

KAP Physics

Course Equivalent at Kenyon College: Physics 140 (Classical Physics)

Course Overview

KAP Physics emphasizes physics knowledge, problem solving, appreciation of the physical world, and understanding connections of physics to other disciplines. This is an advanced course and will be taught at a college level pace. Students are expected to complete assignments on a daily basis including all lab and homework assignments. Laboratory work will be covered as a major part of this course. Concurrent enrollment in calculus is required.

Teaching Strategies

In an effective laboratory program of physics, students are propelled by curiosity to observe and to experiment. In hopes of uncovering deep relationships, students search for patterns among observations, record data, formulate relationships, look at possible counterexamples, and then finally attempt to formally describe the connection they have seen. Students should then communicate it to others and record it for future reference. Accurate communication of ideas is a very important piece of laboratory work.

Other than lab experiments, class time is used for guided inquiry based lecture, class discussions, demonstrations, group work, and problem solving. In a 50-minute class period, the lecture portion typically takes about 20-30 minutes of class-time. The remainder of the time is spent in a variety of the previously mentioned ways. Demonstrations are primarily used to introduce a topic and give students a chance to see the physics. Small group work is often used when students are exploring a new topic or working through homework problems. Students are encouraged to discuss problems with each other. Computer simulations are used when real equipment is not available.

Course Outline (fall semester)

1. Kinematics
 - a. Frame of reference
 - b. Define displacement, average velocity, instantaneous velocity, and average acceleration
 - c. Motion in one dimension
 - d. Free Fall
 - e. Scalars and Vectors, Components of Motion, and Vector addition and subtraction
 - f. Projectile Motion
2. Newton's Laws of Motion
 - a. Concept of Force and Net Force
 - b. Inertia and Newton's 1st Law
 - c. Newton's 2nd and 3rd Law
 - d. Free Body Diagrams
 - e. Friction
 - f. Terminal Velocity and Drag
3. Work, Energy, and Power
 - a. Work done by a constant force
 - b. Work done by a variable force and Hooke's law
 - c. Conservative and Non-conservative forces
 - d. Work-Energy Theorem
 - e. Kinetic Energy
 - f. Potential Energy
 - g. Conservation of Energy
4. Linear Momentum and Systems of Particles
 - a. Linear Momentum
 - b. Impulse
 - c. Conservation of Linear Momentum
 - d. Elastic and Inelastic collisions
5. Circular Motion and Rotation
 - a. Angular Measure

- b. Angular Speed and Velocity
 - c. Uniform Circular Motion
 - d. Relationship between Linear and Angular Variables
 - e. Rigid Bodies
 - f. Moment of Inertia and Torque
 - g. Angular Momentum and Conservation
 - h. Equilibrium: Rotational and Mechanical
 - i. Rolling Motion
6. Oscillations and Gravitation
- a. Simple Harmonic Motion and Pendulums
 - b. Newton's Law of Gravitation
 - c. Kepler's Law and Satellites

Course Outline (winter semester)

1. The Electric Field
 - a. Electric Charge
 - b. Electrostatic Charging
 - c. Coulomb's Law
 - d. Electric Fields
 - e. Conductors and E-fields
2. Guass's Law
 - a. Electric Flux
 - b. Guass's Law
 - c. Various continuous charge distributions
3. Electric Potential
 - a. Potential Energy and Work
 - b. Potential Difference
 - c. Equipotential Surfaces
 - d. Electric Fields and Potential of various charge distributions
4. Capacitors and Dielectrics
 - a. Capacitance
 - b. Equivalent Capacitance
 - c. Cylindrical and Spherical
 - d. Effect of Dielectrics
5. Electric Circuits
 - a. Batteries and Direct Current
 - b. Current
 - c. Kirchoff's Rules
 - d. Equivalent Resistance
 - e. Ohm's Law
 - f. Voltmeters and Ammeters
 - g. Electric Power
 - h. Capacitors in Circuits
 - i. RC Circuits
6. Magnetic Fields and Forces
 - a. Magnets, Magnetic Poles, and Magnetic Fields
 - b. Field Strength
 - c. Magnetic Force on moving charges
 - d. Magnetic Force on current carrying wires
 - e. Biot-Savart Law
 - f. Ampere's Law
7. Electromagnetism
 - a. Electromagnetism and Source of Magnetic Fields
 - b. Faraday's Law

- c. Lenz's Law
- d. Induced emf
- e. Inductance and RL Circuits
- f. Maxwell's equations

Laboratory Experiments

Approximately 15-20 percent of class time is spent on laboratory work. Labs are typically written by me and aimed at providing students an opportunity to experience designing experiments, manipulating equipment, collecting and organizing data, and drawing conclusions based on their data.

The lab report is graded on the student's participation in the actual experiment and the written report that is turned in the following day. Students must keep a detailed lab book that includes each of the following items listed below including a portfolio of the final graded lab reports.

Each lab will typically require:

1. The formation of a hypothesis based on in-class discussion or lectured material
 2. Design of an experiment to test the hypothesis
 3. Collection of data and observations
 4. Calculations using the collected data
 5. Conclusions about how well the hypothesis held up based on their findings
 6. Class discussion of error and variance
 7. Written final report
- Newtonian Mechanics Labs
 - Trig Lab - measure inaccessible heights and distances, castle wall with a moat
 - Motion Detector - compare graphs of distance, velocity, and acceleration
 - Gravity Lab - design multiple experiments to measure g
 - Projectile Motion - find the initial velocity of a dart gun and then predict max range
 - Shoot for your grade - place a target where the ball will land after rolling down an incline
 - Hooke's Law - measure the spring constant of a spring
 - Forces Lab: Friction, Atwood Machines, and Incline Planes
 - Coffin Filter's Terminal Velocity – measure the drag coefficient of the filters
 - Bungee Jumper Lab - designing a bungee cord stunt with a spring acting as a bungee cord
 - Human Horsepower - design and perform multiple experiments to determine the horsepower of a human
 - Egg Drop - understanding momentum and impulse
 - Air Track Collisions - conservation of momentum
 - Balloon Powered Car - thrust lab
 - Uniform Circular Motion - design a lab to solve for an unknown mass hanging from a rotating bob
 - Pendulums (simple and physical) - study the relationship between length, mass, and period
 - Torque and Center of Mass - what makes things balance
 - Electricity and Magnetism Labs
 - Static Electricity – investigating the properties of different materials
 - Coulomb's Law – finding the net charge on hanging balloons
 - Mapping Electric Fields – plotting equipotential and field lines; electric field hockey
 - Ohm's Law and Internal resistance of a Battery
 - Mystery Light Bulb Lab – figuring out how it is wired by looking at the brightness of the bulbs
 - Series and Parallel Circuits – investigate properties of different circuits
 - RC Circuits – build the circuit and find the time-constant by curve fitting techniques
 - Magnetic Fields – investigate various magnetic configurations
 - Solenoid Lab
 - Making an Electromagnet – design a way to make the strongest electromagnetic
 - Ampere's Law

Major Text

We use *Physics for Scientists and Engineers, 6th ed.* by Raymond Serway and John Jewett. It is a traditional calculus-level textbook with great examples and wide variety of homework exercises. Differential and integral calculus is used throughout the course.

Student Evaluation

Quarter grades are computed using homework, labs, and tests as individual categories. Each quarter grade represents 40 percent of the semester grade with the final exam making up the final 20 percent.

- Students are expected to work on homework every night or else it is likely they will fall behind. Homework is discussed in class using guided inquiry where student learning is always the focus rather than just finding out the answer to the problem. Students are forced to think for themselves.
- Tests will typically consist of calculator and non-calculator parts. Tests will also incorporate multiple choice, free response questions, occasionally essay questions, and laboratory questions. Questions from previous AP Exams play an important role in assessment throughout the year. There will be 4-5 tests every quarter depending on the number of topics. Tests will make up about 80% of your grade
- Labs will mainly consist of open-ended questions. Students are provided the objective and a list of equipment, but they must design their own procedure. Lab time is for design, conducting the experiment, and recording data. Students complete the lab report at home including their conclusions and error analysis. After the labs are graded and returned, students organize them in a lab notebook as previously mentioned. There is at least a 2-hour lab every week. Labs will make up about 20% of your grade.

Technology

Teachers use a TI-83 calculator for presentations and every student is required to use a TI-83 or equivalent. Almost all our students have one of the following: TI-83, TI-84, TI-86, or TI-89. We also have eight computers in our classroom that are used during labs or other activities that require computers.

WEBSITE (ECAMPUS)

<http://list.hboe.org/moodle/login/index.php>

It will have bookwork, calendars, worksheets, review sheets, articles, projects, reference material, keys, and helpful links. I will try to update it as much as possible. Ecampus will serve as the class website.

COMMUNICATION

Email is the best way for your parents to communicate with me if they have any questions or concerns. Also, I would highly suggest that your parents or guardians take advantage of the fact that your grades will be posted online and they will have the opportunity to view them at any time to get a real-time update of where you stand in the class.

As a student the easiest way to communicate is to just come and talk to me. If something is obstructing your learning experience, please come and talk to me. We will work on an immediate solution to whatever is disrupting your education.

Email: michael_limbird@hboe.org

➤ HOME ACCESS CENTER

It is now possible to view your student's individual classroom assignments through Home Access Center. You can expect to see scores updated one to two weeks after the assignment is due depending on the size of the assignment.

<https://homeaccess.hboe.org/>