OFFICE OF CURRICULUM, INSTRUCTION, & PROFESSIONAL DEVELOPMENT

HIGH SCHOOL COURSE OUTLINE

(Revised January 2006)

Department	Science	**Course Title**	Physics 1-2	**Course Code**	3841		
Abbreviation	Physics	**Grade Level**	10, 11, 12	**Grad Requirement**	Yes		
Course Length	2 semesters	**Credits/Semester**	5	**Required**		**Elective**	X
Prerequisites	Algebra 1-2 and Geometry 1-2 (or equivalent “a-g” courses)						
Articulated with LBCC	No	**Articulated with CSULB**	No				
Meets UC “a-g” Requirement	Yes (d)	**Meets NCAA Requirement**	Yes				

COURSE DESCRIPTION:

This course is a standards-based study of fundamental physics concepts, such as measurement, calculation, and graphing in kinematics and dynamics, propagation and conservation of energy and momentum, gravitation and orbital mechanics, heat and thermodynamics, waves, optics, electromagnetic phenomena, and relativity and quantum physics. Emphasis is placed on the utilization of mathematical, analytical, data acquisition, graphical, and communication skills as well as interdisciplinary approaches to discovery. Concepts and skills are reinforced by a strong emphasis on hands-on laboratory experiences and the integration of other branches of science. Applications to society, individuals, and the utilization of technology are included. Physics fulfills both the physical science high school graduation requirement and the UC/CSU “d” laboratory science requirement. A course in the biological sciences is also needed to complete the minimum graduation requirement for high school.

GOALS: (Student needs the course is intended to meet)

- Students will learn all of the required California State Standards for Physics and other topics. The use of well-designed, memorable experiences and the application of scientific knowledge and methodology are essential in helping students achieve appropriate comprehension of the content.
- Students will improve their ability to learn independently by drawing generalizations from science related articles, books, graphs, charts, and diagrams. Regular opportunities are provided for students to clearly communicate their understanding through oral and written explanations of physics concepts and laboratory experiences.
- Students will study the applications of physics to medical, safety, commercial, and ethical issues to develop critical thinking skills, as they apply to decision making in both societal and personal contexts. This will inspire students to consider pursuing advanced studies in science and the wide variety of related career choices.

CA CONTENT STANDARDS:

Grade 9-12 Physics:

Standards without asterisks represent those that all students are expected to achieve in the course of their studies. These will be tested on the CST Physics Exam. Standards with asterisks represent those that all students should have the opportunity to learn. For this college-preparatory course, these standards should be included.

Motion and Forces

1. Newton's laws predict the motion of most objects. As a basis for understanding this concept, students know:

   a. how to solve problems that involve constant speed and average speed.

   b. 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. how to apply the law $F = ma$ to solve one-dimensional motion problems that involve constant forces (Newton's second law).

   d. 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. the relationship between the universal law of gravitation and the effect of gravity on an object at the surface of Earth.

   f. 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. circular motion requires the application of a constant force directed toward the center of the circle.

   *h.** 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.** *how to solve two-dimensional trajectory problems.*

   *j.** *how to resolve two-dimensional vectors into their components and calculate the magnitude and direction of a vector from its components.*

   *k.** *how to solve two-dimensional problems involving balanced forces (statics).*

   *l.** *how to solve problems in circular motion by using the formula for centripetal acceleration in the following form:* $a = v^2/r$.

   *m.** 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).

Conservation of Energy and Momentum

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, students know:

   a. how to calculate kinetic energy by using the formula $E = ½mv^2$.

   b. 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. how to solve problems involving conservation of energy in simple systems, such as falling objects.

   d. how to calculate momentum as the product mv.

   e. momentum is a separately conserved quantity different from energy.

   f. an unbalanced force on an object produces a change in its momentum.

   g. how to solve problems involving elastic and inelastic collisions in one dimension by using the principles of conservation of momentum and energy.

   *h.** *how to solve problems involving conservation of energy in simple systems with various sources of potential energy, such as capacitors and springs.*

Heat and Thermodynamics

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, students know:

   a. heat flow and work are two forms of energy transfer between systems.

   b. 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. 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. that most processes tend to decrease the order of a system over time and that energy levels are eventually distributed uniformly.

   e. 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. the statement "Entropy tends to increase" is a law of statistical probability that governs all closed systems (second law of thermodynamics).*

   g. 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.*

Waves

4. Waves have characteristic properties that do not depend on the type of wave. As a basis for understanding this concept, students know:

   a. waves carry energy from one place to another.

   b. how to identify transverse and longitudinal waves in mechanical media, such as springs and ropes, and on the earth (seismic waves).

   c. how to solve problems involving wavelength, frequency, and wave speed.

   d. sound is a longitudinal wave whose speed depends on the properties of the medium in which it propagates.

   e. radio waves, light, and X-rays are different wavelength bands in the spectrum of electromagnetic waves whose speed in a vacuum is approximately 3×10^8m/s (186,000 miles/second).

   f. how to identify the characteristic properties of waves: interference (beats), diffraction, refraction, Doppler effect, and polarization.

Electric and Magnetic Phenomena

5. Electric and magnetic phenomena are related and have many practical applications. As a basis for understanding this concept, students know:

   a. how to predict the voltage or current in simple direct current (DC) electric circuits constructed from batteries, wires, resistors, and capacitors.

   b. how to solve problems involving Ohm's law.

   c. 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 Power = IR (potential difference) x I (current) = I^2R.

   d. the properties of transistors and the role of transistors in electric circuits.

   e. charged particles are sources of electric fields and are subject to the forces of the electric fields from other charges.

   f. 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. how to determine the direction of a magnetic field produced by a current flowing in a straight wire or in a coil.

   h. changing magnetic fields produce electric fields, thereby inducing currents in nearby conductors.

   i. plasmas, the fourth state of matter, contain ions or free electrons or both and conduct electricity.

- *j.* electric and magnetic fields contain energy and act as vector force fields.*
- *k.* the force on a charged particle in an electric field is q**E**, where **E** is the electric field at the position of the particle and q is the charge of the particle.*
- *l.* how to calculate the electric field resulting from a point charge.*
- *m.* static electric fields have as their source some arrangement of electric charges.*
- *n.* 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.* how to apply the concepts of electrical and gravitational potential energy to solve problems involving conservation of energy.*

Investigation and Experimentation .... (10% of CST)

1. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in 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, spread sheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data. (CST)

   b. identify and communicate sources of unavoidable experimental error. (CST)

   c. identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions. (CST, LS10)

   d. formulate explanations using logic and evidence. (CST)

   e. solve scientific problems using quadratic equations and simple trigonometric, exponential, and logarithmic functions. (CST)

   f. distinguish between hypothesis and theory as science terms. (CST, LS10)

   g. recognize the usefulness and limitations of models and theories as scientific representations of reality. (CST)

   h. read and interpret topographic and geologic maps. (CST)

   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). (CST, LS10)

   j. recognize the issues of statistical variability and the need for controlled tests. (CST, LS10)

   k. recognize the cumulative nature of scientific evidence. (CST)

   l. analyze situations and solve problems that require combining and applying concepts from more than one area of science. (CST)

   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. (CST)

   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). (CST)

CST = Standards assessed on the California Standards Test
LS10 = Standards assessed on the 10th grade No Child Left Behind Biology/Life Science Test

DISTRICT PERFORMANCE STANDARDS:

The Long Beach Unified School District has common assessments and assignments that are required for Biology. The Performance Standard Criteria is shown in the table below. The objective is to have all students achieve at or above the Proficient Level and receive a C or better in the course. Performance level is determined by the average of the assessments or assignments.

Science Performance Standard Criteria

	Not Proficient	Partial Proficient	Proficient	Advanced Proficient
Graded Student Work	Average is a 1 or less than 60%	Average is a 2 or 60% - 69%	Average is a 3 or 70% - 84%	Average is a 4 or 85% - 100%
Standards-Based Classroom Assessments	Less than 60%	60% - 69%	70% - 84%	85% - 100%
Written Response / Lab Report / OES (6 point scale)	1-2	3	4	5-6
Written Response / Lab Report / OES (4 point scale)	1	2	3	4
End-Of-Course Exam	Less than 45%	45% - 59%	60% - 84%	85% - 100%

STATE PERFORMANCE STANDARDS:

The California State Board of Education has identified the following performance levels for the California Standards Test (CST) in Physics. The objective of Long Beach Unified School District is to have all students achieve at or above the Proficient Performance Standard (Level).

Far Below Basic	Below Basic	Basic	Proficient	Advanced Proficient
SS 150 – 275	**SS 276 – 299**	**SS 300 – 349**	**SS 350 – 392**	**SS 393 – 600**

OUTLINE OF CONTENT AND RECOMMENDED TIME ALLOTMENT:

The Task Analysis and Key Vocabulary presented here are drawn from the 2003 Science Framework for California Public Schools, which defines the intent and scope of the Science Content Standards. For additional information on the context and the benchmark standards to assess, refer to the Blueprints, Released Questions, and Reference Sheets for the Physics Content Standards Test (CST). Content sequencing, Labs/Demos, and time allocations are only suggestions and may be adjusted to suit school site curriculum plans, available materials, and student needs.

In the Task Analysis section, numbered equations (i.e., "eq 1") refer to the numbering used in the CA Science Framework. Equations, defining units, and constants labeled "CST" correspond to those given on the Reference Sheet that accompanies the STAR Physics Content Standards Test. Where there is overlap, but the symbols may differ (for instance, where **d** is used in the Framework, **Δx** is used on the CST Reference Sheet) the CST symbols have been given preference.

PHYSICS 1-2

Motion and Forces

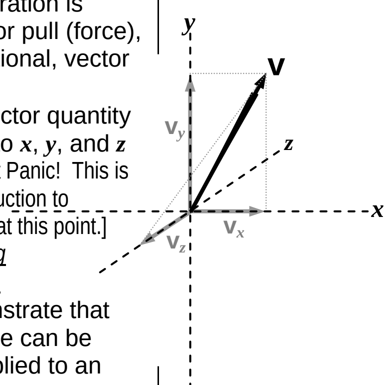
1. Newton's laws predict the motion of most objects.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… how to solve problems that involve constant speed and average speed. **(1,a)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Define **speed** as the rate at which an object moves. ◦ Explain that speed is measured in distance per unit time (e.g., meters/second). ◦ Explain that for an object traveling at a constant speed, a simple linear relationship exists between the speed (or rate of motion, **r**); distance traveled, **d**; and time, **t**. ◦ Graph and explain this linear relationship expressed by the equation, **d=rt**. eq 1 • Explain that when speed does not remain constant, the **average speed** can be determined as the total distance traveled divided by the total time required for the trip. **v = Δx/Δt** CST • Calculate speed and average speed from given values and observation measurements. • Define **velocity** (**v**) as a vector quantity that has both magnitude – the speed – *and* a direction.	**Phys:P&P**, Ch 3:1-3 4:1 5:1 **Con Phys**, Ch 2:1-3,7	***KEY VOCABULARY:*** slope, rate, **speed**, **average speed**, **velocity**, vector, magnitude ***SKILLS FOCUS:*** observe, measure Select and use appropriate tools and technology to perform tests, collect data, analyze relationships, and display data. **(I&E 1.a)** ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P Lab Manual, Lab 3-1, "Analyzing Motion", p 13 • Phys:P&P, Pocket Lab 3, "Notion of Motion", p 58 • Con Phys, Lab 2, "The Physics 500", p 3 • Con Phys, Lab 3, "The Domino Effect", p 5 • **The Physics Classroom:** http://www.glenbrook.k12.il.us/gbssci/phys/Class/1DKin/1DKinTOC.html	4 Days (2 Blocks)

Motion and Forces

1. Newton's laws predict the motion of most objects.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… 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). **(1,b)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Define **acceleration** as a change in velocity with time, expressed as, **$a = \Delta v/\Delta t$**. eq 2/CST • Explain that acceleration may be described as the change in position over time per unit time, giving units of m/s^2, for example. • Explain that acceleration is a vector quantity, having both magnitude and direction. ◦ *Use arrows to qualitatively show the direction of accelerations that would speed up, slow down, or turn an object's motion. (LBUSD)* • Explain that acceleration is caused by a push or pull (force), which is also directional, vector quantity. • Explain that any vector quantity can be resolved into x, y, and z components. [Don't Panic! This is just a qualitative introduction to component vectors … at this point.] *<u>Getting Quantitative Using One-Dimensional Vectors</u>* • Explain and demonstrate that more than one force can be simultaneously applied to an object. ◦ Explain and show that when forces are pointing in the same direction, their magnitudes add. ◦ Explain and show that when forces are pointing in the opposite directions, their magnitudes subtract. ◦ Calculate the net force by adding forces along a line algebraically, keeping track of the directions using +/– signs. *<u>Newton's First Law of Motion</u>* • Explain that if an object is subject to only one force or to multiple forces whose vector sum is not zero, there must be a net force on the object that will change its motion (cause an acceleration). • Explain and give examples to show that objects experiencing a net force of zero will not accelerate. ◦ Draw simple vector (free body) diagrams. ◦ Cite examples and draw vector diagrams of objects in motion at constant velocity. ◦ Cite examples and draw vector diagrams of objects at rest.	**<u>Phys:P&P</u>**, Ch 3:3 5:2-3 6:1 **<u>Con Phys</u>**, Ch 2:4,7 3:1-2 4:1-7	***KEY VOCABULARY:*** **acceleration** **net** force force constant units ***SKILLS FOCUS:*** 1-dimensional vector math Select and use appropriate tools and technology to perform tests, collect data, analyze relationships, and display data. **(I&E 1.a)** ***LABS / DEMOS / ACTIVITIES:*** • <u>Phys:P&P Lab Manual</u>, Lab 5-1, "Accelerated Motion", p 21 • <u>Phys:P&P</u>, Pocket Lab 5-1, "Uniform or Not?", p 87 • <u>Phys:P&P Lab Manual</u>, Lab 6-3, "Pushes, Pulls, and Vectors", p 41 • <u>Con Phys</u>, Lab 4, "Merrily We Roll Along", p 9 • <u>Con Phys</u>, Probeware Lab 1, • p 2 / 72 / 132 • <u>Con Phys</u>, Lab 8, "Going Nuts", p 29 • <u>Con Phys</u>, Lab 9, "Buckle Up!", p 31 • **Inertia Demonstrations** <u>Card & Coin</u>: Students balance a card, lying flat, on the tip of their extended index finger. A quarter is placed on top of the card. With their other hand (or another student), the card can be flicked from the side so that the coin remains on the finger tip. Students explain how Newton's 1st Law explains this. For all of Newton's Laws: • **The Physics Classroom** http://www.physicsclassroom.com/mmedia/newtlaws/newtlawsTOC.html • **Hyperphysics – Georgia State University** http://hyperphysics.phy-astr.gsu.edu/hbase/hph.html	4 Days (2 Blocks)



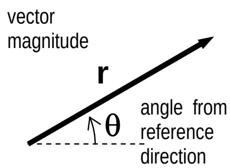
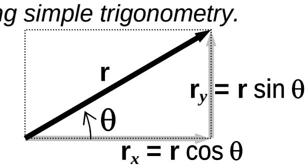
Motion and Forces

1. Newton's laws predict the motion of most objects.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… how to apply the law *F = ma* to solve one-dimensional motion problems that involve constant forces (Newton's second law). **(1,c)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	*Newton's Second Law of Motion* • Recall that if a net force is applied to an object, it will accelerate. • Explain that a relationship exists between the net force (**F**), the object's mass (**m**), and the resulting acceleration (**a**), expressed by Newton's second law of motion: **F = ma**. eq 3/CST • Recall that if mass is in kg and acceleration is in m/s^2, the units of force will be Newtons. • Define one Newton as 1 kg-m/s^2. CST • Explain that if a constant net force is applied to an object, the object will experience a constant acceleration. • For the following equations … $v = v_o + at$ eq 4/CST $x = x_o + v_ot + ½at^2$ eq 5/CST ◦ identify the variables and their units. *[Note that* **t** *is the time during which the force is applied.]* ◦ explain how the equation describes reality. ◦ be able to solve problems using them. ◦ show how the units cancel appropriately.	**Phys:P&P**, Ch 5:3 6:1-2 **Con Phys**, Ch 5:1-7	***KEY VOCABULARY:*** mass **applied** force ***SKILLS FOCUS:*** diagram, analyze Identify and communicate sources of unavoidable experimental error. **(I&E 1.b)** ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P Lab Manual, Lab 6-1, "Newton's Second Law", p 31 • Phys:P&P, Pocket Lab 6-1, "How Far is Forever?", p 119 • Con Phys, Lab 11, "Getting Pushy", p 35 • Con Phys, Lab 12, "Const. Force, Changing Mass", p 39 • Con Phys, Lab 13, "Const. Mass, Changing Force", p 43 • Con Phys, Probeware Lab 4, p 19 / 86 / 144 • Con Phys, Probeware Lab 5, p 23 / 91 / 148 • **Hyperphysics – Georgia State University:** http://hyperphysics.phy-astr.gsu.edu/hbase/hph.html	6 Days (3 Blocks)
… 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). **(1,d)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	*Newton's Third Law of Motion* • Explain Newton's third law of motion, commonly stated, "to every action there is always an equal and opposite reaction" in their own words. • Express this principle of equal and opposite reaction forces in diagrams and mathematically. For example, **F = – F'** eq 6 • Apply this principle to a variety of situations, from gravity's pull on objects and the atmosphere being opposed by upward push from the Earth's surface to the balance of gravity and expansion forces at balance in a stable star.	**Phys:P&P**, Ch 6:3 **Con Phys**, Ch 6:1-7	***KEY VOCABULARY:*** **reaction** force ***SKILLS FOCUS:*** model, analyze Formulate explanations by using logic and evidence. **(I&E 1.d)** ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P, Pocket Lab 6-1, "Tug-of-War Challenge", p 123 • Con Phys, Lab 16, "Balloon Rockets", p 55 • Con Phys, Lab 17, "Tension", p 57 • Con Phys, Lab 18, "Tug-of-War", p 61	2 Days (1 Block)

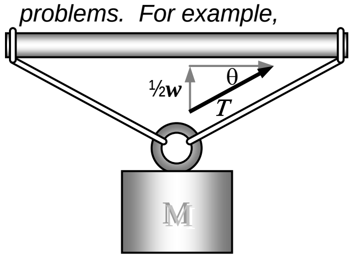
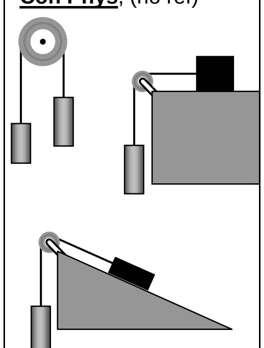
Motion and Forces

1. Newton's laws predict the motion of most objects.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… how to resolve two-dimensional vectors into their components and calculate the magnitude and direction of a vector from its components. **(1,j*)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	∗ *Explain how any vector in a two-dimensional system can be described by a magnitude and an angle.*  ∗ *Calculate component vectors using simple trigonometry.*  ∗ *Calculate the magnitude and direction of a vector from its components using the Pythagorean theorem and trigonometry.* $r^2 = r_x^2 + r_y^2$ $\tan\theta = r_y/r_x$	**Phys:P&P**, Ch 4:1-2 **Con Phys**, Ch 3:3 4:8	***KEY VOCABULARY:*** trigonometry, cosine sine, tangent Pythagorean theorem ***SKILLS FOCUS:*** construct accurate diagrams Solve scientific problems using simple trigonometric functions. **(I&E 1.e)** ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P, Physics Lab, "The Paper River", p 69	2 Days (1 Block)
… how to solve two-dimensional trajectory problems. **(1,i*)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	∗ *Explain how the path of an object thrown up in the air at an angle can be analyzed by considering the horizontal and vertical components that operate independently of one another.* ◦ *Explain that air resistance can be ignored (especially if an object is dense and the speeds are low) to simplify calculations.* ◦ *Explain that the object experiences virtually no horizontal forces to slow it down.* ◦ *Explain that gravity is the only force acting vertically.* ∗ *Calculate maximum height, distance, and time for a projectile when given the initial height and velocity (which includes the angle).*	**Phys:P&P**, Ch 7:2 **Con Phys**, Ch 3:4-6	***KEY VOCABULARY:*** horizontal, **projectile** vertical, **trajectory** ***SKILLS FOCUS:*** measure and analyze projectile motion Select and use appropriate tools and technology to perform tests, collect data, analyze relationships, and display data. **(I&E 1.a)** Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions. **(I&E 1.c)** ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P Lab Manual, Lab 7-2, "Range of a Projectile", p 49 • Phys:P&P, Physics Lab, "The Softball Throw", p 162 • Phys:P&P, Pocket Lab 7-2, "Over the Edge", p 156 • Phys:P&P, Pocket Lab 7-2, "Where the Ball Bounces", p 161 • Con Phys, Lab 7, "Bull's Eye", p 25 • Con Phys, Probeware Lab 3, p 14 / 81 / 140 • **Hyperphysics** http://hyperphysics.phy-astr.gsu.edu/hbase/vect.html	4 Days (2 Blocks)

Motion and Forces

1. Newton's laws predict the motion of most objects.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… how to solve two-dimensional problems involving balanced forces (statics). **(1,k*)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	∗ *Define static equilibrium as a situation where a body is at rest with no net force acting on it.* ∗ *Diagram instances of static equilibrium (i.e., a book on a table or a ladder leaning against a wall) showing that horizontal and vertical component forces acting, and that they equal zero.* $\Sigma F_x = 0, \quad \Sigma F_y = 0$ eq 9 ∗ *Calculate forces involved in various static equilibrium problems. For example,*  *Students are able to determine that each of the equal length ropes supports half of the weight (**w**) of mass (**M**), write a simple trig. equation to relate the forces:* $\frac{1}{2}\mathbf{w} = \mathbf{T} \sin \theta$ *and calculate tension force (**T**) on the ropes.*	**Phys:P&P**, Ch 7:1 **Con Phys**, Ch 4:7-8	***KEY VOCABULARY:*** **static** equilibrium free body diagram ***SKILLS FOCUS:*** construct accurate diagrams Solve scientific problems using simple trigonometric functions. **(I&E 1.e)** ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P Lab Manual, Lab 4-1, "Addition of Vectors", p 17 • Con Phys, Lab 10, "24-Hour Towing Sevice", p 33 • **Force Table** Students investigate various horizontal or vertical arrangements of spring scales attached to masses to determine how calculations compare to measurements, and predict which strings are most likely to break first when tension is increased. • **The Physics Classroom** http://www.physicsclassroom.com/Class/vectors/U3L3c.html	2 Days (1 Blocks)
… how to solve for the acceleration of Atwood machines and account for sliding friction. ***(LBUSD*)*** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	∗ *Show all free-body force vectors involved in the motion of frictionless Atwood machines and similar pulley set ups.* ∗ *Simplify diagram to treat two masses and connecting string as a single object, or "blob".* ∗ *Determine direction of motion and calculate acceleration.* ∗ *Explain how friction is a reaction force.* ∗ *Calculate static and kinetic friction force values and determine how they affect the acceleration of objects.*	**Phys:P&P**, (no ref) **Con Phys**, (no ref) 	***KEY VOCABULARY:*** ***SKILLS FOCUS:*** diagram, calculate Formulate explanations by using logic and evidence. **(I&E 1.d)** ***LABS / DEMOS / ACTIVITIES:*** • **Air Track** Students study and measure the acceleration of air track cars being pulled by falling masses to validate "blob" calculations. • **Atwood's Machine** http://physics.kenyon.edu/EarlyApparatus/Mechanics/Atwoods_Machine/Atwoods_Machine.html	2 Days (1 Block)

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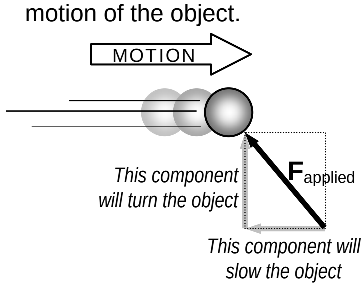
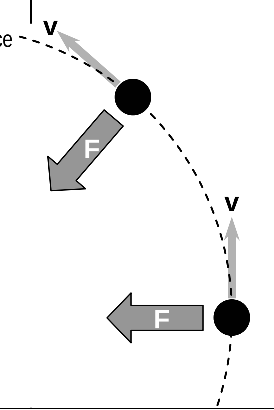
1. Newton's laws predict the motion of most objects.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… the relationship between the universal law of gravitation and the effect of gravity on an object at the surface of Earth. **(1,e)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Explain that all masses attract one another with a force of gravity. ° Solve problems involving gravity using Newton's law of universal gravitation: $\mathbf{F_g = Gm_1m_2/r^2}$ eq 12/CST Where G = 6.67 x 10^{-11} Nm^2/kg^2 CST ° Explain that the acceleration of gravity near the Earth's surface can be calculated as, $\mathbf{g} = Gm_{earth}/r_{earth}^2 = 9.8\ m/s^2$ ° Explain how experiments validate that all objects near the Earth's surface fall at 9.8 m/s2 (in the absence of air resistance). • Explain that the force of gravity (or weight (**w**) of an object) near Earth's surface can be expressed mathematically using Newton's second law, replacing the generic acceleration (**a**) with gravity's acceleration (**g ≈ 9.8 m/s²**). CST **F = w = mg** eq 7/CST	**Phys:P&P**, Ch 8:1-2 **Con Phys**, Ch 12:4-6 13:1-3	***KEY VOCABULARY:*** **gravity** force weight gravity's acceleration ***SKILLS FOCUS:*** dimensional analysis learn to treat equations as descriptions ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P Lab Manual, Lab 5-2, "Acceleration Due to Gravity", p 27 • Phys:P&P, Pocket Lab 8-2, "Weight in a Free Fall", p 188 • Con Phys, Lab 36, "Accel. of Free Fall", p 125 • Con Phys, Lab 37, "Computerized Gravity", p 129 • Con Phys, Probeware Lab 9, p 42 / 106 / 166 • **"g, look what I found!"** Students create their own experiment to determine the acceleration caused by gravity. Students compare their value to a given standard value and evaluate reasons for error and suggest methods and conditions needed to reduce the errors. • **University of Tennesee: Astronomy 161** http://csep10.phys.utk.edu/astr161/lect/history/newtongrav.html • **University of Oregon** http://zebu.uoregon.edu/~soper/Orbits/newtongrav.html	2 Days (1 Block)

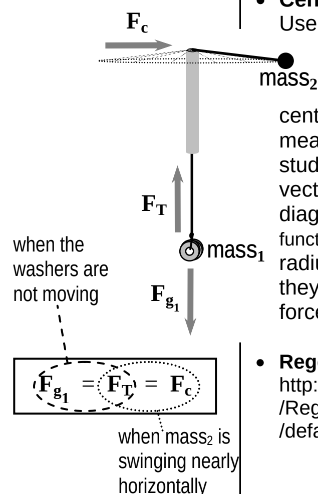
Motion and Forces

1. Newton's laws predict the motion of most objects.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… 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). **(1,f)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Explain that a force may act on an object from any direction, but that the force can be broken into components that are either parallel or perpendicular to the motion of the object.  ∘ Explain that the component of the force that is <u>parallel</u> to the motion of the object will change the <u>speed</u> of the object. ∘ Explain that the component of the force that is <u>perpendicular</u> to the motion of the object will change the <u>direction</u> in which the object travels. • Explain that for a satellite in orbit, the force of gravity is always perpendicular to the motion allowing the satellite to continue in orbit without losing speed.  	**<u>Phys:P&P</u>**, Ch 7:2-3 8:1 **<u>Con Phys</u>**, Ch 9:3-4 12:1-3 14:2	***KEY VOCABULARY:*** component parallel perpendicular ***SKILLS FOCUS:*** model, diagram Formulate explanations by using logic and evidence. **(I&E 1.d)** ***LABS / DEMOS / ACTIVITIES:*** • <u>Phys:P&P</u>, Pocket Lab 7-3, "Target Practice", p 164 • <u>Con Phys</u>, Lab 15, "Riding with the Wind", p 51 • **The Satellite Site (Lockheed-Martin)** http://www.thetech.org/exhibits_ events/online/satellite/home.html	2 Days (1 Block)

Motion and Forces

1. Newton's laws predict the motion of most objects.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
…circular motion requires the application of a constant force directed toward the center of the circle. **(1,g)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Explain that to maintain constant speed circular motion, there needs to be a constant force perpendicular to the motion that changes the direction, but not the speed. • Explain that the perpendicular force constantly points inward toward the center of the circle and for this reason is called the **centripetal force**. • Explain the relationship among the variables in the equation that describes how much force is required to hold a mass (**m**) in circular motion at a radius (**r**) and a constant speed (**v**): $\mathbf{F = mv^2/r}$ eq 8/CST • Rearrange the centripetal force equation as needed to solve for missing variables in given and practical problems. • Explain examples of centripetal forces in string tension, orbits, and electric and magnetic forces that can turn charged particles.	**<u>Phys:P&P</u>**, Ch 7:3 **<u>Con Phys</u>**, Ch 9:1-4 	***KEY VOCABULARY:*** **centripetal** force tension ***SKILLS FOCUS:*** model, identify forces Formulate explanations by using logic and evidence. **(I&E 1.d)** ***LABS / DEMOS / ACTIVITIES:*** • <u>Con Phys</u>, Lab 30, "Going in Circles", p 103 • **Centripetal Force** Use a hollow tube (plastic or glass with flame smoothed ends and wrapped with duct tape for safety) to determine centripetal force two ways. By measuring masses and angles, students calculate the force vectors as shown on the diagram. [Requires basic trig. functions.] By measuring the radius and timing the period they can calculate centripetal force using equation 8, $F = mv^2/r$. • **Regents Prep** http://www.regentsprep.org/Regents/physics/phys06/bcentrif/default.htm	3 Days (1.5 Blocks)
… how to solve problems in circular motion by using the formula for centripetal acceleration in the following form: $a = v^2/r$. **(1,I*)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	∗ *Explain that the velocity of an object in circular motion is constantly changing, even though its speed is constant, because the direction is changing.* ∗ *Explain that the constantly changing velocity implies a constant acceleration.* ∗ *Explain that the direction of this acceleration rotates so that it is always toward the center of the circle (as is the force causing it), making it centripetal acceleration.* ∗ *Apply the centripetal acceleration equations to solve given and practical problems:* $\mathbf{a_c = F_c/m = v^2/r}$ eq 10	**<u>Phys:P&P</u>**, Ch 7:3 **<u>Con Phys</u>**, Ch 9:1-4	***KEY VOCABULARY:*** centripetal acceleration ***SKILLS FOCUS:*** apply concepts Formulate explanations by using logic and evidence. **(I&E 1.d)** ***LABS / DEMOS / ACTIVITIES:*** • <u>Phys:P&P</u>, Enrichment, "2001: A Space Odyssey", p 165 TE • <u>Con Phys</u>, Lab 30, "Going in Circles", p 103 • **Swinging Cup** Demonstrate or have students swing a cup of water around in a circle, showing that the water stays inside the cup. Students explain the acceleration, identify what is pushing on what, and distinguish between centripetal force and the false perception of "centrifugal force". • **Simulated Gravity** http://www.regentsprep.org/Regents/physics/phys06/bartgrav/default.htm	2 Days (1 Block)

Motion and Forces

1. Newton's laws predict the motion of most objects.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… 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). **(1,m*)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	∗ *Explain that both gravitational and electromagnetic forces are inverse square relationships because they act at a distance and the magnitude decreases faster than the distance increases.* *Coulomb's Law* *(Note: Coulomb's Law is handled in detail in the context of electricity in standard 5e.)* ∗ *Solve problems involving electric force using Coulomb's law:* $F_q = kq_1q_2/r^2$ eq 11 *Where* $k = 9 \times 10^9\ Nm^2/coulomb^2$ ∗ *Explain that the charges (q_1 and q_2) are given + or – signs to match their charge meaning that a positive force value will be repulsive and a negative value will be attractive.* *Universal Gravitation* *(Note: Although the Framework details the gravity calculations here, they have been moved to standard 1e, to align with the CST's use of the univ. grav. equation and constant as testable content.)* ∗ *Recall that the universal gravitation equation has the same inverse square form as Coulomb's law.*	**Phys:P&P**, Ch 20:2 **Con Phys**, Ch 32:3	***KEY VOCABULARY:*** **electromagnetic** force charge attractive repulsive inverse square ***SKILLS FOCUS:*** evaluate and rearrange inverse square law equations ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P: On the bottom of page 379 there is a good visual representation of the inverse square relationship between light intensity and distance. Students should explain how this visual relates to the force and distance relationships in this standard. • **Jim Loy** http://www.jimloy.com/physics/inverse.htm • **NDT (Non-Destructive Testing)** http://www.ndt-ed.org/EducationResources/CommunityCollege/Radiography/Physics/inversesquare.htm	1 Day (0.5 Block)

Motion and Forces

1. Newton's laws predict the motion of most objects.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… 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. **(1,h*)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	∗ *Explain that Newton's laws are excellent approximations of motions involving low speeds and macroscopic objects.* <u>*Too Fast for Newton*</u> ∗ *Recall that at speeds close to the speed of light (**c = 3.00 x 10^8 m/s**), Einstein's theory of special relativity is required to describe the motion of an object accurately.* CST ∗ *Explain the four major relativistic principles that are not explained by Newton's theory of mechanics:* *1. The maximum attainable speed for any object is the speed of light.* *2. A moving clock runs more slowly than a stationary one.* *3. The length of an object depends on its velocity with respect to the observer.* *4. The apparent mass of an object increases as its speed increases.* ∗ *Calculate and explain the relativistic changes at extremely high speeds. (LBUSD)* <u>*Too Small for Newton*</u> ∗ *Recall that at the atomic scale, the wavelike nature of matter becomes important and quantum mechanics describes motions better than Newton's laws.* ∗ *Explain that since Quantum mechanics shows that certainty about the motion of particles is not always possible, Newtonian mechanics cannot be applied.*	**<u>Phys:P&P</u>**, Ch 3:1 4:1-2 *(special relativity is covered in Appendix D, Topic 7, pp 861-871)* **<u>Con Phys</u>**, Ch 15:1-8 16:1-2 38:4-9	***KEY VOCABULARY:*** approximation relative relativistic speed of light quantum ***SKILLS FOCUS:*** Recognize the cumulative nature of scientific evidence. **(I&E 1.k)** Recognize the usefulness and limitations of models and theories as scientific representations of reality. **(I&E 1.g)** ***LABS / DEMOS / ACTIVITIES:*** • **Relativity** http://nobelprize.org/physics/educational/relativity/ • **Relativity on the Web** http://math.ucr.edu/home/baez/relativity.html • **Intro to Quantum Mechanics** http://www.hi.is/~hj/QuantumMechanics/quantum.html#Discreteness • **Visual Quantum Mechanics** http://phys.educ.ksu.edu/	5 Days (2.5 Blocks)

Conservation of Energy and Momentum

2. The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… how to calculate kinetic energy by using the formula $E = ½mv^2$. **(2,a)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Define kinetic energy as the energy of motion. • Explain that the kinetic energy of an object is equal to the work needed to create the motion. • Explain that work is defined as how hard an object is pushed or pulled (force applied) multiplied by distance the object moved. **W = Fd** eq 14/CST • Explain that kinetic energy equation, **E = ½mv²** CST describes the work needed to accelerate a mass (m) from rest to a speed (v). • Recall that the units of energy are joules. • Show by dimensional analysis of the equations that **1 joule** is **1 kg·m²/s²** or **1 N·m**. CST • Explain that energy is a scalar quantity, having magnitude but no direction.	**Phys:P&P**, Ch 10:1 **Con Phys**, Ch 8:1-5	***KEY VOCABULARY:*** **work** · **kinetic energy** joule · **scalar** ***SKILLS FOCUS:*** dimensional analysis, treat equations as descriptions of reality Formulate explanations by using logic and evidence. **(I&E 1.d)** ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P Lab Manual, Lab 10-1, "Pulleys", p 71 • Phys:P&P, Pocket Lab 10-1, "Work Out", p 225 • Phys:P&P, Pocket Lab 10-1, "An Inclined Mass", p 227 • Con Phys, Lab 26, "Wrap Your Energy in a Bow", p 85 • **Hyperphysics** http://hyperphysics.phy-astr.gsu.edu/hbase/ke.html#c2 • **University of Oregon** http://jersey.uoregon.edu/vlab/KineticEnergy/	3 Days (1.5 Blocks)
… 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). **(2,b)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Derive the equation for the work needed to lift an object near the Earth's surface by combining **F = ma = mg** (opposing gravity) with **W = Fd** (d is the height lifted) to get **W = E = mgh**. eq 15/CST • Explain that since work and energy have the same units, **mgh** can be defined as the change in gravitational potential energy caused by the change in elevation or height. • Explain that the work done to lift an object (**Fd**, or **F·h = mgh**) is stored in the object as gravitational potential energy that can be released and converted back into kinetic energy as it falls to the ground with increasing speed.	**Phys:P&P**, Ch 11:1 **Con Phys**, Ch 8:4	***KEY VOCABULARY:*** **potential** energy · derive elevation · convert ***SKILLS FOCUS:*** treat equations as descriptions of reality Formulate explanations by using logic and evidence. **(I&E 1.d)** ***LABS / DEMOS / ACTIVITIES:*** • Con Phys, Lab 23, "Cut Short", p 77 • Con Phys, Probeware Lab 7, p 32 / 99 / 156 • **GCSE** http://www.gcse.com/energy/gpe.htm • **Zona Land** http://id.mind.net/~zona/mstm/physics/mechanics/energy/gravitationalPotentialEnergy/gravitationalPotentialEnergy.html	3 Days (1.5 Blocks)

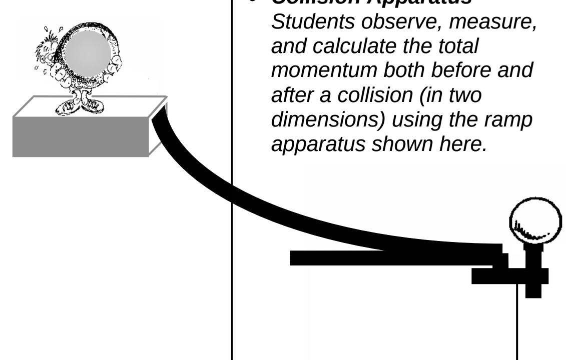
Conservation of Energy and Momentum

2. The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… how to solve problems involving conservation of energy in simple systems, such as falling objects. **(2,c)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Explain that by combining equations *(eq 4 and eq 5)* it is possible to derive a new equation that solves for the final velocity of a free falling object as it hits the ground. $v = \sqrt{2gh}$ eq 16 • Use this term to show mathematically that the amount of kinetic energy at impact is the amount of gravitational potential energy just lost by falling. $v^2 = (\sqrt{2gh})^2$ $E = \frac{1}{2}mv^2 = \frac{1}{2}m(2gh) = mgh$ eq 17 • Define the total energy of an object as the sum of kinetic and potential energy. $\mathbf{\Sigma E = KE + PE}$ eq 18 • Explain that the total energy is conserved in a closed system for forces such as gravity and electromagnetic interactions, and those produced by ideal springs. • Explain that energy can be converted from one form to another, but the total remains the same in a closed system. $\mathbf{\Delta KE + \Delta PE = 0}$ eq 19	**Phys:P&P**, Ch 11:2 **Con Phys**, Ch 8:6	***KEY VOCABULARY:*** **conservation** closed **system** ***SKILLS FOCUS:*** rearrange and combine equations, compare mathematical models to observations ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P Lab Manual, Lab 11-1, "Conservation of Energy", p 75 • Phys:P&P, Physics Lab 11, "Down the Ramp", p 257 • Phys:P&P, Pocket Lab 11-2, "Energy Exchange", p 87 • Con Phys, Lab 24, "Conserving Your Energy", p 79 • **Physics Tutoring** http://www.slcc.edu/schools/hum_sci/physics/tutor/2210/potential_energy/	3 Days (1.5 Blocks)
… how to calculate momentum as the product *mv*. **(2,d)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Define momentum (**p**) as the product of mass and velocity: $\mathbf{p = mv}$ CST • Recall that the units for momentum are kg·m/s. • Explain that momentum is a vector quantity having direction from its velocity.	**Phys:P&P**, Ch 9:1 **Con Phys**, Ch 7:1	***KEY VOCABULARY:*** **momentum** ***SKILLS FOCUS:*** solve vector problems ***LABS / DEMOS / ACTIVITIES:*** • **Glenbrook K-12** http://www.glenbrook.k12.il.us/gbssci/phys/Class/momentum/u4l1a.html	1 Day (0.5 Block)
… momentum is a separately conserved quantity different from energy. **(2,e)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Explain that momentum remains constant unless acted on by a net force. • Recall that conservation of momentum is a fundamental law of physics that restates Newton's first law of motion. • Explain that since the units for momentum do not match the units for energy, it is a different type of quantity, even though it can be conserved.	**Phys:P&P**, Ch 9:2 **Con Phys**, Ch 7:4	***KEY VOCABULARY:*** conserved quantity ***SKILLS FOCUS:*** Formulate explanations by using logic and evidence. **(I&E 1.d)** ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P Lab Manual, Lab 9-1, "Conservation of Momentum", p 63 • Phys:P&P, Physics Lab 9, "The Explosion", p 213 • Phys:P&P, Pocket Lab 9-2, "Skateboard Fun", p 208 • **Glenbrook K-12** http://www.glenbrook.k12.il.us/gbssci/phys/Class/momentum/u4l1a.html	3 Days (1.5 Blocks)

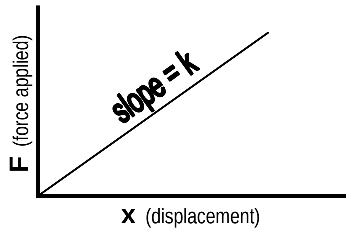
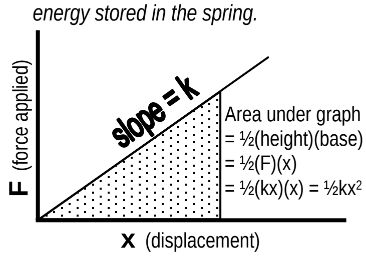
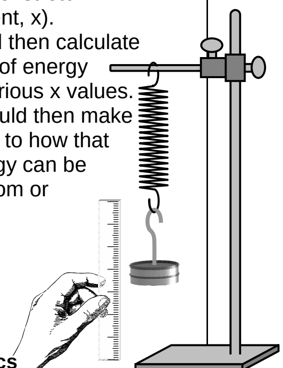
Conservation of Energy and Momentum

2. The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… an unbalanced force on an object produces a change in its momentum. **(2,f)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Recall that an unbalanced (non-zero) net force will change an object's velocity. • Explain that a force (**F**) acting for a time (**Δt**) will change an object's momentum. • Recall that change in momentum (**Δp**) caused by a force acting for a time is called **impulse**. $\Delta \mathbf{p} = \mathbf{F}\Delta \mathbf{t}$ • Explain that, depending on the direction of the force applied, the impulse can increase, decrease, or change the direction of an object's momentum. ∗ *Explain how seat belts and air bags protect people undergoing large impulse during accidents by increasing* $\Delta \mathbf{t}$ *so that the* ***F*** *will be reduced. (LBUSD)*	**Phys:P&P**, Ch 9:1 **Con Phys**, Ch 7:2-3	***KEY VOCABULARY:*** **impulse** ***SKILLS FOCUS:*** model, analyze Formulate explanations by using logic and evidence. **(I&E 1.d)** ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P, Pocket Lab 9-1, "Cart Momentum", p 205 • **Glenbrook K-12** http://www.glenbrook.k12.il.us/gbssci/phys/Class/momentum/u4l1a.html	1 Day (0.5 Block)
… how to solve problems involving elastic and inelastic collisions in one dimension by using the principles of conservation of momentum and energy. **(2,g)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Explain that collisions that conserve kinetic energy are called **elastic collisions**. ◦ Cite examples of collisions that nearly elastic. ◦ Explain that only collisions at the molecular level are truly elastic. • Explain that collisions that do not conserve kinetic energy are called **inelastic collisions**. ◦ Cite examples of inelastic collisions. ◦ Explain how kinetic energy is transformed into other types of energy (i.e., thermal or potential). ◦ Recall that in all cases, the total energy of the system is conserved. • Recall that momentum is always conserved in collisions (elastic or inelastic), meaning that the momentum is the same before and after any collision. ◦ Solve problems describing elastic collisions in one dimension. $[m_1v_1 + m_2v_2]_{initial} = [m_1v_1 + m_2v_2]_{final}$ CST ◦ Solve problems describing inelastic collisions in one dimension $[m_1v_1 + m_2v_2]_{initial} = [(m_1 + m_2)\cdot v]_{final}$ ◦ *Solve problems describing two dimensional momentum problems using vector mathematics. (LBUSD)*	**Phys:P&P**, Ch 9:2 11:2 **Con Phys**, Ch 7:4-6 *(Note: Hewitt does not address Kinetic energy in collisions. When momentum calculations are done with inelastic collisions, students should also calculate ΣKE before and after the collision and explain the results.)* 	***KEY VOCABULARY:*** **elastic collision** **inelastic collision** ***SKILLS FOCUS:*** predict, observe, measure, diagram, calculate ***LABS / DEMOS / ACTIVITIES:*** • Con Phys, Lab 19, "Go Cart", p 65 • Con Phys, Lab 20, "Tailgated by a Dart", p 69 • Con Phys, Probeware Lab 6, p 28 / 95 / 152 • ***Collision Apparatus*** *Students observe, measure, and calculate the total momentum both before and after a collision (in two dimensions) using the ramp apparatus shown here.* • **Lawrence Tech. University** http://www3.ltu.edu/~s_schneider/physlets/main/momenta3.shtml	3 Days (1.5 Blocks)

Conservation of Energy and Momentum

2. The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… how to solve problems involving conservation of energy in simple systems with various sources of potential energy, such as capacitors and springs. **(2,h*)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	<u>*Springs*</u> ∗ *Explain that an ideal spring is a conservative system that stores and releases energy.* ∗ *Explain that stretching or compressing a spring gives a linear relationship between the force applied and the displacement from equilibrium.*  ° *Explain why the slope (k) of this graph indicates the stiffness of the spring.* ° *Explain that this relationship can be given mathematically by Hooke's law:* $F = kx$ eq 20 ° *Explain that calculating the area under the graph is the work done to compress the spring and also the amount of energy stored in the spring.*  $PE = \frac{1}{2}kx^2$ eq 21 ∗ *Solve problems involving the storage of energy in springs.* <u>*Capacitors*</u> (Note: Capacitors are also addressed in standard 5g.) ∗ *Define a capacitor as a device that stores electric charge.* ∗ *Explain that the amount of charge (**Q**) that can be stored depends on the voltage (**ΔV**) according to the equation* $Q = C\Delta V$ eq 22 *where the constant **C** is the capacitance.* ∗ *Recall that the energy stored in a capacitor is given by the equation* $PE = \frac{1}{2}C(\Delta V)^2$ eq 23 ∗ *Solve problems involving the storage of energy in capacitors.*	**<u>Phys:P&P</u>**, Springs: *(Hooke's law is discussed in the context of periodic motion, but not treated quantitatively.)* *(Elastic potential energy is discussed at the end of 11:1, but not calculated.)* Capacitors: 21:2 *(Potential energy stored in capacitors, $PE = \frac{1}{2}CV^2$, is not included and needs to be added.)* **<u>Con Phys</u>**, Springs: Ch 18:3 *(Hooke's law is presented, but elastic potential energy is not discussed.)* Capacitors: Ch 33:6 *(Capacitors are described and diagrammed. Calculations need to be added.)*	***KEY VOCABULARY:*** displacement voltage capacitor **capacitance** ***SKILLS FOCUS:*** connect observations to graphs and equations ***LABS / DEMOS / ACTIVITIES:*** • <u>Con Phys</u>, Lab 43, "Stretch", p 143 • **Hookes' Law** Students determine Hooke's constant for springs and/or rubber bands by hanging different masses and measuring the amount of stretch (displacement, x). They should then calculate the amount of energy stored at various x values. Students could then make applications to how that stored energy can be absorbed from or imparted to various objects for practical or fun purposes.  • **Hyperphysics** http://hyperphysics.phy-astr.gsu.edu/hbase/pespr.html • **Web Physics** http://webphysics.davidson.edu/physlet_resources/bu_semester2/c07_capacitor_energy.html	5 Days (2.5 Blocks)

Heat and Thermodynamics

3. Energy cannot be created or destroyed, although in many processes energy is transferred to the environment as heat.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… heat flow and work are two forms of energy transfer between systems. **(3,a)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Explain that **heat transfer** is energy flow from one system to another because of differences in temperature or because of mechanical work done. • Define **temperature** as the average translational kinetic energy of molecules. ◦ Explain that heat entering a system (such as a pot of cold water), increases the kinetic energy of the random motion of the molecules, raising the temperature. ◦ Explain that at the boiling point, latent (hidden) heat of vaporization added does not change the temperature, because it is being spent on breaking intermolecular bonds to release liquid molecules into the gas phase. ◦ Give examples of how mechanical work can change temperature (e.g., through friction or compression of a gas). ◦ Explain and give examples of how temperature changes can do mechanical work (e.g., heating gases in a sealed piston chamber or warming the coiled wire in a thermostat). ◦ Explain that the transfer of heat energy occurs by three types of flow: conduction, convection, and radiation. (This was first taught in 6th grade.) • Explain that the amount of heat needed to raise the temperature of an object depends on the mass of the object and the ability of the substance to absorb heat – its heat capacity. • Define **specific heat** (**c**) as the amount of energy needed to raise the temperature of one gram of a material by one degree Celsius. $\mathbf{Q = mc\Delta T}$ eq 24/CST ◦ Recall that for water, $\mathbf{c} = 1\ cal/g{\cdot}^{o}C$ ◦ Explain that the relatively high specific heat value for water is the cause of the "tempered" climates at coastal regions. ◦ Explain why the specific heat equation does not work for substances undergoing phase changes.	**<u>Phys:P&P</u>**, Ch 12:1-2 **<u>Con Phys</u>**, Ch 21:1,2,5-8 22:1-3 23:8	***KEY VOCABULARY:*** **heat transfer**, **temperature**, **translational** kinetic energy, **latent** heat, radiation, mechanical work, heat capacity, conduction, **specific heat**, convection, phase change ***SKILLS FOCUS:*** observe, infer Formulate explanations by using logic and evidence. **(I&E 1.d)** ***LABS / DEMOS / ACTIVITIES:*** • <u>Phys:P&P Lab Manual</u>, Lab 12-1, "Specific Heat", p 79 • <u>Phys:P&P</u>, Physics Lab, "Heating Up", p 281 • <u>Phys:P&P</u>, Pocket Lab 12-1, "Melting", p 284 • <u>Phys:P&P</u>, Pocket Lab 12-2, "Cool Times", p 287 • <u>Con Phys</u>, Lab 49 & 50, "Heat Mixes: Parts I and II", p 167 / 171 • <u>Con Phys</u>, Lab 51, "Antifreeze in the Summer", p 175 • **Raymond Walters College** http://www.rwc.uc.edu/koehler/biophys.2ed/heat.html	2 Days (1 Block)

Heat and Thermodynamics

3. Energy cannot be created or destroyed, although in many processes energy is transferred to the environment as heat.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… 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. **(3,b)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Define the total (internal) energy for an isolated system as the sum of the kinetic, potential, and thermal energies. • Explain that since all energy is conserved (in classical processes), the law of conservation of energy can be restated as the first law of thermodynamics by the expression: $\Delta U = Q - W$ eq 25/CST where $\Delta U \equiv$ internal energy change $Q \equiv$ heat added from the surroundings $W \equiv$ work done by the system ∘ Recall that **Q** is positive for heat added to the system and negative for heat transferred to the surroundings. ∘ Recall that W is positive for work done by the system and negative for work done to the system. ∘ Solve problems using the first law of thermodynamics equation and explain the implications of the answers. • Define a heat engine as a device that converts thermal energy into useful mechanical work. ∘ Explain that part of the input heat energy (Q_H) if converted into useful work (W) by the heat engine, while the rest is lost to the environment as exhaust heat (Q_L). ∘ Recall and apply the equation that describes the operation of idealized (Carnot) heat engines: $W = Q_H - Q_L$ eq 26/CST	**Phys:P&P**, Ch 12:2 **Con Phys**, Ch 21:4 24:2-5	***KEY VOCABULARY:*** total (internal energy) thermodynamics input heat engine exhaust **heat of combustion (Q_H)** ***SKILLS FOCUS:*** Recognize the usefulness and limitations of models and theories as scientific representations of reality. **(I&E 1.g)** ***LABS / DEMOS / ACTIVITIES:*** • **Carnot Engine** http://www.rawbw.com/~xmwang/myGUI/CarnotG.html • **Hyperphysics: Carnot Engine** http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/carnot.html	3 Days (1.5 Blocks)

Heat and Thermodynamics

3. Energy cannot be created or destroyed, although in many processes energy is transferred to the environment as heat.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… 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. **(3,c)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Define the internal energy of an object as the motion of their atoms *and* molecules and the energy of the electrons in the atoms. • Explain that transferring energy to a substance increases the average speed of its molecules. • Explain that at a fixed temperature, more massive molecules will have a slower average speed than less massive molecules because their average kinetic energy is the same. $KE_{BIG} = KE_{small}$ $\frac{1}{2} \mathbf{M} v^2 = \frac{1}{2} m V^2$ Ex. $\frac{1}{2}(4)(1)^2 = \frac{1}{2}(1)(2)^2$ *Note that because the velocity is squared, the velocity does not change in the same proportion as the mass.* • Explain that the pressure exerted by a fluid (liquid or gas) is the result of the total number of collisions on a surface as atoms or molecules bump against the surface and change their momentum. • Explain that increasing the temperature of fluid will increase the pressure it exerts in a closed system because the particles hit with greater velocity. • Explain that the average kinetic energy for an individual ideal gas molecule can be calculated as $KE = {}^3/_2\, kT$ eq 27 where $k = 1.38 \times 10^{-23}$ joule/K and **T** is the absolute temperature.	**Phys:P&P**, Ch 12:1 13:1 **Con Phys**, Ch 21:1,3 (Much of this information is not included in the text and needs to added.) Neither text includes eq. 27	***KEY VOCABULARY:*** **thermal** energy, pressure, absolute temperature, fluid ***SKILLS FOCUS:*** Formulate explanations by using logic and evidence. **(I&E 1.d)** ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P, Pocket Lab 13-1, "Foot Pressure", p 303 • Con Phys, Lab 61, "Work for Your Ice Cream", p 211 • **Web Physics – Internal Energy** http://webphysics.davidson.edu/mjb/SESAPS2000/internal_Energy.html • **Hyperphysics– Internal Energy** http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/inteng.html	2 Days (1 Block)

Heat and Thermodynamics

3. Energy cannot be created or destroyed, although in many processes energy is transferred to the environment as heat.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… that most processes tend to decrease the order of a system over time and that energy levels are eventually distributed uniformly. **(3,d)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Explain that energy in the form of heat always transfers from hot to cold because the energy is spreading out until it is shared equally by all components of the system. ° Explain that the transfer of kinetic energy occurs at the molecular level when a fast moving (high KE) molecule collides with a slower moving (low KE) molecule. ° Explain that collisions will distribute the energy until all the molecules in an object share the same probability of having the average KE state. • Explain that most physical processes disorder a system because disordered states vastly outnumber ordered ones and a system changes over time to distribute disorder evenly.	**Phys:P&P**, Ch 12:1-2 **Con Phys**, Ch 21:2-3 24:6	***KEY VOCABULARY:*** order disorder distribute probability ***SKILLS FOCUS:*** visualize abstraction Distinguish between hypothesis and theory as science terms. **(I&E 1.f)** ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P, Pocket Lab 12-2, "Drip, Drip, Drip", p 294	2 Days (1 Block)
… 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. **(3,e)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Explain how distributing energy in substances increases the disorder of material substances. • Define the quantity called **entropy** as a measure of the randomness, or disorder, of a system. ° Recall that a positive change in entropy increases the amount of disorder, or a decrease in order. ° Explain that a system at constant temperature, such as during melting or boiling, the entropy change is given as $\Delta S = Q/T$ eq 28/CST where **Q** is the heat that flows into or out of the system and **T** is the absolute temperature. • Explain that all processes that require energy, for example, biochemical reactions that support life, occur only because the entropy increases as a result of the process.	**Phys:P&P**, Ch 12:2 **Con Phys**, Ch 24:7	***KEY VOCABULARY:*** **entropy** ***SKILLS FOCUS:*** apply entropy Formulate explanations by using logic and evidence. **(I&E 1.d)** ***LABS / DEMOS / ACTIVITIES:***	1 Days (0.5 Block)

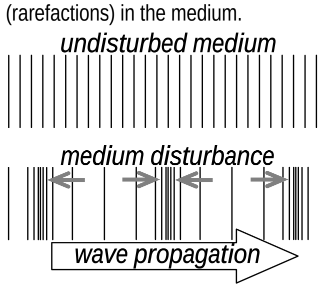
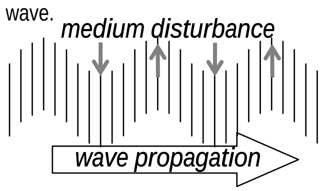
Heat and Thermodynamics

3. Energy cannot be created or destroyed, although in many processes energy is transferred to the environment as heat.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… 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. **(3,g*)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	∗ *Explain that heat is always transferred to the environment, that is to say Q_L is never zero.* ∗ *Describe and explain practical combustion or steam engines.* ◦ *Explain that a practical engine uses steam or gas at a high temperature (T_H) to do work by pushing against a piston or turbine, and then removes the gas or steam at a lower temperature (T_L) to exhaust out to the air.* ◦ *Explain that when an idealized engine completes a cycle, the entropy change is zero.* ◦ *Explain that since* $\Delta S = Q/T$, $Q_H/T_H = Q_L/T_L$ eq 29 ◦ *Combine this relationship with the conservation law,* $W = Q_H - Q_L$, *to calculate the maximum possible efficiency (eff) or the heat engine as* $eff\ (\%) = W/Q_H \cdot 100 = [(T_H - T_L)/T_H] \cdot 100$ ∗ *Explain that the efficiency of converting heat to work is proportional to the difference between the high and low temperatures of the engine's working fluids (usually gases).* ∗ *Explain that for a Carnot engine to be 100% efficient, the temperature of the exhaust would need to be absolute zero (because all heat would have been converted to work), which is impossible.*	**Phys:P&P**, Ch 12:2 **Con Phys**, Ch 24:1,3,5	***KEY VOCABULARY:*** efficiency turbine piston idealized ***SKILLS FOCUS:*** calculate Identify and communicate sources of unavoidable experimental error. **(I&E 1.b)** ***LABS / DEMOS / ACTIVITIES:*** • Con Phys, Lab 62, "The Drinking Bird", p 213 • **Heat Flow** http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/heaeng.html • **Heat Engine Efficiency** http://www.bluffton.edu/~bergerd/NSC_111/thermo4.html	1 Day (0.5 Block)
… 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. **(3,f)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Recall that the second law of thermodynamics states that all spontaneous processes lead to a state of greater disorder. • Give examples of processes that lead to greater disorder. • Explain that in a closed system, all possible states will become equally probable, such that the average energy state is found throughout the system. • Explain that when energy is distributed, rather than concentrated, the system is more disordered. • Explain that when a physical change occurs, energy must be conserved (1st law), but that some of the energy cannot be recovered for useful work because it has added to the disorder of the universe (2nd law).	**Phys:P&P**, Ch 12:2 **Con Phys**, Ch 24:7	***KEY VOCABULARY:*** energy state ***SKILLS FOCUS:*** Formulate explanations by using logic and evidence. **(I&E 1.d)** ***LABS / DEMOS / ACTIVITIES:*** • **Entropy and 2nd Law of Thermodynamics** http://www.entropylaw.com/ • **Entropy: Journal of Chemical Education, October 1999, Vol. 76, No. 10, p. 1385** http://jchemed.chem.wisc.edu/Journal/Issues/1999/Oct/abs1385.html • **Entropy – Kenny Felder, NCSU** http://www.ncsu.edu/felder-public/kenny/papers/entropy.html	2 Days (1 Block)

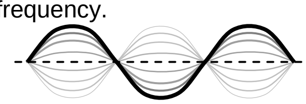
Waves

4. Waves have characteristic properties that do not depend on the type of wave.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… waves carry energy from one place to another. **(4,a)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Explain that waves transport energy through a vacuum or through matter. ° Recall that light waves have the ability to travel through both vacuum (like outer space) and matter (like glass). ° Recall that sound waves (and most other waves) only travel through matter. • Explain that in all waves, there is no net movement of matter, making them different than any other means of transporting energy, such as convection, a waterfall, or even a thrown object.	**Phys:P&P**, Ch 14:1 **Con Phys**, Ch 25:3	***KEY VOCABULARY:*** **wave** vacuum ***SKILLS FOCUS:*** model, analyze Recognize the usefulness and limitations of models and theories as scientific representations of reality. **(I&E 1.g)** ***LABS / DEMOS / ACTIVITIES:*** • **Waves carry energy** http://www.glenbrook.k12.il.us/gbssci/phys/Class/waves/u10l2c.html	1 Day (0.5 Block)
… how to identify transverse and longitudinal waves in mechanical media, such as springs and ropes, and on the earth (seismic waves). **(4,b)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Recall that waves that travel in matter are either longitudinal or transverse. ° Explain that the disturbance that carries energy in a longitudinal wave moves parallel to the direction of the wave. ° Explain that the disturbance in longitudinal waves causes compressions and expansions (rarefactions) in the medium.  ° Recall examples of longitudinal waves, including sound waves and P-type earthquake waves. ° Explain that the disturbance that carries energy in a transverse wave moves perpendicular to the direction of the wave.  ° Recall examples of transverse waves, including electromagnetic (light) waves and S-type earthquake waves.	**Phys:P&P**, Ch 14:1 **Con Phys**, Ch 25:5-6	***KEY VOCABULARY:*** **longitudinal** **compression** transverse rarefaction disturbance ***SKILLS FOCUS:*** observe, model Formulate explanations by using logic and evidence. **(I&E 1.d)** ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P, Physics Lab, "Waves on a Coiled Spring", p 330 • Con Phys, Lab 66, "Catch a Wave", p 225 • **Wave motions – Dr. Dan Russel, Kettering University** http://www.kettering.edu/~drussell/Demos/waves/wavemotion.html	1 Day (0.5 Blocks)

Waves

4. Waves have characteristic properties that do not depend on the type of wave.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… how to solve problems involving wavelength, frequency, and wave speed **(4,c)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Explain that most real waves are **composite**, meaning they can be understood as the sum of many waveforms, each with its own amplitude, frequency, and wavelength. *[Note: You don't need to go any further than this at this point. Constructive and destructive interference are not introduced until standard 4g.]* • Explain that all waves have a velocity (**v**) describing propagation speed and direction. • Explain that periodic, sustained (standing) waves allow easy observation of wavelength and frequency.  ◦ Define and identify wavelength (λ) as the distance between any two repeating points on a periodic wave. ◦ Recall that wavelength is measured in appropriate units of length. ◦ Define frequency as the number of wavelengths (or cycles) that pass any point in space per second. ◦ Recall that the unit for frequency is the inverse second (s^{-1}), also called the hertz (Hz). • Calculate and explain how periodic wave characteristics relate to each other. **$v = f\lambda$** eq 31/CST	**Phys:P&P**, Ch 14:1 **Con Phys**, Ch 25:2-4	***KEY VOCABULARY:*** **composite** frequency waveform wavelength amplitude ***SKILLS FOCUS:*** model, analyze Select and use appropriate tools and technology to perform tests, collect data, analyze relationships, and display data. **(I&E 1.a)** ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P Lab Manual, Lab 14-2, "Velocity, Wavelength, and Frequency in Ripple Tanks", p 97 • Con Phys, Lab 66, "Catch a Wave", p 225 • **Standing Waves** http://hyperphysics.phy-astr.gsu.edu/hbase/waves/standw.html • **University of New South Wales, Australia** http://www.phys.unsw.edu.au/~jw/strings.html • **Standing Waves – Univ. Colorado at Boulder** http://www.colorado.edu/physics/2000/microwaves/standing_wave1.html • **v = fλ – Zona Land** http://id.mind.net/~zona/mstm/physics/waves/wave3d1/wave3d1.htm	2 Days (1 Block)

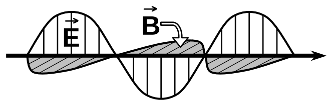
Waves

4. Waves have characteristic properties that do not depend on the type of wave.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… sound is a longitudinal wave whose speed depends on the properties of the medium in which it propagates. **(4,d)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Recall that sound waves may also be called **acoustic waves**. • Explain that sound waves are produced by vibrating objects in contact with an elastic medium (solid, liquid, or gas) to carry the waves. • Explain that since sound is a longitudinal wave that causes compressions and rarefactions (regions of high and low pressure) within the medium that carries it, it cannot travel through a vacuum. ◦ Explain that the eardrum vibrates in response to the pattern of high and low pressure waves hitting it. ◦ Explain that the physical vibrations are translated into a signal brought by the nervous system to the brain where it is interpreted as the familiar sensation of sound. ◦ Explain that microphones similarly translate vibrations into electrical current, and that speakers do the reverse process. • Explain how sound waves get weaker (attenuate) with distance as the wave energy is spread over ever-increasing spherical shell. • Explain that the speed of sound varies depending primarily on the density and elastic properties of the medium it is traveling through. • Recall that sound typically travels faster through solid and liquid media compared to gas media.	**Phys:P&P**, Ch 15:1 **Con Phys**, Ch 26:1-5	***KEY VOCABULARY:*** **acoustic waves** vibration attenuate ***SKILLS FOCUS:*** visualize Formulate explanations by using logic and evidence. **(I&E 1.d)** ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P Lab Manual, Lab 15-2, "Resonance in an Open Tube", p 105 • Phys:P&P, Physics Lab, "The Speed of Sound", p 362 • Phys:P&P, Pocket Lab, "Ring, Ring", p 365 • Con Phys, Lab 68, "Chalk Talk", p 233 • Con Phys, Lab 69, "Mach One", p 235 • **Wave motions – Dr. Dan Russel, Kettering University** http://www.kettering.edu/~drussell /Demos/rad2/mdq.html	1 Day (0.5 Block)

Waves

4. Waves have characteristic properties that do not depend on the type of wave.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… radio waves, light, and X-rays are different wavelength bands in the spectrum of electromagnetic waves whose speed in a vacuum is approximately 3×10^8 m/s (186,000 miles/second). **(4,e)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Explain that electromagnetic waves are made of electric and magnetic fields that are perpendicular to the wave motion and to each other.  • Recall that the range of wavelengths for electromagnetic waves is very large, from nanometers (nm) for X-rays to more than kilometers for radio waves. ° Recall that the human eye is only sensitive to a narrow range of the electromagnetic spectrum from 400 nm to 700 nm. ° Explain that within this range of wavelengths is every perceivable color from violet to red. • Recall that all electromagnetic waves travel at **3.00×10^8 m/s** (186,000 miles per second) in a vacuum. • Define transparent material as media that electromagnetic waves are able to pass through. • Explain that electromagnetic waves are slowed when traveling through a transparent media. • Explain that the ratio of the speed of a wave in a vacuum to its speed in a medium is called that medium's **index of refraction**. ° Recall that the index of refraction for visible light in water is 1.33 and for diamond it is 2.42, meaning that light travels slower in diamond than in water and slower in water than in a vacuum. ° Explain that the index of refraction depends on the properties of the medium and the frequency of the wave.	**Phys:P&P**, Ch 16:1 17:1 **Con Phys**, Ch 27:2-4 37:8	***KEY VOCABULARY:*** spectrum nanometer electromagnetic **index of refraction** ***SKILLS FOCUS:*** Formulate explanations by using logic and evidence. **(I&E 1.d)** ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P, Pocket Lab 16-2, "Hot and Cool Colors", p 383 • **Spectrum** http://www.colorado.edu/physics/2000/waves_particles/ http://csep10.phys.utk.edu/astr162/lect/light/spectrum.html • **NASA** http://imagine.gsfc.nasa.gov/docs/science/know_l1/emspectrum.html http://imagers.gsfc.nasa.gov/ems/ems.html	2 Days (1 Block)

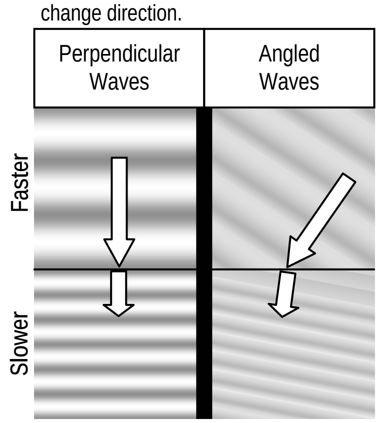
Waves

4. Waves have characteristic properties that do not depend on the type of wave.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… how to identify the characteristic properties of waves: interference (beats), diffraction, refraction, Doppler effect, and polarization. **(4,f)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	*Interference* • Explain that since waves carry energy and are not objects, two or more of them can occupy the same space at the same time. ◦ Explain that when two wave crests overlap at the same instant, there is a greater displacement of the medium from it's equilibrium condition called constructive interference. ◦ Explain that when the crest of one wave overlaps the trough of another at the same instant, the displacement of the medium is reduced by destructive interference. ◦ Explain that the net force acting on a particle within the medium is the algebraic sum of the forces exerted by the various waves acting at that point. • Explain that a standing wave is the result of two continuous waves with the same frequency traveling in opposite directions ◦ Identify the nodes (or nulls) as the places where the two waves are constantly out of phase (destructive). ◦ Identify the antinodes (or maxima) as the places where the waves are constantly in phase (constructive). ◦ Explain that when the two waves have slightly different frequencies, the nodes will slowly turn into antinodes and back again, which for sound causes audible changes from loud to soft, called beats. *Diffraction* • Define diffraction as the constructive and destructive patterns of waves created at the edges of objects. • Recall from observations that diffraction can cause waves to bend around an obstacle or spread out after passing through an opening. • Explain how the size of an object relative to the wavelength of an interacting wave determines the nature of diffraction patterns seen. ◦ Explain that if the size of the obstacle is large compared to the wavelength, sharp shadows will appear. ◦ Explain that if the size of the obstacle is small compared to the wavelength, the waves will wrap around the object leaving little or no shadow. ◦ Apply this principle to practical settings, such as a hand being able to block 500 nm light waves, but not 100 cm sound waves.	**Phys:P&P**, *Interference* Ch 14:2 15:2 *Diffraction* Ch 14:2 *(*19:1-2)* **Con Phys**, *Interference* Ch 26:9-10 25:8 31:3 *Diffraction* Ch 31:1-2 *(*31:4)*	***KEY VOCABULARY:*** **interference** **node** (null) **constructive** **antinode** (maximum) **destructive** **beats** **diffraction** ***SKILLS FOCUS:*** model, diagram, analyze ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P Lab Manual, Lab 14-1, "Ripple Tank Waves", p 91 • Phys:P&P, Physics Lab, "Coiled Spring", p 330 • Con Phys, Lab 85, "Rainbows Without Rain", p 275 • **Superposition of Waves (animation) – Kettering University** http://www.kettering.edu/~drussell/Demos/superposition/superposition.html • **Single Slit Diffraction** http://www.phys.hawaii.edu/~teb/optics/java/slitdiffr/ • **Exploratorium Diffraction** http://www.exploratorium.edu/snacks/diffraction.html • **Sound Diffraction** http://hyperphysics.phy-astr.gsu.edu/hbase/sound/diffrac.html • **Light Refraction Simulator** http://www.ps.missouri.edu/rickspage/refract/refraction.html	3 Days (1.5 Blocks)

Waves

4. Waves have characteristic properties that do not depend on the type of wave.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… how to identify the characteristic properties of waves: interference (beats), diffraction, refraction, Doppler effect, and polarization. **(4,f)** ***- CONTINUED -*** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	*Refraction* • Define refraction as a change in the direction of a wave caused by a change in wave velocity. ◦ Explain that a wave will change velocity when it encounters a boundary where the material changes properties, such as index of refraction, temperature, density, or even depth for water waves. ◦ Explain that a wave must encounter this boundary at some angle other than perpendicular to cause the wave to change direction.  ◦ Explain that sharp boundaries show abrupt turns, but that gradual boundaries will create gradual wave velocity change and a gradual turning of the wave. *Doppler Effect* • Explain that the Doppler effect is a change in the perception of the frequency of a wave caused by movement relative to the source of the waves. ◦ Give real-world examples of the Doppler effects with sound. ◦ Describe how the Doppler effect alters the perception of light sources and how astronomers apply this principle. *Polarization* • Define polarization as the process of selecting transverse wave that are oriented in a certain direction. • Recall that light waves are transverse waves and can be polarized. ◦ Explain how light can be polarized by passing through a material that only lets one direction of polarization through. ◦ Explain how unpolarized light can be polarized by reflection off of angled glass. ◦ Explain the application of polarized lenses in cameras and sunglasses.	**Phys:P&P**, *Refraction* Ch 14:2 17:1 *(*18:2)* *Doppler Effect* Ch 15:1 *Polarization* Ch 16:2 **Con Phys**, *Refraction* Ch 29:6-9*(*10-12)* *(*30:1-8)* 31:1 *Doppler Effect* Ch 25:9 *Polarization* Ch 27:7*(*8)*	***KEY VOCABULARY:*** **refraction** boundary perception **polarization** **Doppler effect** ***SKILLS FOCUS:*** Formulate explanations by using logic and evidence. **(I&E 1.d)** ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P Lab Manual, Lab 14-1, "Ripple Tank Waves", p 91 • Phys:P&P Lab Manual, Lab 14-2, "v, λ, and f in Ripple Tanks", p 97 • Phys:P&P, Physics Lab, "Bending of Light", p 399 • Phys:P&P, Pocket Lab 14-2, "Bent Out of Shape", p 340 • Con Phys, Lab 84, "Air Lens", p 273 • Con Phys, Lab 82, "Bifocals", p 267 • Con Phys, Lab 72, "Shades", p 243 • Con Phys, Probeware Lab 14, p 62 / 124 / 183 • **Making Objects Disappear** Place a piece of transparent quartz (index of refraction = 1.51) into a solution of saturated sugar water (index of refraction = 1.49). Have students explain why the quartz becomes almost completely invisible. Research other solid/liquid combinations that should work and try them as well. CA Sci. Framework, p 175 • **Refraction** http://www.glenbrook.k12.il.us/gbssci/phys/Class/refrn/u14l1a.html • **Polarization – U. Col. Boulder** http://www.colorado.edu/physics/2000/polarization/ • **Doppler Effect** http://www.kettering.edu/~drussell/Demos/doppler/doppler.html	5 Days (2.5 Blocks)

Electric and Magnetic Phenomena

5. Electric and magnetic phenomena are related and have many practical applications.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… how to predict the voltage or current in simple direct current (DC) electric circuits constructed from batteries, wires, resistors, and capacitors. **(5,a)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	*Note: from the CA Science Framework, this appears to be an introductory standard where foundational understanding of current and potential are developed. The Framework discusses calculations about current, voltage and resistance in circuits in standard 5b. It also discusses capacitors at that point, so they are not included here.* • Define electric current (*I*) as the flow of net charge. • Define a **circuit** as a complete, continuous path to allow electric current. • Explain that the direction of current is defined as the direction of the movement of <u>positive</u> charge carriers, which is opposite to the direction that electrons flow in solid conductors. • Explain that electric current is measured as the amount of charge passing a point within a certain time: $I = q/t$ eq 32/CST ◦ Explain that with uniform current, the charge flow is the same along the entire length of wire. ◦ Recall that current (*I*) is measured in units of amperes (A), which are equivalent to coulombs per second (C/s). • Explain that an electric field does work when it moves a charge (*q*), because it changes the charge's potential energy. • Define **electric potential (**or just **potential**) as the potential energy per unit charge at a given point in an electric field. • Define voltage as the difference in potentials between two points (and therefore, the amount of work to move the charge from one point to the other). • Explain how this relationship is shown in the equation: eq 33 $V_{ab} = V_a - V_b = W_{ba}/q = PE_a/q - PE_b/q$ • Recall that potential and voltage are measured in units of volts (**V**), which, according to the definition above, are equal to joules per coulomb (**J/C**). • Explain that for any current-carrying wire, it is the potential difference between two points along that wire that causes the current to flow in that segment.	**<u>Phys:P&P</u>**, Ch 21:2 22:1 **<u>Con Phys</u>**, Ch 33:4-5 34:1-3 35:2	***KEY VOCABULARY:*** current; **circuit**; ampere; charge carrier; electrical **potential**; voltage; volt ***SKILLS FOCUS:*** calculate, predict ***LABS / DEMOS / ACTIVITIES:*** • <u>Phys:P&P</u>, Physics Lab, "Charges, Energy, and Voltage", p 496 • <u>Phys:P&P</u>, Physics Lab, "Mystery Cans", p 518 • <u>Con Phys</u>, Lab 90, "Getting Wired", p 289 • **Voltage and Current in Circuits** http://www.glenbrook.k12.il.us/gbssci/phys/Class/circuits/u9l1c.html	2 Days (1 Blocks)

Electric and Magnetic Phenomena

5. Electric and magnetic phenomena are related and have many practical applications.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… how to solve problems involving Ohm's law. **(5,b)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Define electrical resistance as the opposition to the flow of electric charge in a conductor (measured in ohms). • Recall that Ohm's law expresses the relationship current (**I**), voltage applied (**V**), and the resistance (**R**) as $\boxed{V = IR}$ eq 34/CST ◦ Explain how the variables interact, for instance what happens to the current when the resistance increases, or how to maintain the current when resistance changes. ◦ Calculate current and voltage in simple circuits that include resistors. ◦ Calculate the current flow in each branch of parallel circuits with resistors. ◦ Calculate equivalent resistances for series circuits $R_s = R_1 + R_2 + R_3 + \ldots$ and parallel circuits. $1/R_p = 1/R_1 + 1/R_2 + 1/R_3 + \ldots$ ◦ Use equivalent resistances to determine the total current for circuits. • Define **capacitors** as devices that store electrical charge. • Recall that a capacitor typically consists of metal plates with a potential difference insulated from each other by a **dielectric**, a material that does not conduct electricity. • Define capacitance (**C**)as the ability to store electric charge (**q**), expressed by the equation: $\boxed{C = q/\Delta V}$ eq 35 ◦ Explain that the charge is stored as **+q** on one plate of the capacitor and **–q** on the other. ◦ Recall that the units for capacitance are farads, which from the equation above are defined as coulombs per volt (C/V). ◦ Explain how the variables interact, for instance, that large conducting plates can hold a greater charge without experiencing as large of a potential difference, giving it a greater capacitance. ◦ Solve simple problems involving capacitance, charge, and potential difference. * *Calculate equivalent capacitance for capacitors in series* $1/C_s = 1/C_1 + 1/C_2 + 1/C_3 + \ldots$ *and capacitors in parallel.* $C_p = C_1 + C_2 + C_3 + \ldots$ * *Calculate charge stored and voltages at various points in circuits containing capacitors in series and parallel.*	**Phys:P&P**, Ch 22:1 23:1-2 21:2 **Con Phys**, Ch 34:4-5(*6) 35:3-6(*7) 33:6	***KEY VOCABULARY:*** equivalent resistance dielectric equivalent capacitance ***SKILLS FOCUS:*** analyze diagrams, calculate Recognize the usefulness and limitations of models and theories as scientific representations of reality. **(I&E 1.g)** ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P Lab Manual, Lab 21-1, "The Capacitor", p 155 • Phys:P&P Lab Manual, Lab 22-1, "Ohm's Law", p 159 • Phys:P&P Lab Manual, Lab 23-1, "Series Resistance", p 167 • Phys:P&P Lab Manual, Lab 23-2, "Parallel Resistance", p 171 • Phys:P&P, Physics Lab, "Circuits", p 545 • Phys:P&P, Pocket Lab 22-1, "Lighting Up", p 512 • Phys:P&P, Pocket Lab 22-1, "Running Out", p 516 • Phys:P&P, Pocket Lab 23-1, "Series Resistance", p 534 • Phys:P&P, Pocket Lab 23-1, "Parallel Resistance", p 539 • Phys:P&P, Pocket Lab 23-2, "Ammeter Resistance", p 547 • Con Phys, Lab 87, "Sparky, the Electrician", p 279 • Con Phys, Lab 89, "Ohm Sweet Ohm", p 285 • Con Phys, Lab 91, "Cranking Up", p 293 • Con Phys, Lab 88, "Brown Out", p 283 • Con Phys, Probeware Lab 15, p 67 / 127 / 189 • **ASPIRE (Alabama Superconducting Prog. …)** http://www.aspire.cs.uah.edu/textbook/ohms.html • **Hyperphysics** http://hyperphysics.phy-astr.gsu.edu/hbase/electric/ohmlaw.html • **Capacitance: Molecular Expressions** http://micro.magnet.fsu.edu/electromag/electricity/capacitance.html	4 Days (2 Blocks)

Electric and Magnetic Phenomena

5. Electric and magnetic phenomena are related and have many practical applications.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… 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 Power = *IR* (potential difference) x *I* (current) = I^2R. **(5,c)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Define **electric power** as the rate at which electric energy is dissipated by (or the rate at which heat is produced in) a resistor. • Recall Joule's law that calculates power as **P = IV** eq 36/CST • Recall that by combining Joule's law with Ohm's law, power can be calculated as $\mathbf{P = I^2R}$ CST or $P = V^2/R$ • Recall that power is measured in watts, where 1 watt = 1 ampere·volt = 1 joule/second **1 W = 1 J/s** CST • Explain that on a practical level, **electric power** is equivalent to the amount of work done per second that must be done to maintain an electric current or the rate at which electrical energy is transferred from the source to other parts of the circuit. • Recall that the unit kilowatt hour (kWH) is used commercially to represent energy production and consumption, where $1\ kWH = 3.6 \times 10^6\ J$. • Solve practical and theoretical problems involving electrical power.	**Phys:P&P**, Ch 22:2 **Con Phys**, Ch 34:11	***KEY VOCABULARY:*** **electric power** watt ***SKILLS FOCUS:*** observe, calculate, apply Formulate explanations by using logic and evidence. **(I&E 1.d)** ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P Lab Manual, Lab 22-2, "Electric Equivalent of Heat", p 163 • Phys:P&P, Pocket Lab 22-2, "Appliances", p 521 • Phys:P&P, Pocket Lab 22-2, "Heating Up", p 522 • **Electric Power** http://hyperphysics.phy-astr.gsu.edu/hbase/electric/elepow.html	2 Days (1 Block)

Electric and Magnetic Phenomena

5. Electric and magnetic phenomena are related and have many practical applications.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… the properties of transistors and the role of transistors in electric circuits. **(5,d)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Explain that semiconductors are materials with an energy barrier that only allows electrons above a certain energy level to flow. • Explain that as temperature rises, more electrons are free to move in semiconductors. • Explain that transistors are made of layers of semiconductors that are "doped" with various impurity atoms and arranged in a way that allows them to use very small voltages to greatly amplify current in a circuit. • Recall that the development of transistors was the first step in greatly reducing the size of electronic devices by replacing large vacuum tubes that originally performed current amplification functions.	**<u>Phys:P&P</u>**, Ch 29:1-2 **<u>Con Phys</u>**, Ch 32:4 *("How transistors and other semiconductor devices work will not be covered in this book.")*	***KEY VOCABULARY:*** semiconductor, transistor, doped, amplify ***SKILLS FOCUS:*** Formulate explanations by using logic and evidence. **(I&E 1.d)** ***LABS / DEMOS / ACTIVITIES:*** • <u>Phys:P&P Lab Manual</u>, Lab 29-1, "Semiconductor Properties", p 219 • <u>Phys:P&P Lab Manual</u>, Lab 29-2, "Integrated-Circuit Logic Devices", p 223 • <u>Phys:P&P</u>, Physics Lab, "The Stoplight", p 684 • <u>Phys:P&P</u>, Pocket Lab 29-1, "All Aboard!", p 675 • <u>Phys:P&P</u>, Pocket Lab 29-2, "Red Light", p 682 • **How Transistors Work – Intel** http://www.intel.com/education/transworks/INDEX.HTM • **History of Transistors** http://www.lucent.com/minds/transistor/ • **Bipolar Transistors** http://www.st-andrews.ac.uk/~www_pa/Scots_Guide/info/comp/active/BiPolar/page1.html	2 Days (1 Block)
… charged particles are sources of electric fields and are subject to the forces of the electric fields from other charges. **(5,e)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Define electrostatic force as in interaction across space between two charged bodies. ◦ Explain that electrostatic force between two charges (q_1 and q_2) separated by a distance (r) is an inverse square law, like gravity, expressed by Coulomb's law as $F = kq_1q_2/r^2$ eq 37 ◦ Recall that k is a constant equaling 9×10^9 Nm^2/C^2. • Explain that an electric field is a condition produced in space that can be measured as the amount of force produced on a test charge in a region. • Solve for forces and predict motions (or change of motion) of charged particles in electric fields. ◦ Calculate individual and net forces in problems involving the presence of three (or more?) charges. ◦ Demonstrate qualitatively that an electric field at a given point may be produced by a single charge or by complex distribution of charges.	**<u>Phys:P&P</u>**, Ch 20:1-2 **<u>Con Phys</u>**, Ch 32:1-3	***KEY VOCABULARY:*** **electrostatic** force electric field ***SKILLS FOCUS:*** explain how variables interact mathematically and in physical reality Formulate explanations by using logic and evidence. **(I&E 1.d)** ***LABS / DEMOS / ACTIVITIES:*** • <u>Phys:P&P Lab Manual</u>, Lab 20-1, "Investigating Static Electricity", p 149 • <u>Phys:P&P</u>, Physics Lab, "What's the Charge?", p 467 • <u>Phys:P&P</u>, Pocket Lab 20-2, "Charged Up", p 471 • <u>Phys:P&P</u>, Pocket Lab 20-2, "Reach Out", p 472 • **Coulomb's Law: Michigan State Univ.** http://www.pa.msu.edu/courses/1997spring/PHY232/lectures/coulombslaw/ • **Glenbrook** http://www.glenbrook.k12.il.us/gbssci/phys/Class/estatics/u8l3d.html	3 Days (1.5 Blocks)

Electric and Magnetic Phenomena

5. Electric and magnetic phenomena are related and have many practical applications.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… electric and magnetic fields contain energy and act as vector force fields. **(5,j*)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	∗ *Explain that both electric fields (E) and magnetic fields (B) are vector fields, having both magnitude and direction.* ∗ *Draw magnetic fields for stable fields around steady electric currents in wires or permanent magnets.* ∗ *Draw the "lines of force" that represent electric fields from matter starting on positive charges and ending on negative charges.* ∗ *Explain why electric fields never form closed loops, but that magnetic fields always do.* ∗ *Explain that electric and magnetic fields are said to contain energy, because the movement of charges is affected to minimize their energy.* ° *Describe and quantify the potential energy between two charges (q_1 and q_2) as* $PE = kq_1q_2/r$ *eq 39* ° *Define the potential energy of a system of fixed-point charges as the work required to assemble the system by bringing in each charge from an infinite distance.*	**Phys:P&P**, Ch 21:1-2 24:1 **Con Phys**, Ch 33:1-2 36:2-3	***KEY VOCABULARY:*** lines of force ***SKILLS FOCUS:*** analyze abstract models of fields Formulate explanations by using logic and evidence. **(I&E 1.d)** ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P, Pocket Lab 24-1, "3-D Magnetic Fields", p 564 • Con Phys, Lab 93, "3-D Magnetic Field", p 299 • **Interactive Electric Fields** http://www3.ltu.edu/~s_schneider/physlets/main/efield.shtml • **Interactive Magnetic Fields** http://webphysics.davidson.edu/physlet_resources/pp_errata/new_html/new_directory/illustration27_1.html • **Electrical Potential Energy** http://en.wikipedia.org/wiki/Potential_energy	1 Day (0.5 Block)
… 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. **(5,k*)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	∗ *Define electric field strength (E) at a given point as force experienced by a unit positive charge.* ∗ *Identify this definition in the equation* $E = F/q$ ∗ *Identify the units of electric field strength as newtons per coulomb (N/C).* ∗ *Explain that the force vector experienced by a charged particle depends on the particle's charge and the strength of the E field at the particle's position, as expressed in the equation,* $F = qE$ *eq 39*	**Phys:P&P**, Ch 21:1 **Con Phys**, Ch 33:1	***KEY VOCABULARY:*** **field strength** ***SKILLS FOCUS:*** define and explain abstractions ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P, Pocket Lab 21-1, "Electric Fields", p 484 • **Force on charges in E Field: Univ. Col. at Boulder** http://www.colorado.edu/physics/2000/waves_particles/wavpart2.html	1 Day (0.5 Block)

Electric and Magnetic Phenomena

5. Electric and magnetic phenomena are related and have many practical applications.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… how to calculate the electric field resulting from a point charge. **(5,I*)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	∗ *Explain how to calculate the E field produced by a point charge by combining the definition of an E field (E = F/q) with Coulomb's law:* $E = F/q_{(2)}$ $F = kq_1q_2/r^2$ *where q_1 is considered the fixed point charge generating the field and q_2 is a positive unit test charge within the field.* $E = kq_1\not{q_2}/\not{q_{(2)}}r^2$ $\boldsymbol{E = kq_1/r^2}$ eq 40 ∗ *Recall that the direction of E is determined by the type of the source charge generating the field: away from a positive charge and toward a negative charge.*	**Phys:P&P**, Ch 21:1-2 **Con Phys**, Ch 33:2	***KEY VOCABULARY:*** ***SKILLS FOCUS:*** Formulate explanations by using logic and evidence. **(I&E 1.d)** ***LABS / DEMOS / ACTIVITIES:*** • **Electrical Potential Storage: College Physics, K. Koehler** http://www.rwc.uc.edu/koehler/biophys/4b.html • **School Science** http://www.schoolscience.co.uk/content/5/physics/particles/partich5pg1.html	1 Day (0.5 Block)
… static electric fields have as their source some arrangement of electric charges. **(5,m*)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	∗ *Explain that a static electric field implies a certain distribution of charges as the source* ∗ *Explain that any set of charges or charged surfaces sets up an electric field in the surrounding space* ∗ *Define field lines (lines of force) as the path that would be taken by a small, positive charges particle released within the field.* ∗ *Draw visualizations of electric fields showing how lines of force run from regions of high potential (positive point charges) to regions of low potential (negative point charges).* ∗ *Calculate and draw force vectors on a test charge resulting from two source charges and determine the net force vector that aligns with the lines of force.*	**Phys:P&P**, Ch 20:2 **Con Phys**, Ch 32:2-3	***KEY VOCABULARY:*** field lines ***SKILLS FOCUS:*** diagram, analyze, calculate ***LABS / DEMOS / ACTIVITIES:***	2 Days (1 Block)

Electric and Magnetic Phenomena

5. Electric and magnetic phenomena are related and have many practical applications.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… how to apply the concepts of electrical and gravitational potential energy to solve problems involving conservation of energy. **(5,o*)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	* *Explain that energy can be stored in electrostatic systems similar to the way it is stored in object that are in a gravitational field.* * *Explain that work must be done to increase the separation between two opposite charges.* * *Define the work done to separate opposite charges as positive and the work done to separate like charges as negative.* * *Explain that the work done on charges can be thought of as stored in the system, which can be transformed into other forms, such as kinetic and thermal energy.* * *Calculate the energy stored by moving charged particles as* $\Delta PE = q\Delta V$ eq 42 * *Explain that by conservation of energy, the amount of kinetic energy gained or lost by a charge can be determined by* $\Delta KE = \Delta PE = q\Delta V$ eq 43 * *Predict the final velocity (or other values) by inserting the term ½mv^2 for ΔKE, for charges accelerated by electric potentials (assuming the velocity does not approach the speed of light).* * *Recall that using electric potentials to accelerate charged particles is applied is television sets and accelerators used in modern atomic and nuclear experiments.*	**Phys:P&P**, Ch 21:2 30:2 **Con Phys**, Ch 33:5 39:7	***KEY VOCABULARY:*** ***SKILLS FOCUS:*** explain dynamic energy changes Formulate explanations by using logic and evidence. **(I&E 1.d)** ***LABS / DEMOS / ACTIVITIES:*** • **Electrical Potential Storage: College Physics, Kenneth Koehler** http://www.rwc.uc.edu/koehler/biophys/4b.html • **School Science** http://www.schoolscience.co.uk/content/5/physics/particles/partich5pg1.html	2 Days (1 Block)

Electric and Magnetic Phenomena

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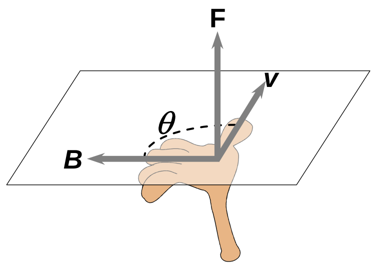
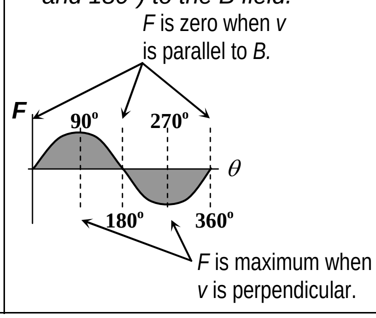
Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… magnetic materials and electric currents (moving electric charges) are sources of magnetic fields and are subject to forces arising from the magnetic fields of other sources. **(5,f)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Explain that, to the best of our current scientific knowledge, all magnetic effects result from the motion of electrical charges. ◦ Recall the magnets and current-carrying conductors produce magnetic forces. ◦ Recall that a stationary charge does not produce magnetic forces. ◦ Recall that scientists have found no evidence for the existence of magnetic monopoles (hypothetical particles responsible for magnetism that would be equivalent to electric charges). ◦ Explain that iron and other materials that can be magnetized have domains in which the combined motion of electrons produces the equivalent of small magnets in the metal. ◦ Explain that when many domains are aligned, the entire metal object becomes a strong magnet. • Explain that the motion of charges (in conductors or within the domains of magnetic materials) generates magnetic fields. ◦ Recall that Tesla (T) is the unit describing magnetic field strength. ◦ Explain that electric charges moving in a magnetic field experience a magnetic force perpendicular to their line of motion. ◦ Explain that the force experienced by a charge is at maximum when the direction of motion is perpendicular to the magnetic field and zero when the two are parallel. *(This concept is quantified in standard 5n*.)*	**Phys:P&P**, Ch 24:1 **Con Phys**, Ch 36:1,4-5	***KEY VOCABULARY:*** "monopole" domains Tesla ***SKILLS FOCUS:*** Recognize the usefulness and limitations of models and theories as scientific representations of reality. **(I&E 1.g)** ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P Lab Manual, Lab 24-1, "The Nature of Magnetism", p 177 • Phys:P&P, Pocket Lab 24-1, "Monopoles?", p 557 • Phys:P&P, Pocket Lab 24-1, "Funny Balls", p 559 • Con Phys, Lab 94, "You're Repulsive", p 301 • **NASA** http://www-istp.gsfc.nasa.gov/Education/Imagnet.html • **UC Berkeley** http://www.newi.ac.uk/BUCKLEYC/magnet.htm • **Univ. of Tenn. at Martin** http://www.utm.edu/staff/cerkal/magnetic.htm	1 Day (0.5 Block)
… how to determine the direction of a magnetic field produced by a current flowing in a straight wire or in a coil. **(5,g)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Recall that the direction of a magnetic field is assigned by convention to be outward from a north pole and inward toward a south pole. • Apply the right hand rule to determine the direction of magnetic fields generated by current flowing in wires and coils of wire.	**Phys:P&P**, Ch 24:1 **Con Phys**, Ch 36:2-5	***KEY VOCABULARY:*** right hand rule ***SKILLS FOCUS:*** apply and model a definition ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P Lab Manual, Lab 24-2, "Principles of Electromagnetism", p 181 • Phys:P&P, Physics Lab, "Coils and Currents", p 562 • Phys:P&P, Pocket Lab 24-1, "3-D Magnetic Fields", p 564 • **Hyperphysics** http://hyperphysics.phy-astr.gsu.edu/hbase/magnetic/solenoid.html • **Buffalo State activity** http://physicsed.buffalostate.edu/SeatExpts/EandM/solenoid/	2 Days (1 Block)

Electric and Magnetic Phenomena

5. Electric and magnetic phenomena are related and have many practical applications.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
…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. **(5,n*)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	* *Identify the variables in the equation,* **$F = qvB \sin\theta$** eq 41 *where θ is the angle between motion (**v**) of the charged particle and the magnetic field (**B**).* * *Calculate the amount of force (**F**) experienced by a charged particle moving through a magnetic field.* * *Recall that the direction of the force is given by a right hand rule where the fingers point in the direction of **B**, the extended thumb points in the direction of **v**, and the **F** is exerted straight out from the palm, (perpendicular to the plane defined by B and v).*  * *Explain how the **sinθ** term describes how the force is a maximum when the velocity is perpendicular to the B field and decreases as the velocity becomes more parallel (at 0^o and 180^o) to the B field.* 	**Phys:P&P**, Ch 24:2 **Con Phys**, Ch 36:6-7	***KEY VOCABULARY:*** ***SKILLS FOCUS:*** connect spatial orientation to mathematical relationships ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P, Quick Demo, TE, p 568 • Phys:P&P, Assessment Performance, TE, p 569 • **Right hand rule** http://sol.sci.uop.edu/~jfalward/magneticforcesfields/magneticforcesfields.html	2 Days (1 Block)

Electric and Magnetic Phenomena

5. Electric and magnetic phenomena are related and have many practical applications.

Standards and Assessments "Students know…"	Task Analysis "Students are able to …"	Adopted Textbook Correlation(s)	Connections	Appx Time (per 180 days)
… changing magnetic fields produce electric fields, thereby inducing currents in nearby conductors. **(5,h)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Explain that just as moving or changing electric fields are sources of magnetic fields, changing magnetic fields create electric fields. • Recall that this process is called electromagnetic induction. • Explain that induced electric fields can drive a current in a conductor. • Explain that the direction of the induced current is always a direction to oppose the magnetic field that created it. • Recall that this principle is called Lenz's law.	**Phys:P&P**, Ch 25:1-2 **Con Phys**, Ch 37:1-4	***KEY VOCABULARY:*** electromagnetic induction ***SKILLS FOCUS:*** Formulate explanations by using logic and evidence. **(I&E 1.d)** ***LABS / DEMOS / ACTIVITIES:*** • Phys:P&P Lab Manual, Lab 25-1, "Electromag. Induction 1", p 189 • Phys:P&P Lab Manual, Lab 25-2, "Electromag. Induction 2", p 193 • Phys:P&P, Physics Lab, "Swinging Coils", p 595 • Phys:P&P, Pocket Lab 25-1, "Making Currents", p 585 • Phys:P&P, Pocket Lab 25-1, "Motor and Generator", p 588 • Phys:P&P, Pocket Lab 25-2, "Slow Motor", p 591 • Phys:P&P, Pocket Lab 25-2, "Slow Magnet", p 593 • Con Phys, Lab 95, "Jump Rope Generator", p 305 • **Electromagnetic Induction** http://micro.magnet.fsu.edu/ electromag/java/faraday2/ • **Faraday's Experiment** http://micro.magnet.fsu.edu/ electromag/java/faraday/ • **Electromagnetic Induction** http://www.slcc.edu/schools/hum_ sci/physics/tutor/2220/em_ induction/ • **EM Induction Applications** http://physics.bu.edu/~duffy/ PY106/Electricgenerators.html	2 Days (1 Block)
… plasmas, the fourth state of matter, contain ions or free electrons or both and conduct electricity. **(5,i)** **DISTRICT ASSESSMENTS:** OES: pending PT: pending	• Recall that plasma is considered the fourth state of matter, as fundamental as solid, liquid, and gas. • Define a **plasma** as mixture of positive ions and free electrons that is electrically neutral as a whole, but conducts electricity. • Explain that plasmas are formed at high temperatures where molecules break up into their constituent atoms and the atoms further break up into positively charged ions and negatively charged electrons. • Explain that much of the matter in the universe is in stars in the form of plasma.	**Phys:P&P**, Ch 13:2 **Con Phys**, Ch 17:9 40:7	***KEY VOCABULARY:*** **plasma** ***SKILLS FOCUS:*** analyze, explain ***LABS / DEMOS / ACTIVITIES:*** • **Plasma: NASA** http://liftoff.msfc.nasa.gov/ academy/universe/fourth_matter .html • **Plasma: Fusion Education** http://fusedweb.pppt.gov/CPEP/ Chart_Pages/5.Plasma4State Matter.html • **Plasma in the Universe** http://pluto.space.swri.edu/IMAGE /glossary/plasma.html • **5th State of Matter?** http://jersey.uoregon.edu/~mstrick /AskGeoMan/geoQuerry52.html	0.5 Day (0.25 Block)

LABORATORY RECOMMENDATIONS:

Core experiences for this course should include detailed laboratories with complete write-ups (when appropriate) on the following topics:

1. Newton's Laws
2. 2-dimensional Forces
3. Conservation of Energy
4. Momentum
5. Hooke's Law
6. Heat / Work
7. Wave Properties and Interactions
8. Electric Circuits
9. E/M Fields and Forces

A minimum of 20 laboratories is recommended for this course. Our district recommends that 40% of instructional time be devoted to hands-on laboratory and project-based activities.

MATERIALS:

Basic Textbook and Supplementary Materials: Glencoe Physics: Principles & Problems, Zitzewitz, Glencoe/McGraw-Hill, © 2002

Or Alternate Basic Textbook and Supplements: Conceptual Physics, Hewitt, Prentice Hall, © 2002

Safety Equipment:	fire extinguisher, eye wash station, goggles
Measuring Devices:	centigram balances, meter sticks, mm rulers, spring scales, accelerometers, triple beam balances
Other Laboratory Equipment:	air track, stop watches, meters and materials for electrical experimentation, magnets, ripple tank and accessories
Laboratory Supplies:	lenses, mirrors, diffraction gratings, assorted springs/slinkies, thermometers, clamps
Other:	Computer-based software and hardware, including computer labs, internet access, word processing and presentation programs, and student tutorials/practice.

- ❖ Many items are shared in your science department or may be available through Science/Math Resource Center (SMRC).

METHODS:

Learning styles of students may be addressed by implementing combinations of the following:

Significant, Proven Science Strategies for ALL Science Students

- ❑ Hands-On Lab's
- ❑ Inquiry Activities
- ❑ Short/Long-term projects
- ❑ Student Presentations
- ❑ Peer Teaching
- ❑ Summarization
- ❑ Essential Questions
- ❑ Thematic Units
- ❑ Field Experiences
- ❑ Current Events
- ❑ Career Choices
- ❑ Guest Speakers

Reading Strategies in Science

- ❑ Learning Logs
- ❑ Pre-teaching
- ❑ Vocabulary
- ❑ Pre-reading
- ❑ Text Structures
- ❑ Trail Markers
- ❑ Reciprocal Teaching
- ❑ Functional Text

SDAIE Strategies for English Learners

- ❑ Tapping/Building Prior Knowledge (Graphic Organizers, Schema)
- ❑ Grouping Strategies
- ❑ Multiple Intelligences
- ❑ Adapt the Text
- ❑ Interactive Learning (Manipulatives, Visuals)
- ❑ Acquisition Levels
- ❑ Language Sensitivity
- ❑ Lower the Affective Filter (including Processing Time)
- ❑ Home/School Connection (including Cultural Aspects)

Differentiation for Advanced Learners

- ❑ Curriculum Compacting
- ❑ Tiered Assignments
- ❑ Flexible Grouping
- ❑ Acceleration
- ❑ Depth and Complexity
- ❑ Independent Study

Please note that these strategies often overlap and should not be limited to specifically defined courses or student populations.

RESOURCES:

Documents

- Science Framework: .... http://www.cde.ca.gov/re/pn/fd/sci-frame-dwnld.asp
- CST / NCLB Test Blueprints: .... http://www.cde.ca.gov/ta/tg/sr/blueprints.asp
- CST Reference Sheets: .... http://www.cde.ca.gov/ta/tg/sr/cstsciref.asp
- National Science Standards: .... http://www.nap.edu/readingroom/books/nses/html/
- Science Safety Handbook for CA Public Schools (1999) can be ordered from the CDE at ....http://www.cde.ca.gov/re/pn/rc/
- LBUSD Approved Chemicals List, Chemical Hygiene Plan, and Science Fair Resources: http://www.lbusd.k12.ca.us/curriculum/Curriculum%20Services/Science/science.htm

District Offices

- Science Curriculum Office (562) 997-8000 (ext. 2963)
  - K-12 science standards, curriculum, professional development, science fair
- Science / Math Resource Center (562) 997-8000 (ext. 2964)
  - hands-on materials, consumable material orders, alternative standards-based curriculum packets
- Instructional Materials Workshop (IMW) (562) 997-8000 (ext. 2965)
  - standards-based instructional materials
  - content integrated instructional materials
  - monthly theme-based literacy supplements for science
  - wood shop / lumber room
  - copying, enlarging, and laminating
- Office of Multimedia Services (OMS) (562) 997-8000 (ext. 7145)
  - videos for check out to fit the curriculum (see your librarian for current catalogs)
  - district TV channels programming
- PALMS Office — Program Assistance for Language Minority Students (562) 997-8000 (ext. 8031)
  - technical assistance and professional development for English Language Development (ELD) and Specially Designed Academic Instruction In English (SDAIE)
  - assistance in the implementation and maintenance of programs addressing the needs of English Language Learners (ELLs)

EVALUATION METHODS:

Learning styles of students may be best assessed by implementing combinations of the following:

- laboratory-based performance tasks
- long-term projects and inventions
- portfolios
- model-building
- research projects using primary source
- written reports with oral presentations
- cooperative group assessment
- homework assessment
- notebook organization and note-taking skills
- peer evaluation
- rubric scoring
- open-ended written assessment
- single-response testing

SUGGESTED GRADE WEIGHTING:
(with some possible examples)

1. Assessment ~30%
   - objective tests including comprehensive finals
   - performance tasks (rubric scored)
   - open-ended questions (rubric scored)
   - portfolios
   - peer evaluations
2. Homework ~10%
   - discovery assignments
   - assignments reinforcing class lesson
   - essays
   - organization
3. Labs ~20%
   - lab reports
   - active participation
4. Projects ~20%
   - science fair projects
   - research-based reports and projects
5. Classwork ~20%
   - note taking skills
   - organization skills
   - oral presentations
   - individual and group projects and assessments

Note: Extra credit should only be given for content-based activities that go beyond normal class assignments. It should not be used as compensation credit for missed assignments. Also, extra credit should not be given in exchange for tasks performed (such as cleaning, decorating, or grading papers) or for materials donated.

STANDARD GRADING SCALE:

A	90 – 100%
B	80 – 89%
C	70 – 79%
D	60 – 69%
F	0 – 59%

Submitted by: Eric Brundin
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