PARSIPPANY-TROY HILLS TOWNSHIP PUBLIC SCHOOL DISTRICT

SCN414 AP PHYSICS - HIGH SCHOOL

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I. OVERVIEW

In the Advanced Placement Physics course the students will learn to use the basic tools of physics to study significant conceptual principles while integrating mathematical and technological techniques. The students will be guided through the basic concepts of electricity and magnetism and be made aware of the tremendous advances and ferment of activity in the science of physics. Conventional concepts and strengths learned in the first year course will be expanded and enhanced, while new topics in the realm of electromagnetism and its applications will assist students to forge a bridge between concepts, reasoning and application. The principles of calculus and rigorous problem-solving will be emphasized throughout the course in order to thoroughly develop each concept studied. The students will learn how physics works, by testing their understanding of concepts and applying them to real world scenarios.

Mechanics is reviewed, and electricity and magnetism are studied in depth, incorporating calculus to enhance the study and understanding in certain areas. The course includes numerous hands-on experiments, including a unit of activities using computer-monitored sensing devices. The process of instruction focuses on problem solving through classroom exercises as well as laboratory investigations. Separately we assess students to gauge progress and inform instruction. Benchmark assessments for students in grades 9 through 12 are administered in the form of a midterm and final exam for full year courses. *Special Note: Only final exams are administered at the end of quarter courses and semester courses.

The course is specifically designed for AP credit, although it is not required that the student take the test.

II. RATIONALE

Advanced Placement Physics is a full-year course open to juniors and seniors who exhibit exemplary math skills and who are seeking a challenging scientific experience. The necessary prerequisite course is Physics 1, with a preference of Honors Physics. The necessary corequisite class is Calculus, with a preference of AP Calculus. This course is aligned with the New Jersey Student Learning Standards (NJSLS, also known as NGSS) and the New Jersey Student Learning Standards (for Technology (NJSLS for Technology). Using a variety of materials and resources, the course reinforces and augments the educational skills of scientific interpretation, problem solving, critical analysis and technological research. District initiatives in assessment and critical reading and writing are also being emphasized.

III. STUDENT OUTCOMES (Link to New Jersey Student Learning Standards)

In accordance with district policy as mandated by the New Jersey Administrative Code and the New Student Learning Standards, the following are proficiencies required for the successful completion of the above named course.

The student will:

1. Review the basic concepts of kinematics, dynamics, energy and momentum involved in rotational and rolling motion with particular emphasis on the use of differential and integral calculus to develop principles and solve problems.

2. Become familiar with Coulomb's Law, electric forces and electric fields. Calculation of electric fields generated by a variety of charge distribution will be analyzed.
3. Understand Gauss' Law and appreciate its significance relative to Coulomb's Law and be able to derive one from the other.
4. Understand the concept of electric potential, electric field and electric potential energy and be able to use calculus to derive the values of any one of these from knowledge of the other.
5. Learn about capacitors and their function and be able to make circuit diagrams involving several capacitors and calculate the contribution of each.
6. Learn about resistance, resistivity and resistors. Circuits using one or more resistors will be studied with a particular emphasis on Ohm's Law and calculations of currents, voltages, equivalent resistance and electrical power.

7. Study the motion of a charged particle moving in a magnetic field with emphasis on the function of particle accelerators in the modern world.

8. Understand the source and nature of magnetic fields with particular focus on Ampere's Law. Fields generated by a variety of current configurations will be developed and related problems will be solved.

9. Learn about electromagnetic induction and the contribution of Faraday and Lenz to understanding the phenomena. Modern day applications of inductors and circuits containing them will be emphasized.
10. Become familiar with the life and contribution of important scientists and be literate in terms of major significant technological advances their works have helped to make.

Link to NEW JERSEY STUDENT LEARNING STANDARDS

- 3 - English Language Arts
- 4 - Mathematics
- 5 - Science
- 8 - Technology
- 9 - 21st Century Life and Careers

Modifications/Differentiation and Adaptations:

For guidelines on how to modify and adapt curricula to best meet the needs of all students, instructional staff should refer to the Curriculum Modifications and Adaptations included as an Appendix in this curriculum. Instructional staff of students with Individualized Education Plans (IEPs) must adhere to the recommended modifications outlined in each individual plan.

IV. ESSENTIAL QUESTIONS AND CONTENT

Overarching Essential Questions:

a) How can physics be applied to understanding everyday life?

b) How should one design a scientific investigation?

c) Why is it important to define system boundaries?

d) How can scientific ideas be used to solve problems?

e) What are different means of communicating scientific knowledge?

f) How can scientific arguments be evaluated?

g) How can rules and relationships be used to predict what will happen in a physical situation?

h) How are physics and engineering related?

i) How are mathematical and graphical models created from experimental data?

j) How are fields used to model physics phenomena?

k) How can abstract mathematics be used to describe phenomena and to represent relationships between variables?

l) How does physics explain change and constancy in the universe?

m) Why are assumptions and approximations important in physics and how does this limit the usefulness of your results?

n) To what extent does physics explain cause and effect?

o) How is matter and energy related?

p) In what ways do we witness the effects of something having energy?

Content:

Mechanics

- How do you implement the application of Calculus to problems in Physics?
- How would you apply the concepts of mechanics to rigid-body rotation and rolling?
- How is Gravitation used as a varying force?

Electricity

- How would you determine the force between charges using Coulomb's Law?
- How do you map field lines using the concept of electric fields?
- What is Gauss' Law and the concept of electric flux?
- What are the concepts of electric potential and electric potential energy?
- What is the idea of capacitance and its geometric dependence?
- How do you calculate the total capacitance in both series and parallel circuits?
- What is resistance, resistivity and conductance?
- What is Ohm's Law?
- How do you apply it to single and multi-loop circuits?
- How do you connect ammeters and voltmeters into a circuit?
- What is electrical power and how would you use it in problems?
- What is exponential rise and the decay of current and charges in a R-C Circuit?

Magnetism and Electromagnetism

- What are the sources of magnetic fields and be able to map magnetic field lines?
- Define the physics of a charged particle moving in a magnetic field?
- How do you calculate the magnetic forces due to a current carrying wire?
- What is Ampere's Law?
- Can you solve problems using Ampere's Law?
- How do you apply the concepts of net magnetic fields to solenoids and toroids?
- What are the causes of changing magnetic flux and induction?
- How does Faraday's & Lenz's laws apply to problems?
- What is the design of an inductor and the concepts of mutual and self-inductance?
- How can you construct an R-L Circuit and solve for current?
- How would you tie in the symmetries between electricity and magnetism by using Maxwell's Equations?
- How would you qualitatively explain the mechanics of an L-C Oscillating Circuit and identify the similarities between this (a electromagnetic oscillator) and a mechanical oscillator?
- What are the effects of alternating current sources in an R-L-C Circuit?
- How can you calculate the impedance, phase angles and power in a series R-L-C Circuit?
- What are the functions of a Transformer?

V. STRATEGIES

- Student projects
- Group discussion
- Individual conferencing
- Student-designed experiments, AP syllabus inquiry- based labs, observations, and data analysis
- Teacher presentations/lectures

VI. EVALUATION

Tests: 45%
Quizzes: 15%
Labs/Mini-labs/Activities: 30% - This could include laboratory investigations, projects, data analysis.
Homework/Classwork: 10% - This would include:

- Active engagement in class activities
- Demonstration of knowledge and understanding of course materials via worksheets, practice problems, etc.
- Skills and safety during lab investigations
- Do Now/Exit Questions
- Homework

VII. REQUIRED RESOURCES

Hardware

- Halliday, D. R. Resnick, and J. Walker. *Fundamentals of Physics.* 11th ed. New York, New York: John Wiley and Sons, 2017.

Supplemental Resources:

- **Serway, R.A. and J. Walker.** ***Physics for Scientists and Engineers with Modern Physics*** 9th ed. Boston, MA: Brooks/Cole, 2014.

- Halliday, D., R. Resnick and J. Walker. *Fundamentals of physics.* 8th ed. New York, New York: John Wiley and Sons, 2008. Volume 1&2

- Bueche, F. and E. Hecht. *Schaum's outline of Theory and Problems of College Physics. 9thed. New York, New York: McGraw Hill, 1997.*

- Giancoli, D. *Physics for Scientists and Engineers.* 5th ed. Upper Saddle River, New Jersey: Prentice Hall, 2002.

- Young, H. and R. Freedman. *University Physics.* 10th ed. New York, New York: Addison-Wesley, 2000.

Software

- PASCO Capstone

WEBSITES

Required
www.webassign.net

Supplemental
www.explorelearning.com
www.scilinks.org

www.physicsclassroom.com
www.thephysicsaviary.com

VIII. SCOPE AND SEQUENCE

1. Mechanics (3-4 weeks)
   - Implement the application of calculus to problems in Physics.
   - Apply the concepts of mechanics to rigid-body rotation and rolling.
   - Understand Gravitation as a varying force.

Standards Covered:
Science Standards: HS-ETS1-1, HS-ETS1-2, HS-PS2-1, HS-PS2-2, HS-PS2-3, HS-PS2-4, HS-PS2-5, HS-PS3-1, HS-PS3-2, HS-PS3-3, HS-ESS1-4, HS-ESS1-5, HS-ESS2-1,

Math Standards: N- RN A1, A2, B3; N - Q A1, A2, A3; N - VM A1, A2, A3, B4(a-c), B5(a-b); A - SSE A1(a-b), A2, B3(a-b), B4; A- APR A1, C4, C5, D6, D7; A - CED A1, A2, A3, A4; A - REI A1, A2, B3, B4(a-b), C5, C6, C7, D10, D11, D12; F -IF A1, A2, A3, B4, B5, B6, C7(a-e), C8(a-b), C9; F - BF A1(a-c), A2, B3, B4(a-d), B5; F - LE A1(a-c), A2, A3, A4, B5, F - TF A1, A2, A3, A4, B5, B6, B7, C8, C9; G - CO A1, A2, A3, B6, B7, B8; G - SRT A1(a-b), A2, A3, B4, B5, C7, C8, D11; G - C A1, A2, A3, A4, B5; G - GPE A1, A2, A3, B4, B5, B6, B7; G - GMD A1, A3, B4; G - MG A1, A2, A3; S - ID A1, A2, A3, A4, B5, B6(a-c), C7, C8, C9; S - IC A1, A2, B3, B4, B5, B6; S - CP A1, A2, A3, B7, B8, B9; S - MD A1, A2, A3, A4, B6, B7

Technology Standards: 8.1.12.A.3, 8.1.12.C.1, 8.1.12.D.1. 8.1.12.F.1, 8.2.12.B.3, 8.2.12.B.5, 8.2.12.C.2, 8.2.12.C.4, 8.2.12.D.3, 8.2.12.E1,

ELA Standards: NJSLSA.R1, NJSLSA.R2, NJSLSA.R4, NJSLSA.R7, NJSLSA.R8, NJSLSA.R9, NJSLSA.W1, NJSLSA.W2, NJSLSA.W3, NJSLSA.W4, NJSLSA.W5, NJSLSA.W6, NJSLSA.W7, NJSLSA.W8, NJSLSA.W9, NJSLSA.SL1, NJSLSA.SL2, NJSLSA.SL3, NJSLSA.SL4, NJSLSA.SL5. NJSLSA.SL6, NJSLSA.L1, NJSLSA.L2, NJSLSA.L3, NJSLSA.L4, NJSLSA.L5, NJSLSA.L6,

21st Century Standards: CRP1, CRP2, CRP4, CRP5, CRP6, CRP7, CRP8, CRP9, CRP11, CRP12, 9.3.ST.1, 9.3.ST.2, 9.3.ST.3, 9.3.ST.4, 9.3.ST.5, 9.3.ST.6, 9.3.ST-ET.1, 9.3.ST-ET.2, 9.3.ST-ET.3, 9.3.ST-ET.4, 9.3.ST-ET.5, 9.3.ST-ET.6, 9.3.ST-SM.1, 9.3.ST-SM.2, 9.3.ST-SM.3, 9.3.ST-SM.4

Suggested Activities:
   a. Work independently to analytically examine how the derivative and integral can be used in kinematic application.
   b. Perform an experiment which uses force sensors to determine the change of force as a function of time. Students will then relate the graphical parameters to the integral and derivative.
   c. Perform an experiment which determines the rotational inertia of a point mass, disk and ring using rotary motion sensors.
   d. Perform an experiment which verifies the Law of Conservation of Angular Momentum by using a rotary motion sensor.
   e. Work in small groups to solve a series of teacher-created angular mechanics and dynamics problems in order to strengthen understanding.

f. Witness demonstrations of conservation of angular momentum in practical applications using bicycle wheels and dumbbells. Students will then discuss the difference between translational and rotational parameters.
g. Work in groups to solve for the escape velocities of various planets in our solar system. Students will need to research mass and radius of the planets.
h. View video clip from *Kepler's Laws* to show understanding of conservation of angular momentum in satellite motion. Students will take notes to use in a class discussion.
i. Work in small groups to solve selected problems based on past AP tests involving gravitational potential energy of a body in satellite motion.
j. Work in small groups to solve selected problems based on past AP Mechanics tests to solve a variety of problems to review concepts from all of mechanics.

Teachers Notes:

To ensure students can perform the necessary calculations, additional calculus assignments should be given to students

2. Electricity (13-14 weeks)
   - Use Coulomb's Law to determine the force between charges.
   - Understand the concept of electric fields and be able to map field lines.
   - State and explain Gauss' Law and the concept of electric flux.
   - Understand the concepts of electric potential and electric potential energy.
   - Understand the idea of capacitance and its geometric dependence.
   - Calculate the total capacitance in both series and parallel circuits.
   - Define resistance, resistivity, and conductance
   - State and explain Ohm's Law, and apply it to single- and multi-loop circuits.
   - Demonstrate the proper method for connecting ammeters and voltmeters into a circuit.
   - Define electrical power and use it in problems.
   - Understand the exponential rise and decay of current and charges in an R-C circuit.

Standards Covered:
Science Standards: HS-ETS1-2, HS-ETS1-4, HS-PS2-1, HS-PS2-2, HS-PS2-4, HS-PS2-5, HS-PS2-6, HS-PS3-1, HS-PS3-2, HS-PS3-5, HS-PS4-1, HS-PS4-2, HS-PS4-5

Math Standards: N- RN A1, A2, B3; N - Q A1, A2, A3; N - VM A1, A2, A3, B4(a-c), B5(a-b); A - SSE A1(a-b), A2, B3(a-b), B4; A- APR A1, C4, C5, D6, D7; A - CED A1, A2, A3, A4; A - REI A1, A2, B3, B4(a-b), C5, C6, C7, D10, D11, D12; F -IF A1, A2, A3, B4, B5, B6, C7(a-e), C8(a-b), C9; F - BF A1(a-c), A2, B3, B4(a-d), B5; F - LE A1(a-c), A2, A3, A4, B5, F - TF A1, A2, A3, A4, B5, B6, B7, C8, C9; G - CO A1, A2, A3, B6, B7, B8; G - SRT A1(a-b), A2, A3, B4, B5, C7, C8, D11; G - C A1, A2, A3, A4, B5; G - GPE A1, A2, A3, B4, B5, B6, B7; G - GMD A1, A3, B4; G - MG A1, A2, A3; S - ID A1, A2, A3, A4, B5, B6(a-c), C7, C8, C9; S - IC A1, A2, B3, B4, B5, B6; S - CP A1, A2, A3, B7, B8, B9; S - MD A1, A2, A3, A4, B6, B7

Technology Standards: 8.1.12.A.3, 8.1.12.C.1, 8.1.12.D.1. 8.1.12.F.1, 8.2.12.B.3, 8.2.12.B.5, 8.2.12.C.2, 8.2.12.C.4, 8.2.12.D.3, 8.2.12.E1,

ELA Standards: NJSLSA.R1, NJSLSA.R2, NJSLSA.R4, NJSLSA.R7, NJSLSA.R8, NJSLSA.R9, NJSLSA.W1, NJSLSA.W2, NJSLSA.W3, NJSLSA.W4, NJSLSA.W5, NJSLSA.W6, NJSLSA.W7, NJSLSA.W8, NJSLSA.W9, NJSLSA.SL1, NJSLSA.SL2, NJSLSA.SL3, NJSLSA.SL4, NJSLSA.SL5. NJSLSA.SL6, NJSLSA.L1, NJSLSA.L2, NJSLSA.L3, NJSLSA.L4, NJSLSA.L5, NJSLSA.L6,

21st Century Standards: CRP1, CRP2, CRP4, CRP5, CRP6, CRP7, CRP8, CRP9, CRP11, CRP12, 9.3.ST.1, 9.3.ST.2, 9.3.ST.3, 9.3.ST.4, 9.3.ST.5, 9.3.ST.6, 9.3.ST-ET.1, 9.3.ST-ET.2, 9.3.ST-ET.3, 9.3.ST-ET.4, 9.3.ST-ET.5, 9.3.ST-ET.6, 9.3.ST-SM.1, 9.3.ST-SM.2, 9.3.ST-SM.3, 9.3.ST-SM.4

Suggested Activities:

a. Participate in a variety of activities involving pith balls, electroscopes, a Vand de Graff generator, and a Wimshurst's machine in order to show static electric charges.
b. Work in groups to solve a series of problems in order to strengthen their knowledge and understanding of Coulomb's Law for various charge configurations.
c. Perform an experiment in which they map the electric field lines around various charge configurations using conductive paper and ink.
d. Work in collaborative groups in order to solve for electric fields due to infinite shapes using Gauss' Law.
e. View video clip fro *Potential and Capacitance*. The students will record their thoughts and ideas to be used in a class discussion.
f. Work independently to solve a series of problems designed to strengthen their understanding of the concept of electric potential.
g. Complete a project to design and build a capacitor using teacher specifications and equipment found in the home. Students will then calculate the predicted capacitance.
h. Perform an experiment to map the electric field lines and equipotential surfaces from a parallel plate capacitor using conductive paper and ink.
i. Work independently to solve a series of problems designed to strengthen their understanding of capacitance.
j. Perform an experiment in which students build circuits with capacitors in series and parallel. Students will then calculate and measure the total capacitance of the circuit.
k. Work independently to solve a series of problems designed to strengthen their understanding of capacitors in a series and a parallel circuit.
l. Design an experiment to determine which factors affect the resistance of a conductor. Students will then calculate the resistance of the conductor recombination rates using a model organism.
m. Design an experiment to determine the mathematical relationship of resistors in a series and parallel circuit boards.
n. Work independently to solve a series of problems designed to strengthen their understanding of Ohm's Law.
o. Participate in an activity where they learn, hands-on, how to assemble a circuit and attach voltmeters and ammeters. Students will then observe and measure real phenomenon involving current and voltages. Students will organize and display the data to solve for the resistance.
p. Perform an activity where students compare the brightness of light bulbs in a series and a parallel circuit using a light meter to the electrical power emitted by

the power source. Students will draw inferences from their data to analyze their sources of error.

q. Work independently to solve a series of problems designed to strengthen their understanding of electrical power.
r. Engage in an energy awareness case study. Students will determine ways of conserving energy within their homes and then compare electrical bills from two consecutive months.
s. Perform an experiment to observe the rise and decay of the voltage across the capacitor plates and then will then plot their data and determine the time constant.
t. Work in small groups to solve selected problems based on past AP tests involving rise and decay of current and voltage in an R-C circuit.

3. <u>Magnetism and Electromagnetism (6-8 weeks)</u>

- Identify the sources of magnetic fields and be able to map magnetic field lines.
- Explain the physics of a charged particle moving in a magnetic field.
- Calculate the magnetic forces due to a current carrying wire.
- Display an understanding of Ampere's Law and solve problems involving the same.
- Apply the concepts of net magnetic fields to solenoids and toroids.
- Understand the causes of changing magnetic flux and induction.
- Apply Faraday's Law and Lenz's Law to problems.
- Understand the design of an inductor and the concepts of mutual and self-inductance.
- Construct an R-L circuit and solve for current.
- Correlate the symmetries between electricity and magnetism by using Maxwell's Equations.
- Understand the mechanics of an L-C oscillating circuit.
- Understand the effects of alternating current sources in an R-L-C circuit.
- Calculate the impedance, phase angles and power in a series R-L-C circuit.
- Display an understanding of the functions of a transformer.

<u>Standards Covered:</u>
Science Standards: HS-ETS1-2, HS-ETS1-4, HS-PS2-1, HS-PS2-2, HS-PS2-4, HS-PS2-5, HS-PS2-6, HS-PS3-1, HS-PS3-2, HS-PS3-5, HS-PS4-1, HS-PS4-2, HS-PS4-5,

Math Standards: N- RN A1, A2, B3; N - Q A1, A2, A3; N - VM A1, A2, A3, B4(a-c), B5(a-b); A - SSE A1(a-b), A2, B3(a-b), B4; A- APR A1, C4, C5, D6, D7; A - CED A1, A2, A3, A4; A - REI A1, A2, B3, B4(a-b), C5, C6, C7, D10, D11, D12; F -IF A1, A2, A3, B4, B5, B6, C7(a-e), C8(a-b), C9; F - BF A1(a-c), A2, B3, B4(a-d), B5; F - LE A1(a-c), A2, A3, A4, B5, F - TF A1, A2, A3, A4, B5, B6, B7, C8, C9; G - CO A1, A2, A3, B6, B7, B8; G - SRT A1(a-b), A2, A3, B4, B5, C7, C8, D11; G - C A1, A2, A3, A4, B5; G - GPE A1, A2, A3, B4, B5, B6, B7; G - GMD A1, A3, B4; G - MG A1, A2, A3; S - ID A1, A2, A3, A4, B5, B6(a-c), C7, C8, C9; S - IC A1, A2, B3, B4, B5, B6; S - CP A1, A2, A3, B7, B8, B9; S - MD A1, A2, A3, A4, B6, B7

Technology Standards: 8.1.12.A.3, 8.1.12.C.1, 8.1.12.D.1. 8.1.12.F.1, 8.2.12.B.3, 8.2.12.B.5, 8.2.12.C.2, 8.2.12.C.4, 8.2.12.D.3, 8.2.12.E1, NJSLSA.R1, NJSLSA.R2, NJSLSA.R4, NJSLSA.R7,

ELA Standards: NJSLSA.R8, NJSLSA.R9, NJSLSA.W1, NJSLSA.W2, NJSLSA.W3, NJSLSA.W4,

NJSLSA.W5, NJSLSA.W6, NJSLSA.W7, NJSLSA.W8, NJSLSA.W9, NJSLSA.SL1, NJSLSA.SL2, NJSLSA.SL3, NJSLSA.SL4, NJSLSA.SL5. NJSLSA.SL6, NJSLSA.L1, NJSLSA.L2, NJSLSA.L3, NJSLSA.L4, NJSLSA.L5, NJSLSA.L6,

21st Century Skills Standards: CRP1, CRP2, CRP4, CRP5, CRP6, CRP7, CRP8, CRP9, CRP11, CRP12, 9.3.ST.1, 9.3.ST.2, 9.3.ST.3, 9.3.ST.4, 9.3.ST.5, 9.3.ST.6, 9.3.ST-ET.1, 9.3.ST-ET.2, 9.3.ST-ET.3, 9.3.ST-ET.4, 9.3.ST-ET.5, 9.3.ST-ET.6, 9.3.ST-SM.1, 9.3.ST-SM.2, 9.3.ST-SM.3, 9.3.ST-SM.4

Suggested Activities:

a. Participate in an activity in which students map the magnetic field lines formed from iron filings and compasses placed near various magnets.
b. View video clip from *Magnetism* and then take notes in order to answer teacher-directed questions.
c. Work in small groups to solve a series of problems designed to strengthen the concepts of cross product, right-hand rule, and circular motion.
d. Research the causes of the Aurora Borealis. They will then present their findings both written and orally.
e. Perform an experiment where they calculate the strength of the magnetic field produced in a coil of wire using the current-balance equipment.
f. Work in small groups to solve a series of problems designed to strengthen their ability to solve magnetic forces due to current.
g. Work in collaborative groups in order to solve for magnetic fields due to current-carrying wires.
h. Perform an experiment using a rheostat as a solenoid in order to measure the magnetic field as a function of current and location.
i. Participate in an investigatory activity to deduce inductance as an effect of changing magnetic flux through a series of experimental observations.
j. Engage in hands-on demonstrations of Faraday's Law of induction and Lenz's Law by use of a galvanometer and magnets with copper tubing. Students will take notes on observations and attempt to explain.
k. Work in small groups to solve selected problems based on past AP tests involving Faraday's Law and Lenz's Law.
l. Complete a project to design and build an inductor, using teacher specifications and equipment found in the home and then calculate the predicted inductance.
m. Use knowledge of calculus to derive expressions for inductance of various shapes.
n. Perform an experiment to observe the rise and decay of the voltage within an R-L circuit. Students will then plot their data and determine the time constant.
o. Work independently to solve a series of problems designed to strengthen their understanding of inductance and its role in an R-L circuit.
p. View video clips from *Maxwell's Equations* and take notes in order to answer teacher directed questions.
q. Work with a partner to identify the similarities between a mechanical oscillator and electromagnetic oscillations.
r. Work independently to solve a series of problems in order to strengthen their knowledge of angular frequency in an L-C circuit.
s. Participate in a classroom activity to take apart a speaker to view the internal circuit elements. Students will then identify the elements and explain the function of each.
t. Use knowledge of calculus to derive expressions for impedance, reactance, phase

constant, and resonant frequency.

u. Work in groups to resolve a series of problems designed to strengthen their knowledge of R-L-C circuit parameters.
v. Research the sources of power in a typical home, and prepare an oral presentation stating the design of the power source and the need for a transformer.
w. Work independently to solve a series of problems designed to strengthen their understanding of transformers and RMS values.