AP® Physics 1 and 2
Instructor: Gabriel de la Paz

Overview:
AP® Physics 1 and 2 is a science course designed to replicate a full year of an algebra/trigonometry based course of the type traditionally known as "college physics." The course includes topics in kinematics, dynamics, energy, momentum, oscillations, fluid mechanics, thermodynamics, electrostatics, DC circuits, magnetism, optics, waves, quantum physics, atomic physics, and nuclear physics.

The design of the course is based on a teaching methodology known as modeling, in which students learn physics by constructing scientific models that underlie each unit specifically, and physics in general. Where possible, each unit begins with an experiment in which students begin to flesh out one or more physical relationships that serve as a basis for a scientific model. After analyzing one or more experiments, student lab groups present their findings to the class, leading to class discussion to begin formal development of the model. These models are often expressed verbally, graphically, mathematically, and diagrammatically.

Most students enter the course with this methodology well understood, having practiced it through the Honors Freshman Physics course developed during the 9th grade. In this preliminary course students have already developed models to represent uniform motion, uniformly accelerated motion, forces, and energy, and have developed a laboratory portfolio that documents the initial development of each model. The portion of this course makes liberal use of the foundation built during the previous course.

Textbook:
College Physics, AP Edition
Eugenia Etkina, Michael Gentile, Alan van Heuvelen
Pearson ©2014

Evaluation:

Semester grades are assigned based on
- Exams (Summative)—30%
- Laboratory (Formative)—20%
- Quizzes (Formative)—25%
- Prep/Practice (Formative)—5%
- Final Exam (Summative)—17%
- Paths To A Plus (Summative) —3%

Exams:
Each major unit will be followed by an 80-minute exam. The exams are broken into two parts, approximately half multiple choice and half free response, to simulate the structure of the AP® Physics 2 Exam that will be taken in May. The AP® Physics Exams have two sections, multiple-choice and free response, which are weighted equally. The multiple-choice section contains 40 questions for which 80 minutes are allowed. The free-response section has 4 questions for which an additional 100 minutes are allowed.

Each unit test for the course will therefore typically contain approximately 10-20 multiple-choice questions, and 1-2 free-response questions to be completed in an 80-minute session. The nature of the multiple-choice and free-response questions is intended to replicate the style and difficulty of the questions that appear on the AP® Physics Exams. You will be allowed to do test corrections to recover credit up to 90% (You will receive the average of your original grade and corrected grade up to a maximum of 90%). If you miss an exam, you will be assigned a grade of "Insufficient Evidence" (0%) until you make up the exam within 5 days of your return during Greyhound Time/Lunch. Failure to make up the exam within this time frame will result in a grade of "Final Missing" (48%)

Laboratory:

Where possible, each major unit begins with one or more laboratory investigations, designed to build a physical foundation for the scientific model building process. Students will be engaged in laboratory work for at least 25% of the time in the class. These investigations are open-ended, with no hint as to expected outcomes. They typically begin with a class discussion about a particular system, leading to an experimental design and specification of which variables and relationships should be investigated. Formal experimental procedure handouts are avoided, although, in the interest of time, parameters for variables are typically suggested. Each guided inquiry investigation includes a session in which students prepare a whiteboard to present and discuss their results with the class. In these whiteboard sessions, students are expected to use the principles of scientific argumentation (claims, evidence, and questioning). Limitations to the model are also discussed during this scientific argumentation session. This process leads to the development of the model and various ways that it might be represented.

In addition to such investigations, experiments are often performed with the primary purpose of applying concepts or "deploying models" that have been developed in the unit. These can take the form of small group experiments, or individual, small group, or whole class lab practicums. In such experiments, nature is the judge as to student success in the application of models.

A high percentage of both types of laboratory activities make use of computer based data collection technology including photogates, motion detectors, force probes, force plates, temperature probes, pressure sensors, computer-connected balances, magnetic field sensors, microphones, light sensors, and spectrometers, most connected to the computer through an appropriate computer interface. Other standard physics laboratory equipment is also used throughout the course, with experience with "low-tech" techniques provided where appropriate.

The specific laboratory activities that are part of each unit are specified in the section of this document that describes those units in more detail.

Each spring, students in AP Physics attend an all day field trip to attend Physics Day at Six Flags St. Louis amusement park. Students are expected to collect and analyze data for multiple rides. This experience provides the opportunity for students to apply multiple enduring understandings in a real world setting.

Lab discussion typically occurs the day after the lab is performed. For this reason, any lab assignments not submitted in Google Classroom by the due date will be assigned a grade of "Final Missing" (48%).

Quizzes:
Quizzes will be given once a week on Friday. They are used to assess student progress in applying concepts at various stages of a unit. Each quiz will be over new material as well as reassessing the previous week's quiz material. Sometimes, a lab practicum is used to assess student understanding of the model being developed in a unit, and often counts as a quiz grade. Because of the frequency of quizzes, make ups will not be necessary until more than two quizzes are missed in a quarter.

Prep and Practice:
Beyond the work done outside of class in preparing lab reports and reading assignments, students are frequently engaged in homework assignments that require conceptual explanation and/or quantitative problem solving. This work comes from a variety of sources including worksheets from the Modeling Program at Arizona State University, selected problems from the Etkina textbook, old AP Physics B free response questions with particular emphasis on the current unit of study, teacher produced worksheets and problem sets, and a variety of other possible sources. This work (like almost all other work other than exams and quizzes in this class) will be turned in electronically. Because of the pace of this class, work turned in after the due date will not be accepted for credit and will be marked as "Final Missing" (48%).

Final Exam:
The final exam for each semester will be a practice AP Physics 1 or 2 exam. All students will take the final exams, regardless of whether they are signed up to take the AP exams in the Spring.

Paths To A Plus:

Each semester grade will be capped at 97% unless students complete one of the "Paths To A Plus." A student can earn a grade of A+ for each semester upon completing one of the following paths:

- Project Path—the student must design, execute, analyze, write up, and present an experiment not included in the curriculum. This project must be approved by the teacher before the second week of the second quarter of each semester.
- Competition Path—At the end of each semester, there will be a build competition. Placing first or second in the competition will satisfy the path requirements. Additionally, second semester there are numerous physics competitions in which placing well will satisfy the requirements. Examples include: TEAMS, Academic Challenge (formerly WYSE), SLAPT Physics Contest, and the F=ma Contest.

Personal Electronic Devices

Our goal at Clayton High School is always to maintain a distraction free, academic environment. With this in mind, the use of electronic devices such as (but not limited to) cell phones and earbuds is prohibited during instructional time. Smart watches and similar wearable devices should be placed in airplane or school mode. The expectation is that all students will have these devices put away during instructional time unless the teacher has given permission for use in a specific instructional activity. Students who violate the personal electronic device expectations will be subject to progressive disciplinary consequences including, but not limited to, loss of privileges. Exceptions to this rule may apply based on accommodations included in a student's 504, IEP or health plan. As a reminder, students should only access the internet through district-provided networks during the school day.

Attendance

Clayton High School values students being in class every day and recognizes the importance of regular student attendance to a successful learning experience. CHS recognizes that frequent absences of students from regular classroom learning experiences disrupt the continuity of the instructional process and that the benefits of classroom instruction, once lost, cannot be entirely regained. Partnering with the families of Clayton High School to increase student attendance has been mission critical. With these partnerships in mind and valuing the learning experience, below is our expectation of student attendance for all classes:

A student will not be allowed more than EIGHT (8) absences per semester, excused or unexcused. On the ninth absence, "No Credit - Absences" (NCA) will be issued for the class. Students will need to serve a Greyhound Time detention to mitigate a class absence (One detention served will count for one class absence removed). If the student is failing the course at the end of the semester, an "F" will override the "NCA." If the student is passing the class, an "NCA" will appear on the grade report to indicate that a passing grade was earned but credit was not awarded for that course due to lack of attendance in the class. For more information, please reference this document.
*Please note, Religious Observances, while excused, do not factor into the count of 8+ absences.

Greyhound Time

Clayton High School provides a common time each day to support the academic and personal growth of students. This time may be used in a variety of ways such as academic support (tutoring, reassessment, conferences), club meetings, LINK Crew meetings, exercise and mental wellness activities. While students are encouraged to be proactive in meeting their academic needs, teachers may require students to come to office hours for additional assistance. The expectation is that students will prioritize their academic needs during this time. Failure to comply with teacher requests may result in a loss of privileges until their academic obligations are met and/or appropriate disciplinary action.

Course Outline and Objectives:

The remainder of this document outlines the topics and major concepts for each unit of the course. Units 1-8 comprise the AP Physics 1 curriculum while AP Physics 2 consists of units 9-15.

Unit 0: Introduction

- Systems of measurement and scientific conventions
- Scientific notation
- Significant Figures
- Unit Conversion and Dimensional Analysis
- Experimental Design
- Graphical and Mathematical Analysis of Data (including hand and computer generated graphs)

Unit 1: Kinematics

- Development of position and time as variables required to describe motion
- Graphical analysis of position vs. time graphs with development of the physical significance of the slope of the graph as velocity.
- Graphical analysis of velocity vs. time graphs with development of the physical significance of the slope of the graph as acceleration.
- Graphical analysis of velocity vs. time graphs with development of the physical significance of the area under the graph as displacement.
- Development of mathematical models for kinematics including uniform and uniformly accelerated motion based on graphs and algebraic manipulation.
- Apply the general model of uniformly accelerated motion to the specific case of free fall.
- Add and subtract displacement vectors in one, two, or three dimensions
- Add and subtract velocity vectors in one or two dimensions and apply to relative motion.
- Add and subtract force vectors to determine the resultant force on a system or the equilibrant for a set of forces.
- Describe the horizontal and vertical components of the motion of a projectile.
- Understand the independence of those motions in order to determine the position or velocity components of the object at any point in its flight.

Unit 2: Newton's Laws of Motion Review/Extension

- Understanding the concepts of mass and gravitational force (weight) and their difference
- Using force diagrams (free-body diagrams) to represent the forces on a system
- Static systems in equilibrium
- Using force diagrams to develop equations to describe systems from a force perspective
- Describing the motion of systems experiencing no net force
- Describing the motion of systems experiencing a constant net force
- Understanding the effect of changing the net force on the motion of a system
- Understanding the effect of changing the mass of a system on its motion
- Formal development of Newton's 2nd Law, and understanding of Newton's 1st Law as a special case of it.
- Understanding the nature of force as an interaction and the concept of "force pairs"

- Formal development of Newton’s 3rd Law
- Static friction, qualitative and quantitative models
- Kinetic friction, qualitative and quantitative models graphs of frictional force vs. normal force as objects as the mass of the object being pulled is increased for both static and kinetic friction. Compare results with groups using different surfaces.)
- LP – Individual lab practicum where students are given an air track and a glider of known mass and are expected to produce a falling mass that will cause an acceleration of somepredetermined amount.
- Develop concept of centripetal acceleration as radial component of the acceleration of an object moving in a circular path, and corresponding mathematical model.
- Use force diagrams (free-body diagrams) to determine unknown forces on objects moving in circular paths
- Apply centrally bound force model to systems moving in horizontal circles
- Apply centrally bound force model to systems moving in vertical circles
- Newton’ s Law of Universal Gravitation
- Using Newton’s Law of Universal Gravitation along with circular motion to predict behavior of satellite/planetary systems
- Kepler’ s Laws

Unit 3: Energy

This unit is primarily a review of the energy unit from freshman physics. The various ways in which energy can be stored in a system and transferred into or out of a system are explored. Introduction to concept of efficiency.

- Conservation of energy
- Modes of energy storage including kinetic energy, elastic energy, gravitational energy, internal energy, chemical energy
- Modes of energy transfer including working, heating, and radiating
- Development of energy representational tools including pie charts and bar graphs
- Understanding the significance of the area under a force vs. position graph as work or some other means of changing how energy is stored in a system
- Calculating work in specific cases of a constant force on an object undergoing a specific displacement
- Using analysis of systems and representational tools to develop and solve energy equations for systems
- Power
- Using Newton’s Law of Universal Gravitation along with circular motion to predict behavior of satellite/planetary systems
- Kepler’ s Laws

Unit 4: Momentum

- Develop concept of center of mass and how it is determined.
- Develop concept of momentum and its vector nature
- Develop concept of impulse and its vector nature
- Explore quantitative relationship between impulse and momentum
- Understand impulse as the area under a force vs. time graph
- Conservation of linear momentum

- Application of conservation of linear momentum in one dimension
- Application of conservation of linear momentum in two dimensions
- Energy considerations during sticking and bouncing collisions and explosions

Units 5 and 6: Rotational Topics

- Develop rotational analogs to position, velocity, acceleration, mass, force, kinetic energy and linear momentum—angular position, angular velocity, angular acceleration, moment of inertia, torque, rotational kinetic energy, and angular momentum
- Use concepts of force torque to analyze systems in static equilibrium

Unit 7: Oscillations

- Requirements for simple harmonic motion
- Position vs. time, velocity vs. time, and acceleration vs. time relationships for systems undergoing simple harmonic motion
- Kinetic energy vs. time, elastic energy vs. time, total energy vs. time relationships for systems undergoing simple harmonic motion
- Periodic motion concepts including period, frequency, amplitude
- Appropriate expressions for position, velocity, and acceleration as a function of time for systems in simple harmonic motion, expressed in terms of sinusoidal functions
- Recognize points of maximum and minimum position, velocity, and acceleration for systems undergoing simple harmonic motion, and the phase relationship among the graphs of those quantities vs. time
- Factors affecting period of system undergoing simple harmonic motion
- Factors affecting period of a simple pendulum system

Unit 8: Fluid Mechanics

Develop concepts of hydrostatic pressure, density, buoyancy and fluid flow and the relationships among them.

- Hydrostatic Pressure and its relationship to density, gravitational field strength, and depth.
- Pascal' s Principle
- Buoyancy and Archimedes' Principle
- Fluid flow continuity
- Energy considerations in Fluids and Bernoulli's Equation

Unit 9: Thermodynamics

Develop concepts relating temperature, heat, kinetic theory, and thermodynamics

- Mechanical Equivalent of Heat
- Heat Transfer and Thermal Expansion
- Kinetic Theory
- Ideal Gases
- Understanding pressure vs. volume graphs
- Isothermal, Adiabatic, Isobaric and Isochoric processes in thermodynamic systems
- The First Law of Thermodynamics

- Energy transfers (heating and working) during expansion and compression of thermodynamic systems
- Understanding meaning of area under sections of pressure vs. volume graphs and sections enclosed by pressure vs. volume graphs.
- Efficiency of heat engines
- The Carnot Cycle
- The Second Law of Thermodynamics

Unit 10: Electrostatics

- Conductors vs. insulators
- Methods of charging-polarization, conduction, induction
- Coulomb' s Law
- Electric fields
- Electric Potential
- Capacitance and capacitors
- Dielectrics

Unit 11: Electric Circuits

- Current
- Resistance and resistivity
- Electric potential difference
- Steady state direct current in systems with batteries and resistors
- Ohm's Law
- Series and Parallel Circuits
- Equivalent Resistance
- Kirchoff' s Laws
- Power dissipation in resistive circuits
- Capacitors in circuits, Steady and transient states

Unit 12: Magnetic Fields and Electromagnetism (3 weeks)

- Permanent Magnets
- Magnetic Fields around long current-carrying wires
- Magnetic Fields inside current-carrying loops
- Forces on charges in magnetic fields
- Forces on current-carrying wires in magnetic fields
- Electromagnetic Induction
- Faraday' s Law
- Lenz's Law

Unit 13: Geometric Optics

- Reflection and Plane Mirrors
- Curved Mirrors—converging and diverging
- Refraction
- Dispersion
- Total internal reflection

- Lenses—converging and diverging
- Spherical aberration and Chromatic aberration
- Mathematical models relating image distance, object distance, image height, object height for curved mirrors and lenses
- Ray diagrams for plane mirrors, rays traveling between media, curved mirrors, and lenses
- Focal lengths
- Magnification
- Nature of images produced by curved mirrors and lenses as determined by position of object relative to optical device and foci.

Unit 14: Waves, Sound, Physical Optics

- Traveling waves
- Wave propagation
- Wave behavior at boundary between different media
- Superposition of waves
- Speed, frequency, wavelength relationship
- Quantities which affect wave speed in a given medium
- Standing waves
- Transverse vs. longitudinal waves
- Polarization
- Sound
- The Doppler Effect
- Beats
- Wave diffraction and interference
- Single slits, Double slits, and Multiple slits
- Interference patterns and corresponding intensity vs. position graphs
- Maxima and minima in interference patterns relative to geometry of slits relative to each other and screen
- Young's method for determining wavelength using interference patterns
- Diffraction gratings
- Thin film interference
- Interferometry

Unit 15: Modern Physics

- The Photoelectric Effect experiment and its implications
- The Photon, its energy and momentum
- Compton scattering
- Atomic energy levels and their relation to Emission and absorption spectra for gases
- Wave-Particle Duality
- deBroglie wavelength
- Mass-energy equivalence
- Nuclear reactions and conservation of mass and charge
- Alpha, Beta, and Gamma decay
- Nuclear force, its range and relative strength
- Half-life
- Nuclear fission and Nuclear Fusion