AP Physics:

The course is organized around units that roughly correspond to the chapters in the text. Homework is assigned daily, and the answers are provided on the school website. A test is given at the end of each unit and the homework sets for the unit are due on the day of the test. Labs are completed almost weekly. Two or three labs a year are written up in a formal lab report, but most are kept in their notebooks, which are graded for thoroughness and achievement of the lab objective. In addition, discovery activities are done that are not graded in the notebook. Once a quarter, students are offered an independent study option for extra credit, two examples are given in the syllabus, but depend on discussion topics and student interest.

The text used is: Hecht, Eugene. *Physics: Algebra/Trig*. Pacific Grove, CA, Brooks/Cole Publishing.

I. Kinematics :

1. Units, conversions, dimensional analysis
2. One Dimensional Motion – (Position, Velocity, Acceleration)
3. Vectors Algebra
4. Relative Velocity and Acceleration
5. Projectile Motion

Open Ended Lab: Kinematics of a Student – Students use the ticker-tape timer to determine position and velocity of a person while walking for 1 second. Students describe, in a written lab report, the manner of their walking using graphs and their measured and calculated data. The lab is open-ended – students are not given a goal for their walk and are encouraged to draw their own conclusions about their walk.

Discovery Activity- Graph Matching using Vernier Software and Rangefinder

Guided Discovery Lab: Projectiles - Students do a virtual lab using the graphing calculators using sets of parametric equations to determine the range and hang-time for projectiles fired at various angles. Students are instructed to determine the ranges and hang times for angles from 0-90 degrees and report any patterns in the data. Knowledge gained from the results is put into practice while playing a computer game called Howitzer, which has been ported to the graphing calculator. Results are kept in the student's physics notebook as reference.

II. Dynamics-

1. Weight / Mass
2. Newton's Laws
3. One Dimensional Force Problems
4. Connected objects.
5. Two Dimensional Force Problems (including Inclined Planes)
6. Friction

Traditional Lab: Newton's Second Law: Students use dynamics carts, and Vernier smart pulleys connected to a computer, to determine the acceleration of carts under the influence of various forces. Students graph the resulting forces and accelerations to determine the mass of the system. Students are challenged to determine why the mass of the system is constant even though the masses resting on the cart are changed in each trial. Results of the lab are presented in a written lab report.

Guided Discovery Lab: Friction principles – Students use Vernier force sensors and drag Corian® blocks across various surfaces to demonstrate the principles of static and kinetic friction (independence upon area, dependence on Normal Force and surface types, Independence of sliding speed, and nature of static friction. Students are given blocks, masses and a force sensor attached to a computer display; then they are asked to verify each principle of friction using a procedure of their own choosing. The lab is open ended, and the results are kept in their notebook as reference. The computer gives real-time graphs of force v. time.

III. Statics

1. 1st Law of Equilibrium (Two Dimensional Forces)
2. Torque
3. Center of Mass/Gravity
4. 2nd Law of Equilibrium
5. Statics problems applying both laws of equilibrium

Open Ended Lab: Equilibrium of forces – using a force table with spring scales, three forces are shown to be in equilibrium by adding their x and y components. Angles are measured with a protractor and their calculations are kept in their lab notebook.

Open Ended Lab: Proving the entire weight of an object manifests itself at the CG – Students are given a meterstick, a meterstick hanger, scale, and two masses. They are instructed to find the CM of the stick and then devise an experiment to show that the entire mass of the stick appears to manifest itself at the CM of the stick. Results of the lab are kept in the student's lab notebook.

Guided Discovery Lab: Center of Mass of a Person – Students use a sturdy board, and a force scale connected to a computer to determine the position of their own center of mass. Torques are calculated based on the equilibrium of the system, and the position of the CM is determined. The CM's of the class are compared and the relative positions of Male and Female CM's are compared to show that Female CM is lower than Male CM (measured relative to the Hip Socket). Calculations and results are kept in the student's lab notebook.

IV. Work and Energy

1. Work
2. Potential and Kinetic Energy (Elastic, Gravitational, Translational)

3. Power
4. Work - Energy Theorem
5. Conservation of Mechanical Energy

Independent Study Option: Students are invited to construct and video a Rube Goldberg device of their own design and present it to the class.

Traditional Lab: Human Horsepower- Students run up stairs to calculate their personal horsepower. Results are kept in their notebooks and complete historical records are maintained on the school's website for students to reference.

Open Ended Lab: Coefficient of Restitution – Students are given the formula to calculate COR, and provided with various sports balls, a meterstick and a balance. Students devise their own procedure to determine the velocities of each ball before and after an impact. Results are kept in their notebooks.

V. Momentum -

1. Impulse and Momentum
2. Conservation of Momentum
3. Elastic and Inelastic Collisions in one and two dimensions.

Independent Study Option: Students are invited to produce a video presentation of the Physics of Billiards to present to the class.

VI. Rotating Systems -

1. Angular Quantities/Radian Measure (displacement, velocity, acceleration)
2. Centripetal Acceleration
3. Horizontal and Vertical Circular motion.
4. Universal Gravitation Law.
5. Satellite Orbits

Open Ended Lab: The force on an orbiting ball. A whirl – a – gig is used to determine the force needed to maintain a circular orbit of a rubber ball. Students are given access to rulers, scales and stopwatches and asked to determine the force needed to maintain circular motion. The exact procedure is left to the students. Results are kept in their notebooks.

Virtual Lab: Students use a computer program call Gravitation Ltd. to explore gravity on a galactic scale. A virtual planetary system is created and tested by the students.

V. SHM-

1. Hooke's Law
2. Periods of Springs and Pendulums

3. Rotational Motion vs. SHM
4. Position, Velocity, Acceleration and Energy of an Object in SHM

Open Ended Lab: Determine the period of a mass on a spring- Students are provided with springs, masses, and stopwatch and asked to verify that the formula for the period of a mass on a spring is valid. Open ended lab – results kept in notebook.

VI. Gas Laws-

1. Charles, Boyle, Gay-Lussac
2. Absolute Temperature Scales
3. Ideal Gas Law
4. P-V-T processes (Isothermal, Isobaric, Isochoric)

Guided Discovery Lab: Boyle's law – Students use books, piled on syringes, to demonstrate Boyle's law. The results are graphed, and the students are challenged to explain why doubling the number of books on the syringe doesn't cut the volume in half as Boyle's Law predicts.

VII. Heat – Thermodynamics

1. Thermal Expansion
2. Kinetic Theory
3. Laws of Thermodynamics
4. Cyclical Processes
5. Carnot type engines.
6. Heat Flow/Thermal Conductivity

Traditional Lab: Newton's Law of Cooling – Students are provided with hot water and temperature probes. They are instructed to monitor the temperature of a cup of water for enough time to see the a trend in the graphical results. Students present their findings in a formal lab write-up.

VIII. Pressure:

1. Hydrostatic Pressure
2. Pascal's Principal / Hydraulics
3. Buoyancy (Archimedes' Principle)
4. Fluid Flow Characteristics
5. Continuity Equation
6. Bernoulli's Principle/Equation

Open Ended Lab: Archimedes' Principle: Students are asked to prove that the weight of displaced equals the buoyant force. Students are provided with mass cylinders, water, spring scales and rulers.

IX. Static Electricity

1. Coulomb's Law
2. Behavior of Charges on Insulators and Conductors.
3. Charging by Induction and Conduction.
4. Electric Fields around Point Charges, Plates and Lines of Charge
5. Electrical Potential of Point Charges and other Charge Distributions
6. Work done moving a charge across an Electric Field.
7. Gauss' Law

Guided Discovery Lab: Mapping Electric Fields – Students use a computer program to map the electric field lines and equipotential lines around various configurations of static charges. Discovery approach – students are given a time constraint and are challenged to map the fields of four different charge distributions.

Open Ended Lab: Electronegativity- Various materials are rubbed together to determine which objects will become positively and negatively charged. The exact procedure is determined by the students. Students are instructed to construct a scale that ranks materials, in order, from the most negative to the most positive. The results are kept in their notebooks.

X. Current Electricity:

1. Ohm's Law
2. Power
3. Capacitors and Resistors in Series and Parallel Circuits
4. Kirchhoff's Rules
5. Internal Resistance

Guided Discovery Lab: Students are guided to discover the principles of series and parallel circuits. Voltmeters and ammeters are used to measure the voltage drop and current through each identical lightbulb. Students keep the results in their notebooks.

X. Magnetism:

1. Permanent and Temporary Magnets (domains)
2. Fields of Permanent Magnets
3. Fields and Forces due to moving Charges
4. Magnetic Flux
5. Farraday's Law
6. Lenz' Law

Guided Discovery Lab: Students are encouraged to experiment with bar magnets to determine the direction of the magnetic forces experienced by other magnets. Students use a compass needle to map the magnetic force direction at various locations around the bar magnet. A question is posed about the earth's magnetic field and the students

are asked to determine the orientation of the earth's magnetic field. Results are kept in the student's notebook.

XI. Waves and Sound

1. Properties of Traveling and Standing Waves
2. Doppler Effect
3. Interference
4. Fourier Decomposition (Sound Quality)
5. Sound production/Resonance in tubes and strings
6. Musical Instruments

Guided Discovery Lab: Slinkey Waves – Students are provided with slinkeys, springs and strings, and instructed to determine the effect of density, wavelength and amplitude on wave speed. Students also demonstrate interference of waves and investicate the effects on waves as they enter new materials. Results are kept in their notebooks.

Discovery Lab: Students use their accumulated knowledge of waves to construct a musical instrument using drinking straws. Discovery Lab – no results are kept.

XIII Light

1. Nature of Light
2. Reflection/Refraction
3. Total Internal Reflection (Fiber Optics)
4. Geometric Optics (Images formed by Lenses and Curved Mirrors)
5. Interference/Diffraction
6. Color Vision
7. Eye Defects

Guided Discovery Lab: Images in Plane Mirrors – Standard optics kits are used to determine the image position of a pin. The Law of Reflection is verified using a ray tracing method. A guided discovery approach is used and results are kept in the student's notebooks.

Guided Discovery Lab: Determine the Index of Refraction – Standard optics kits are used to determine the index of refraction of water. A guided discovery approach is used and results are kept in the student's notebook.

Discovery Experiment: Students are asked to determine the focal length of a converging lens by focusing the sun's rays to a spot. Students explore the heat produced by the lens by burning small leaves and bits of paper. Students are asked to determine what the spot really is.

XIV Modern Physics-

1. Atomic Models
2. Atomic Spectra
3. Photoelectric Effect
4. Nuclear Decay (Alpha and Beta)
5. Mass and Energy
6. Subatomic Particle Basics
7. Special and General Relativity