



# PHYSICS

## Principles and Problems

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STANDARDS	PAGE REFERENCES
<b>Physics: Embedded Inquiry</b>	
<p><b>Conceptual Strand</b> <i>Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.</i></p>	
<p><b>Guiding Question</b> <i>What tools, skills, and knowledge are needed to conduct scientific inquiry?</i></p>	
<b>Course Level Expectations</b>	
<p><b>CLE 3231.Inq.1</b> Recognize that science is a progressive endeavor that reevaluates and extends what is already accepted.</p>	<p><b>Student Edition:</b> 3-10, 172-178, 747-759, 760-761, 818-823 <i>Extreme Physics</i> 78, 506, 792 <i>Future Technology</i> 22, 768 <b>Teacher Wraparound Edition:</b> CB 39, 730, 757; HSS 8; IM 9, 172; PP 6, 762; RLP 173, 175; TPK 760</p>
<p><b>CLE 3231.Inq.2</b> Design and conduct scientific investigations to explore new phenomena, verify previous results, test how well a theory predicts, and compare opposing theories.</p>	<p><b>Student Edition:</b> 8-10, 723, 726-729, 752-758, 760-761, 776-783 <i>Design Your Own Physics Lab</i> 392-393, 532-533 <i>Physics Lab</i> 332-333, 738-739 <b>Teacher Wraparound Edition:</b> A 761; QD 272, 440</p>

STANDARDS	PAGE REFERENCES
<p><b>CLE 3231.Inq.3</b> Use appropriate tools and technology to collect precise and accurate data.</p>	<p><b>Student Edition:</b>            12-14, 502-503  <i>Concepts In Motion</i> 12  <i>How It Works</i> 534, 688, 740  <i>Physics Lab</i> 136-137, 332-333, 580-581, 790-791  <b>Teacher Wraparound Edition:</b>            CB 9; CH 183; RLP 5</p>
<p><b>CLE 3231.Inq.4</b> Apply qualitative and quantitative measures to analyze data and draw conclusions that are free of bias.</p>	<p><b>Student Edition:</b>            12, 15-18  <i>Connecting Math to Physics</i> 16, 47, 295  <i>Physics Lab</i> 186-187, 274-275, 580-581, 790-791  <i>Problem-Solving Strategies</i> 16, 728  <i>Technology and Society</i> 220, 394, 608  <b>Teacher Wraparound Edition:</b>            CB 12; UA 16</p>
<p><b>CLE 3231.Inq.5</b> Compare experimental evidence and conclusions with those drawn by others about the same testable question.</p>	<p><b>Student Edition:</b>            8-12, 172-176, 184-185, 735-737, 748-756, 760-761  <i>Share Your Data</i> 21, 77, 247  <b>Teacher Wraparound Edition:</b>            BA 747; CB 757; IM 172</p>
<p><b>CLE 3231.Inq.6</b> Communicate and defend scientific findings.</p>	<p><b>Student Edition:</b>            8-10, 175-176, 723-731, 735-737, 748-749, 760-761  <i>Concepts In Motion</i> 698, 748  <i>Personal Tutor</i> 346, 658, 728, 755  <i>Share Your Data</i> 21, 77, 109, 247  <i>Technology and Society</i> 220, 394  <b>Teacher Wraparound Edition:</b>            CB 730; CD 7; HSS 748; PP 172</p>
<p><b>Checks for Understanding</b></p>	
<p><b>3231.Inq.1</b> Trace the historical development of a scientific principle or theory.</p>	<p><b>Student Edition:</b>            171-176, 184-185, 344-346, 352-358, 573, 648-649, 752-759, 760-761, 779-783, 787-789, 818-823  <i>Extreme Physics</i> 188, 506, 792  <i>Future Technology</i> 22, 768, 826  <b>Teacher Wraparound Edition:</b>            A 9; CB 184; PP 603; RLP 93, 329</p>

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<p><b>3231.Inq.2</b> Conduct scientific investigations that include testable questions, verifiable hypotheses, and appropriate variables to explore new phenomena or verify the experimental results of others.</p>	<p><b>Student Edition:</b>            8-10, 15-19, 172-176, 184-185  <i>Design Your Own Physics Lab</i> 392-393, 532-533, 554-555, 824-825  <i>Physics Lab</i> 332-333, 364-365  <b>Teacher Wraparound Edition:</b>            CB 39; HSS 8; PP 172</p>
<p><b>3231.Inq.3</b> Select appropriate independent, dependent, or controlled variables for an experiment.</p>	<p><b>Student Edition:</b>            15-17  <i>Design Your Own Physics Lab</i> 392-393, 532-533, 554-555, 824-825  <i>Internet Physics Lab</i> 20-21  <b>Teacher Wraparound Edition:</b>            AIL 161, 607; CB 39</p>
<p><b>3231.Inq.4</b> Analyze the components of a properly designed scientific investigation.</p>	<p><b>Student Edition:</b>            3-14, 177-178, 573-574, 748-749  <i>Extreme Physics</i> 366, 506  <i>Future Technology</i> 768  <i>Physics Lab</i> 274-275, 420-421, 580-581, 790-791  <b>Teacher Wraparound Edition:</b>            CB 749; CU 14; HSS 8</p>
<p><b>3231.Inq.5</b> Perform an experiment to test a prediction.</p>	<p><b>Student Edition:</b>            8-10, 15-19  <i>Design Your Own Physics Lab</i> 160-161, 392-393, 532-533, 554-555, 660-661, 824-825  <i>Extreme Physics</i> 366, 506  <b>Teacher Wraparound Edition:</b>            BA 15; CT 18</p>
<p><b>3231.Inq.6</b> Select appropriate tools and technology to collect precise and accurate quantitative and qualitative data.</p>	<p><b>Student Edition:</b>            12-14, 502-503  <i>How It Works</i> 534, 740  <i>Physics Lab</i> 136-137, 332-333, 580-581, 790-791  <i>Technology and Society</i> 220, 394, 608  <b>Teacher Wraparound Edition:</b>            CB 9; CH 183; RLP 5</p>
<p><b>3231.Inq.7</b> Determine if data supports or contradicts a hypothesis or conclusion.</p>	<p><b>Student Edition:</b>            8-10, 15-18  <i>Design Your Own Physics Lab</i> 160-161, 392-393, 532-533, 554-555, 660-661, 824-825  <b>Teacher Wraparound Edition:</b>            BA 15; CT 18</p>

STANDARDS	PAGE REFERENCES
<p><b>3231.Inq.8</b> Recognize, analyze, and evaluate alternative explanations for the same set of observations.</p>	<p><b>Student Edition:</b> 9-10, 102-107, 723-729, 735-737, 748-750, 760-761, 818-823 <i>Extreme Physics</i> 78, 366, 506</p> <p><b>Teacher Wraparound Edition:</b> CB 9, 819; CD 737; IM 61, 729, 736; PP 762</p>
<p><b>3231.Inq.9</b> Evaluate the accuracy and precision of data.</p>	<p><b>Student Edition:</b> 12-14, 16-19 <i>Concepts In Motion</i> 12 <i>Design Your Own Physics Lab</i> 160-161, 532-533 <i>Math Handbook</i> 833-836, 848-852 <i>Physics Lab</i> 218-219, 790-791</p> <p><b>Teacher Wraparound Edition:</b> CB 12; CD 177; CT 14; CU 14; TPK 11</p>
<p><b>3231.Inq.10</b> State a conclusion in terms of the relationship between two or more variables.</p>	<p><b>Student Edition:</b> 15-18 <i>Design Your Own Physics Lab</i> 160-161, 392-393 <i>Internet Physics Lab</i> 20-21, 76-77, 108-109 <i>Math Handbook</i> 844-845, 850-852 <i>Physics Lab</i> 136-137, 420-421, 790-791 <i>Problem-Solving Strategies</i> 16</p> <p><b>Teacher Wraparound Edition:</b> AIL 21; CU 19; UA 16</p>
<p><b>3231.Inq.11</b> Defend a conclusion based on scientific evidence.</p>	<p><b>Student Edition:</b> 8-10, 175-176, 723-731, 735-737, 748-749, 760-761 <i>Concepts In Motion</i> 698, 748 <i>Personal Tutor</i> 346, 658, 728, 755 <i>Share Your Data</i> 21, 77, 109, 247 <i>Technology and Society</i> 220, 394</p> <p><b>Teacher Wraparound Edition:</b> CB 730; CD 7; HSS 748; PP 172</p>
<p><b>3231.Inq.12</b> Analyze experimental results and identify possible sources of bias or experimental error.</p>	<p><b>Student Edition:</b> 11-12, 16-19 <i>Physics Lab</i> 136-137, 186-187, 274-275, 302-303, 392-393, 420-421, 474-475, 532-533, 606-607</p> <p><b>Teacher Wraparound Edition:</b> CT 14, 18; GF 303; PP 16</p>

STANDARDS	PAGE REFERENCES
<p><b>3231.Inq.13</b> Compare the results of an experiment with what is already known about the topic under investigation.</p>	<p><b>Student Edition:</b>            8-10  <i>Design Your Own Physics Lab</i> 392-393, 532-533  <i>Internet Physics Lab</i> 76-77, 504-505  <i>Physics Lab</i> 186-187, 420-421, 606-607  <b>Teacher Wraparound Edition:</b>            AIL 77</p>
<p><b>3231.Inq.14</b> Suggest alternative explanations for the same set of observations.</p>	<p><b>Student Edition:</b>            9-10, 102-107, 723-729, 735-737, 748-750, 760-761, 818-823  <i>Extreme Physics</i> 78, 366, 506  <b>Teacher Wraparound Edition:</b>            CB 9, 819; CD 737; IM 61, 729, 736; PP 762</p>
<p><b>3231.Inq.15</b> Formulate and revise scientific explanations and models using logic and evidence.</p>	<p><b>Student Edition:</b>            8-10, 12, 752, 760-761  <i>Design Your Own Physics Lab</i> 392-393  <i>Extreme Physics</i> 78, 188  <i>Physics Lab</i> 420-421  <b>Teacher Wraparound Edition:</b>            CB 757; R 33; TPK 11</p>
<p><b>3231.Inq.16</b> Compare conclusions that offer different, but acceptable explanations for the same set of experimental data.</p>	<p><b>Student Edition:</b>            9-10, 102-107, 723-729, 735-737, 748-750, 760-761, 818-823  <i>Extreme Physics</i> 78, 366, 506  <b>Teacher Wraparound Edition:</b>            CB 9, 819; CD 737; IM 61, 729, 736; PP 762</p>

STANDARDS	PAGE REFERENCES
<b>Physics: Embedded Technology and Engineering</b>	
<b>Conceptual Strand</b> <i>Society benefits when engineers apply scientific discoveries to design materials and processes that develop into enabling technologies.</i>	
<b>Guiding Question</b> <i>How do science concepts, engineering skills, and applications of technology improve the quality of life?</i>	
<b>Course Level Expectations</b>	
<b>CLE 3231.T/E.1</b> Explore the impact of technology on social, political, and economic systems.	<b>Student Edition:</b> 14, 171-173, 184-185, 445-447, 764-765, 784-789 <i>Extreme Physics</i> 50, 662, 792 <i>Future Technology</i> 22, 162, 556, 768, 826 <i>How It Works</i> 688 <i>Technology and Society</i> 394, 608, 716 <b>Teacher Wraparound Edition:</b> RLP 93, 154; E 156; IM 172
<b>CLE 3231.T/E.2</b> Differentiate among elements of the engineering design cycle: design constraints, model building, testing, evaluating, modifying, and retesting.	<b>Student Edition:</b> 9-10, 19, 266-273, 341-348 <i>Extreme Physics</i> 662, 792 <i>Future Technology</i> 476, 556 <i>Physics Lab</i> 714-715 <i>Technology and Society</i> 220, 304, 450, 608 <b>Teacher Wraparound Edition:</b> AIL 715; UA 348
<b>CLE 3231.T/E.3</b> Explain the relationship between the properties of a material and the use of the material in the application of a technology.	<b>Student Edition:</b> 317-322, 323-324; 360-363, 544-545, 777-781, 811 <i>Extreme Physics</i> 662 <i>Physics Lab</i> 364-365, 790-791 <i>Technology and Society</i> 304, 450 <b>Teacher Wraparound Edition:</b> A 544; CB 321, 595; CT 812; PP 350, 361; QD 810; RLP 701, 725, 753

STANDARDS	PAGE REFERENCES
<p><b>CLE 3231.T/E.4</b> Describe the dynamic interplay among science, technology, and engineering within living, earth-space, and physical systems.</p>	<p><b>Student Edition:</b>            171-181, 184-185, 239-240, 266-273, 500-501  <i>Extreme Physics</i> 188, 506, 662, 792  <i>Future Technology</i> 22, 476, 768  <i>How It Works</i> 276, 582, 688, 740  <i>Physics Lab</i> 186-187  <i>Technology and Society</i> 138, 220, 304, 394, 450, 608, 716</p> <p><b>Teacher Wraparound Edition:</b>            PP 213, 232; RLC 214; RLP 175</p>
<p><b>Checks for Understanding</b></p>	
<p><b>3231.T/E.1</b> Select appropriate tools and procedures best suited to conduct a specified scientific inquiry.</p>	<p><b>Student Edition:</b>            12-14, 502-503  <i>How It Works</i> 534, 740  <i>Physics Lab</i> 136-137, 218-219, 332-333, 420-421, 580-581, 790-791  <i>Technology and Society</i> 394, 608</p> <p><b>Teacher Wraparound Edition:</b>            A 9; CD 172, CH 183; E 156; RLP 5</p>
<p><b>3231.T/E.2</b> Apply the engineering design process to construct a prototype that meets developmentally appropriate specifications.</p>	<p><b>Student Edition:</b>            9-10  <i>Extreme Physics</i> 792  <i>Future Technology</i> 476  <i>Physics Lab</i> 714-715  <i>Technology and Society</i> 304, 450, 608</p> <p><b>Teacher Wraparound Edition:</b>            AIL 715</p>
<p><b>3231.T/E.3</b> Evaluate a protocol to determine the degree to which an engineering design process was successfully applied.</p>	<p><b>Student Edition:</b>            8-10, 15-19  <i>Design Your Own Physics Lab</i> 392-393, 532-533, 554-555, 714-715, 790-791, 824-825</p> <p><b>Teacher Wraparound Edition:</b>            CB 39; HSS 8</p>

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<p><b>3231.T/E.4</b> Explore how the unintended consequences of new technologies can impact human and non-human communities.</p>	<p><b>Student Edition:</b>  648, 675-685, 812-813  <i>Applying Physics</i> 154  <i>Extreme Physics</i> 662  <i>Future Technology</i> 826  <i>Technology and Society</i> 394, 608, 716</p> <p><b>Teacher Wraparound Edition:</b>  CB 599; CT 602, 812; CU 358; E 605; RLC 811</p>
<p><b>3231.T/E.5</b> Evaluate the overall benefit to cost ratio of a new technology.</p>	<p><b>Student Edition:</b>  604-605  <i>Applying Physics</i> 154  <i>Future Technology</i> 826  <i>Technology and Society</i> 394, 608</p> <p><b>Teacher Wraparound Edition:</b>  CB 599; CT 602; CU 605</p>
<p><b>3231.T/E.6</b> Present research on current engineering technologies that contribute to improvements in our daily lives.</p>	<p><b>Student Edition:</b>  14, 764-765, 788-789  <i>Extreme Physics</i> 662  <i>Future Technology</i> 22  <i>How It Works</i> 276, 334, 534, 582, 634, 688  <i>Technology and Society</i> 220, 304, 394, 608, 716</p> <p><b>Teacher Wraparound Edition:</b>  AP 764; CH 357; CT 708; E 10; PP 764; RLP 5, 779</p>
<p><b>3231.T/E.7</b> Design a series of multi-view drawings that can be used by others to construct an adaptive design and test its effectiveness.</p>	<p><b>Student Edition:</b>  <i>Problem-Solving Strategies</i> 599</p> <p><b>Teacher Wraparound Edition:</b>  A 394; E 631</p>

STANDARDS	PAGE REFERENCES
<b>Physics: Embedded Mathematics</b>	
<b>Conceptual Strand</b> <i>Physics applies mathematics to investigate questions, solve problems, and communicate findings.</i>	
<b>Guiding Question</b> <i>What mathematical skills and understandings are needed to successfully investigate physics?</i>	
<b>Course Level Expectations</b>	
<b>CLE.3231.Math.1</b> Graph relationships and functions between manipulated (independent) variables and responding (dependent) variables.	<b>Student Edition:</b> 38-42, 43-44, 65-66, 72-73, 90-91 <i>Internet Physics Lab</i> 76-77 <i>Launch Lab</i> 57 <i>Math Handbook</i> 848-852 <i>Physics Lab</i> 186-187, 580-581, 790-791 <b>Teacher Wraparound Edition:</b> BA 38; CT 59; UM 74
<b>CLE.3231.Math.2</b> Solve for variables in an algebraic formula.	<b>Student Edition:</b> 4, 60, 69-70, 97, 207, 214-215, 271, 296, 346, 654 <i>Math Handbook</i> 843-846 <i>Physics Lab</i> 186-187 <b>Teacher Wraparound Edition:</b> HSS 296; ICE 4, 63, 214
<b>CLE.3231.Math.3</b> Apply statistical techniques to manipulate data.	<b>Student Edition:</b> 44-47 <i>Math Handbook</i> 833-835 <b>Teacher Wraparound Edition:</b> ICE 60
<b>CLE.3231.Math.4</b> Investigate trigonometric connections to physics.	<b>Student Edition:</b> 120-125, 202, 260, 486-489, 673-674 <i>Math Handbook</i> 855-856 <b>Teacher Wraparound Edition:</b> ICE 121, 202, 262, 487, 674; R 678
<b>CLE.3231.Math.5</b> Utilize calculus to understand physics principles.	<b>Teacher Wraparound Edition:</b> CD 176

STANDARDS	PAGE REFERENCES
<b>Checks for Understanding</b>	
<b>3231.Math.1</b> Plot points on the Cartesian coordinate graphing system.	<b>Student Edition:</b> 15-18, 38-40, 58-64 <i>Concepts In Motion</i> 15, 465 <i>Math Handbook</i> 848-852 <i>Problem-Solving Strategies</i> 16 <b>Teacher Wraparound Edition:</b> BA 15; CT 18; QD 17
<b>3231.Math.2</b> Graph basic relations and functions.	<b>Student Edition:</b> 15-18, 38-40, 59-61 <i>Math Handbook</i> 848-852 <i>Problem-Solving Strategies</i> 16 <b>Teacher Wraparound Edition:</b> BA 15; CT 18; QD 17
<b>3231.Math.3</b> Determine the slope of a linear function.	<b>Student Edition:</b> 16-17, 58-59 <i>Internet Physics Lab</i> 20-21, 76-77 <i>Math Handbook</i> 850 <i>Problem-Solving Strategies</i> 16 <b>Teacher Wraparound Edition:</b> UA 16
<b>3231.Math.4</b> Determine the frequency, range, mode, median, and mean from a list of data.	
<b>3231.Math.5</b> Utilize a graphing calculator to enter data and find basic statistics: frequency, range, means, mode, median, and standard deviation.	
<b>3231.Math.6</b> Solve for all variables based on a formula.	<b>Student Edition:</b> <i>Connecting Math to Physics</i> 408 <i>Math Handbook</i> 843-845 <b>Teacher Wraparound Edition:</b> UM 4
<b>3231.Math.7</b> Solve for the $t$ – value, $p$ (probability), and % of confidence between two lists of data (manipulated variables and responding variables).	
<b>3231.Math.8</b> Reject or accept a null hypothesis based on statistical analysis.	

STANDARDS	PAGE REFERENCES
<p><b>3231.Math.9</b> Find the regression line (equation) between data for manipulated and responding variables.</p>	<p><b>Student Edition:</b> 15-17 <i>Math Handbook</i> 848 <i>Physics Lab</i> 274-275 <i>Problem-Solving Strategies</i> 16</p>
<p><b>3231.Math.10</b> Utilize trigonometric functions (sine, cosine, and tangent) to solve simple vector problems.</p>	<p><b>Student Edition:</b> 120-124 <i>Math Handbook</i> 855 <i>Problem-Solving Strategies</i> 123 <b>Teacher Wraparound Edition:</b> ICE 121, 124, 135</p>
<p><b>3231.Math.11</b> Apply the laws of sine and cosine to solve vector problems.</p>	<p><b>Student Edition:</b> 120-121 <i>Math Handbook</i> 855-856 <b>Teacher Wraparound Edition:</b> ICE 121</p>
<p><b>3231.Math.12</b> Solve mechanics problems using the quadratic formula.</p>	<p><b>Student Edition:</b> 17, 150-151 <i>Math Handbook</i> 846 <b>Teacher Wraparound Edition:</b> HSS 17</p>
<p><b>3231.Math.13</b> Find the derivative (velocity function) of a distance (displacement) function.</p>	<p><b>Student Edition:</b> 43-47 <b>Teacher Wraparound Edition:</b> A 47; ICE 45</p>
<p><b>3231.Math.14</b> Find the derivative (acceleration function) of a velocity function.</p>	<p><b>Student Edition:</b> 59-63 <b>Teacher Wraparound Edition:</b> ICE 60, 63</p>
<p><b>3231.Math.15</b> Link various calculus procedures to solve physics problems.</p>	

STANDARDS	PAGE REFERENCES
<b>Physics: Standard 1 – Mechanics</b>	
<b>Conceptual Strand 1</b> <i>Laws and properties of mechanics are the foundations of physics.</i>	
<b>Guiding Question 1</b> <i>How do the laws and properties of mechanics govern the basic understanding of physics.</i>	
<b>Course Level Expectations</b>	
<b>CLE 3231.1.1</b> Investigate fundamental physical quantities of mass and time.	<b>Student Edition:</b> 36-37, 176-185, 292, 802-803 <i>Design Your Own Physics Lab</i> 392-393 <i>Extreme Physics</i> 50, 78, 188, 506 <i>Internet Physics Lab</i> 108-109, 246-247 <b>Teacher Wraparound Edition:</b> CD 803; E 37; IM 39
<b>CLE 3231.1.2</b> Analyze and apply Newton’s three laws of motion.	<b>Student Edition:</b> 92, 93, 94-95, 96-101, 102-107, 154-155, 182, 208-210, 754-755 <b>Teacher Wraparound Edition:</b> A 93; BA 102; CB 92; CU 95; D 96; HSS 104; ICE 97, 99, 106, 129; IM 103; R 107; UA 105
<b>CLE 3231.1.3</b> Understand work, energy, and power.	<b>Student Edition:</b> 258-265, 286-290, 293-296 <i>Applying Physics</i> 265 <i>Launch Lab</i> 257 <i>Physics Lab</i> 274-275 <b>Teacher Wraparound Edition:</b> ICE 261; QD 287; R 259; RLP 260
<b>CLE 3231.1.4</b> Investigate kinematics and dynamics.	<b>Student Edition:</b> 38-40, 43-47, 59-63, 93-95, 102-107, 126-129, 131-135, 147-152, 153-156, 175-176, 198-199 <i>Internet Physics Lab</i> 108-109 <i>Physics Lab</i> 138-139 <i>Problem-Solving Strategies</i> 98, 103, 149 <b>Teacher Wraparound Edition:</b> ICE 41; IM 199; PP 45; RLP 93, 134; UA 62

STANDARDS	PAGE REFERENCES
<p><b>CLE 3231.1.5</b> Investigate and apply Archimedes's Principle.</p>	<p><b>Student Edition:</b> 354-356 <i>Launch Lab</i> 341</p> <p><b>Teacher Wraparound Edition:</b> CB 354; CT 355; ICE 356</p>
<p><b>CLE 3231.1.6</b> Explore Pascal's Principle.</p>	<p><b>Student Edition:</b> 352-354</p> <p><b>Teacher Wraparound Edition:</b> TPK 352; TT 353</p>
<p><b>CLE 3231.1.7</b> Analyze applications of Bernoulli's Principle.</p>	<p><b>Student Edition:</b> 357-358</p> <p><b>Teacher Wraparound Edition:</b> CD 357; E 358; RLP 356</p>
<b>Checks for Understanding</b>	
<p><b>3231.1.1</b> Explore displacement, velocity, and acceleration.</p> <p>Average Velocity: <math>v_{av} = \frac{d_f - d_i}{t_f - t_i}</math></p> <p>Final Velocity: <math>v_f = v_i + a \Delta t</math></p> <p>Final Velocity of Falling: <math>v_f = v_i + g \Delta t</math></p> <p>Average Acceleration: <math>a_{av} = \frac{v_f - v_i}{t_f - t_i}</math></p> <p>Displacement: <math>\Delta d = v_i \Delta t + \frac{1}{2} a_{av} (\Delta t)^2</math></p> <p>Displacement of Falling: <math>\Delta d = v_i \Delta t + \frac{1}{2} g (\Delta t)^2</math></p>	<p><b>Student Edition:</b> 36-37, 43-47, 59-64, 65-71, 72-75, 132-135, 147-150, 153-159, 179-182</p> <p><i>Internet Physics Lab</i> 20-21, 76-77, 108-109</p> <p><i>Physics Lab</i> 48-49</p> <p><b>Teacher Wraparound Edition:</b> CH 66; CU 71; ICE 60, 70; IM 36; QD 69</p>
<p><b>3231.1.2</b> Analyze vector diagrams and solve composition and resolution problems for force and momentum.</p>	<p><b>Student Edition:</b> 35-37, 120-125, 131-135, 230-235, 241-242, 375-380</p> <p><i>Personal Tutor</i> 378</p> <p><i>Problem-Solving Strategies</i> 123</p> <p><b>Teacher Wraparound Edition:</b> A 122; CD 131; CU 125, 135; IM 132; R 232; UA 36</p>

STANDARDS	PAGE REFERENCES
<p><b>3231.1.3</b> Explore characteristics of rectilinear motion and create distance-time graphs (velocity), velocity-time graphs (acceleration and distance).</p>	<p><b>Student Edition:</b> 34-37, 38-42, 43-47, 57-64, 65-71 <i>Launch Lab</i> 57 <i>Physics Lab</i> 48-49</p> <p><b>Teacher Wraparound Edition:</b> CD 38; IM 36; R 63</p>
<p><b>3231.1.4</b> Investigate the characteristics of centripetal motion and centripetal acceleration.</p> <p>Centripetal Force: <math>F_c = m \frac{v^2}{r}</math></p> <p>Angular Velocity: <math>\omega = \frac{\Delta\theta}{\Delta t}</math></p> <p>Angular Acceleration: <math>\alpha = \frac{\Delta\omega}{\Delta t}</math></p>	<p><b>Student Edition:</b> 153-156, 198-200, 216 <i>Future Technology</i> 162</p> <p><b>Teacher Wraparound Edition:</b> BA 153; CU 200; QD 154; R 216</p>
<p><b>3231.1.5</b> Evaluate the dynamics of systems in motion including friction, gravity, impulse and momentum, change in momentum, and conservation of momentum.</p> <p>Coefficient of Friction: <math>\mu = \frac{F_f}{F_N}</math></p> <p>Law of Universal Gravitation: <math>F = G \frac{m_1 m_2}{d^2}</math></p> <p>Impulse and Change of Momentum: <math>F\Delta t = m\Delta v</math></p>	<p><b>Student Edition:</b> 72-75, 93-95, 100-107, 126-130, 153-156, 175-176, 230-232, 236-241 <i>Internet Physics Lab</i> 76-77, 108-109, 246-247 <i>Physics Lab</i> 136-137 <i>Problem-Solving Strategies</i> 98, 149 <i>Technology and Society</i> 138</p> <p><b>Teacher Wraparound Edition:</b> CD 73, 230; PP 127; TPK 236</p>
<p><b>3231.1.6</b> Investigate projectile motion. Parabolic Equations With Quadratic Formula:</p> $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$	<p><b>Student Edition:</b> 120-121, 147-152 <i>Design Your Own Physics Lab</i> 160-161 <i>Launch Lab</i> 147 <i>Math Handbook</i> 846, 852</p> <p><b>Teacher Wraparound Edition:</b> CH 151; HSS 17; ICE 124; IM 122, 150</p>

STANDARDS	PAGE REFERENCES
<p><b>3231.1.7</b> Apply mathematics to solve motion problems.</p>	<p><b>Student Edition:</b>            34-37, 38-42, 43-47, 58-63, 65-68, 72-75, 93-95, 96-101, 102-107, 119-125  <i>Connecting Math to Physics</i> 47, 68  <i>Future Technology</i> 476  <i>Internet Physics Lab</i> 20-21, 76-77, 108-109  <i>Launch Lab</i> 57  <i>Math Handbook</i> 848-851  <i>Physics Lab</i> 48-49, 218-219  <i>Problem-Solving Strategies</i> 98, 103, 123, 149  <b>Teacher Wraparound Edition:</b>            CU 37, 42; HSS 121; ICE 70, 97; UA 62</p>
<p><b>3231.1.8</b> Experiment with elastic and inelastic collisions.</p>	<p><b>Student Edition:</b>            236, 241-242, 297-301  <i>Internet Physics Lab</i> 246-247  <b>Teacher Wraparound Edition:</b>            CH 300; D 298; EX 301</p>
<p><b>3231.1.9</b> Experiment with pendulums.            Pendulum Period: <math>T = 2\pi\sqrt{\frac{l}{g}}</math></p>	<p><b>Student Edition:</b>            294-295, 378-379, 384-386, 396-400  <i>Design Your Own Physics Lab</i> 392-393  <b>Teacher Wraparound Edition:</b>            A 384; AML 295; CH 294; ICE 379</p>
<p><b>3231.1.10</b> Utilize trigonometry and vector analysis to solve force and momentum problems [Sine, Cosine, Tangent Functions, Law of Sine, and Law of Cosine].</p>	<p><b>Student Edition:</b>            88-95, 96-101, 102-107, 131-135, 230-235, 236-242  <i>Math Handbook</i> 855-856  <i>Physics Lab</i> 136-137  <b>Teacher Wraparound Edition:</b>            CB 92; CD 91; ICE 134</p>
<p><b>3231.1.11</b> Apply elementary calculus to solve motion.            Velocity = derivative of position with respect to time, and Acceleration = derivative of velocity with respect to time</p>	
<p><b>3231.1.12</b> Experiment with elastic and inelastic collisions.            Elastic Collisions in One Dimension:  <math>m_1v_1 + m_2v_2 = m_1v_3 + m_2v_4</math>            Inelastic Collisions in One Dimension:  <math>m_1v_1 + m_2v_2 = (m_1 + m_2)v_3</math></p>	<p><b>Student Edition:</b>            236, 241-242, 297-301  <i>Internet Physics Lab</i> 246-247  <b>Teacher Wraparound Edition:</b>            CH 300; D 298; EX 301</p>

STANDARDS	PAGE REFERENCES
<p><b>3231.1.13</b> Distinguish between mass and weight using base units in the SI system.</p>	<p><b>Student Edition:</b> 96-98, 102-107, 184 <i>How It Works</i> 110 <i>Internet Physics Lab</i> 108-109</p> <p><b>Teacher Wraparound Edition:</b> BA 96; PP 99</p>
<p><b>3231.1.14</b> Associate time with the independent variable in most experiments.</p>	<p><b>Student Edition:</b> 36-37, 38-40, 58-63, 65-68, 72-75 <i>Internet Physics Lab</i> 76-77 <i>Math Handbook</i> 848 <i>Physics Lab</i> 48-49</p> <p><b>Teacher Wraparound Edition:</b> ICE 60, 67; TPK 34</p>
<p><b>3231.1.15</b> Relate inertia, force or action-reaction forces to Newton’s three laws of motion.</p>	<p><b>Student Edition:</b> 92-95, 96-101, 102-107, 154-155, 182, 208-210, 754-755</p> <p><b>Teacher Wraparound Edition:</b> A 93; BA 102; CB 92; D 96; HSS 104; ICE 97, 99, 106, 129; IM 103; R 107; RLP 93; UA 105</p>
<p><b>3231.1.16</b> Compare, contrast, and apply characteristic properties of scalar and vector quantities.</p>	<p><b>Student Edition:</b> 35-37, 120-125, 131-135, 230-235, 241-242, 375-380 <i>Problem-Solving Strategies</i> 123</p> <p><b>Teacher Wraparound Edition:</b> A 122; CD 131; CU 37, 125, 135; IM 36, 132; R 35, 232</p>
<p><b>3231.1.17</b> Investigate the definitions of force, work, power, kinetic energy, and potential energy.</p> <p>Force: <math>F = ma</math>    Work: <math>W = Fd</math></p> <p>Power: <math>P = \frac{F\Delta d}{\Delta t}</math>    Energy: <math>EK = \frac{1}{2}mv^2</math></p> <p>Potential Energy: <math>EP = mg\Delta h</math></p>	<p><b>Student Edition:</b> 258-265, 286-290, 293-296, 376-378 <i>Applying Physics</i> 265 <i>Launch Lab</i> 257, 285 <i>Physics Lab</i> 274-275 <i>Problem-Solving Strategies</i> 260</p> <p><b>Teacher Wraparound Edition:</b> HSS 296; ICE 261, 377; QD 287; R 259; RLP 260</p>
<p><b>3231.1.18</b> Analyze the characteristics of energy, conservation of energy including friction, and gravitational potential energy.</p> <p>Gravitational Potential Energy: <math>EP = mgh</math></p>	<p><b>Student Edition:</b> 258, 287-292, 293-296 <i>Physics Lab</i> 302-303 <i>Problem-Solving Strategies</i> 295</p> <p><b>Teacher Wraparound Edition:</b> CD 294; HSS 296; ICE 296; IM 263, 288; QD 295</p>

STANDARDS	PAGE REFERENCES
<p><b>3231.1.19</b> Relate work and power to various simple machines, mechanical advantage of different machines, and recognize simple machines that are combined to form compound machines.</p> <p>Work: <math>W = F\Delta d</math>    Power: <math>p = \frac{F\Delta d}{\Delta t}</math></p> <p>Efficiency: <math>e = \frac{W_{out}}{W_{in}} 100</math>, percent</p>	<p><b>Student Edition:</b> 266-273</p> <p><b>Teacher Wraparound Edition:</b> CB 267; CD 266; R 273; RLP 268</p>
<p><b>3231.1.20</b> Describe rotational equilibrium and relate this factor to torque.</p> <p>Rotational Inertia: <math>T = I\alpha</math>    Torque: <math>T = Fr</math></p>	<p><b>Student Edition:</b> 213-215</p> <p><i>Physics Lab</i> 218-219 <i>Technology and Society</i> 220</p> <p><b>Teacher Wraparound Edition:</b> CT 215</p>
<p>3231.1.21 Determine the magnitude of the buoyant force exerted on floating and submerged objects (<math>F_B = m_f g = \rho_f V_f g</math>).</p>	<p><b>Student Edition:</b> 354-356</p> <p><i>Launch Lab</i> 341</p> <p><b>Teacher Wraparound Edition:</b> CT 354, 355; ICE 356</p>
<p>3231.1.22 Investigate the apparent weight of an object submerged in a fluid (<math>F_{net} = F_B - F_g</math>).</p>	<p><b>Student Edition:</b> 354-356</p> <p><b>Teacher Wraparound Edition:</b> CT 354, 355; ICE 356; IM 353</p>
<p>3231.1.23 Explain why objects float or sink in terms of force and density.</p>	<p><b>Student Edition:</b> 354-356</p> <p><i>Launch Lab</i> 341</p> <p><b>Teacher Wraparound Edition:</b> CT 354, 355</p>
<p>3231.1.24 Calculate the pressure exerted by a fluid according to Pascal's Principle (<math>P_{inc} = F_1/A_1 = F_2/A_2</math>).</p>	<p><b>Student Edition:</b> 352</p> <p><b>Teacher Wraparound Edition:</b> TPK 352</p>
<p>3231.1.25 Calculate how pressure varies with depth (<math>P = P_0 + \rho gh</math>).</p>	<p><b>Student Edition:</b> 353-354</p> <p><b>Teacher Wraparound Edition:</b> QD 353</p>

STANDARDS	PAGE REFERENCES
3231.1.26 Examine the motion of a fluid using the continuity equation ( $A_1 v_1 = A_2 v_2$ ).	<b>Student Edition:</b> 357-358 <b>Teacher Wraparound Edition:</b> R 357
3231.1.27 Recognize the effects of Bernoulli's principle on fluid motion (e.g., lift, ball trajectories, and wind around/over object).	<b>Student Edition:</b> 357-358 <b>Teacher Wraparound Edition:</b> CD 357; CU 358
<b>Physics: Standard 2 – Thermodynamics</b>	
<b>Conceptual Strand 2</b>	
<i>The principles and laws of thermodynamics are essential for understanding the concept of energy.</i>	
<b>Guiding Question 2</b>	
<i>How do the laws of thermodynamics relate to understanding the conservation of energy?</i>	
<b>Course Level Expectations</b>	
<b>CLE 3231.2.1</b> Develop a deep understanding of heat and internal energy.	<b>Student Edition:</b> 317-320, 323-328 <b>Teacher Wraparound Edition:</b> HSS 320
<b>CLE 3231.2.2</b> Compare Celsius, Kelvin and the Absolute temperature scales.	<b>Student Edition:</b> 316 <b>Teacher Wraparound Edition:</b> IM 316
<b>CLE 3231.2.3</b> Investigate exchanges in internal energy.	<b>Student Edition:</b> 258-259, 288-290, 293-296, 317-320, 323-324, 326-331 <i>Math Link</i> 301 <i>Physics Lab</i> 332-333 <b>Teacher Wraparound Edition:</b> HSS 296, 320; ICE 321; IM 326; UM 324
<b>Checks for Understanding</b>	
<b>3231.2.1</b> Investigate temperature in relationship to kinetic energy.	<b>Student Edition:</b> 314-318 <i>Physics Lab</i> 332-333 <b>Teacher Wraparound Edition:</b> AML 330; CD 314; IM 316

STANDARDS	PAGE REFERENCES
<p><b>3231.2.2</b> Identify the characteristics of internal energy and temperature/heat (joules/calories).</p>	<p><b>Student Edition:</b> 314-318, 323-328 <i>Physics Lab</i> 332-333</p> <p><b>Teacher Wraparound Edition:</b> AML 330; CD 314; HSS 320; IM 316</p>
<p><b>3231.2.3</b> Investigate changes in heat content (quantity of thermal energy) and relate to kinetic energy and specific heat.</p>	<p><b>Student Edition:</b> 317-321, 323-328</p> <p><b>Teacher Wraparound Edition:</b> CB 318</p>
<p><b>3231.2.4</b> Investigate potential energy changes (phase changes) of heat of fusion, heat of vaporization, and heat of sublimation.</p> <p>Change in Heat: <math>Q = m H_{fus}</math>; <math>Q = m H_{vap}</math>; <math>Q = m H_{sub}</math></p>	<p><b>Student Edition:</b> 323-325, 337-338 <i>Physics Lab</i> 332-333</p> <p><b>Teacher Wraparound Edition:</b> ICE 325; UM 324</p>
<p><b>3231.2.5</b> Explore thermal expansion.</p> <p>Linear Expansion: <math>\Delta L = L_1 \alpha \Delta T</math></p> <p>Volumetric Expansion: <math>\Delta V = V_1 \beta \Delta T</math></p>	<p><b>Student Edition:</b> 347-348, 360-363</p> <p><b>Teacher Wraparound Edition:</b> CT 360; IM 361; UA 348</p>
<p><b>3231.2.6</b> Apply the second law of thermodynamics to the Carnot engine.</p>	<p><b>Student Edition:</b> 328-331</p> <p><b>Teacher Wraparound Edition:</b> RLP 329</p>
<p><b>3231.2.7</b> Apply the Laws of Thermodynamics to the atmospheric levels of the earth (i.e., greenhouse effect and global warming)</p>	<p><b>Student Edition:</b> 326-331</p> <p><b>Teacher Wraparound Edition:</b> CD 327</p>
<p><b>3231.2.8</b> Recognize that absolute zero is the absence of molecular kinetic energy.</p>	<p><b>Student Edition:</b> 316</p>
<p><b>3231.2.9</b> Relate the First Law of Thermodynamics as an application of the Law of Conservation of Energy and heat transfer through conduction, convection, and radiation.</p> <p>Heat Lost = Heat Gained: <math>Q_L = Q_G</math></p>	<p><b>Student Edition:</b> 293-296, 317-318, 326-327 <i>Problem-Solving Strategies</i> 295</p> <p><b>Teacher Wraparound Edition:</b> CD 294; TT 317</p>
<p><b>3231.2.10</b> Relate change in heat content (quantity of thermal energy) to kinetic energy and specific heat.</p> <p>Change in Heat: <math>Q = mC\Delta T</math></p>	<p><b>Student Edition:</b> 317-321, 323-328</p> <p><b>Teacher Wraparound Edition:</b> CB 318</p>

STANDARDS	PAGE REFERENCES
<b>Physics: Standard 3 – Waves</b>	
<b>Conceptual Strand 3</b> <i>Investigating wave behavior reveals information about sound and light..</i>	
<b>Guiding Question 3</b> <i>How do the properties of mechanical waves, sound, and light explain the behavior of waves?</i>	
<b>Course Level Expectations</b>	
<b>CLE 3231.3.1</b> Explore conditions associated with simple harmonic motion.	<b>Student Edition:</b> 375-380, 384-386 <i>Design Your Own Physics Lab</i> 392-393 <b>Teacher Wraparound Edition:</b> BA 375; CH 377; CU 380; ICE 379R 384
<b>CLE 3231.3.2</b> Investigate Hooke’s law.	<b>Student Edition:</b> 375-377 <b>Teacher Wraparound Edition:</b> CH 377; IM 376
<b>CLE 3231.3.3</b> Understand wave mechanics.	<b>Student Edition:</b> 381-385, 387-391, 404-406, 415-419 <i>Physics Lab</i> 420-421 <i>Technology and Society</i> 394 <b>Teacher Wraparound Edition:</b> HSS 407; QD 383; UM 404
<b>CLE 3231.3.4</b> Examine the Doppler Effect.	<b>Student Edition:</b> 407-410, 445-447 <i>Biology Connection</i> 410 <i>Extreme Physics</i> 422 <b>Teacher Wraparound Edition:</b> CB 446; CD 407; D 410; QD 408; R 446
<b>CLE 3231.3.5</b> Explore the characteristics and properties of sound.	<b>Student Edition:</b> 404-410, 412-419 <i>Biology Connection</i> 410 <i>Physics Lab</i> 420-421 <b>Teacher Wraparound Edition:</b> AML 406; HSS 407; IM 405; QD 408; UA 404
<b>Checks for Understanding</b>	
<b>3231.3.1</b> Investigate simple harmonic motion.	<b>Student Edition:</b> 375-380, 384-386 <i>Design Your Own Physics Lab</i> 392-393 <b>Teacher Wraparound Edition:</b> BA 375; CH 377; CU 380; ICE 379R 384

STANDARDS	PAGE REFERENCES
<p><b>3231.3.2</b> Investigate and analyze wavelength, frequency, and amplitude of longitudinal and transverse waves.</p>	<p><b>Student Edition:</b> 381-386, 404-405 <i>Technology and Society</i> 394</p> <p><b>Teacher Wraparound Edition:</b> CU 386; QD 382; R 405</p>
<p><b>3231.3.3</b> Describe a wave interaction as reflection, refraction, diffraction, or interference.</p>	<p><b>Student Edition:</b> 387-391, 458-460, 485-490, 516-523, 524-531 <i>Design Your Own Physics Lab</i> 532-533 <i>How It Works</i> 534 <i>Problem-Solving Strategies</i> 521</p> <p><b>Teacher Wraparound Edition:</b> AML 388; QD 525; RLP 487; UM 458</p>
<p><b>3231.3.4</b> Explore Hooke’s Law.</p>	<p><b>Student Edition:</b> 375-377</p> <p><b>Teacher Wraparound Edition:</b> CH 377; IM 376</p>
<p><b>3231.3.5</b> Investigate reflection, refraction, diffraction, and interference of sound waves.</p>	<p><b>Student Edition:</b> 407-410</p> <p><b>Teacher Wraparound Edition:</b> E 410; QD 408</p>
<p><b>3231.3.6</b> Compare mechanical and electromagnetic waves.</p>	<p><b>Student Edition:</b> 381-385, 387-391, 404-406, 415-419, 705-713 <i>Physics Lab</i> 420-421, 714-715 <i>Technology and Society</i> 394</p> <p><b>Teacher Wraparound Edition:</b> AML 709; HSS 407; QD 383; R 706; UM 404</p>
<p><b>3231.3.7</b> Explain the Doppler Effect.</p> $f_d = f_s \left( \frac{v - v_d}{v - v_s} \right)$	<p><b>Student Edition:</b> 407-410, 445-447 <i>Biology Connection</i> 410 <i>Extreme Physics</i> 422</p> <p><b>Teacher Wraparound Edition:</b> CB 446; CD 407; D 410; QD 408; R 446</p>
<p><b>3231.3.8</b> Determine the speed of sound experimentally and describe the effects various materials and temperatures on sound transmission.</p>	<p><b>Student Edition:</b> 387, 404-405, 416 <i>Physics Lab</i> 420-421</p> <p><b>Teacher Wraparound Edition:</b> R 390</p>

STANDARDS	PAGE REFERENCES
<b>3231.3.9</b> Measure spring constants.	<b>Student Edition:</b> 376-377 <b>Teacher Wraparound Edition:</b> R 376
<b>3231.3.10</b> Solve problems related to wave length, frequency and speed.  Wave Velocity: $v = f\lambda$	<b>Student Edition:</b> 381-386, 404-405 <i>Physics Lab</i> 420-421 <i>Technology and Society</i> 394 <b>Teacher Wraparound Edition:</b> CU 386; QD 382; R 390, 405
<b>3231.3.11</b> Determine the speed of sound experimentally using various materials and temperatures.  Sound Velocity: $v_s = f\lambda$ Sound Velocity (using air temp.): $v_s = 331.5 \text{ ms}^{-1} + 0.56 \text{ ms}^{-1} T^{\circ\text{C}}$	<b>Student Edition:</b> 382-385, 387, 404-405, 416 <i>Physics Lab</i> 420-421 <b>Teacher Wraparound Edition:</b> R 390
<b>3231.3.12</b> Describe simple harmonic motion.	<b>Student Edition:</b> 375-380, 384-386 <i>Design Your Own Physics Lab</i> 392-393 <b>Teacher Wraparound Edition:</b> BA 375; CH 377; CU 380; ICE 379R 384
<b>3231.3.13</b> Compare the wave characteristics of natural auditory phenomena.	<b>Student Edition:</b> 407-410 <b>Teacher Wraparound Edition:</b> E 410; QD 408
<b>Physics: Standard 4 – Optics</b>	
<b>Conceptual Strand 4</b>	
<i>Understanding optics is accomplished by investigating the behavior and laws of light.</i>	
<b>Guiding Question 4</b>	
<i>How do the properties and behavior of light relate to the basic principles of optics?</i>	
<b>Course Level Expectations</b>	
<b>CLE 3231.4.1</b> Describe the characteristics of the electromagnetic spectrum.	<b>Student Edition:</b> 708-712 <i>Physics Lab</i> 714-715 <b>Teacher Wraparound Edition:</b> AML 709; CB 706

STANDARDS	PAGE REFERENCES
<b>CLE 3231.4.2</b> Investigate the interaction of light waves.	<b>Student Edition:</b> 515-523, 524-531 <i>Design Your Own Physics Lab</i> 532-533 <i>How It Works</i> 534 <i>Problem-Solving Strategies</i> 521 <b>Teacher Wraparound Edition:</b> BA 515; CU 531; E 523; QD 516; UA 517
<b>CLE 3231.4.3</b> Explore the optics of lenses.	<b>Student Edition:</b> 489, 493-499, 500-501 <i>Physics Lab</i> 504-505 <b>Teacher Wraparound Edition:</b> AML 497; BA 493; CD 494; CT 495; E 499; ICE 496; IM 494; R 492
<b>CLE 3231.4.4</b> Analyze the optics of mirrors.	<b>Student Edition:</b> 457-463, 464-473, 480-482 <i>Challenge Problem</i> 470 <i>Connecting Math to Physics</i> 468 <i>Physics Lab</i> 474-475 <i>Problem-Solving Strategies</i> 466 <b>Teacher Wraparound Edition:</b> AML 471; BA 457; CU 463; CT 461; HSS 468; ICE 469, 472; IM 466
<b>CLE 3231.4.5</b> Investigate the phenomenon of color.	<b>Student Edition:</b> 440-442, 520 <i>Biology Connection</i> 442 <i>Chemistry Connection</i> 442 <i>Math Link</i> 441 <b>Teacher Wraparound Edition:</b> A 442
<b>Checks for Understanding</b>	
<b>3231.4.1</b> Explore properties of electromagnetic radiation.	<b>Student Edition:</b> 705-713, 724-725 <i>Physics Lab</i> 714-715 <b>Teacher Wraparound Edition:</b> AML 709; CB 706, 719; QD 707

STANDARDS	PAGE REFERENCES
<p><b>3231.4.2</b> Examine properties of light waves.</p>	<p><b>Student Edition:</b> 515-523, 524-531 <i>Design Your Own Physics Lab</i> 532-533 <i>How It Works</i> 534 <i>Problem-Solving Strategies</i> 521 <b>Teacher Wraparound Edition:</b> BA 515; CU 531; E 523; QD 516; UA 517</p>
<p><b>3231.4.3</b> Investigate the polarization of light.</p>	<p><b>Student Edition:</b> 443-444 <i>Physics Lab</i> 448-449 <b>Teacher Wraparound Edition:</b> CT 444; DI 443</p>
<p><b>3231.4.4</b> Investigate the optical properties of plane and curved mirrors.</p> <p>Focal Length: <math>\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}</math></p> <p>Images in Mirrors and Lenses: <math>\frac{h_i}{h_o} = \frac{-d_i}{d_o}</math></p>	<p><b>Student Edition:</b> 493-496 <i>Physics Lab</i> 504-505 <b>Teacher Wraparound Edition:</b> CD 494; CT 495; E 499</p>
<p><b>3231.4.5</b> Investigate the optical properties of plane and curved mirrors.</p>	<p><b>Student Edition:</b> 493-496 <i>Physics Lab</i> 504-505 <b>Teacher Wraparound Edition:</b> CD 494; CT 495; E 499</p>
<p><b>3231.4.6</b> Draw, explain, and solve problems for the optics of mirrors and lenses.</p>	<p><b>Student Edition:</b> 457-463, 464-473, 480-482, 489, 493-499, 500-501 <i>Challenge Problem</i> 470 <i>Connecting Math to Physics</i> 468 <i>Physics Lab</i> 474-475, 504-505 <i>Problem-Solving Strategies</i> 466 <b>Teacher Wraparound Edition:</b> AML 471, 497; BA 457, 493; CD 494; CT 461, 495; CU 463; HSS 468; ICE 469, 496; IM 466; R 492</p>
<p><b>3231.4.7</b> Investigate optical phenomena (i.e., mirage, optical illusions, and dichromatic lens effect).</p>	<p><b>Student Edition:</b> 443-444, 490, 498-499, 501 <i>Applying Physics</i> 467 <i>Extreme Physics</i> 506 <i>Future Technology</i> 476 <b>Teacher Wraparound Edition:</b> CB 467; CH 458, 489; CT 444; IM 502</p>

STANDARDS	PAGE REFERENCES
<p><b>3231.4.8</b> Solve problems related to Snell's law.</p> <p>Index of Refraction: <math>n = \frac{\sin \theta_r}{\sin \theta_i}</math></p> <p>Snell's Law: <math>n_i \sin \theta_i = n_r \sin \theta_r</math></p>	<p><b>Student Edition:</b> 486-489, 509, 510</p> <p><b>Teacher Wraparound Edition:</b> ICE 487; R 492</p>
<p><b>3231.4.9</b> Differentiate among transmission, reflection, refraction, diffraction, and interference of light waves.</p>	<p><b>Student Edition:</b> 485-492, 515-523, 524-531 <i>Design Your Own Physics Lab</i> 532-533 <i>How It Works</i> 534 <i>Problem-Solving Strategies</i> 521</p> <p><b>Teacher Wraparound Edition:</b> BA 515; CU 531; E 523; IM 486; QD 516; TPK 493; UA 517</p>
<p><b>3231.4.10</b> Explore the formation of color (both additive and subtractive properties).</p> <p>Additive Color Theory: <math>W = B + G + R</math>; <math>Y = G + R</math>; <math>C = B + G</math>; <math>M = R + B</math></p> <p>Subtractive Color Theory: <math>B = W - Y</math>; <math>C = W - R</math>; <math>M = W - G</math></p>	<p><b>Student Edition:</b> 440-442, 520 <i>Biology Connection</i> 442 <i>Chemistry Connection</i> 442 <i>Math Link</i> 441</p> <p><b>Teacher Wraparound Edition:</b> A 442</p>

STANDARDS	PAGE REFERENCES
<b>Physics: Standard 5 – Electricity and Magnetism</b>	
<b>Conceptual Strand 5</b> <i>Understanding electricity and magnetism is explained by the physics of electrons and magnets.</i>	
<b>Guiding Question 5</b> <i>How do the properties of electricity and magnetism relate to the physics of electrons and magnets?</i>	
<b>Course Level Expectations</b>	
<b>CLE 3231.5.1</b> Examine the properties of electric forces, electric charges, and electric fields.	<b>Student Edition:</b> 546-553, 564-568, 575-579 <i>Design Your Own Physics Lab</i> 554-555 <i>Future Technology</i> 556 <i>Launch Lab</i> 563 <i>Physics Lab</i> 580-581 <i>Problem-Solving Strategies</i> 550 <b>Teacher Wraparound Edition:</b> CB 548; E 553; IM 552; TPK 546; UA 564; UM 575
<b>CLE 3231.5.2</b> Explore the flow of charge and electric currents.	<b>Student Edition:</b> 591-594, 631, 655-656, 672, 675-678 <i>Mini Lab</i> 599 <i>Physics Lab</i> 606-607 <b>Teacher Wraparound Edition:</b> CD 593; D 671; UA 592
<b>CLE 3231.5.3</b> Investigate Ohm's law.	<b>Student Edition:</b> 595-597 <b>Teacher Wraparound Edition:</b> QD 597
<b>CLE 3231.5.4</b> Compare and contrast series and parallel circuits.	<b>Student Edition:</b> 618-622, 623-626 <i>Physics Lab</i> 632-633 <i>Problem-Solving Strategies</i> 629 <b>Teacher Wraparound Edition:</b> A 618; AML 625; CH 623; CT 620; CU 626; D 628
<b>CLE 3231.5.5</b> Analyze components of electrical schematic diagrams.	<b>Student Edition:</b> 597-600, 623-624, 629, 631 <i>Problem-Solving Strategies</i> 599 <b>Teacher Wraparound Edition:</b> CH 674; E 631

STANDARDS	PAGE REFERENCES
<p><b>CLE 3231.5.6</b> Understand magnetic poles, magnetic fields, and investigate electromagnetic induction.</p>	<p><b>Student Edition:</b> 644-651, 672-674, 675-678, 679-685 <i>Launch Lab</i> 643 <i>Mini Lab</i> 650 <b>Teacher Wraparound Edition:</b> CU 651; D 682; UA 673</p>
<b>Checks for Understanding</b>	
<p><b>3231.5.1</b> Create a simple electromagnet.</p>	<p><b>Student Edition:</b> 649-650 <i>Design Your Own Physics Lab</i> 660-661 <b>Teacher Wraparound Edition:</b> R 649</p>
<p><b>3231.5.2</b> Draw an electric field based on a description of the charged particles.</p>	<p><b>Student Edition:</b> 567-568 <b>Teacher Wraparound Edition:</b> HSS 567</p>
<p><b>3231.5.3</b> Solve problems of resistance using Ohm's law. Ohm's Law: <math>E = IR</math> or <math>V = IR</math></p>	<p><b>Student Edition:</b> 595-597, 618-621, 623-626 <i>Physics Lab</i> 606-607 <b>Teacher Wraparound Edition:</b> ICE 598, 602, 621, 625; QD 597</p>
<p><b>3231.5.4</b> Draw and explain series and parallel circuits.</p>	<p><b>Student Edition:</b> 618-622, 623-626 <i>Physics Lab</i> 632-633 <i>Problem-Solving Strategies</i> 629 <b>Teacher Wraparound Edition:</b> A 618; AML 625; CH 623; CT 620; CU 626; D 628</p>
<p><b>3231.5.5</b> Solve problems related to voltage, amperage, and resistance. Voltage: <math>V = IR</math> Series Circuit Formulas: <math>R_T = R_1 + R_2 + \dots</math> <math>I_T = I_1 = I_2 = \dots</math>; <math>V_T = V_1 + V_2 + \dots</math> Parallel Circuit Formulas: <math>\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \dots</math> <math>I_T = I_1 + I_2 + \dots</math>; <math>V_T = V_1 = V_2 = \dots</math></p>	<p><b>Student Edition:</b> 618-622, 623-626, 629-631 <i>Physics Lab</i> 632-633 <i>Problem-Solving Strategies</i> 629 <b>Teacher Wraparound Edition:</b> AML 625; CH 623; CT 620; CU 626; D 628; IM 618; QD 631; UM 629</p>

STANDARDS	PAGE REFERENCES
<p><b>3231.5.6</b> Build series and parallel circuits and explain how they function.</p>	<p><b>Student Edition:</b> 618-622, 623-626 <i>Mini Lab</i> 623 <i>Physics Lab</i> 632-633</p> <p><b>Teacher Wraparound Edition:</b> BA 617, 627; R 626</p>
<p><b>3231.5.7</b> Demonstrate a generated current by electromagnetic induction.</p>	<p><b>Student Edition:</b> 671-674, 675-678, 679-685 <i>Launch Lab</i> 671 <i>Physics Lab</i> 686-687</p> <p><b>Teacher Wraparound Edition:</b> CB 671, 675; TT 681; UA 673</p>
<p><b>3231.5.8</b> Design an experiment to demonstrate the flow of charged particles and an electric current.</p>	<p><b>Student Edition:</b> <i>Design Your Own Physics Lab</i> 660-661 <i>Mini Lab</i> 599 <i>Physics Lab</i> 606-607, 632-633, 790-791</p> <p><b>Teacher Wraparound Edition:</b> AIL 607, 661, 791; AML 595, 598, 625</p>
<p><b>3231.5.9</b> Analyze a group of charges for repulsion and attraction.</p>	<p><b>Student Edition:</b> 542-543, 546-548 <i>Launch Lab</i> 541</p> <p><b>Teacher Wraparound Edition:</b> LL 540-541</p>
<p><b>3231.5.10</b> Distinguish between charged particles related to repulsion and attraction.</p>	<p><b>Student Edition:</b> 542-543, 546-548, 549-553 <i>Launch Lab</i> 541 <i>Problem-Solving Strategies</i> 550</p> <p><b>Teacher Wraparound Edition:</b> CH 551; IM 542; LL 540-541; R 553</p>
<p><b>3231.5.11</b> Describe the electric field that fills the space around a charged particle or group of charges</p> <p>Coulomb's Law: <math>F = k \frac{Q_1 Q_2}{d^2}</math></p>	<p><b>Student Edition:</b> 549-552, 564 <i>Problem-Solving Strategies</i> 55</p> <p><b>Teacher Wraparound Edition:</b> E 553; ICE 551; IM 552; R 550</p>

STANDARDS	PAGE REFERENCES
<p><b>3231.5.12</b> Identify components of series and parallel circuits and solve problems related to voltage, amperage, and resistance.</p>	<p><b>Student Edition:</b> 618-622, 623-626, 629-631 <i>Physics Lab</i> 632-633 <i>Problem-Solving Strategies</i> 629</p> <p><b>Teacher Wraparound Edition:</b> AML 625; CH 623; CT 620; CU 626; D 628; IM 618; QD 631; UM 629</p>
<p><b>3231.5.13</b> Describe how current is generated by electromagnetic induction.</p>	<p><b>Student Edition:</b> 671-674, 675-678, 679-685 <i>Launch Lab</i> 671 <i>Physics Lab</i> 686-687</p> <p><b>Teacher Wraparound Edition:</b> CB 671, 675; TT 681; UA 673</p>
<p><b>Physics: Standard 6 – Nuclear Physics</b></p>	
<p><b>Conceptual Strand 6</b> <i>A deep understanding of particle physics is accomplished by investigating the properties of nuclear physics.</i></p>	
<p><b>Guiding Question 6</b> <i>How is the investigation of the properties of nuclear physics related to understanding nuclear particles?</i></p>	
<p><b>Course Level Expectations</b></p>	
<p><b>CLE 3231.6.1</b> Investigate the properties and structure of the atom.</p>	<p><b>Student Edition:</b> 748-759, 760-761, 777-779, 800-801, 818-819 <i>Applying Physics</i> 289 <i>Mini Lab</i> 755 <i>Physics Lab</i> 766-767</p> <p><b>Teacher Wraparound Edition:</b> A 761; BA 760; CB 757, 778; D 804; R 765, 801</p>
<p><b>CLE 3231.6.2</b> Compare and contrast the Bohr model and the quantum model of the atom.</p>	<p><b>Student Edition:</b> 747-759, 760-761, 776-777</p> <p><b>Teacher Wraparound Edition:</b> BA 760; CU 759; HSS 756; TPK 747</p>
<p><b>CLE 3231.6.3</b> Explore the dynamics of the nucleus: radioactivity, nuclear decay, radiocarbon/uranium dating and half-life.</p>	<p><b>Student Edition:</b> 806-810, 821-822 <i>Design Your Own Physics Lab</i> 824-825 <i>Launch Lab</i> 799 <i>Mini Lab</i> 813</p> <p><b>Teacher Wraparound Edition:</b> AML 807; BA 806; CB 809; CD 822; E 814; ICE 808; IM 810</p>

STANDARDS	PAGE REFERENCES
<b>CLE 3231.6.4</b> Compare and contrast nuclear fission and nuclear fusion.	<b>Student Edition:</b> 811-814 <i>Future Technology</i> 826 <b>Teacher Wraparound Edition:</b> CU 814; UM 812
<b>CLE 3231.6.5</b> Investigate the quantum theory.	<b>Student Edition:</b> 726-734, 735-737, 760-761 <b>Teacher Wraparound Edition:</b> AML 727; BA 760; QD 726; R 765
<b>Checks for Understanding</b>	
<b>3231.6.1</b> Write and balance equations for the three forms of radioactive decay.	<b>Student Edition:</b> 806-808, 821-822 <i>Design Your Own Physics Lab</i> 824-825 <i>Mini Lab</i> 813 <b>Teacher Wraparound Edition:</b> CD 822; CH 821; R 806
<b>3231.6.2</b> Solve half-life problems. Decay Constant: $k = \frac{0.693}{T_{1/2}}$ Nuclear Decay: $A_f = A_o e^{-kt}$	<b>Student Edition:</b> 809-810 <i>Design Your Own Physics Lab</i> 824-825 <i>MiniLAB</i> 813 <b>Teacher Wraparound Edition:</b> CB 809; IM 810
<b>3231.6.3</b> Explain dating methods using carbon-14 or uranium.	<b>Student Edition:</b> 810 <b>Teacher Wraparound Edition:</b> CB 809
<b>3231.6.4</b> Investigate the concept of half-life.	<b>Student Edition:</b> 809-810, 821-822 <i>Mini Lab</i> 813 <b>Teacher Wraparound Edition:</b> CB 809; E 814; IM 810
<b>3231.6.5</b> Explain how particles behave like waves.	<b>Student Edition:</b> 439-735-737 <i>Future Technology</i> 768 <b>Teacher Wraparound Edition:</b> CB 730; CD 733; CU 737; IM 736; UA 732
<b>3231.6.6</b> Distinguish between coherent and incoherent light.	<b>Student Edition:</b> 515-519, 761-765 <b>Teacher Wraparound Edition:</b> QD 516; R 762

STANDARDS	PAGE REFERENCES
<p><b>3231.6.7</b> Recognize how the quantum theory explains the photoelectric effect.</p>	<p><b>Student Edition:</b> 747-759, 760-761, 776-777</p> <p><b>Teacher Wraparound Edition:</b> BA 760; CU 759; HSS 756; TPK 747</p>
<p><b>3231.6.8</b> Investigate the history and current events associated with nuclear and radioactive science.</p>	<p><b>Student Edition:</b> 748-749, 799-805, 806-814, 815-823 <i>Future Technology</i> 826</p> <p><b>Teacher Wraparound Edition:</b> CB 749, 801; CD 803; CH 821; HSS 748; RLP 822</p>
<p><b>3231.6.9</b> Identify the parts of an atom.</p>	<p><b>Student Edition:</b> 748-759, 760-761, 777-779, 800-801, 818-819 <i>Applying Physics</i> 289 <i>Mini Lab</i> 755 <i>Physics Lab</i> 766-767</p> <p><b>Teacher Wraparound Edition:</b> A 761; BA 760; CB 757, 778; D 804; R 765, 801</p>
<p><b>3231.6.10</b> Describe the properties and location of subatomic particles.</p>	<p><b>Student Edition:</b> 754-756, 777-781, 799-800, 802, 818-823</p> <p><b>Teacher Wraparound Edition:</b> CB 801, 818; CU 823; HSS 756; RLP 822</p>
<p><b>3231.6.11</b> Describe three forms of radioactivity.</p>	<p><b>Student Edition:</b> 806-808, 821-822 <i>Design Your Own Physics Lab</i> 824-825 <i>Mini Lab</i> 813</p> <p><b>Teacher Wraparound Edition:</b> CD 822; CH 821; R 806</p>
<p><b>3231.6.12</b> Distinguish between nuclear fission and nuclear fusion.</p>	<p><b>Student Edition:</b> 811-814 <i>Future Technology</i> 826</p> <p><b>Teacher Wraparound Edition:</b> CU 814; UM 812</p>
<p><b>3231.6.13</b> Distinguish between the Bohr model and the quantum model of an atom.</p>	<p><b>Student Edition:</b> 747-759, 760-761, 776-777</p> <p><b>Teacher Wraparound Edition:</b> BA 760; CU 759; HSS 756; TPK 747</p>

STANDARDS	PAGE REFERENCES
<p><b>3231.6.14</b> Explain the changes in atomic number or mass number for each form of radioactivity.</p>	<p><b>Student Edition:</b> 806-808, 821-822 <i>Mini Lab</i> 813</p> <p><b>Teacher Wraparound Edition:</b> CD 822; R 806</p>
<p><b>3231.6.15</b> Discuss transmutation and transuranium.</p>	<p><b>Student Edition:</b> 806-808, 811-813</p> <p><b>Teacher Wraparound Edition:</b> E 814; ICE 808; IM 801</p>
<p><b>3231.6.16</b> Examine the properties of lasers.</p>	<p><b>Student Edition:</b> 761-765 <i>Future Technology</i> 768</p> <p><b>Teacher Wraparound Edition:</b> CB 761</p>