

**Science Instructional Guide Overview**

- I. Major District Initiatives
  - Secondary Literacy Plan
  - Culturally Relevant Teaching Methods to Close the Achievement Gap
  - Small Learning Communities
  - MSP-SCALE
- II. State of California Document
  - *The California Content Standards*
  - *Science Framework for California Public Schools*
  - *California Standards for the Teaching Profession*
- III. Science Pedagogy
- IV. Assessment
  - Periodic Assessment
  - Scoring of Periodic Assessments
  - Unit Reflection and Intervention
- Appendix
  - District Contacts and other useful information

**Science Instructional Guide Graphic Organizer Overview For Physics**

**Instructional Component 1**

- Standard Sets:  
(1a, 1b, 1c, 1d, 1e), (1j), (1k), (1i), (1f, 1g, 1l, 1m)
- Content Standard Group
  - Analyzed Standard
  - Instructional Resources:
    - Sample Performance Tasks
    - Sample Scoring Criteria
    - Some Suggested Concepts and Skills to Support Student Success on the Sample Performance
  - Possible Standards Aligned Resources

**Instructional Component 2**

- Standard Sets:  
(2d, 2e, 2f, 2g), (2a, 2b, 2c, 2g, 2h), (3a, 3b, 3c, 3g, 5i), (3d, 3e, 3f), (4a, 4b, 4c, 4d, 4e, 4f)
- Content Standard Group
  - Analyzed Standard
  - Instructional Resources:
    - Sample Performance Tasks
    - Sample Scoring Criteria
    - Some Suggested Concepts and Skills to Support Student Success on the Sample Performance
  - Possible Standards Aligned Resources

**Instructional Component 3**

- Standard Sets:  
(1m, 5e, 5j, 5k, 5l, 5m), (5a, 5b, 5c, 5d), (5f, 5g, 5h, 5j, 5n), (5o)
- Content Standard Group
  - Analyzed Standard
  - Instructional Resources:
    - Sample Performance Tasks
    - Sample Scoring Criteria
    - Some Suggested Concepts and Skills to Support Student Success on the Sample Performance
  - Possible Standards Aligned Resources

**Overarching Instructional Components**

- Review and Re-teach
- Review results of Periodic Assessments
- Extended Learning Interventions
- Student/teacher reflection on student work
- End of unit assessments
- Use of data

Science Periodic Assessment 1

Science Periodic Assessment 2

Science Periodic Assessment 3

California NCLB Standards Test

**LAUSD - High School Instructional Guide  
Legend for Matrix Chart**

<b>Standards for Instructional Component</b>		
<p>The Standard Sets lay the foundation for each Instructional Component. The standards to be learned during this Instructional Component are listed numerically and alphabetically for easy reference and do not intend to suggest any order of teaching the standards.</p>		
<p><b>Content Standard Group:</b> The standards within each Standard Set are organized into smaller “Standard Groups” that provide a conceptual approach for teaching the standards within each Instructional Component. Key Concept for the Content Standard Group: <b>The Key Concept signifies the “big idea” represented by each Standards Group.</b></p>		
<b>Analyzed Standards</b>	<b>Instructional Resources</b>	<b>Connections and Notes</b>
<p>The Standards grouped here cover the Key Concept.</p>		
<p>Analyzed Standards are a translation of the State's content standards (that begin with students know) into statements of student performance that describes both the activity and the "cognitive" demand placed on the students. The detailed description of the content standards in the <i>Science Framework for California Public Schools: Kindergarten Through Grade Twelve</i> (2003) was used extensively in the development of the analyzed standards.</p>	<p><b>Possible Standards Aligned Resources</b></p> <p><b>A. Text Activities</b> Laboratory and other supplemental activities that address the Standards taken from the supplemental materials of the cited textbooks.</p> <p><b>B. Supplemental Activities/Resources</b> Laboratory and other supplemental activities that address the Standards taken from various cited sources</p> <p><b>C. Text Book References</b> Textbook references from LAUSD adopted series that have been correlated with the Content Standard Group. (The standard(s) for each reference are in parenthesis before the page numbers.) The textbooks referenced are:</p> <p><b><i>Physics: Principles and Problems, CA Ed., (Zitzelwitz, et al.) 2007</i></b> <b><i>Holt Physics, CA Edition, (Serway, Faughn), 2007</i></b> <b><i>Conceptual Physics, (Hewitt), 2006</i></b></p>	<p>Connections to Investigation and Experimentation standards (I&amp;E), English Language Arts Standards (ELA) and Math Standards (Algebra 1 and Geometry) and space for teachers to make their own notes.</p>

**LAUSD – High School Instructional Guide**  
**Physics**  
**Motion and Forces**

Instructional Component 1	1a; Key Concept: One Dimensional Kinematics
	1b, 1c, 1d, 1h, 1e; Key Concept: Newton's Laws
	1j; Key Concept: Vectors
	1k; Key Concept: Statics
	1i; Key Concept: Trajectory Motion
	1f, 1g; 1l, 1m (gravity only); Key Concept: Circular Motion and Gravity
	Instructional Component 2
Instructional Component 2	2a, 2b, 2c, 2g, 2h; Key Concept: Conservation of Energy
	3a, 3b, 3c 3g, 5i; Key Concept: Thermal Energy
	3d, 3e, 3f; Key Concept: Entropy
	4a, 4b, 4c, 4d, 4e, 4f; Waves
Instructional Component 3	1m (electrostatic only), 5e, 5j (electric field), 5k, 5l, 5m; Key Concept: Electrostatics
	5a, 5b, 5c, 5d; Key Concept: Circuits and Components
	5f, 5g, 5h, 5j (magnetic field), 5n; Key Concept: Magnetism
	5o; Key Concept: Conservation of Energy

## Standards for Instructional Component 1

1. Newton's laws predict the motion of most objects. As a basis for understanding this concept:
  - a. Students know how to solve problems that involve constant speed and average speed.
  - b. Students know that when forces are balanced, no acceleration occurs; thus an object continues to move at a constant speed or stays at rest (Newton's first law).
  - c. Students know how to apply the law  $F=ma$  to solve one-dimensional motion problems that involve constant forces (Newton's second law).
  - d. Students know that when one object exerts a force on a second object, the second object always exerts a force of equal magnitude and in the opposite direction (Newton's third law).
  - e. Students know the relationship between the universal law of gravitation and the effect of gravity on an object at the surface of Earth.
  - f. Students know applying a force to an object perpendicular to the direction of its motion causes the object to change direction but not speed (e.g., Earth's gravitational force causes a satellite in a circular orbit to change direction but not speed).
  - g. Students know circular motion requires the application of a constant force directed toward the center of the circle.
  - h. \* Students know Newton's laws are not exact but provide very good approximations unless an object is moving close to the speed of light or is small enough that quantum effects are important.
  - i. \* Students know how to solve two-dimensional trajectory problems.
  - j. \* Students know how to resolve two-dimensional vectors into their components and calculate the magnitude and direction of a vector from its components.
  - k. \* Students know how to solve two-dimensional problems involving balanced forces (statics).
  - l. \* Students know how to solve problems in circular motion by using the formula for centripetal acceleration in the following form:  $a=v^2/r$ .
  - m. \* Students know how to solve problems involving the forces between two electric charges at a distance (Coulomb's law) or the forces between two masses at a distance (universal gravitation).

## Investigation and Experimentation (I & E) Standards:

- I. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content of the other four strands, students should develop their own questions and perform investigations. Students will:
  - a. Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
  - b. Identify and communicate sources of unavoidable experimental error.
  - c. Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.
  - d. Formulate explanations by using logic and evidence.
  - e. Solve scientific problems by using quadratic equations and simple trigonometric, exponential, and logarithmic functions.
  - f. Distinguish between hypothesis and theory as scientific terms.
  - g. Recognize the usefulness and limitations of models and theories as scientific representations of reality.
  - h. Analyze the locations, sequences, or time intervals that are characteristic of natural phenomena (e.g., relative ages of rocks, locations of planets over time, and succession of species in an ecosystem).
  - i. Recognize the issues of statistical variability and the need for controlled tests.
  - j. Recognize the cumulative nature of scientific evidence.
  - k. Analyze situations and solve problems that require combining and applying concepts from more than one area of science.
  - l. Investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings. Examples of issues include irradiation of food, cloning of animals by somatic cell nuclear transfer, choice of energy sources, and land and water use decisions in California.
  - m. Know that when an observation does not agree with an accepted scientific theory, the observation is sometimes mistaken or fraudulent (e.g., the Piltdown Man fossil or unidentified flying objects) and that the theory is sometimes wrong (e.g., the Ptolemaic model of the movement of the Sun, Moon, and planets).

### Instructional Component 1 Overview

Standards	Suggested Activities	Notes
<b>Kinematics</b>		
1a Students know how to solve problems that involve constant speed and average speed.	Golf ball/ramp Wind-up toy race	$d=vt$ , for constant $v$ ( $v$ =rate, $t$ ) <i>avg. <math>v=\Delta d/\Delta t</math></i>
<b>Newton's Laws</b>		
1b Students know that when forces are balanced, no acceleration occurs; thus an object continues to move at a constant speed or stays at rest (Newton's first law).	Sprint Race Spring Scale demo Inclined plane demo Inertia & paper towel roll Inertia & 2 weights tied together demo ESPN Sports: That Mu You Do NOVA: Newton's Dark Secrets NOVA: $E=mc^2$ : Einstein's Big Idea Inventors Series: Galileo	Introduce $\Delta$ Falling objects: Galileo vs. Aristotle $a=\Delta v/\Delta t$ $F=ma$ $v=v_o + at$ $d=d_o + v_o t + \frac{1}{2} at^2$ $F_{21} = -F_{12}$
1c Students know how to apply the law $F=ma$ to solve one-dimensional motion problems that involve constant forces (Newton's second law).		
1d Students know that when one object exerts a force on a second object, the second object always exerts a force of equal magnitude and in the opposite direction (Newton's third law).		
1h Students know Newton's laws are not exact but provide very good approximations unless an object is moving close to the speed of light or is small enough that quantum effects are important.		
1e Students know the relationship between the universal law of gravitation and the effect of gravity on an object at the surface of Earth.		
<b>Vectors</b>		
1j Students know how to resolve two-dimensional vectors into their components and calculate the magnitude and direction of a vector from its components.	Vector Treasure Hunt	
<b>Statics</b>		
1k Students know how to solve two-dimensional problems involving balanced forces (statics).	Force Table Tow rope/clothesline demo Catapult culminating activity 2 point fixed rope + mass Ring stands, mass & spring scales	
<b>Trajectory Motion</b>		
1i Students know how to solve two-dimensional trajectory problems.	Egg Smash Softball throw with videotape Marble launcher ESPN Sports: Big Air Rules	
<b>Circular Motion &amp; Gravity</b>		
1f Students know applying a force to an object perpendicular to the direction of its motion causes the object to change direction but not speed.	Ball & string Spring & weight Tetherball	
1g Students know circular motion requires the application of a constant force directed toward the center of the circle.		
1l Students know how to solve problems in circular motion by using the formula for		

centripetal acceleration in the following form: $a=v^2/r$		
1m.Students know how to solve problems involving the forces between two masses at a distance (universal gravitation).		

\*Throughout this instructional guide, recommendations will be made to integrate certain Investigation and Experimentation (I &E) standards with specific content standards and/or analyzed standards. The recommendations are made when there appears to be a natural connection in content between the analyzed standards and the I & E standards. The I & E standards not specifically highlighted for integration with specific analyzed standards should be addressed in related labs or activities assigned to students in the physics course.

\*\*Terms and equations in italics do not appear in the standards, but are considered useful to teaching the concept.

## Instructional Component 1

### Standard Group 1

#### Key Concept – One Dimensional Kinematics

Analyzed Standards 1a	Instructional Activities, Resources, and Performance Tasks	Connections and Notes*
1a <ul style="list-style-type: none"> <li>• Solve problems that involve constant speed and average speed.</li> <li>• Distinguish between constant speed and average speed.</li> </ul>	<p><b><u>Conceptual Physics:</u></b> (1a) 2.2-2.3  <b><u>Glencoe Physics:</u></b> (1a) 2.4  <b><u>Holt Physics:</u></b> (1a) 2-1</p> <p><b>Labs/Demos:</b>  <b><u>Conceptual Physics:</u></b>            Making Hypothesis LM 1            CD 1-1            CP Physics 500 LM 2            CP Merrily we go roll along LM 4            CP Conceptual ranger LM 5            CP CD 2-1, 2-2</p> <p><b><u>Glencoe Physics:</u></b>            Motion Diagram (GP 48)</p> <p><b><u>Holt Physics:</u></b>            Discovery Lab, Motion ANC ch. 2 opener            Demo, Displacement TE 2-1            Demo's, Acceleration/Constant Acceleration TE 2-2            Quick Lab, Time Interval of Free Fall SE 2-3            Skills Practice Lab, Free-Fall Acceleration SE 2-3</p> <p><b><i>TOPS Mechanical Plane Lab            Inclined Plane</i></b></p>	<p>*Integrate I&amp;E standards 1a, 1b, 1j, 1n</p> <p>Key Equations:  <math>d=vt</math>, for constant <math>v</math> (<math>v</math>=rate, <math>t</math>)  <i>**avg. <math>v=\Delta d/\Delta t</math></i></p> <p>Key Terms:            speed vs. velocity  <i>instantaneous velocity</i>  <i>average velocity</i>            time  <i>vector vs. scalar</i>  <i>distance vs. displacement</i></p> <p>Other kinematic equations are included in Standard Group 2</p>

## Instructional Component 1

### Standard Group 2

#### Key Concept: Newton's Laws

Analyzed Standards 1b, 1c, 1d, 1h, 1e	Instructional Activities, Resources, and Performance Tasks	Connections and Notes
<p>1b</p> <ul style="list-style-type: none"> <li>Distinguish between balanced (equilibrium) and unbalanced forces.</li> <li>Explain Newton's first law in terms of balanced forces.</li> </ul> <p>1c</p> <ul style="list-style-type: none"> <li>Use kinematic equations to solve one-dimensional motion problems.</li> <li>Identify the effect of force on acceleration.</li> </ul> <p>1d</p> <ul style="list-style-type: none"> <li>Identify the equal and opposite forces in an interaction (action – reaction pairs)</li> </ul> <p>1h</p> <ul style="list-style-type: none"> <li>Explain the limitations of Newton's Laws for objects moving at speeds close to the speed of light (Einstein's Theory of Special Relativity) and for the subatomic scale (Quantum Mechanics).</li> </ul> <p>1e</p> <ul style="list-style-type: none"> <li>Distinguish between mass and weight</li> <li>Calculate weight at the Earth's surface.</li> </ul>	<p><b>Conceptual Physics:</b> (1b) 2.4-2.5, 4.7; (1c) 5.1, 5.3; (1d) 6.2-6.4; (1h) 16.5; (1e) 12.4-12.5, 13.1, 13.3</p> <p><b>Glencoe Physics:</b> (1b, 1c, 1d) 4.1-4.3; (1e) 7.1-7.2</p> <p><b>Holt Physics:</b> (1b, 1c, 1d, 1h, 1e) 4-1, 4-2, 4-3, 4-4, 7-2</p> <p><b>Labs/Demos:</b>  <b>Conceptual Physics:</b>            Going nuts LM 8            Buckle up LM 9            Getting pushy LM 11            Constant force and changing LM 12            Constant mass changing force LM 13            Balloon rockets LM 16            CD 3-1 to 5-5</p> <p><b>Media:</b>            Mechanical Universe: Newton's Laws            ESPN Sports: That Mu You Do            NOVA: Newton's Dark Secrets            NOVA: <math>E=mc^2</math>: Einstein's Big Idea</p> <p><b>Glencoe Physics:</b>            Forces in Elevator (GP 108)</p> <p><b>Holt Physics:</b>            Discovery Lab: Newton's Laws ANC Ch.4 Opener            Quick Lab SE Force and Changes in Motion 4-1            Skills Practice Lab Force and Acceleration SE 4-3</p>	<p>Integrate I&amp;E standards</p> <p>Introduce <math>\Delta</math>            Falling objects: Galileo vs. Aristotle            Einstein's Special Theory of Relativity</p> <p>Key Equations:  <math>a = \Delta v / \Delta t</math>  <math>F = ma</math>  <math>F = w = mg</math>  <math>g = 9.8 \text{ m/s}^2</math>  <math>v = v_o + at</math>  <math>d = d_o + v_o t + \frac{1}{2} at^2</math>  <math>F_{21} = -F_{12}</math></p> <p>Key Terms:            speed            force            weight vs. mass            acceleration            acceleration due to gravity            inertia  <i>friction</i>  <i>normal force</i></p>

Analyzed Standards 1b, 1c, 1d, 1h, 1e	Instructional Activities, Resources, and Performance Tasks	Connections and Notes
	<p><b>Culminating Activity:</b>  “Make Something That Works” [MSTW.DOC]</p> <p><i>Sprint Race</i>  <i>Spring Scale demo</i>  <i>Inclined plane demo</i>  <i>Inertia &amp; paper towel roll</i>  <i>Inertia &amp; 2 weights tied together demo</i></p> <p><b>Culminating Activity:</b>  <i>Mousetrap car</i>  <i>Wind-up car pulling a trailer</i>  <i>Balloon rockets</i></p>	

## Instructional Component 1

### Standard Group 2 Key Concept – Vectors

Analyzed Standards 1j	Instructional Activities, Resources, and Performance Tasks	Connections and Notes
<p>1j</p> <ul style="list-style-type: none"> <li>Resolve two-dimensional vectors into their components.</li> <li>Calculate the magnitude and direction of a vector from its components.</li> </ul>	<p><b>Conceptual Physics:</b> (1j) 13.1-13.3  <b>Glencoe Physics:</b> (1j) 5.1  <b>Holt Physics:</b> (1j) 3-2, 3-3, 3-4</p> <p><b>Labs/Demos:</b>  <b>Conceptual Physics:</b>            Vector Treasure Hunt (treasure hunt.pdf)</p> <p><b>Media:</b>  <span style="color: red;"><b>Physics Demonstrations</b></span>  <u><b>A Sourcebook for Teachers of Physics</b></u>  <u><b>Julien Clinton Sprott</b></u>  <b>C3P:</b> <a href="http://phys.udallas.edu/">http://phys.udallas.edu/</a>            (Suggested Workshop)</p> <p><b>Glencoe Physics:</b>            Launch Lab (GP 119)</p> <p><b>Holt Physics:</b>            Discovery Lab, Vector Treasure Hunt ANC Ch. 3            Opener            Demo, Vector Addition TE 3-1</p> <p><i>Media:</i>  <i>Standard Deviants: Physics</i></p>	<p>Integrate I&amp;E standards 1e (trig)</p> <p>Key Equations:  <math>r_x = r \cos\Phi</math>  <math>r_y = r \sin\Phi</math>  <math>r^2 = r_x^2 + r_y^2</math>  <math>\Phi = r_y / r_x</math>            “SOH CAH TOA”</p> <p>Key Terms:            component            magnitude            direction  <i>resultant</i></p>

## Instructional Component 1

Standard Group 3  
Key Concept: Statics

Analyzed Standards 1k	Instructional Activities, Resources, and Performance Tasks	Connections and Notes
<p>1k</p> <ul style="list-style-type: none"> <li>Solve two-dimensional statics problems involving balanced forces.</li> </ul>	<p><b><u>Conceptual Physics:</u></b> (1k) 4.8  <b><u>Glencoe Physics:</u></b> (1k) 5.3  <b><u>Holt Physics:</u></b> (1k) 4-1, 4-4</p> <p><b>Labs/Demos:</b>  <b><u>Conceptual Physics:</u></b>            CP Force Table F905.pdf            CP 24-hour towing service LM 10            CP Tug of war LM 18  <b><u>Holt Physics:</u></b>            Discovery Lab, Discovering Newton's Laws ANC            ch. 4 opener            Demo, Inertia TE 4-3            Quick Lab, Inertia SE 4-3</p> <p><i>Tow rope/clothesline demo</i>  <i>Ring stands, mass &amp; spring scales</i></p>	<p>Integrate I &amp; E Standards</p> <p>Introduce <math>\Sigma</math></p> <p>Key Equations:  <math>\Sigma F_y = 0</math>  <math>\Sigma F_x = 0</math></p> <p>Key Terms:            Tension</p>

## Instructional Component 1

### Standard Group 5

#### Key Concept: Trajectory Motion

Analyzed Standards 1i	Instructional Activities, Resources, and Performance Tasks	Connections and Notes
1i <ul style="list-style-type: none"> <li>• Recognize the independence of horizontal and vertical motion in two-dimensional trajectory problems.</li> <li>• Solve two-dimensional trajectory problems.</li> </ul>	<p><b><u>Conceptual Physics:</u></b> (1i) 3.4  <b><u>Glencoe Physics:</u></b> (1i) 6.1  <b><u>Holt Physics:</u></b> (1i) 3-3</p> <p><b>Labs/Demos:</b>  <b><u>Conceptual Physics:</u></b>            Bull's eye LM 7  <b><u>Glencoe Physics:</u></b>            On Target (GP 160)  <b><u>Holt Physics:</u></b>            Discovery Lab, Vector Treasure Hunt ANC ch. 3 opener            Demo, Vector Addition TE 3-1            Demo, Air Resistance TE 3-3            Quick Lab, Projectile Motion SE 3-3            Inquiry Lab, Velocity of a Projectile SE 3-3            Invention Lab, The Path of a Human Cannonball ANC 3-3</p> <p style="text-align: center;"><i>Catapult culminating activity</i>  <i>Egg Smash</i>  <i>Softball throw with videotape</i>  <i>Marble launcher</i></p>	Integrate I & E Standards  Key Equations:  Key Terms: Trajectory

## Instructional Component 1

### Standard Group 6

#### Key Concept: Circular Motion and Gravity

Analyzed Standards 1f, 1g; 1l, 1m (gravity only)	Instructional Activities, Resources, and Performance Tasks	Connections and Notes
<p>1f</p> <ul style="list-style-type: none"> <li>• Explain how a perpendicular force can change the direction but not the speed of an object.</li> </ul> <p>1g</p> <ul style="list-style-type: none"> <li>• Explain the force that causes an object to move in uniform circular motion.</li> <li>• Relate the centripetal force to mass, velocity and radius in uniform circular motion.</li> </ul> <p>1l</p> <ul style="list-style-type: none"> <li>• Solve problems in circular motion by using the formula for centripetal acceleration.</li> </ul> <p>1m (gravity only)</p> <ul style="list-style-type: none"> <li>• Solve problems involving Newton's law of universal gravitation.</li> <li>• Relate the gravitational and the electromagnetic forces to the inverse square relationship.</li> </ul>	<p><b><u>Conceptual Physics:</u></b> (1f) 9.1-9.6, 12.2; (1g) 9.3; (1l) 9.3, 9.4; (1m) 12.1-12.6, 32.3??</p> <p><b><u>Glencoe Physics:</u></b> (1f, 1g, 1l, 1m) 6.2, 7.1-7.2</p> <p><b><u>Holt Physics:</u></b> (1f, 1g, 1l, 1m) 7-1, 7-2</p> <p><b>Labs/Demos:</b></p> <p><b><u>Conceptual Physics:</u></b> Ball &amp; string Spring &amp; weight Tetherball</p> <p><b><u>Glencoe Physics:</u></b> Modeling the Orbits of Planets and Satellites (GP 186)</p> <p><b><u>Holt Physics:</u></b> Discovery Labs, Circular Motion, Torque and Center of Mass ANC Ch. 7 Opener Quick Lab, Force and Changes in Motion SE 4-1 Demos Friction, (3) General &amp; Advanced TE 2-4 Skills Practice Lab SE 4-3 Demos, Centripetal Acceleration/Force TE 7-2 Quick Lab, Gravitational Field Strength</p>	<p>Integrate I &amp; E Standards 1f</p> <p>Key Equations: <math>a_c = F_c/m = v^2/r</math></p> <p>Key Terms: Perpendicular Centripetal force Centrifugal force Inverse-square Law</p>

**LAUSD – High School Instructional Guide**  
**Physics**  
**Instructional Component 2**

**Standards for Instructional Component 2**

2. The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects. As a basis for understanding this concept:
  - a. *Students know* how to calculate kinetic energy by using the formula  $E = (1/2)mv^2$ .
  - b. *Students know* how to calculate changes in gravitational potential energy near Earth by using the formula (change in potential energy) =  $mgh$  ( $h$  is the change in the elevation).
  - c. *Students know* how to solve problems involving conservation of energy in simple systems, such as falling objects.
  - d. *Students know* how to calculate momentum as the product  $mv$ .
  - e. *Students know* momentum is a separately conserved quantity different from energy.
  - f. *Students know* an unbalanced force on an object produces a change in its momentum.
  - g. *Students know* how to solve problems involving elastic and inelastic collisions in one dimension by using the principles of conservation of momentum and energy.
  - h. \* *Students know* how to solve problems involving conservation of energy in simple systems with various sources of potential energy, such as capacitors and springs.
3. Energy cannot be created or destroyed, although in many processes energy is transferred to the environment as heat. As a basis for understanding this concept:
  - a. *Students know* heat flow and work are two forms of energy transfer between systems.
  - b. *Students know* that the work done by a heat engine that is working in a cycle is the difference between the heat flow into the engine at high temperature and the heat flow out at a lower temperature (first law of thermodynamics) and that this is an example of the law of conservation of energy.
  - c. *Students know* the internal energy of an object includes the energy of random motion of the object's atoms and molecules, often referred to as thermal energy. The greater the temperature of the object, the greater the energy of motion of the atoms and molecules that make up the object.
  - d. *Students know* that most processes tend to decrease the order of a system over time and that energy levels are eventually distributed uniformly.
  - e. *Students know* that entropy is a quantity that measures the order or disorder of a system and that this quantity is larger for a more disordered system.
  - f. \* *Students know* the statement "Entropy tends to increase" is a law of statistical probability that governs all closed systems (second law of thermodynamics).
  - g. \* *Students know* how to solve problems involving heat flow, work, and efficiency in a heat engine and know that all real engines lose some heat to their surroundings.
4. Waves have characteristic properties that do not depend on the type of wave. As a basis for understanding this concept:
  - a. *Students know* waves carry energy from one place to another.

- b. *Students know* how to identify transverse and longitudinal waves in mechanical media, such as springs and ropes, and on the earth (seismic waves).
  - c. *Students know* how to solve problems involving wavelength, frequency, and wave speed.
  - d. *Students know* sound is a longitudinal wave whose speed depends on the properties of the medium in which it propagates.
  - e. *Students know* radio waves, light, and X-rays are different wavelength bands in the spectrum of electromagnetic waves whose speed in a vacuum is approximately  $3 \times 10^8$  m/s (186,000 miles/second).
  - f. *Students know* how to identify the characteristic properties of waves: interference (beats), diffraction, refraction, Doppler Effect, and polarization.
5. Electric and magnetic phenomena are related and have many practical applications. As a basis for understanding this concept::
- i. *Students know* plasmas, the fourth state of matter, contain ions or free electrons or both and conduct electricity.

### **Investigation and Experimentation (I & E) Standards:**

I. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content of the other four strands, students should develop their own questions and perform investigations. Students will:

- a. Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
- b. Identify and communicate sources of unavoidable experimental error.
- c. Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.
- d. Formulate explanations by using logic and evidence.
- e. Solve scientific problems by using quadratic equations and simple trigonometric, exponential, and logarithmic functions.
- f. Distinguish between hypothesis and theory as scientific terms.
- g. Recognize the usefulness and limitations of models and theories as scientific representations of reality.
- i. Analyze the locations, sequences, or time intervals that are characteristic of natural phenomena (e.g., relative ages of rocks, locations of planets over time, and succession of species in an ecosystem).

- j. Recognize the issues of statistical variability and the need for controlled tests.
- k. Recognize the cumulative nature of scientific evidence.
- l. Analyze situations and solve problems that require combining and applying concepts from more than one area of science.
- m. Investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings. Examples of issues include irradiation of food, cloning of animals by somatic cell nuclear transfer, choice of energy sources, and land and water use decisions in California.
- n. Know that when an observation does not agree with an accepted scientific theory, the observation is sometimes mistaken or fraudulent (e.g., the Piltdown Man fossil or unidentified flying objects) and that the theory is sometimes wrong (e.g., the Ptolemaic model of the movement of the Sun, Moon, and planets).

## Instructional Component 2 Overview

Standards	Suggested Activities	Notes
<b>Momentum and Impulse</b>		
2d. <i>Students know</i> how to calculate momentum as the product $mv$ .	Egg drop/catch	$p=mv$
2e. <i>Students know</i> momentum is a separately conserved quantity different from energy.	Water rockets	impulse= $F\Delta t=\Delta(mv)$
2f. Students know an unbalanced force on an object produces a change in its momentum.	Water balloon toss	Impulse
2g. Students know how to solve problems involving elastic and inelastic collisions in one dimension by using the principles of conservation of momentum and energy.	Newton's cradle	Momentum Elastic Collision Inelastic Collision Conservation of momentum
<b>Conservation of Energy</b>		
2a. <i>Students know</i> how to calculate kinetic energy by using the formula $E = \frac{1}{2}mv^2$	Mousetrap cars	$KE = \frac{1}{2}mv^2$
2b. <i>Students know</i> how to calculate changes in gravitational potential energy near Earth by using the formula (change in potential energy) = $mgh$ ( $h$ is the change in the elevation).	Marble tracks	$W = Fd$
2c. <i>Students know</i> how to solve problems involving conservation of energy in simple systems, such as falling objects.	Roller coaster	$PE = mgh = W$ (gravitational)
2g. Students know how to solve problems involving elastic and inelastic collisions in one dimension by using the principles of conservation of momentum and energy.	Pendulum/nose	$v = \sqrt{2gh}$
2h*. Students know how to solve problems involving conservation of energy in simple systems with various sources of potential energy such as capacitors and springs.	Standard 2h:(electric charge in a capacitor) is addressed in Instructional Component 3	$E_{total} = KE + PE$ $\Delta KE + \Delta PE = 0$ $F = -kx$ $PE_{spring} = \frac{1}{2}kx^2$ Kinetic and Potential Energy Work Conservation of Energy Spring Constant
<b>Thermal Energy</b>		
3a. Students know heat flow and work are two forms of energy transfer between systems.	Calorimeter	$Q = mC\Delta T$
3b. Students know that the work done by a heat engine that is working in a cycle is the difference between the heat flow into the engine at high temperature and the heat flow out at a lower temperature (First Law of Thermodynamics) and that this is an example of the Law of Conservation of Energy.	Specific heat of metals	$\Delta U = Q - W$
3c. Students know the internal energy of an object includes the energy of random motion of the object's atoms and molecules, often referred to as thermal energy. The greater the temperature of the object, the greater the energy of motion of the atoms and molecules that make up the object.	Heating curve of water	$W = Q_H - Q_L$
3g* Students know how to solve problems involving heat flow, work, and efficiency in a heat engine, and know that all real engines lose some heat to their surroundings.	Internal Combustion Engine	$E = \frac{3}{2}kT$
5i. Students know plasmas, the fourth state of matter, contain ions or free electrons or both and conduct electricity.	Refrigerator	$Q_H/T_H = Q_L/T_L$
	Superheated steam	$eff(\%) = 100 \times W/Q_H$ $= 100 \times (T_H - T_L)/T_H$
	Thermo-powered fan	Heat vs temperature
	Media:	Latent heat of fusion & vaporization
	Ring of Truth: Change	Specific heat
	<i>Kelvin/Celsius scale is addressed in (Chemistry 4d,4e)</i>	Heat of combustion( $Q_H$ )
		Laws of Thermodynamics
		Carnot Engine
		<i>States of Matter(solid, liquid, gas, plasma)</i>

<b>Entropy</b>		
3d. Students know that most processes tend to decrease until thermal equilibrium regardless of the transfer mechanism the order of a system over time and that energy levels are eventually distributed uniformly.	Food coloring in different temperatures of water.	$\Delta S=Q/T$
3e. Students know that entropy is a quantity that measures the order or disorder of a system and that this quantity is larger for a more disordered system.	Convection demonstration (rheoscopic fluid/food coloring)	Entropy
3f.* Students know the statement "Entropy tends to increase" is a law of the statistical probability that governs all closed systems (second law of thermodynamics).	Deck of cards Dye and water Student bedroom(clean -> messy)	Radiation, Conduction, Convection 2 <sup>nd</sup> Law of Thermodynamics Order & Disorder <i>Absolute zero</i>
<b>Waves</b>		
4a. Student know waves carry energy from one place to another.	Rope, slinky, pendulum, human wave,	$v=f\lambda$
4b. Students know how to identify transverse and longitudinal waves in mechanical media, such as springs and ropes, and on the earth (seismic waves).	Wave machine	Frequency
4c. Students know how to solve problems involving wavelength, frequency and wave speed.	Torsional Wave Generator	<i>Period</i>
4d. Students know that sound is a longitudinal wave whose speed depends on the properties of the medium in which it propagates.	Doppler balls (spin around for effect)	Transverse wave
4e. Students know radio waves, light and x-rays are different wavelength bands in the spectrum of electromagnetic waves whose speed in a vacuum is approximately $3 \times 10^8$ m/s (186,000 miles/second).	Computer LCDs are polarized!	Longitudinal wave
4f. Students know how to identify the characteristic properties of waves: interference (beats), diffraction, refraction, Doppler effect, and polarization.	3D glasses	Sound wave
	Invisible beaker in Wesson oil	Compression
	Wine glass resonance	Rarefaction
	Resonance tube/straw flute/singing tube	Wavelength
	Standing flame wave	Wavespeed
	Computer tone generator (interference and beats)	Propagation
	Diffraction grating	Hertz ( $s^{-1}$ )
	Doppler Effect and red/blue shifts	Index of Refraction
		Speed of light
		Constructive interference
		Destructive interference
		Node/null
		Maxima/Antinodes
		Standing wave
		Diffraction
		Beats
		Refraction
		Doppler Effect
		Polarization
		<i>Reflection</i>
		<i>Red shift</i>
		<i>Blue shift</i>

**LAUSD – High School Instructional Guide**  
**Physics**  
**Instructional Component 2 - Matrix**

**Standard Group 1**

**Key Concept – Momentum and Impulse**

Analyzed Standards 2d, 2e, 2f, 2g	Instructional Activities, Resources, and Performance Tasks	Connections and Notes
<p>2d</p> <ul style="list-style-type: none"> <li>Calculate momentum.</li> </ul> <p>2e</p> <ul style="list-style-type: none"> <li>Explain the law of conservation of momentum.</li> </ul> <p>2f</p> <ul style="list-style-type: none"> <li>Relate the change in momentum to an impulse.</li> <li>An unbalanced force provides a change in velocity and hence momentum.</li> </ul> <p>2g</p> <ul style="list-style-type: none"> <li>Explain that momentum is always conserved in collisions.</li> <li>Differentiate between elastic and inelastic collisions.</li> <li>Explain that for inelastic collisions, kinetic energy is transformed to other forms of energy (heat).</li> </ul>	<p><b>Conceptual Physics:</b> (2d) 7.1-7.2; (2e) 7.4; (2f) 7.2; (2g) 7.5</p> <p><b>Glencoe Physics:</b> (2d, 2e, 2f) 9.1-9.2; (2g) 9.1-9.2, 11.2</p> <p><b>Holt Physics:</b> (2d, 2e, 2f, 2g) 6-1, 6-2, 6-3</p> <p><b>Labs/Demos:</b></p> <p><b>Conceptual Physics:</b>  Egg drop/catch  Water rockets  Water balloon toss  Newton’s cradle  LM 20 Tailgated by a Dart  CD 7-1</p> <p><b>Glencoe Physics:</b>  Sticky Collision (GP 246)</p> <p><b>Holt Physics:</b>  Demo, Impulse TE 6-1  Inquiry Lab, Conservation of Momentum SE 6-2  Quick Lab, Elastic and Inelastic Collisions SE -3  Demo, Inelastic Collisions TE 6-3</p>	<p>Integrate I&amp;E standards</p> <p>Key Equations:  <math>p=mv</math>  impulse=<math>F\Delta t=\Delta(mv)</math></p> <p>Key Terms:  Impulse  Momentum  Elastic Collision  Inelastic Collision  Conservation of momentum</p>

## Standard Group 2

### Key Concept – Conservation of Energy

Analyzed Standards 2a, 2b, 2c, 2g, 2h	Instructional Activities, Resources, and Performance Tasks	Connections and Notes
<p>2a</p> <ul style="list-style-type: none"> <li>Solve problems involving kinetic energy and work.</li> <li>Relate work to kinetic energy</li> </ul> <p>2b</p> <ul style="list-style-type: none"> <li>Calculate changes in gravitational potential energy near Earth's surface.</li> <li>Relate work to potential energy</li> </ul> <p>2c</p> <ul style="list-style-type: none"> <li>Explain the law of conservation of energy.</li> <li>Describe total energy of a system.</li> <li>Solve problems involving conservation of energy in simple systems.</li> </ul> <p>2g</p> <ul style="list-style-type: none"> <li>Explain that momentum is always conserved in collisions.</li> <li>Differentiate between elastic and inelastic collisions.</li> <li>Explain that for inelastic collisions, kinetic energy is transformed to other forms of energy (heat).</li> </ul> <p>2h</p> <ul style="list-style-type: none"> <li>Solve problems converting potential energy to</li> </ul>	<p><b>Conceptual Physics:</b> (2a) 8.1-8.6; (2b) 8.1-8.4; (2c) 8.5-8.7; (2g) 7.5, (2h) 8.7, 18.3  <b>Glencoe Physics:</b> (2a, 2b, 2c, 2g, 2h) 10.1-10.2; 11.1-11.2  <b>Holt Physics:</b> (2a, 2b, 2c, 2g, 2h) 5-2, 5-3, 6-3</p> <p><b>Labs/Demos:</b>  <b>Conceptual Physics:</b>            LM 21 Making the Grade            LM 24 Conserving Energy            LM 27 On a Roll            CD 8-1 to 8-3            Mousetrap cars            Marble tracks            Roller coaster            Pendulum/nose  <b>Glencoe Physics:</b>            Stair Climbing (GP 274)            Conservation of Energy (GP 302)  <b>Holt Physics:</b>            Discovery Lab, Exploring Work &amp; Energy ANC Ch. 5 opener            Demos, Work/Quantifying Work TE 5-1            Demo, Potential Energy TE 5-2            Quick Lab, Mechanical Energy SE 5-3            Demo, Physics in Your Face [Bowling Ball Pendulum/Students' nose]            Skills Practice Lab, Conservation of Mechanical Energy SE ANC 5-3</p>	<p>Integrate I&amp;E standards</p> <p>Standard 2h:(electric charge in a capacitor) is addressed in Instructional Component 3</p> <p>Key Equations:  <math>KE = \frac{1}{2}mv^2</math>  <math>W = Fd</math>  <math>PE = mgh = W</math> (gravitational)  <math>v = \sqrt{2gh}</math>            Conservation of Energy:  <math>KE = \frac{1}{2}mv^2 = \frac{1}{2}m(2gh) = mgh</math>  <math>E_{total} = KE + PE</math>  <math>\Delta KE + \Delta PE = 0</math>  <math>F = kx</math>  <math>PE_{spring} = \frac{1}{2}kx^2</math></p> <p>Key Terms:            Energy            Scalar            Joules            Kinetic Energy            Potential Energy            Work            Conservation of Energy            Spring Constant</p>

Analyzed Standards 2a, 2b, 2c, 2g, 2h	Instructional Activities, Resources, and Performance Tasks	Connections and Notes
kinetic energy and vice versa. • Solve problems using Hooke's Law for springs.	Demos, Mechanical Energy/Conservation of Energy TE 5-3 Demos, A Vibrating Spring/An Oscillating Pendulum/Hooke's Law TE 11-1 Quick Lab, Energy of a Pendulum SE 11-1	

### Standard Group 3

#### Key Concept – Thermal Energy

Analyzed Standards 3a, 3b, 3c 3g, 5i	Instructional Activities, Resources, and Performance Tasks	Connections and Notes
<p>3a</p> <ul style="list-style-type: none"> <li>Relate heat transfer (energy flow) to either a change in temperature or to work.</li> <li>Explain why temperature remains constant during phase changes (boiling and freezing).</li> <li>Explain difference between temperature and heat.</li> <li>Solve calorimetry problems relating mass, specific heat, and a change in temperature.</li> <li>Recognize high heat capacity of water.</li> </ul> <p>3b</p> <ul style="list-style-type: none"> <li>Explain that the total energy of an isolated system is the sum of the kinetic, potential and thermal energies.</li> <li>Relate the first law of thermodynamics to the law of conservation of energy.</li> <li>Ideal gasses are used to exemplify the application of conservation of energy to heat transfers.</li> </ul> <p>3c</p> <ul style="list-style-type: none"> <li>Relate the internal energy of objects to the random motion of atoms and molecules.</li> <li>Explain that the pressure of a gas results from gas molecules striking the containing surfaces.</li> <li>Relate internal energy of an ideal gas to temperature.</li> </ul>	<p><b>Conceptual Physics:</b> (3a) 8.1, 8.9; (3b) 24.1-24.2; (3c) 17.9, 21.1; (3g) 8.8; (5i) 17.9</p> <p><b>Glencoe Physics:</b> (3a, 3b, 3c, 3g) 12.1-12.2; (5i) 13.1</p> <p><b>Holt Physics:</b> (3a, 3b, 3c, 3g, 5i) 9-1, 9-2, 10-1, 10-2, 10-3</p> <p><b>Labs/Demos:</b>  <b>Conceptual Physics:</b>            Calorimeter            Specific heat of metals            Heating curve of water            Internal Combustion Engine            Refrigerator            Superheated steam            Thermo-powered fan</p> <p><b>Glencoe Physics:</b>            Heating and Cooling (GP 332)            Evaporative Cooling (GP 364)</p> <p><b>Holt Physics:</b>            Demo, Work from Heat TE 10-1            Quick Lab, Entropy and Probability SE 10-</p> <p><b>Media:</b>  <b>Ring of Truth: Change</b></p>	<p>Integrate I&amp;E standards</p> <p>Key Equations:  <math>Q = mC\Delta T</math>  <math>\Delta U = Q - W</math>  <math>W = Q_H - Q_L</math>  <math>E = 3/2 kT</math>  <math>Q_H/T_H = Q_L/T_L</math>  <math>eff(\%) = 100 \times W/Q_H</math>  <math>= 100 \times (T_H - T_L)/T_H</math></p> <p>Key Terms:            Heat vs temperature            Heat transfer            Heat flow            Thermal energy            Latent heat of vaporization  <i>Latent heat of fusion</i>            Specific heat            Heat of combustion(<math>Q_H</math>)            Thermodynamics            1<sup>st</sup> Law of Thermodynamics            2<sup>nd</sup> Law of Thermodynamics            Carnot Engine  <i>Kelvin/ Celsius scale(Chemistry 4d,4e)</i>            Efficiency  <i>States of Matter(solid, liquid, gas)</i>            Plasma</p>

Analyzed Standards 3a, 3b, 3c 3g, 5i	Instructional Activities, Resources, and Performance Tasks	Connections and Notes
<p>3g</p> <ul style="list-style-type: none"> <li>• Explain that, in a heat engine, part of the input heat energy is converted into useful work, but the remaining heat is exhausted to the environment.</li> <li>• Solve heat engine efficiency problems.</li> </ul> <p>5i</p> <ul style="list-style-type: none"> <li>• Describe plasma as the fourth and most common state of matter with free electrons and ions as a good electrical conductor. Plasmas generally exist at high temperatures to keep the constituent atoms dissociated.</li> </ul>		

## Standard Group 4

### Key Concept – Entropy

Analyzed Standards 3d, 3e, 3f	Instructional Activities, Resources, and Performance Tasks	Connections and Notes
<p>3d</p> <ul style="list-style-type: none"> <li>Recognize that heat flows from hot to cold (conduction, convection or radiation).</li> </ul> <p>3e</p> <ul style="list-style-type: none"> <li>Explain that entropy is a measure of the disorder of a system.</li> </ul> <p>3f</p> <ul style="list-style-type: none"> <li>Explain that in any real process, some energy cannot be recovered for useful work because it has added to the disorder of the universe (usually as heat).</li> </ul>	<p><b>Conceptual Physics:</b> (3d) 24.6-24.7; (3e) 24.6-24.7; (3f) 24.4-25.5</p> <p><b>Glencoe Physics:</b> (3d, 3e, 3f) 12.1-12.2</p> <p><b>Holt Physics:</b> (3d, 3e, 3f) 3-3</p> <p><b>Labs/Demos:</b></p> <p><b>Conceptual Physics:</b> LM 63 The Uncommon Cold Convection demonstration (theoscopic fluid/food coloring) Deck of cards Student bedroom(clean -&gt; messy)</p> <p><b>Holt Physics:</b> End of class entropy reduction lab (cleanup)</p> <p><i>Food coloring in different temperatures of water.</i> <i>Convection demonstration(theoscopic fluid/food coloring)</i> <i>Deck of cards</i> <i>Dye and water</i></p>	<p>Integrate I&amp;E standards</p> <p>Key Equations: <math>\Delta S=Q/T</math></p> <p>Key Terms: Entropy Radiation Conduction Convection 2<sup>nd</sup> Law of Thermodynamics Order Disorder <i>Absolute zero</i></p>

## Standard Group 5

### Key Concept – Waves

Analyzed Standards 4a, 4b, 4c, 4d, 4e, 4f	Instructional Activities, Resources, and Performance Tasks	Connections and Notes
<p>4a</p> <ul style="list-style-type: none"> <li>Explain how waves can carry energy without any net movement of matter</li> </ul> <p>4b</p> <ul style="list-style-type: none"> <li>Compare and contrast longitudinal and transverse waves in mechanical media.</li> </ul> <p>4c</p> <ul style="list-style-type: none"> <li>Explain the inverse relationship between wavelength and frequency for a given wave speed.</li> <li>Solve problems involving wavelength, frequency and wave speed.</li> </ul> <p>4d</p> <ul style="list-style-type: none"> <li>Explain that sound is a longitudinal wave consisting of regions of compression and rarefaction in a medium.</li> <li>Relate the density and elastic properties of the medium to the speed of sound.</li> </ul> <p>4e</p> <ul style="list-style-type: none"> <li>Identify parts of the electromagnetic spectrum by wavelength and frequency.</li> <li>Recall speed of light is <math>3 \times 10^8</math> m/s in a vacuum and is slower for propagation in matter.</li> <li>Calculate index of refraction for a given</li> </ul>	<p><b>Conceptual Physics:</b> (4a) 22.3-22.5, 25.3; (4b) 25.5-25.6; (4c) 25.2-25.4; (4d) 26.1-26.4; (4e) 22.3, 25.3, 27.2-27.3; (4f) 25.7-25.1</p> <p><b>Glencoe Physics:</b> (4a, 4b, 4c, 4d, 4f) 14.2-14.3, 15.1-15.2, 16.2, 17.1, 18.1, 19.1- 19.2</p> <p><b>Holt Physics:</b> (4a, 4b, 4c, 4d, 4e, 4f) 11-3, 11-4, 21-1, 13-1, 13-4, 14-1, 14-3, 15-1, 15-2</p> <p><b>Labs/Demos:</b>  <b>Conceptual Physics:</b>            LM 64 Tick-Tock            LM 65 Grand Father Clock            LM 66 Catch a Wave            LM 69 Match One            LM 72 Shades            CD 25-1, 25-3, 26-1, 27-1 27-2, 29-1 to 29-4            human wave, Wave machine            Computer LCDs are polarized!            3D glasses            Invisible beaker in Wesson oil            Wine glass resonance            Resonance tube/straw flute/singing tube            Standing flame wave            Computer tone generator (interference and beats)            Diffraction grating            Doppler Effect and red/blue shifts</p> <p><b>Glencoe Physics:</b></p>	<p>Integrate I&amp;E standards</p> <p>Key Equations:  <math>v = f\lambda</math></p> <p>Key Terms:            Frequency  <i>Period</i>            Transverse wave            Longitudinal wave            Sound wave            Compression            Rarefaction            Wavelength            Wavespeed            Propagation            Hertz (<math>s^{-1}</math>)            Index of Refraction            Speed of light            Constructive interference            Destructive interference            Node/null            Maxima/ Antinodes            Standing wave            Diffraction            Beats            Refraction            Doppler Effect            Polarization  <i>Reflection</i></p>

Analyzed Standards 4a, 4b, 4c, 4d, 4e, 4f	Instructional Activities, Resources, and Performance Tasks	Connections and Notes
<p>material. 4f</p> <ul style="list-style-type: none"> <li>• Explain that wave energy incident on a boundary can be reflected, transmitted or absorbed.</li> <li>• Explain constructive and destructive interference (beats) between waves based on the principle of superposition.</li> <li>• Explain that diffraction is the bending of waves around an obstacle</li> <li>• Relate the ratio of object size to wavelength to the sharpness of the wave shadow.</li> <li>• Explain that refraction is a change in direction in a wave when passing from one medium to another.</li> <li>• Explain that the Doppler Effect is a change in frequency resulting from relative motion between source and receiver of waves.</li> <li>• Explain polarization for transverse waves (light).</li> </ul>	<p>Launch Lab (GP 403) Speed of Sound (GP 420) Polarization of Light (GP 448) Double-Slit Interference (GP 532)</p> <p><b>Holt Physics:</b> Demo, Period and Frequency TE 11-2 Inquiry Lab, Simple Harmonic Motion of a Pendulum SE 11-2 Lab, J. L's Determination of "g" With a Pendulum Lab [jl_Little g Lab.doc] Demo's, Wave Motion/Transverse Waves/Longitudinal Waves/ Amplitude, Wavelength, and Wave Speed TE 11-3 Demo's, Wave Superposition, Waves Passing Each Other/Wave Reflection/Standing Waves</p> <p><i>Rope, slinky, pendulum, human wave, Wave machine</i> <i>Torsional Wave Generator</i> <i>Doppler balls (spin around for effect)</i></p>	<p><i>Red shift</i> <i>Blue shift</i></p>

**LAUSD – High School Instructional Guide**  
**Physics**  
**Instructional Component 3**

**Standards for Instructional Component 3**

1. Newton's laws predict the motion of most objects. As a basis for understanding this concept:
  - m.\* Students know how to solve problems involving the forces between two electric charges at a distance (Coulomb's law) or the forces between two masses at a distance (universal gravitation).
5. Electric and magnetic phenomena are related and have many practical applications. As a basis for understanding this concept:
  - a. Students know how to predict the voltage or current in simple direct current (DC) electric circuits constructed from batteries, wires, resistors, and capacitors.
  - b. Students know how to solve problems involving Ohm's law.
  - c. Students know any resistive element in a DC circuit dissipates energy, which heats the resistor. Students can calculate the power (rate of energy dissipation) in any resistive circuit element by using the formula  $\text{Power} = IR$  (potential difference)  $\times I$  (current) =  $I^2R$ .
  - d. Students know the properties of transistors and the role of transistors in electric circuits.
  - e. Students know charged particles are sources of electric fields and are subject to the forces of the electric fields from other charges.
  - f. Students know magnetic materials and electric currents (moving electric charges) are sources of magnetic fields and are subject to forces arising from the magnetic fields of other sources.
  - g. Students know how to determine the direction of a magnetic field produced by a current flowing in a straight wire or in a coil.
  - h. Students know changing magnetic fields produce electric fields, thereby inducing currents in nearby conductors.
  - i. Students know plasmas, the fourth state of matter, contain ions or free electrons or both and conduct electricity.
  - j. \* Students know electric and magnetic fields contain energy and act as vector force fields.
  - k. \* Students know the force on a charged particle in an electric field is  $qE$ , where  $E$  is the electric field at the position of the particle and  $q$  is the charge of the particle.
  - l. \* Students know how to calculate the electric field resulting from a point charge.
  - m. \* Students know static electric fields have as their source some arrangement of electric charges.
  - n. \* Students know the magnitude of the force on a moving particle (with charge  $q$ ) in a magnetic field is  $qvB \sin(a)$ , where  $a$  is the angle between  $v$  and  $B$  ( $v$  and  $B$  are the magnitudes of vectors  $v$  and  $B$ , respectively), and students use the right-hand rule to find the direction of this force.

o\* Students know how to apply the concepts of electrical and gravitational potential energy to solve problems involving conservation of energy.

### **Investigation and Experimentation (I & E) Standards:**

I. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content of the other four strands, students should develop their own questions and perform investigations. Students will:

- a. Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
- b. Identify and communicate sources of unavoidable experimental error.
- c. Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.
- d. Formulate explanations by using logic and evidence.
- e. Solve scientific problems by using quadratic equations and simple trigonometric, exponential, and logarithmic functions.
- f. Distinguish between hypothesis and theory as scientific terms.
- g. Recognize the usefulness and limitations of models and theories as scientific representations of reality.
- i. Analyze the locations, sequences, or time intervals that are characteristic of natural phenomena (e.g., relative ages of rocks, locations of planets over time, and succession of species in an ecosystem).
- j. Recognize the issues of statistical variability and the need for controlled tests.
- k. Recognize the cumulative nature of scientific evidence.
- l. Analyze situations and solve problems that require combining and applying concepts from more than one area of science.

m. Investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings. Examples of issues include irradiation of food, cloning of animals by somatic cell nuclear transfer, choice of energy sources, and land and water use decisions in California.

n. Know that when an observation does not agree with an accepted scientific theory, the observation is sometimes mistaken or fraudulent (e.g., the Piltdown Man fossil or unidentified flying objects) and that the theory is sometimes wrong (e.g., the Ptolemaic model of the movement of the Sun, Moon, and planets).

### Instructional Component 3 Overview

Standards	Suggested Activities	Notes
<b>Electrostatics</b>		
1m.* <i>Students know</i> how to solve problems involving the forces between two electric charges at a distance (Coulomb's law) or the forces between two masses at a distance (universal gravitation).	Charging balloons/rulers/etc. then picking up pieces of paper Fluorescent tube Van de Graff generator Electroscope Scotch Tape experiment Lightning Video	$F = kq_1q_2/r^2$ $F = qE$ $E = kq_1/r^2$  Electric field Electric field lines Field strength Point charge Coulombs
5e. Students know charged particles are sources of electric fields and are subject to the forces of the electric fields from other charges.		
5j*. Students know electric and magnetic fields contain energy and act as vector force fields.		
5k*. Students know the force on a charged particle in an electric field is $qE$ , where $E$ is the electric field at the position of the particle and $q$ is the charge of the particle.		
5l*. Students know how to calculate the electric field resulting from a point charge.		
5m*. Students know static electric fields have as their source some arrangement of electric charges.		
<b>Circuits and Components</b>		
5a. Students know how to predict the voltage or current in simple direct current (DC) electric circuits constructed from batteries, wires, resistors, and capacitors.	FOSS Kit: Electricity Water hose/pipe analogy Simple circuit design and testing Resistor testing Foil and Saran wrap capacitor Leyden Jar Build buzzer game	$I = q/t$ $V_{ab} = V_a - V_b = W_{ba}/q = PE_a/q - PE_b/q$ $V = IR$ $C = q/V$ $P = IV$ Electric Current (AC, DC) Electric Circuit Components <i>Series/ Parallel</i>
5b. Students know how to solve problems involving Ohm's law.		
5c. Students know any resistive element in a DC circuit dissipates energy, which heats the resistor. Students can calculate the power (rate of energy dissipation) in any resistive circuit element by using the formula $\text{Power} = IR(\text{potential difference}) \times I(\text{current}) = I^2R$ .		
5d. Students know the properties of transistors and the role of transistors in electric circuits.		
<b>Magnetism</b>		
5f. Students know magnetic materials and electric currents (moving electric charges) are sources of magnetic fields and are subject to forces arising from the magnetic fields of other sources.	Magnetic field line demonstrations Building an electric motor Build an electromagnet Tesla video Electronic Storage Media(Hard drives/videotape/etc.) Slow Magnet (magnet in copper tube)	$F = qvB\sin(\theta)$ Magnetic field(B) Tesla Right Hand Rule Lenz's Law Magnetic Field Lines North Pole South Pole Magnetic Domain Induced Current
5g Students know how to determine the direction of a magnetic field produced by a current flowing in a straight wire or in a coil.		
5h. Students know changing magnetic fields produce electric fields, thereby inducing currents in nearby conductors.		
5j*. Students know electric and magnetic fields contain energy and act as vector force fields.		
5n*. Students know the magnitude of the force on a moving particle (with charge $q$ ) in a magnetic field $qvB \sin a$ , where $a$ is the angle between $v$ and $B$ . ( $v$ and $B$ are the magnitudes of the vectors $v$ and $B$ , respectively), and students use the right-hand rule to find the direction of this force.		
<b>Conservation of Energy</b>		
5o*. Students know how to apply the concepts of electrical and gravitational potential energy to solve problems involving conservation of energy.	Neverdie Flashlight Hydroelectric Generator	$\Delta KE = \Delta PE = qV_{ab}$ $PE = \frac{1}{2}CV^2$   $Q = CV$

LAUSD – High School Instructional Guide

Physics  
Instructional Component 3 - Matrix

Standard Group 1

Key Concept – Electrostatics

Analyzed Standards 1m (electrostatics only), 5e, 5j (electric field), 5k, 5l, 5m	Instructional Activities, Resources, and Performance Tasks	Connections and Notes
<p>1m (electrostatics only)</p> <ul style="list-style-type: none"> <li>Solve problems involving Coulomb’s law</li> <li>Relate the gravitational and the electromagnetic forces to the inverse square relationship.</li> </ul> <p>5e</p> <ul style="list-style-type: none"> <li>Solve problems involving Coulomb’s law. (See standard 1m.)</li> <li>Relate the charge of a particle to its electric field and to its response to external electric fields.</li> </ul> <p>5j (electric field)</p> <ul style="list-style-type: none"> <li>Describe the nature of both electric and magnetic fields.</li> <li>Calculate the potential energy of an electric field <math>PE=kq_1q_2/r</math>.</li> </ul> <p>5k</p> <ul style="list-style-type: none"> <li>Calculate the force on a charged particle in an electric field as <math>F=qE</math>.</li> </ul>	<p><b>Conceptual Physics:</b> (1m) 12.5, 32.3; (5e) 32.1-32.2, 33.1-33.2; (5j) 33.1-33.7, 36.1-36.9, 37.1-37.8; (5k) 32.1-32.7; (5l) 32.1-32.7; (5m) 32.1-32.7; 33.1-33.7</p> <p><b>Glencoe Physics:</b> (1m, 5e, 5j, 5k, 5l, 5m) 20.1-20.2, 21.1-21.2</p> <p><b>Holt Physics:</b> (1m, 5e, 5j, 5k, 5l, 5m) 16-2, 16-3</p> <p><b>Labs/Demos:</b>  <b>Conceptual Physics:</b>            LM 86 Static Cling            LM Sparky the Electrician            LM 88 Brown Out (use 1F capacitor)            CD 32-1, 32-2, 33-1, 33-2            Charging balloons/rulers/etc. then picking up pieces of paper            Fluorescent tube            Van de Graff generator            Electroscope            Scotch Tape experiment            Lightning Video</p> <p><b>Glencoe Physics:</b>            Charged Particles (GP 554)</p>	<p>Integrate I&amp;E standards</p> <p>Key Equations:  <math>F=kq_1q_2/r^2</math>  <math>F=qE</math>  <math>E=kq_1/r^2</math></p> <p>Key Terms:            Electric field            Electric field lines            Field strength            Point charge            Coulombs</p>

Analyzed Standards 1m (electrostatics only), 5e, 5j (electric field), 5k, 5l, 5m	Instructional Activities, Resources, and Performance Tasks	Connections and Notes
<p>5l</p> <ul style="list-style-type: none"> <li>Calculate the electric field by dividing Coulomb's Law by a test charge <math>q_2</math> to get <math>E=kq_1/r^2</math>. The direction of the field is away from a positive (+) charge and toward a negative (-) charge.</li> </ul> <p>5m</p> <ul style="list-style-type: none"> <li>Create a drawing of the electric field lines for configurations of one or two charges.</li> </ul>	<p><b>Holt Physics:</b>  Discovery Lab, Charges and Electrostatics ANC ch. 16 opener  Demos, Effects of Charge/Jumping  Spices/Polarization TE 16-1  Quick Lab, Polarization SE 16-1  Skills Practice Lab SE 16-1  Demo, Electric Force TE 16-2  Demo, Electric Field Strength/Charge Accumulation TE 16-3  Invention Lab, Levitating Toys ANC 16-3</p>	

## Standard Group 2

### Key Concept – Circuits and Components

Analyzed Standards 5a, 5b, 5c, 5d	Instructional Activities, Resources, and Performance Tasks	Connections and Notes
<p>5a</p> <ul style="list-style-type: none"> <li>Relate the flow of charge in a closed circuit to the difference in electric potential (voltage) between two points.</li> <li>Relate electric potential to potential energy and work.</li> </ul> <p>5b</p> <ul style="list-style-type: none"> <li>Relate resistance to current and voltage.</li> <li>Solve problems using Ohm’s law.</li> <li>Explain the storage of charge on parallel plate capacitors.</li> </ul> <p>5c</p> <ul style="list-style-type: none"> <li>Calculate power in a circuit.</li> <li>Relate dissipation of energy as heat to electrical resistance.</li> </ul> <p>5d</p> <ul style="list-style-type: none"> <li>Explain that transistors amplify a current and have contributed to miniaturization by replacing vacuum tubes.</li> </ul>	<p><b>Conceptual Physics:</b> (5a) 33.5-33.6, 34.2-34.4; (5b) 34.5-34.7; (5c) 34.4-34.5; (5d) none</p> <p><b>Glencoe Physics:</b> (5a, 5b, 5c, 5d) 22.1-22.2, 23.1-23.2</p> <p><b>Holt Physics:</b> (5a, 5b, 5c, 5d) 17-3, 17-4, 18-1, 18-2</p> <p><b>Labs/Demos:</b>  <b>Conceptual Physics:</b>            LM 89 Ohm Sweet Ohm            CD 34-1, 34-2, 35-1, 35-2            Water hose/pipe analogy            Simple circuit design and testing            Resistor testing            Foil and Saran wrap capacitor            Leyden Jar            Build buzzer game</p> <p><b>Glencoe Physics:</b>            Ohm’s Law (GP 606)</p> <p><b>Holt Physics:</b>            Discovery Lab, Exploring Circuit Elements ANC ch. 18 opener            Quick Lab, Simple Circuits SE 18-1            Demos, Resistors in Series/Parallel TE 18-2            Inquiry Lab, Resistors in Series and Parallel ANC 18-2            Invention Lab, Designing a Dimmer Switch ANC 18-3            Demos, Capacitor Discharge TE 17-2            Quick Lab, A Lemon Battery SE 17-3</p>	<p>Integrate I&amp;E standards: 1a(Use of a multimeter), 1d, 1g(problems with water hose analogy)</p> <p>Key Equations:  <math>I=q/t</math>  <math>V_{ab}=V_a-V_b = W_{ba}/q=PE_a/q-</math>  <math>PE_b/q</math>  <math>V=IR</math>  <math>C=q/V</math>  <math>P=IV</math>  <math>R_{total}=R_1+R_2+\dots</math> (series)**  <math>1/R_{total}=1/R_1+1/R_2+\dots</math> (parallel)**  <math>1/C_{total}=1/C_1+1/C_2+\dots</math> (series)**  <math>C_{total}=C_1+C_2+\dots</math> (parallel)**</p> <p>Key Terms:            Electric Current            Direct Current            Alternating Current            Electric Circuit            Electric Potential            Conventional Current            Voltage            Electric Power            Resistance            Capacitance</p>

Analyzed Standards 5a, 5b, 5c, 5d	Instructional Activities, Resources, and Performance Tasks	Connections and Notes
	<p>Skills Practice Lab, Current and Resistance SE 17-3  Demos, Drift Speed/Non-Ohmic  Resistance/Resistance Factors TE 17-3  Quick Lab, Energy Use in Appliances SE 17-4  Demo, Potential Difference as a Source of Current TE 17-4  Invention Lab, Battery-Operated Heater ANC 17-4</p> <p><i>FOSS Kit: Electricity</i>  <i>Ohm's Law – Bottle with squirt cap.</i>  <i>Ohm's Law – Water hose/pipe analogy</i>  <i>Ohm's Law – Straws in series/parallel – Blow through them</i>  <i>Vinegar Battery</i>  <i>Potato/Lemon Clock</i></p> <p><b>Culminating activities:</b>  Build buzzer game</p>	<p>Insulator  Dielectric  Ohm's Law  Capacitor  Resistor  Transistor  Semiconductor  Watts  Volts  Amps  Farads  Ohms  <i>Series</i>  <i>Parallel</i>  <i>Switch</i></p>

### Standard Group 3

#### Key Concept – Magnetism

Analyzed Standards 5f, 5g, 5h, 5j (magnetic fields), 5n	Instructional Activities, Resources, and Performance Tasks	Connections and Notes
<p>5f</p> <ul style="list-style-type: none"> <li>Explain that moving electric charges produce magnetic fields.</li> </ul> <p>5g</p> <ul style="list-style-type: none"> <li>Apply the right hand rule to find the direction of a magnetic field produced by a current carrying wire.</li> <li>Compare and contrast the magnetic field produced by a straight wire with that from a coil.</li> </ul> <p>5h</p> <ul style="list-style-type: none"> <li>Apply Lenz’s law that the direction of induced current is always such that it opposes the changing magnetic field that caused it.</li> </ul> <p>5j</p> <ul style="list-style-type: none"> <li>Describe the nature of both electric and magnetic fields.</li> </ul> <p>5n</p> <ul style="list-style-type: none"> <li>Calculate the magnitude of the magnetic force on a moving particle of charge <math>q</math> and determine its direction using the right-hand rule.</li> </ul>	<p><b>Conceptual Physics:</b> (5f) 36.2-36.5; (5g) 36.6-36.7; (5h) 37.1-37.8; (5j) 36.1-36.9; (5n) 33.1-33.6</p> <p><b>Glencoe Physics:</b> (5f, 5g, 5h, 5j, 5n) 21.1; 24.1-24.2, 25.1-25.2</p> <p><b>Holt Physics:</b> (5f, 5g, 5h, 5j, 5n) 16-2, 16-3, 19-1, 19-2, 19-3, 20-1, 20-2</p> <p><b>Labs/Demos:</b>  <b>Conceptual Physics:</b>            LM 93 Magnetic Field            LM 94 You’re Repulsive            CD 36-1, 37-1            Magnetic field line demonstrations            Building an electric motor            Build an electromagnet            Tesla video            Electronic Storage Media(Hard drives/videotape/etc.)</p> <p><b>Glencoe Physics:</b>            Creating an Electromagnet (GP 660)</p> <p><b>Holt Physics:</b>            Discovery Lab, Magnetism ANC ch. 19 opening            Quick Lab, Magnetic Field of a File Cabinet SE 19-1            Demos, Magnetic Poles/Magnetic Domains/Magnetic Fields TE 19-1            Quick Lab, Electromagnetism SE 19-2            Skills Practice Lab, Magnetic Field of a Conducting Wire SE 19-2            Demo, Current-Carrying Wire SE 19-2            Demos, Electromagnetic Force/Force Between Parallel Conductors TE 19-3</p>	<p>Integrate I&amp;E standards</p> <p>Key Equations:</p> $F=qvB\sin(\theta)$ <p>Key Terms:            Magnetic field(B)            Tesla            Right Hand Rule            Lenz’s Law            Magnetic Field Lines            North Pole            South Pole            Magnetic Domain            Induced Current</p>

Analyzed Standards 5f, 5g, 5h, 5j (magnetic fields), 5n	Instructional Activities, Resources, and Performance Tasks	Connections and Notes
	Invention Lab, Designing a Magnetic Spring ANC 19-3  <i>Slow Magnet (magnet in copper tube)</i>	

Standard Group 4

Key Concept – Conservation of Energy

Analyzed Standards 5o	Instructional Activities, Resources, and Performance Tasks	Connections and Notes
<p>5o</p> <ul style="list-style-type: none"> <li>Apply the concepts of electrical and gravitational potential energy to solving problems involving conservation of energy (e.g., see 2a for kinetic energy, 2b for gravitational potential energy, and 2h for electrical potential energy).</li> </ul>	<p><b><u>Conceptual Physics:</u></b> (5o) 8.1-8.9  <b><u>Glencoe Physics:</u></b> 11.1-11.2; 21.2  <b><u>Holt Physics:</u></b> ???</p> <p><b>Labs/Demos:</b>  <b><u>Conceptual Physics:</u></b>            Hand cranked Flashlight            Hydroelectric Generator  <b><u>Holt Physics:</u></b>            Quick Lab, A Voltaic Pile SE 17-17-1            Demo, Potential Energy TE 17-1</p> <p><i>Neverdie Flashlight</i>  <i>Hydroelectric Generator</i></p>	<p>Integrate I&amp;E standards            Key Equations:  <math>\Delta PE = qV_{ab}</math>  <math>\Delta KE = \Delta PE = qV_{ab}</math>  <math>Q = CV</math>  <math>PE = \frac{1}{2}CV^2</math></p>

**VI. Sample Immersion (Extended Investigation) Project for Physics**

**A. Physics  
Immersion Unit  
Under Construction**