of light	123	measure wavelengths of visible light using a spectrometer
				536	the electromagnetic spectrum		

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.4.02 Physics	Light and Optics	Understanding optics is accomplished by investigating the behavior and laws of light.	Examine properties of light waves.	478 482 483 485 499 501 502 512 524	seeing and reflected light reflection of light color and light how the human eye sees color mirrors reflect light reflection explained the law of reflection magnification energy and color of light	111 113 113 114 114 119 120 120 121 123 123	colors of light investigate law of reflection use a mirror to observe reflected light use results to derive law of reflection use a prism to investigate light rays investigate lenses and magnification using a mirror to reflect light investigate reflection of light use a lens to refract light how colors of light relate to frequency and wavelength measure wavelengths of visible light using a spectrometer
3231.4.03 Physics	Light and Optics	Understanding optics is accomplished by investigating the behavior and laws of light.	Investigate the polarization of light.	531	polarization	125 126	explore polarization of light explore the concept of polarization of light

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.4.04 Physics	Light and Optics	Understanding optics is accomplished by investigating the behavior and laws of light.	Investigate the optical properties of plane and curved mirrors.	499	mirrors reflect light	113 120	use a mirror to observe reflected light using a mirror to reflect light
3231.4.05 Physics	Light and Optics	Understanding optics is accomplished by investigating the behavior and laws of light.	Investigate the optical properties of plane and curved mirrors. (note: this is an acutal repeat in document).	499	mirrors reflect light	113 120	use a mirror to observe reflected light using a mirror to reflect light
3231.4.06 Physics	Light and Optics	Understanding optics is accomplished by investigating the behavior and laws of light.	Solve problems related to Snell's law	482 503 504	refraction of light understanding refraction angles of incidence and refraction	115 121	investigate refraction investigate refraction of light
3231.4.07 Physics	Light and Optics	Understanding optics is accomplished by investigating the behavior and laws of light.	Explore the formation of color (both additive and subtractive properties).	488 489	the CMYK color process the RGB color process	111 112	investigate the RGB model of color investigate the CMYK model of color

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.4.08 Physics	Light and Optics	Understanding optics is accomplished by investigating the behavior and laws of light.	Draw, explain, and solve problems for the optics of mirrors and lenses.	482 498 499 502 502 503 503 504 507 508 509 510 511 512 514	refraction of light optical systems mirrors reflect light drawing a ray diagram the law of reflection index of refraction understanding refraction angles of incidence and refraction objects and images ray diagram of an image in a mirror focal point and focal length ray diagram for a converging lens the image formed by a lens magnification understanding optical systems	113 113 113 114 114 114 117 117 119 120 121 121	construct ray diagrams investigate law of reflection use a mirror to observe reflected light construct ray diagrams use results to derive law of reflection use a prism to investigate light rays find focal lengths of lenses investigate images formed by lenses investigate lenses and magnification using a mirror to reflect light investigate refraction of light use a lens to refract light
3231.4.09 Physics	Light and Optics	Understanding optics is accomplished by investigating the behavior and laws of light.	Investigate optical phenomena (i.e., mirage, optical illusions, and dichromatic lens effect).	498 514	optical systems understanding optical systems		

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.4.10 Physics	Light and Optics	Understanding optics is accomplished by investigating the behavior and laws of light.	Differentiate among transmission, reflection, refraction, diffraction, and interference of light waves.	482 482 501 503 504 528 529 530	reflection of light refraction of light reflection explained understanding refraction angles of incidence and refraction diffraction and light interference of light waves diffraction gratings and spectrometers	120 121 122	investigate reflection of light investigate refraction of light investigate diffraction of light
3231.5.01 Physics	Electricity and Magnetism	Electric charge is the fundamental quantity that underlies electricity and magnetism.	Create a simple electromagnet.	364 365 387	electromagnets building an electromagnet electromagnetic induction explained	80 80 81 85	explore properties of electromagnets compare magnetic force and electric current in an electromagnet find relationship between current and magnetic field investigate electromagnetic induction
3231.5.02 Physics	Electricity and Magnetism	Electric charge is the fundamental quantity that underlies electricity and magnetism.	Draw an electric field, given a scenario of charged particles.	361 404	using magnetic forces the electric field	89	understand and investigate electric and gravitational fields

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.5.03 Physics	Electricity and Magnetism	Electric charge is the fundamental quantity that underlies electricity and magnetism.	Solve problems of resistance using Ohm's law.	300 306 307 308 309 311 319 321	resistors understanding electrical resistance measuring resistance Ohm's law resistance of common objects resistors resistance in a series circuit Ohm's law and voltage drops	61 62 63 63 67 75	investigate resistance investigate Ohm's law investigate resistance and potentiometers use Ohm's law Ohm's law and short circuits work with Ohm's law
3231.5.04 Physics	Electricity and Magnetism	Electric charge is the fundamental quantity that underlies electricity and magnetism.	Draw and explain series and parallel circuits.	299 299 301 318 323 325 326	electric circuits examples of electric circuits in nature battery circuits series circuits parallel circuits comparing series and parallel circuits parallel circuits in homes	57 60 65 65 66 68 68 69	build circuits a circuit with a dimmer switch investigate series circuits build a circuit with three bulbs and a switch investigate series circuits compare series and parallel circuits investigate parallel circuits construct a simple circuit

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.5.05 Physics	Electricity and Magnetism	Electric charge is the fundamental quantity that underlies electricity and magnetism.	Solve problems related to voltage, current, and resistance.	308 321	Ohm's law Ohm's law and voltage drops	62 63 67 75	investigate Ohm's law use Ohm's law Ohm's law and short circuits work with Ohm's law
3231.5.06 Physics	Electricity and Magnetism	Electric charge is the fundamental quantity that underlies electricity and magnetism.	Build series and parallel circuits to demonstrate how they function.	299 299 301 318 323 325 326	electric circuits examples of electric circuits in nature battery circuits series circuits parallel circuits comparing series and parallel circuits parallel circuits in homes	57 60 65 65 66 68 68 69	build circuits a circuit with a dimmer switch investigate series circuits build a circuit with three bulbs and a switch investigate series circuits compare series and parallel circuits investigate parallel circuits construct a simple circuit
3231.5.07 Physics	Electricity and Magnetism	Electric charge is the fundamental quantity that underlies electricity and magnetism.	Demonstrate a generated current by electromagnetic induction.	364 365 387 388 389	electromagnets building an electromagnet electromagnetic induction explained Faraday's law of induction how a generator works	85 87	investigate electromagnetic induction investigate how generators work

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.5.08 Physics	Electricity and Magnetism	Electric charge is the fundamental quantity that underlies electricity and magnetism.	Design a lab to demonstrate the flow of charged particles and an electric current.	310 310 348 348 348 350 351 351 352	semiconductors conductors and insulators superconductors electrons and insulators electrons and semiconductors how capacitors work charging a capacitor capacitors and current measuring capacitance	70 75	investigate capacitors calculate charge stored in capacitor
3231.5.09 Physics	Electricity and Magnetism	Electric charge is the fundamental quantity that underlies electricity and magnetism.	Analyze a given group of charges for repulsion and attraction.	340 341 341 342 354	understanding electric charge what causes shocks charged objects and static electricity understanding Coulomb's law understanding lightning	72	investigate the nature of electric charge
3231.5.10 Physics	Electricity and Magnetism	Electric charge is the fundamental quantity that underlies electricity and magnetism.	Distinguish between charged particles related to repulsion and attraction.	340 341 341 354	understanding electric charge what causes shocks charged objects and static electricity understanding lightning	72	investigate the nature of electric charge

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.5.11 Physics	Electricity and Magnetism	Electric charge is the fundamental quantity that underlies electricity and magnetism.	Describe the electric field that fills the space around a charged particle or group of charges	404	the electric field	89	understand and investigate electric and gravitational fields
3231.5.12 Physics	Electricity and Magnetism	Electric charge is the fundamental quantity that underlies electricity and magnetism.	Identify components of series and parallel circuits and solve problems related to voltage, current, and resistance.	308 321 325	Ohm's law Ohm's law and voltage drops comparing series and parallel circuits	62 63 67 68 75	investigate Ohm's law use Ohm's law Ohm's law and short circuits compare series and parallel circuits work with Ohm's law
3231.5.13 Physics	Electricity and Magnetism	Electric charge is the fundamental quantity that underlies electricity and magnetism.	Describe how current is generated by electromagnetic induction.	389	how a generator works	87	investigate how generators work
3231.6.01 Physics	Nuclear Physics	Nuclear physics can be better understood with a deeper understanding of particle physics.	Write and balance equations for the three forms of radioactive decay.	221 222 267 268 269 270 270 271	weak force explained radioactive decay nuclear reactions explained nuclear reactions and energy fusion reactions fission reactions radioactive materials types of radioactivity	51	investigate concepts of radioactivity

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.6.02 Physics	Nuclear Physics	Nuclear physics can be better understood with a deeper understanding of particle physics.	Solve half-life problems.	221 222 267 268 269 270 270	weak force explained radioactive decay nuclear reactions explained nuclear reactions and energy fusion reactions fission reactions radioactive materials		
3231.6.03 Physics	Nuclear Physics	Nuclear physics can be better understood with a deeper understanding of particle physics.	Explain dating methods using carbon-14 or uranium.	273	the process of carbon dating		
3231.6.04 Physics	Nuclear Physics	Nuclear physics can be better understood with a deeper understanding of particle physics.	Investigate the concept of half-life.	221 222 270 272	weak force explained radioactive decay radioactive materials half-life	52	investigate concept of half-life
3231.6.05 Physics	Nuclear Physics	Nuclear physics can be better understood with a deeper understanding of particle physics.	Explain how particles behave like waves.	231 233	Planck's constant probability and quantum theory		

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.6.06 Physics	Nuclear Physics	Nuclear physics can be better understood with a deeper understanding of particle physics.	Distinguish between coherent and incoherent light.	446	how a laser works		
3231.6.07 Physics	Nuclear Physics	Nuclear physics can be better understood with a deeper understanding of particle physics.	Recognize how the quantum theory explains the photoelectric effect.	231 233	Planck's constant probability and quantum theory		
3231.6.08 Physics	Nuclear Physics	Nuclear physics can be better understood with a deeper understanding of particle physics.	Investigate the history and current events associated with nuclear and radioactive science.	273	the process of carbon dating		
3231.6.09 Physics	Nuclear Physics	Nuclear physics can be better understood with a deeper understanding of particle physics.	Identify the parts of an atom.	220 220 226 230 343 347	subatomic particles and charge protons and neutrons and electrons electrons and energy levels the Bohr model and electron shells electrons and picture tubes electron motion and current	140 39	electron configuration atomic structure

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.6.10 Physics	Nuclear Physics	Nuclear physics can be better understood with a deeper understanding of particle physics.	Describe the properties and location of subatomic particles.	220	subatomic particles and charge		
3231.6.11 Physics	Nuclear Physics	Nuclear physics can be better understood with a deeper understanding of particle physics.	Describe three forms of radioactivity.	221 222 267 268 269 270 270	weak force explained radioactive decay nuclear reactions explained nuclear reactions and energy fusion reactions fission reactions radioactive materials		
3231.6.12 Physics	Nuclear Physics	Nuclear physics can be better understood with a deeper understanding of particle physics.	Distinguish between nuclear fission and nuclear fusion.	269 270	fusion reactions fission reactions		
3231.6.13 Physics	Nuclear Physics	Nuclear physics can be better understood with a deeper understanding of particle physics.	Investigate and describe quantum mechanics and the properties of quantum theory.	230 231 231 233	quantum theory explained quantum model of the atom Planck's constant probability and quantum theory	42	relate idea that electrons exist at set energy levels to quantum theory

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.6.14 Physics	Nuclear Physics	Nuclear physics can be better understood with a deeper understanding of particle physics.	Explain the changes in atomic number or mass number for each form of radioactivity.	267 268	nuclear reactions explained nuclear reactions and energy		
3231.6.15 Physics	Nuclear Physics	Nuclear physics can be better understood with a deeper understanding of particle physics.	Discuss transmutation and transuranium.	221 222 267 268 269 270 270	weak force explained radioactive decay nuclear reactions explained nuclear reactions and energy fusion reactions fission reactions radioactive materials		
3231.6.16 Physics	Nuclear Physics	Nuclear physics can be better understood with a deeper understanding of particle physics.	Explain how particles behave like waves.	231 233	Planck's constant probability and quantum theory		
3231.6.17 Physics	Nuclear Physics	Nuclear physics can be better understood with a deeper understanding of particle physics.	Describe how a laser is produced.	446	how a laser works		

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.6.18 Physics	Nuclear Physics	Nuclear physics can be better understood with a deeper understanding of particle physics.	Recognize how the quantum theory explains the photoelectric effect.	231 233	Planck's constant probability and quantum theory		
3231.Inq.01 Physics	Embedded Inquiry	Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.	Trace the historical development of a scientific principle or theory.	22 22 167 218 219 224	Fleming's investigations discovery of Penicillin history of atomic theory atomic theory development of atom models development of periodic table		

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.Inq.02 Physics	Embedded Inquiry	Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.	Conduct scientific investigations that include testable questions, verifiable hypotheses, and appropriate variables to explore new phenomena or verify the experimental results of others.	4	what is an experiment	27	identify and control variables
				6	what is a variable	30	state a hypothesis about the water's energy
				8	scientific method	47	design an experiment
				8	formulating a hypothesis	6	form a hypothesis
				8	hypothesis defined	6	recognize and control variables
				8	independent variables	94	state a hypothesis about period of pendulum
				8	dependent variables	94	investigate variables and how they affect the period of a pendulum
				8	control and experimental variables	94	design pendulum experiments
				8	designing experiments	96	state a hypothesis about the natural frequency of the oscillator
				16	graphs and independent variables		
				16	graphs and dependent variables		
				22	scientific method in action		
				24	importance of changing one variable at a time in an experiment		

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.Inq.03 Physics	Embedded Inquiry	Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.	Select appropriate independent, dependent, or controlled variables for an experiment.	6 8 8 8 16 16 24	what is a variable independent variables dependent variables control and experimental variables graphs and independent variables graphs and dependent variables importance of changing one variable at a time in an experiment	27 6 94	identify and control variables recognize and control variables investigate variables and how they affect the period of a pendulum
3231.Inq.04 Physics	Embedded Inquiry	Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.	Analyze the components of a properly designed scientific investigation.	4 8 8 22	what is an experiment scientific method designing experiments scientific method in action	13 15 47 6 94	design other experiments design another experiment design an experiment design a better experiment design pendulum experiments

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3231.Inq.05 Physics	Embedded Inquiry	Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.	Perform an experiment to test a prediction.	8	scientific method	15	predict speed of car
				22	scientific method in action	21	predict speed of car
						30	predict temperature of mixture
						45	predict how many bounces the car will make
						47	conduct the experiment you designed
						6	predict fastest car
						96	make predictions about natural frequency

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3231.Inq.06 Physics	Embedded Inquiry	Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.	Select appropriate tools and technology to collect precise and accurate quantitative and qualitative data.	11	measurement		
				12	metric system		
				13	measuring time		
				171	how a thermometer works		
				305	using a multimeter to measure current	1	collect accurate, precise data with electronic timer
				307	using a multimeter to measure resistance	150	using computer spreadsheets
						2	using timers and photogates
						22	use spring scales
						27	how can photogate ensure consistent results?
						44	using a timer and photogates
						46	using a timer and photogates
						47	conduct the experiment you designed
						59	use a multimeter
						61	collect and record resistance data
						61	using a multimeter to measure resistance
						62	use a multimeter to measure current
						63	use a multimeter to measure resistance of a pot

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						64	use a multimeter to measure voltage drop
						65	use a multimeter to measure voltage
						66	use a multimeter to measure current
						7	collect precise data
						74	use a multimeter to measure voltage
						78	estimate the precision of measurements
						85	use a multimeter to measure voltage
						86	use a timer and photogate to measure speed of rotor
						93	use a timer and photogate to measure the period of a pendulum
						96	use a timer and photogate to measure the natural frequency of an oscillator

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3231.Inq.07 Physics	Embedded Inquiry	Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.	Determine if data supports or contradicts a hypothesis or conclusion.	10	what is a model	11 15 21 30 45 47 52 6 6 6 60 7 9 96	what experimental data support answer? predict speed of car predict speed of car predict temperature of mixture predict how many bounces the car will make construct a reasonable explanation find a percentage do results agree with hypothesis? predict fastest car reflecting on the experiment propose a relationship between power and voltage construct explanations supported by evidence how do your observations support your answer? make predictions about natural frequency

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.Inq.08 Physics	Embedded Inquiry	Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.	Recognize, analyze, and evaluate alternative explanations for the same set of observations.			11 47 6 60 7 9	what experimental data support answer? construct a reasonable explanation reflecting on the experiment propose a relationship between power and voltage construct explanations supported by evidence how do your observations support your answer?
3231.Inq.09 Physics	Embedded Inquiry	Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.	Evaluate the accuracy and precision of data.	10	what is a model	1 27 44 7 78	collect accurate, precise data with electronic timer how can photogate ensure consistent results? make a precise time measurement collect precise data estimate the precision of measurements

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.Inq.10 Physics	Embedded Inquiry	Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.	State a conclusion in terms of the relationship between two or more variables.	19	mathematical descriptions	11	what experimental data support answer?
				26	interpreting distance/time graph	11	find formula for acceleration
				34	mathematical model of acceleration	13	derive a formula
				35	Newton's second law equation	154	calculate gear ratio
				41	average speed equation	17	derive a formula to use with ropes and pulleys
				43	calculating weight	17	calculate mechanical advantage
				61	momentum equation	29	find a mathematical name for the steepness ratio
				62	relating impulse and momentum conservation	29	calculate the ratio
				68	kinetic energy formula	31	calculate temperature of mixture
				86	the work equation	47	construct a reasonable explanation
				89	the power equation	6	reflecting on the experiment
				96	calculating mechanical advantage	60	propose a relationship between power and voltage
				118	Hooke's law equation	69	calculate power used by the bulb
				141	projectile motion problems	7	construct explanations supported by evidence
				143	calculating angular speed	75	derive a formula to calculate the charge
				144	finding the circumference of a circle		
				145	linear speed equation		
				153	equation for law of universal gravitation		
				179	the heat equation		

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				193	density formula	76	calculate the number of electrons
				208	pressure and temperature relationship	9	how do your observations support your answer?
				308	equation for Ohm's law	99	calculate natural frequency and period
				342	equation for Coulomb's law		
				438	calculating wave speeds		
				439	equation for the speed of a wave		
				525	equation for the speed of light		
3231.Inq.11 Physics	Embedded Inquiry	Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.	Defend a conclusion based on scientific evidence.			11	what experimental data support answer?
						47	construct a reasonable explanation
						52	find a percentage
						6	reflecting on the experiment
						60	propose a relationship between power and voltage
						7	construct explanations supported by evidence
						9	how do your observations support your answer?

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.Inq.12 Physics	Embedded Inquiry	Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.	Analyze experimental results and identify possible sources of bias or experimental error.	10	what is a model	21 26 27 3 4	how close is your prediction to the actual measurement? spotting the landing point of the marble is tricky marble launching technique is a possible source of error car launching technique is a possible source of error car launching technique is a possible source of error
3231.Inq.13 Physics	Embedded Inquiry	Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.	Compare the results of an experiment with what is already known about the topic under investigation.	19 28 28 52 166	mathematical models Newton's idea of force Newton and the history of physics history of high-speed photography Robert Brown and Brownian motion		

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3231.Inq.14 Physics	Embedded Inquiry	Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.	Suggest alternative explanations for the same set of observations.			11 47 6 60 7 9	what experimental data support answer? construct a reasonable explanation reflecting on the experiment propose a relationship between power and voltage construct explanations supported by evidence how do your observations support your answer?

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.Inq.15 Physics	Embedded Inquiry	Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.	Formulate and revise scientific explanations and models using logic and evidence.	10	what is a model	11	create a graph
				16	constructing graphs	15	graph speed vs. height
				16	steps to follow for graph construction	20	graph work done vs. deflection of rubber band
				25	constructing a graph	21	graph speed vs. rubber band deflection
				46	motion graphs	25	graph friction vs. mass
				48	motion graphs	27	graph launch angle vs. range
				112	using a graph to find force vector components	29	graph acceleration vs. steepness ratio
				419	harmonic motion graphs	4	construct a graph
				420	finding the amplitude on a harmonic motion graph	45	make a graph of efficiency vs. speed
						50	graph time vs. temperature
						52	construct a graph
						75	graph current vs. time for the capacitor
						86	graph voltage vs. speed
						94	sketch harmonic motion graphs

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.Inq.16 Physics	Embedded Inquiry	Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.	Compare conclusions that offer different, but acceptable explanations for the same set of experimental data.			11 21 26 27 3 4 47 6 60 7 9	what experimental data support answer? how close is your prediction to the actual measurement? spotting the landing point of the marble is tricky marble launching technique is a possible source of error car launching technique is a possible source of error car launching technique is a possible source of error construct a reasonable explanation reflecting on the experiment propose a relationship between power and voltage construct explanations supported by evidence how do your observations support your answer?

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.Math.01 Physics	Embedded Mathematics	Physics applies mathematics to investigate questions, solve problems, and communicate findings.	Plot points on the Cartesian coordinate graphing system.	16	constructing graphs	11	create a graph
				16	steps to follow for graph construction	15	graph speed vs. height
				25	constructing a graph	20	graph work done vs. deflection of rubber band
				46	motion graphs	21	graph speed vs. rubber band deflection
				48	motion graphs	25	graph friction vs. mass
				112	using a graph to find force vector components	27	graph launch angle vs. range
				419	harmonic motion graphs	29	graph acceleration vs. steepness ratio
				420	finding the amplitude on a harmonic motion graph	4	construct a graph
						45	make a graph of efficiency vs. speed
						50	graph time vs. temperature
						52	construct a graph
						75	graph current vs. time for the capacitor
						86	graph voltage vs. speed
		94	sketch harmonic motion graphs				

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.Math.02 Physics	Embedded Mathematics	Physics applies mathematics to investigate questions, solve problems, and communicate findings.	Graph basic relations and functions.	16	constructing graphs	11	create a graph
				16	steps to follow for graph construction	11	speed vs. time graph
				25	constructing a graph	15	graph speed vs. height
				46	position vs. time graphs	20	graph work done vs. deflection of rubber band
				46	motion graphs	21	graph speed vs. rubber band deflection
				47	position vs. time graph for accelerating motion	25	graph friction vs. mass
				48	speed vs. time graph	27	graph launch angle vs. range
				48	motion graphs		
				49	speed vs. time graph for accelerating motion	29	graph acceleration vs. steepness ratio
				51	finding distance from a speed vs. time graph	4	position vs. time graph
						4	construct a graph
				112	using a graph to find force vector components	45	make a graph of efficiency vs. speed
				419	harmonic motion graphs	50	graph time vs. temperature
				420	finding the amplitude on a harmonic motion graph	52	construct a graph
						75	graph current vs. time for the capacitor
						86	graph voltage vs. speed
						94	sketch harmonic motion graphs

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.Math.03 Physics	Embedded Mathematics	Physics applies mathematics to investigate questions, solve problems, and communicate findings.	Determine the slope of a linear function.	46 50	slope of a position vs. time graph slope of a speed vs. time graph	29	investigate slope
3231.Math.04 Physics	Embedded Mathematics	Physics applies mathematics to investigate questions, solve problems, and communicate findings.	Determine the frequency, range, mode, median, and mean from a list of data.	4	what is analysis	71	find the average of the three times
3231.Math.05 Physics	Embedded Mathematics	Physics applies mathematics to investigate questions, solve problems, and communicate findings.	Utilize a graphing calculator to enter data and find basic statistics: frequency, range, means, mode, median, and standard deviation.	4	what is analysis	21 26 27 3 4 71	how close is your prediction to the actual measurement? spotting the landing point of the marble is tricky marble launching technique is a possible source of error car launching technique is a possible source of error car launching technique is a possible source of error find the average of the three times

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.Math.06 Physics	Embedded Mathematics	Physics applies mathematics to investigate questions, solve problems, and communicate findings.	Solve for all variables based on a formula.	19	mathematical descriptions	11	find formula for acceleration
				26	interpreting distance/time graph	13	derive a formula
				34	mathematical model of acceleration	154	calculate gear ratio
				35	Newton's second law equation	17	calculate mechanical advantage
				41	average speed equation	17	derive a formula to use with ropes and pulleys
				43	calculating weight	29	find a mathematical name for the steepness ratio
				61	momentum equation		
				62	relating impulse and momentum conservation	29	calculate the ratio
				68	kinetic energy formula	31	calculate temperature of mixture
				86	the work equation	69	calculate power used by the bulb
				89	the power equation		
				96	calculating mechanical advantage	75	derive a formula to calculate the charge
				118	Hooke's law equation	76	calculate the number of electrons
				141	projectile motion problems		
				143	calculating angular speed	99	calculate natural frequency and period
				144	finding the circumference of a circle		
				145	linear speed equation		
				153	equation for law of universal gravitation		
				179	the heat equation		

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
				193	density formula		
				208	pressure and temperature relationship		
				308	equation for Ohm's law		
				342	equation for Coulomb's law		
				438	calculating wave speeds		
				439	equation for the speed of a wave		
				525	equation for the speed of light		
3231.Math.07 Physics	Embedded Mathematics	Physics applies mathematics to investigate questions, solve problems, and communicate findings.	Solve for the t – value, p (probability), and % of confidence between two lists of data (manipulated variables and responding variables).	4	what is analysis	71	find the average of the three times
				4	what is analysis	71	find the average of the three times

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.Math.08 Physics	Embedded Mathematics	Physics applies mathematics to investigate questions, solve problems, and communicate findings.	Reject or accept a null hypothesis based on statistical analysis	56	analyze a speed/distance graph	154 21 26 27 3 4 47	analyze gear ratio data how close is your prediction to the actual measurement? spotting the landing point of the marble is tricky marble launching technique is a possible source of error car launching technique is a possible source of error car launching technique is a possible source of error analyze the results

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.Math.09 Physics	Embedded Mathematics	Physics applies mathematics to investigate questions, solve problems, and communicate findings.	Find the regression line (equation) between data for manipulated and responding variables.	4	what is analysis	11	create a graph
				16	constructing graphs	15	graph speed vs. height
				16	steps to follow for graph construction	20	graph work done vs. deflection of rubber band
				25	constructing a graph	21	graph speed vs. rubber band deflection
				46	motion graphs	25	graph friction vs. mass
				48	motion graphs	27	graph launch angle vs. range
				112	using a graph to find force vector components	29	graph acceleration vs. steepness ratio
				419	harmonic motion graphs	4	construct a graph
				420	finding the amplitude on a harmonic motion graph	45	make a graph of efficiency vs. speed
						50	graph time vs. temperature
						52	construct a graph
						71	find the average of the three times
						75	graph current vs. time for the capacitor
						86	graph voltage vs. speed
						94	sketch harmonic motion graphs

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.Math.10 Physics	Embedded Mathematics	Physics applies mathematics to investigate questions, solve problems, and communicate findings.	Utilize trigonometric functions (sine, cosine, and tangent) to solve simple vector problems.	31 37 111 112 115 116	net force explained net force and second law calculating force vectors resolving vectors finding resultant vector when net force is zero	11 22 23	investigate net force when net force is zero use force vectors
3231.Math.11 Physics	Embedded Mathematics	Physics applies mathematics to investigate questions, solve problems, and communicate findings.	Apply the laws of sine and cosine to solve vector problems.	31 37 111 112 115 116	net force explained net force and second law calculating force vectors resolving vectors finding resultant vector when net force is zero	11 22 23	investigate net force when net force is zero use force vectors
3231.Math.12 Physics	Embedded Mathematics	Physics applies mathematics to investigate questions, solve problems, and communicate findings.	Solve mechanics problems using the quadratic formula.	39 39 52 88 137 138 402	calculations pertaining to free fall effect of gravity on motion acceleration shown through strobe photography work and gravity projectile explained free fall component of a trajectory gravitational field	26	investigate projectile motion

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.Math.13 Physics	Embedded Mathematics	Physics applies mathematics to investigate questions, solve problems, and communicate findings.	Find the derivative (velocity function) of a distance (displacement) function.	17	constant speed	11	find formula for acceleration
				19	mathematical descriptions	11	investigating net force and acceleration
				26	interpreting distance/time graph	13	derive a formula
				34	mathematical model of acceleration	154	calculate gear ratio
				35	Newton's second law equation	17	calculate mechanical advantage
				35	changes in speed or direction always involve acceleration	17	derive a formula to use with ropes and pulleys
				36	zero acceleration explained	29	find a mathematical name for the steepness ratio
				41	average speed equation	29	calculate the ratio
				43	calculating weight	31	calculate temperature of mixture
				61	momentum equation	69	calculate power used by the bulb
				62	relating impulse and momentum conservation	75	derive a formula to calculate the charge
				68	kinetic energy formula	76	calculate the number of electrons
				86	the work equation	99	calculate natural frequency and period
				89	the power equation		
				96	calculating mechanical advantage		
				118	Hooke's law equation		
				141	projectile motion problems		
				143	calculating angular speed		

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
				144	finding the circumference of a circle		
				145	linear speed equation		
				153	equation for law of universal gravitation		
				179	the heat equation		
				193	density formula		
				208	pressure and temperature relationship		
				308	equation for Ohm's law		
				342	equation for Coulomb's law		
				438	calculating wave speeds		
				439	equation for the speed of a wave		
				525	equation for the speed of light		
3231.Math.14 Physics	Embedded Mathematics	Physics applies mathematics to investigate questions, solve problems, and communicate findings.	Find the derivative (acceleration function) of a velocity function.	33	acceleration and velocity		

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.Math.15 Physics	Embedded Mathematics	Physics applies mathematics to investigate questions, solve problems, and communicate findings.	Link various calculus procedures to solve physics problems.	19	mathematical descriptions	11	find formula for acceleration
				26	interpreting distance/time graph	13	derive a formula
				34	mathematical model of acceleration	154	calculate gear ratio
				35	Newton's second law equation	17	calculate mechanical advantage
				41	average speed equation	17	derive a formula to use with ropes and pulleys
				43	calculating weight	29	find a mathematical name for the steepness ratio
				61	momentum equation		
				62	relating impulse and momentum conservation	29	calculate the ratio
				68	kinetic energy formula	31	calculate temperature of mixture
				86	the work equation	69	calculate power used by the bulb
				89	the power equation		
				96	calculating mechanical advantage	75	derive a formula to calculate the charge
				118	Hooke's law equation	76	calculate the number of electrons
				141	projectile motion problems		
				143	calculating angular speed	99	calculate natural frequency and period
				144	finding the circumference of a circle		
				145	linear speed equation		
				153	equation for law of universal gravitation		
				179	the heat equation		

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
				193	density formula		
				208	pressure and temperature relationship		
				308	equation for Ohm's law		
				342	equation for Coulomb's law		
				438	calculating wave speeds		
				439	equation for the speed of a wave		
				525	equation for the speed of light		

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.T/E.1 Physics	Embedded Technology and Engineering	Society benefits when engineers apply scientific discoveries to design materials and processes that develop into enabling technologies.	Select appropriate tools and procedures best suited to conduct a specified scientific inquiry.	11	measurement		computer spreadsheets and graphing software can be used throughout the curriculum for data analysis and presentation
				12	metric system		
				13	measuring time		
				171	how a thermometer works		
				305	using a multimeter to measure current	1	collect accurate, precise data with electronic timer
				307	using a multimeter to measure resistance	150	using computer spreadsheets
						2	using timers and photogates
						22	use spring scales
						27	how can photogate ensure consistent results?
						44	using a timer and photogates
						46	using a timer and photogates
						47	conduct the experiment you designed
						59	use a multimeter
						61	collect and record resistance data
						61	using a multimeter to measure resistance
						62	use a multimeter to measure current
						63	use a multimeter to measure resistance of a pot

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
						64	use a multimeter to measure voltage drop
						65	use a multimeter to measure voltage
						66	use a multimeter to measure current
						7	collect precise data
						74	use a multimeter to measure voltage
						78	estimate the precision of measurements
						85	use a multimeter to measure voltage
						86	use a timer and photogate to measure speed of rotor
						93	use a timer and photogate to measure the period of a pendulum
						96	use a timer and photogate to measure the natural frequency of an oscillator

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.T/E.2 Physics	Embedded Technology and Engineering	Society benefits when engineers apply scientific discoveries to design materials and processes that develop into enabling technologies.	Apply the engineering design process to construct a prototype that meets developmentally appropriate specifications.	105	engineering design cycle in action		
3231.T/E.3 Physics	Embedded Technology and Engineering	Society benefits when engineers apply scientific discoveries to design materials and processes that develop into enabling technologies.	Evaluate a protocol to determine the degree to which an engineering design process was successfully applied.			86	what changes have the largest effect on voltage produced?
						86	implement your generator design change ideas
						87	measure voltage for each different generator
						87	evaluate the effects your design change produced
						87	building different generators
						87	try your design change ideas
3231.T/E.4 Physics	Embedded Technology and Engineering	Society benefits when engineers apply scientific discoveries to design materials and processes that develop into enabling technologies.	Explore how the unintended consequences of new technologies can impact human and non-human communities.	72	energy usage and conservation		

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.T/E.5 Physics	Embedded Technology and Engineering	Society benefits when engineers apply scientific discoveries to design materials and processes that develop into enabling technologies.	Evaluate the overall benefit to cost ratio of a new technology.			86 87 87	what changes have the largest effect on voltage produced? measure voltage for each different generator evaluate the effects your design change produced
3231.T/E.6 Physics	Embedded Technology and Engineering	Society benefits when engineers apply scientific discoveries to design materials and processes that develop into enabling technologies.	Present research on current engineering technologies that contribute to improvements in our daily lives.	53 78 79 104 122 213 235 273 458 532	relationship between science and technology rocket technology new technologies prosthetic legs and technology maglev train technology deep water submarine technology technology and archaeology how a smoke detector works recording sound applications of polarization	112 161	research how computer monitors and televisions make colros making a model maglev train

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Standard #: Course	Standard	Conceptual Strand	Checks for Understanding	student text pg	detail	investigation pg	detail
3231.T/E.7 Physics	Embedded Technology and Engineering	Society benefits when engineers apply scientific discoveries to design materials and processes that develop into enabling technologies.	Design a series of multi-view drawings that can be used by others to construct an adaptive design and test its effectiveness.			153	draw a schematic diagram