

Newport-Mesa Unified School District
Office of Secondary Curriculum and Instruction
High School Course of Study

Course Title	AP Physics C: Electricity and Magnetism	Course Code	R0401-R0402
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Transcript Title:	AP Physics C: Electricity and Magnetism			Grades Levels:	11-12	Board Adoption Date:		July 2013
Content Area:	Science			GPA Scale:	Weighted	Date Course Submitted:		May 2013
Credential Req:	Science		Graduation Subject Areas:		Elective			
UC/CSU "A-G" Area Approvals:		Yes		School Site that wrote and submitted the course:			Newport Harbor High School	
Prerequisite(s):	Completion of AP Physics C: Mechanics, concurrent enrollment in AP Calculus, teacher recommendation							
Next course(s):								

COURSE DESCRIPTION

IB Physics HL course has five units, including waves (sound and light), heat, quantum mechanics and fluid mechanics.

Electricity and Magnetism is divided into 5 units, to be started Part way through the school year. Concepts and problem-solving techniques are introduced through a combination of lectures, demonstrations, lab experiments, question-answer sessions, assignments from the textbook, and teacher-generated worksheets. Calculus is used throughout and where appropriate.

For students who have taken AP Physics C: Mechanics, they will be able to continue their study of physics by taking this course. This course is equivalent to the pre-engineering introductory Physics course for university bound students. The emphasis is on understanding the concepts and skills and using concepts and formulae to solve problems. Laboratory work is an integral part of this course. Students engage in inquiry-based activities to develop their understanding of the material of the course.

GOALS:

The goal in the Advanced Physics course is to provide an excellent first-year college-level calculus-based physics education.

1. Students will master a conceptual understanding of electrostatics in physics by studying electric forces and fields.
2. Students will study the concepts of electric flux, Gauss's Law (general), Gauss's Law and various continuous charge distributions.
3. Students will study Electric potential and potential difference, potential differences in uniform electric fields, potential and point charges, potential and continuous charge distributions. Students derive electric potentials for continuous charge distributions and produce appropriate graphs.
4. Students will study the importance of Capacitance, Gauss's Law and capacitance, combination of capacitors, energy stored in capacitors, Dielectrics.
5. Students will study Ohm's Law, electrical power, electromotive force and internal resistance.
6. Student will study Magnetic force on moving charges and currents,

7. Students should also be able to apply their understanding to approach and solve problems that are essentially new to them.
8. Students will develop skills in performing lab experiments, by practicing experimental design and proper data collection methods.
9. Students will develop skills in analyzing laboratory experiments, using calculus and graphical methods to analyze data.

California Content Standards

Physics

Motion and Forces

1. Newton's laws predict the motion of most objects. As a basis for understanding this concept:
 - m. Students know how to solve problems involving the forces between two electric charges at a distance (Coulomb's law)

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

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:
 - a. Students know heat flow and work are two forms of energy transfer between systems.
 - b. Students know that the work done by a heat engine that is working in a cycle is the difference between the heat flow into the engine at high temperature and the heat flow out at a lower temperature (first law of thermodynamics) and that this is an example of the law of conservation of energy.
 - c. Students know the internal energy of an object includes the energy of random motion of the object's atoms and molecules, often referred to as thermal energy. The greater the temperature of the object, the greater the energy of motion of the atoms and molecules that make up the object.
 - d. Students know that most processes tend to decrease the order of a system over time and that energy levels are eventually distributed uniformly.
 - e. Students know that entropy is a quantity that measures the order or disorder of a system and that this quantity is larger for a more disordered system.
 - f.* Students know the statement "Entropy tends to increase" is a law of statistical probability that governs all closed systems (second law of thermodynamics).
 - g.* Students know how to solve problems involving heat flow, work, and efficiency in a heat engine and know that all real engines lose some heat to their surroundings.

Waves

4. Waves have characteristic properties that do not depend on the type of wave. As a basis for understanding this concept:
 - a. Students know waves carry energy from one place to another.
 - b. Students know how to identify transverse and longitudinal waves in mechanical media, such as springs and ropes, and on the earth (seismic waves).
 - c. Students know how to solve problems involving wavelength, frequency, and wave speed.
 - d. Students know sound is a longitudinal wave whose speed depends on the properties of the medium in which it propagates.
 - e. Students know radio waves, light, and X-rays are different wavelength bands in the spectrum of electromagnetic waves whose speed in a vacuum is approximately 3×10^8 m/s (186,000 miles/second).
 - f. Students know how to identify the characteristic properties of waves: interference (beats), diffraction, refraction, Doppler effect, and polarization.

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 how to predict the voltage or current in simple direct current (DC) electric circuits constructed from batteries, wires, resistors, and capacitors.
 - Students know how to solve problems involving Ohm's law.
 - Students know any resistive element in a DC circuit dissipates energy, which heats the resistor. Students can calculate the power (rate of energy dissipation) in any resistive circuit element by using the formula $\text{Power} = IR$ (potential difference) $\times I$ (current) $= I^2R$.
 - Students know the properties of transistors and the role of transistors in electric circuits.
 - Students know charged particles are sources of electric fields and are subject to the forces of the electric fields from other charges.
 - Students know magnetic materials and electric currents (moving electric charges) are sources of magnetic fields and are subject to forces arising from the magnetic fields of other sources.
 - Students know how to determine the direction of a magnetic field produced by a current flowing in a straight wire or in a coil.
 - Students know changing magnetic fields produce electric fields, thereby inducing currents in nearby conductors.
 - Students know plasmas, the fourth state of matter, contain ions or free electrons or both and conduct electricity.
 - * Students know electric and magnetic fields contain energy and act as vector force fields.
 - * Students know the force on a charged particle in an electric field is qE , where E is the electric field at the position of the particle and q is the charge of the particle.
 - * Students know how to calculate the electric field resulting from a point charge.
 - * Students know static electric fields have as their source some arrangement of electric charges.
 - * Students know the magnitude of the force on a moving particle (with charge q) in a magnetic field is $qvB \sin(a)$, where a is the angle between $\mathbf{v}$ and $\mathbf{B}$ (v and B are the magnitudes of vectors $\mathbf{v}$ and $\mathbf{B}$, respectively), and students use the right-hand rule to find the direction of this force.
 - * Students know how to apply the concepts of electrical and gravitational potential energy to solve problems involving conservation of energy.

Nuclear Processes (Chemistry)

11. Nuclear processes are those in which an atomic nucleus changes, including radioactive decay of naturally occurring and human-made isotopes, nuclear fission, and nuclear fusion. As a basis for understanding this concept:
- Students know protons and neutrons in the nucleus are held together by nuclear forces that overcome the electromagnetic repulsion between the protons.
 - Students know the energy release per gram of material is much larger in nuclear fusion or fission reactions than in chemical reactions. The change in mass (calculated by $E=mc^2$) is small but significant in nuclear reactions.
 - Students know some naturally occurring isotopes of elements are radioactive, as are isotopes formed in nuclear reactions.
 - Students know the three most common forms of radioactive decay (alpha, beta, and gamma) and know how the nucleus changes in each type of decay.
 - Students know alpha, beta, and gamma radiation produce different amounts and kinds of damage in matter and have different penetrations.
 - * Students know how to calculate the amount of a radioactive substance remaining after an integral number of half-lives have passed.
 - * Students know protons and neutrons have substructures and consist of particles called quarks.

Investigation and Experimentation

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:
- Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
 - Identify and communicate sources of unavoidable experimental error.
 - Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.
 - Formulate explanations by using logic and evidence.
 - Solve scientific problems by using quadratic equations and simple trigonometric, exponential, and logarithmic functions.
 - Distinguish between hypothesis and theory as scientific terms.
 - Recognize the usefulness and limitations of models and theories as scientific representations of reality.

Evaluation

Student achievement will be measured using multiple assessment tools, included but not limited to benchmark test results, final exams, end-of-unit tests, quizzes, homework, classwork, notebooks, portfolios, authentic performance assessments, and written assessments using the district's rubric. District-wide benchmark assessments will be assessed using the following chart:

Performance Standards - Benchmark Assessments				
Far Below Basic = F	Below Basic = D	Basic = C	Proficient = B	Advanced Proficient = A

Unit 1	Length of Unit (3 weeks)			
	Key Terms	Standards*	Model Tasks**	Tools & Text

<i>The Electric Field and Gauss's Law</i>	Charge Coulomb's Law Electroscope Electric field Electron Proton Neutron	1m. Students know how to solve problems involving the forces between two electric charges at a distance (Coulomb's law) 5l. Students know how to calculate the electric field resulting from a point charge. 5m. Students know static electric fields have as their source some arrangement of electric charges.		1. Students will draw electric field lines that result from a variety of static charge placements. 2. Students will discover through experimentation how to use an electroscope	D C B A	Teacher resource book Student textbook Mechanical Universe video series AP Released exams
Differentiation	Support -- for students who are struggling with the content	Meet with instructor during Prep periods to help with understanding, Up to date website communications to facilitate understanding.				
	Extension – for high achieving students. Required activities for all honors courses.	This course is designed as an advanced course to earn College Credit. The course itself is designed as an extension of the regular HS curriculum.				
Evaluation	<i>Formative Assessments: Students will be assessed through weekly quizzes, homework review, chapter tests.</i> <i>Summative Assessments: Unit exams, Complete AP exams</i>					

* Standards are to be identified by frequency on California Standards Tests. A high frequency standard will be labeled with an "H", a medium frequency standard will be labeled "M", and a low frequency standard will be labeled "L".

** Tasks are to be identified by the Application Taxonomy Quadrant designed by the International Center for Leadership in Education.

Unit 2	Length of Unit (3 weeks)					
	Key Terms	Standards*		Model Tasks**		Tools & Text
<i>Electric Potential and Capacitance</i>	Electric Potential, Potential difference, point charges capacitance, dielectrics	2h. Students know how to solve problems involving conservation of energy in simple systems with various sources of potential energy, such as capacitors and springs. 5k. Students know the force on a charged particle in an electric field is $q\mathbf{E}$, where $\mathbf{E}$ is the electric field at the position of the particle and q is the charge of the particle.		1. Students will analyze parallel plate, cylindrical, and spherical capacitors 2. Students derive electric potentials for continuous charge distributions	D C B A	Teacher resource book Student textbook Mechanical Universe video series AP Released exams
Differentiation	Support -- for students who are struggling with the content	Meet with instructor during Prep periods to help with understanding, Up to date website communications to facilitate understanding.				
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Unit 3	Length of Unit (3 Weeks)					
	Key Terms	Standards*		Model Tasks**		Tools & Text
DC Circuits	Resistance Current Parallel Series Power Electromotive Force Internal Resistance Resistance	5a. Students know how to predict the voltage or current in simple direct current (DC) electric circuits constructed from batteries, wires, resistors, and capacitors. 5b. Students know how to solve problems involving Ohm’s law. 5c. Students know any resistive element in a DC circuit dissipates energy, which heats the resistor. Students can calculate the power (rate of energy dissipation) in any resistive circuit element by using the formula $Power = V^2 / R$ (potential difference) $= I^2 R$ (current).	H M L	Students create multiloop circuits or are provided with simulations of such circuits. Calculators are used to solve simultaneous equations for the current in each loop. Students construct RC circuits with known resistors and capacitors. Computer probes are use to acquire data and create graphs. Data analysis is used to find charge stored.	D C B A	Teacher resource book Student textbook Mechanical Universe video series AP Released exams
Differentiation	Support -- for students who are struggling with the content	Meet with instructor during Prep periods to help with understanding, Up to date website communications to facilitate understanding.				
	Extension – for high achieving students. Required activities for all honors courses.	This course is designed as an advanced course to earn College Credit. The course itself is designed as an extension of the regular HS curriculum.				
Evaluation	Formative Assessments: Students will be assessed through weekly quizzes, homework review, chapter tests. Summative Assessments: Unit exams, Complete AP exams					

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Unit 4	Length of Unit (3 Weeks)				
	Key Terms	Standards*	Model Tasks**		Tools & Text
Magnetostatics	Magnetic Field Hall Effect Biot-Savart Law Ampere’s Law Solenoid	5j. Students know electric and magnetic fields contain energy and act as vector force fields. 5n. Students know the magnitude of the force on a moving particle (with charge q) in a magnetic field 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.	H M L	The measurement of magnetic field inside a solenoid and its variation with current. Students calculate the number of coils using the current and magnetic field strength. Students construct a device that shows the existence of a magnetic force on a current carrying wire using common lab equipment.	D C B A Teacher resource book Student textbook Mechanical Universe video series AP Released exams
Differentiation	Support -- for students who are struggling with the content	Meet with instructor during Prep periods to help with understanding, Up to date website communications to facilitate understanding.			
	Extension – for high achieving students. Required activities for all honors courses.	This course is designed as an advanced course to earn College Credit. The course itself is designed as an extension of the regular HS curriculum.			
Evaluation	Formative Assessments: Students will be assessed through weekly quizzes, homework review, chapter tests. Summative Assessments: Unit exams, Complete AP exams				

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Unit 5	Length of Unit (4 Weeks)					
	Key Terms	Standards*		Model Tasks**		Tools & Text
<i>Electromagnetic Induction and Inductance</i>	Magnetic Flux Lenz’s Law Induced emf Generators Motors Inductance	5 g. Students know how to determine the direction of a magnetic field produced by a current flowing in a straight wire or in a coil. 5h. Students know changing magnetic fields produce electric fields, thereby inducing currents in nearby conductors.	H M L	Students dissect a small electric motor and produce diagrams to explain how it works Students are provided with two solenoids, iron bar, and computer probeware to illustrate Faraday’s Law Students will be able to explain the forces that act on induced currents so they can determine the consequences of those forces.	D C B A	Teacher resource book Student textbook Mechanical Universe video series AP Released exams
Differentiation	Support -- for students who are struggling with the content	Meet with instructor during Prep periods to help with understanding, Up to date website communications to facilitate understanding.				
	Extension – for high achieving students. Required activities for all honors courses.	This course is designed as an advanced course to earn College Credit. The course itself is designed as an extension of the regular HS curriculum.				
Evaluation	<i>Formative Assessments: Students will be assessed through weekly quizzes, homework review, chapter tests.</i> <i>Summative Assessments: Unit exams, Complete AP exams</i>					

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Unit 6	Length of Unit (3 Weeks)					
	Key Terms	Standards*		Model Tasks**		Tools & Text
<i>Waves and Sound</i>	Transverse Longitudinal Wavelength Frequency Period	4a. Students know waves carry energy from one place to another. 4b. Students know how to identify transverse and longitudinal waves in mechanical media, such as springs and ropes, and on the earth (seismic waves). 4c. Students know how to solve problems involving wavelength, frequency, and wave speed. 4d. Students know sound is a longitudinal wave whose speed depends on the properties of the medium in which it propagates.	H M L	Students use a spring to create transverse and longitudinal waves Students use tuning forks and a resonance apparatus to determine the speed of sound	D C B A	Teacher resource book Student textbook Mechanical Universe video series AP Released exams
Differentiation	Support -- for students who are struggling with the content	Meet with instructor during Prep periods to help with understanding, Up to date website communications to facilitate understanding.				
	Extension – for high achieving students. Required activities for all honors courses.	This course is designed as an advanced course to earn College Credit. The course itself is designed as an extension of the regular HS curriculum.				
Evaluation	<i>Formative Assessments: Students will be assessed through weekly quizzes, homework review, chapter tests.</i> <i>Summative Assessments: Unit exams, Complete AP exams</i>					

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Unit 7	Length of Unit (3 Weeks)					
	Key Terms	Standards*		Model Tasks**		Tools & Text
Light and Optics	Reflection Refraction Interference Diffraction	4e. Students know how to identify transverse and longitudinal Students know radio waves, light, and X-rays are different wavelength bands in the spectrum of electromagnetic waves whose speed in a vacuum is approximately 3×10^8 m/s (186,000 miles/second). 4f. Students know how to identify the characteristic properties of waves: interference (beats), diffraction, refraction, Doppler effect, and polarization.	H M L	Students will use a pencil, compass and a ruler to predict the formation of images for curved mirrors and lenses. Using a square of glass, students will measure the index of refraction. Students will recreate the spectrum and rank the parts of the spectrum in order of their frequencies.	D C B A	Teacher resource book Student textbook Mechanical Universe video series AP Released exams
Differentiation	Support -- for students who are struggling with the content	Meet with instructor during Prep periods to help with understanding, Up to date website communications to facilitate understanding.				
	Extension – for high achieving students. Required activities for all honors courses.	This course is designed as an advanced course to earn College Credit. The course itself is designed as an extension of the regular HS curriculum.				
Evaluation	Formative Assessments: Students will be assessed through weekly quizzes, homework review, chapter tests. Summative Assessments: Unit exams, Complete AP exams					

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Unit 8	Length of Unit (4 Weeks)				
	Key Terms	Standards*	Model Tasks**		Tools & Text
<i>Fluid Dynamics and Thermal Physics</i>	Pressure Buoyancy Bernoulli's Principle Heat Temperature Thermodynamics Carnot Cycle	3a. Students know heat flow and work are two forms of energy transfer between systems. 3b. Students know that the work done by a heat engine that is working in a cycle is the difference between the heat flow into the engine at high temperature and the heat flow out at a lower temperature (first law of thermodynamics) and that this is an example of the law of conservation of energy. 3c. Students know the internal energy of an object includes the energy of random motion of the object's atoms and molecules, often referred to as thermal energy. The greater the temperature of the object, the greater the energy of motion of the atoms and molecules that make up the object.	1. Students will determine the density of two unknown materials. Using a triple-beam balance, overflow can, beaker, various metal objects and string. 2. Students will determine the exit velocity of a liquid and to investigate the range attained with holes at varying heights. 3. Students will determine the coefficient of linear expansion of two metal rods.	D C B A	Teacher resource book Student textbook Mechanical Universe video series AP Released exams
Differentiation	Support -- for students who are struggling with the content	Meet with instructor during Prep periods to help with understanding, Up to date website communications to facilitate understanding.			
	Extension – for high achieving students. Required activities for all honors courses.	This course is designed as an advanced course to earn College Credit. The course itself is designed as an extension of the regular HS curriculum.			
Evaluation	Formative Assessments: Students will be assessed through weekly quizzes, homework review, chapter tests. Summative Assessments: Unit exams, Complete AP exams				

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Unit 9	Length of Unit (4 Weeks)					
	Key Terms	Standards*		Model Tasks**		Tools & Text
Modern Physics	Photoelectric Effect Wave-Particle Duality	4a. Students know waves carry energy from one place to another. 4b. Students know how to identify transverse and longitudinal waves in mechanical media, such as springs and ropes, and on the earth (seismic waves). 4c. Students know how to solve problems involving wavelength, frequency, and wave speed. 4d. Students know sound is a longitudinal wave whose speed depends on the properties of the medium in which it propagates.		1. Students will determine the experimental value of the frequency of standing waves in a string by means of a graph of collected data. 2. Students will determine the wavelength of a source of light by using a double slit and a diffraction grating of known spacing. 3. Students will determine the index of refraction of an acrylic block	D C B A	Teacher resource book Student textbook Mechanical Universe video series AP Released exams
Differentiation	Support -- for students who are struggling with the content	Meet with instructor during Prep periods to help with understanding, Up to date website communications to facilitate understanding.				
	Extension – for high achieving students. Required activities for all honors courses.	This course is designed as an advanced course to earn College Credit. The course itself is designed as an extension of the regular HS curriculum.				
Evaluation	Formative Assessments: Students will be assessed through weekly quizzes, homework review, chapter tests. Summative Assessments: Unit exams, Complete AP exams					

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Unit 10	Length of Unit (2 Weeks)				
	Key Terms	Standards*		Model Tasks**	Tools & Text
<i>Atomic and Nuclear Physics</i>	Photons Photoelectric Compton Scattering Energy Levels Nuclear reaction	11b. Students know the energy release per gram of material is much larger in nuclear fusion or fission reactions than in chemical reactions. The change in mass (calculated by $E=mc^2$) is small but significant in nuclear reactions. 11c. Students know some naturally occurring isotopes of elements are radioactive, as are isotopes formed in nuclear reactions. 11d. Students know the three most common forms of radioactive decay (alpha, beta, and gamma) and know how the nucleus changes in each type of decay.		1. Students will, using a simulation, collect data to create a graph that will allow you to find the value of Planck's constant for three different metals.	D C B A Teacher resource book Student textbook Mechanical Universe video series AP Released exams
Differentiation	Support -- for students who are struggling with the content	Meet with instructor during Prep periods to help with understanding, Up to date website communications to facilitate understanding.			
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Evaluation	<i>Formative Assessments: Students will be assessed through weekly quizzes, homework review, chapter tests.</i> <i>Summative Assessments: Unit exams, Complete AP exams</i>				