AP Physics B

Course Syllabus 2010-2011

Course Overview: The class consists of 5 periods per week for a total time each day of 1 hour and 30 minutes. The class meets for this time period from the beginning to the end of the school year. There is sufficient time allocated during the class that labs are simply incorporated into the class time.

Texts:

Physics by Daniel Giancoli, 6th edition, published by Pearson Education, 2005, ISBN 0-13-184661-2, primary instructional text

Conceptual Physics by Paul Hewitt, 9th edition, Published by Addison Wesley, 2002, ISBN 0-321-05202-1; supplemental text to reinforce primary text above.

5 Steps to a 5 by Greg Jacobs and Joshua Shuman, 2011-2012 edition; as classwork review and study guide.

In addition, MIT Open Courseware has kindly provided specific content area lectures to reinforce and demonstrate concepts on the Physics B and C exams. This series of lectures and demonstrations is available at: http://ocw.mit.edu/OcwWeb/hs/physics/physics/index.htm

Grading Policy:

Tests- (45%) Test are administered after each unit of material with the exception of the units concerning mechanics and the unit concerning electricity and magnetism which are divided into three tests. Tests always consist of multiple choice questions from the content area, free-response questions, and questions that relate to lab based experiments.

Homework Problems- (15%) Specific problem sets are requested for each focus of the curriculum. They are a combination of non- mathematical problems that indicate a thorough reading of the material and mathematical problems that lead to a mastery of the mathematical concepts.

Class Problems and Quizzes- (10%) Problems and quizzes consist of free response questions that indicate familiarity with recent content.

Laboratory- (30%) The labs are graded based on a thorough understanding of the concepts related to the lab as described in the syllabus. The emphasis is on correct acquisition of data, manipulation of the data including applications of graphical analysis, and finally extension questions related to the lab. The lab grade is largely based on the content of the laboratory notebook, though specific labs may be written up in a formal manner.

Course Syllabus:

The following is a course content outline with an approximate time frame for completion. Testing, problems and quizzes are included in the time frame allocation.

AP Physics B

I. Mathematics Review- (1 week) *Physics*: Chapter 1 with vector component from *Physics*: Chapter 3
   a. Review of algebra
   b. Dimensional analysis- multiplying by "1"
   c. Data collection and analysis
      i. Margins of error
   d. Vectors and calculations involving vectors
      i. Graphical methods of vector analysis
      ii. Algebraic method for vector analysis

II. Kinematics- (10.0 weeks)
   a. Mechanics
      i. Motion in one dimension- *Physics*: Ch 2
         1. Position-time graphs, velocity-time graphs
         2. Motion equations using constant acceleration
      ii. Motion in two dimensions- Chapter 3
         1. Projectile motion
   b. Newton's Laws of Motion- *Physics*: Chapters 4 and 5, *Conceptual Physics:* Chapters 2-5
      i. Static equilibrium- 1^{st} Law
         1. Translational equilibrium
         2. Rotational equilibrium
      ii. Dynamics- 2^{nd} Law
      iii. Systems of two or more bodies- 3^{rd} Law
      iv. Gravitation- *Physics*: Chapter 5, *Conceptual Physics:* Chapter 9
         1. Universal gravitation
         2. Gravitational dynamics
         3. Weightlessness
         4. Kepler's Laws
      v. Applications of Newton's and Kepler's Laws
         1. Inclined planes
         2. Atwood Machine
         3. Static and kinetic friction
         4. Planetary motion- *Conceptual Physics:* Chapter 10
   c. Work, Energy, and Power- *Physics*: Chapter 6, *Conceptual Physics:* Chapter 7
      i. Work and the work energy theorem
      ii. Conservative forces and potential energy
      iii. Conservation of energy

iv. Power

d. Systems of particles, linear momentum- *Physics*: Ch 7, *Conceptual Physics:* Chapter 6
    i. Impulse and momentum
    ii. Conservation of linear momentum: collisions
e. Uniform circular motion- *Physics*: Ch 5, *Conceptual Physics:* Chapter 8
        1. banked curves
        2. non-banked curves
    ii. Torque and rotational statics- *Physics*: Chapter 8
        1. Angular quantities
        2. Rotational inertia
        3. Angular momentum and its conservation
f. Statics- *Physics*: Chapter 9
    i. Equilibrium
    ii. Statics problems
    iii. Stress and strain
g. Oscillations- *Physics*: Chapter 11
    i. Simple harmonic motion
    ii. Mass on a string
    iii. Pendulum and other oscillations

III. **Forces in Fluids**-(2.0 weeks) *Physics*: Ch 10, *Conceptual Physics:* Chapter 13
a. Phases of matter
b. Density and pressure
    i. Specific gravity
    ii. Atmospheric pressure, gauge pressure
    iii. Pascal's Principle
c. Buoyancy and Archimedes Principle
d. Motion in Fluids
    i. Flow rate and the Equation of Continuity
    ii. Bernoulli's Equation

IV. **Heat, Kinetic Theory, and Thermodynamics** (3.0 weeks)*Physics*: Chapters 13, 14, and 15, *Conceptual Physics:* Chapters 15, 16, and 18
a. Atomic Theory of Matter
b. Temperature and heat
    i. Mechanical equivalent of heat
    ii. Specific and latent heat
    iii. Heat transfer and thermal expansion
c. Kinetic Theory and Thermodynamics
    i. Ideal gases
        1. Kinetic model
        2. Ideal Gas Law
    ii. Laws of Thermodynamics
        1. First Law and PV diagrams

2. Second Law and heat engines

V. Electricity and Magnetism (10 weeks)

a. Electrostatics- *Physics*: Chapter 16, *Conceptual Physics:* Chapter 22
   i. Charge, field and potential
      1. Electric charge
      2. Conductors and insulators
      3. Coulomb's Law
      4. Fields and field lines
   ii. Electric Potential Energy
      1. Potential difference and electric fields
      2. The electron volt
      3. Capacitance and dielectrics

b. Conductors and Capacitors- *Physics*: Chapter 17
   i. Electrostatics with conductors
   ii. Capacitors- parallel plates

c. Electric Circuits- *Physics*: Chapters 18 and 19, *Conceptual Physics:* Chapter 23
   i. Current
   ii. Resistance
      1. Ohm's law
      2. Resistivity
   iii. Power
      1. AC circuits
      2. DC circuits
      3. RC circuits

d. Magnetostatics- *Physics*: Chapter 20, *Conceptual Physics:* Chapter 24
   i. Forces on moving charges in magnetic fields
      1. Electric currents and magnetic fields
      2. B
   ii. Forces in current carrying wires in magnetic fields
      1. Ampere's Law
      2. Magnetic moment
   iii. Fields of long current carrying wires

e. Electromagnetic induction- *Physics*: Chapter 21, *Conceptual Physics:* Chapter 24
   i. Induction- Faraday's Law
   ii. Magnetic flux produces an electric field
   iii. Transformers
   iv. Uses of induction
   v. Electromagnetic Waves are produced by accelerating electric charge

VI. Waves and Optics (3.0 weeks)

a. Types of waves- *Physics*: Chapters 11
   i. Wave energy
   ii. Wave properties

1. frequency, and wavelength
2. speed of waves
    a. sound
    b. light

iii. Longitudinal and transverse waves

b. Sound- *Physics*: Chapter 12, *Conceptual Physics:* Chapter 20
    i. Intensity: decibel
    ii. Strings and columns
    iii. Superposition
    iv. Beats
    v. Doppler
    vi. Sound applications
c. Wave motion- *Physics*: Chapters 22 and 24
    i. Properties of travelling and standing waves
    ii. Interference and diffraction
d. Light and the Electromagnetic spectrum- *Conceptual Physics:* Chapter 26
e. Geometric Optics- *Physics*: Chapter 23 and 25, *Conceptual Physics:* Chapter 28
    i. Ray diagrams and magnification
    ii. Reflection
        1. Plane mirrors
        2. Diverging and converging mirrors
    iii. Lenses and refraction
        1. Index of refraction and Snell's Law
        2. Diverging and converging lenses
    iv. Optical instruments
f. Interference
    i. Single and double slit interference
    ii. Spectroscopy
    iii. Diffraction
    iv. Polarization

VII. Modern Physics (2.0 weeks)

a. Relativity- *Physics*: Chapter 26, *Conceptual Physics:* Chapter 35
    i. Galilean –Newtonian Relativity
    ii. Special Relativity
        1. Time dilation
        2. Length contraction
        3. The Ultimate Speed and energy- mass relationships
        4. Relativistic momentum and mass
b. Atomic physics and quantum effects- *Physics*: Chapters 27 and 28, *Conceptual Physics:* Chapter 32
    i. Elementary particles and models of the atom
    ii. Alpha particle scattering and the Rutherford Model

iii. Photons and the photoelectric effect
iv. Wave-particle duality
v. The wave nature of matter
    1. The Bohr model of the atom
    2. Atomic spectra
vi. Heisenberg and Probability vs. Determinism
vii. Quantum numbers
    1. The Elements
    2. Fluorescence

c. Nuclear Physics and Radioactivity- *Physics*: Chapters 30-32, *Conceptual Physics:* Chapter 33
    i. Nuclear forces
        1. Strong and weak force
        2. Radioactivity
            a. α decay
            b. β decay
            c. Gamma decay
            d. Half life and rates of decay
    ii. Nuclear reactions
        1. Fission
        2. Fusion
    iii. Elementary particles
        1. Particles and anti-particles
        2. Neutrinos
        3. Quarks
    iv. The Standard Model and Grand Unified Theories

Laboratories: I believe physics should be a hands-on exploration of the physical world and think that a great deal of understanding is gained by the creation and subsequent execution of any lab. As the class investigates topics through the course, many of the laboratories listed below may be presented to the students in the form of a problem. Very often a demonstration of a physical phenomenon will be presented to the class and an explanation of the event will be requested. Students will be broken into small groups and encouraged to discuss and debate among themselves about possible hypotheses explaining the phenomena. They are to identify the variables that are at work in the phenomenon and then to decide how those variables may be manipulated given the available equipment and time. They are to design an experiment or experiments using the tools at hand by developing ways of isolating and manipulating these variables to test their hypotheses. Observations and, whenever possible, measured data will be taken from these tests. Results will be presented to the class and judgments will be made as to what conclusions can be drawn from the data, including possible experimental errors and how the experiment could be improved or expanded. Finally at the end of their experimentation, when data has

been produced and analyzed, students will be presented with the "expected" result. The students are to discuss possible reasons for their variation from the expected result (error analysis). In their laboratory notebooks, the students will produce a formal report summarizing the following: the problem or question to be addressed, constructing a hypothesis, a careful recording of the experimental procedure, a record of data and or observations, calculations and formula used to manipulate data, and finally the conclusions and error analysis.

I. **Kinematics**

Measurements: objective- measuring length with calipers, determining margins of error
Velocity: objective- using CPO timers to calculate velocity using short distances and incremental times. Expand the data to also calculate and graph changes in acceleration.
Projectile motion: objective- calculating range and height by using formula and then comparing hypothetical calculations to actual data results.
Gravity: objective: calculate acceleration due to gravity of falling bodies.
Vectors and Forces: objective- experimentally calculating forces using a force table. Compliment calculations by repeating experiment analytically.
Coefficients of friction: objective- the "μ" of the shoe. Calculating coefficients of friction for various objects and materials
Momentum: objective- Calculate momentum of elastic and inelastic collisions using dynamics carts and air tracks.
Inclined planes: objective- determine the impact of angles on acceleration due to gravity
Conservation of KE and PE: objective-analytically determine a mass using an Atwood's machine. Experimentally determine the mass of an unknown.
Centripetal Force: objective- Determine the relationship between the period, mass, speed, and radius of an object in uniform circular motion.

II. **Forces in Fluids**

Archimedes's Principle: objective- Determine the type of an unknown metal wire using Archimedes's Principle of displacement.
Buoyant force: objective- Experimentally determine the buoyant force of an object

III. **Heat, Kinetic Theory, and Thermodynamics**

Thermal expansion: objective- analytically determine expansion of a known, repeat using experimentation. Determine unknown by experimentation using thermal expansion.

IV. **Electricity and Magnetism**

Static electricity: objective- producing attractive and repulsive forces using a variety of objects.
Resistance: objective- determining resistance using a Wheatstone Bridge.
Series and Parallel circuits: objective- building series and parallel circuits and experimentally testing voltage, current, and resistance.
Magnetic fields: objective-drawing magnetic fields produced by different strengths of magnets; the relationship of field size to filed strength.

V. **Waves and Optics:**

Mirrors: objective- analytically determine image distance, focal length or radius of curvature in concave mirrors then experimentally each for unknown mirrors.

The Lensmaker's Equation: objective- analytically determine image distance, focal length or object distance then experimentally each for unknown convex mirrors.

Total internal reflection: objective- analytically and experimentally determine the critical angle of refractive substances.

VI. Modern Physics

Absorption and Emission Lines: objective: gas discharge tubes and diffraction gratings are used to demonstrate emission lines of a variety of elements. Predictions regarding unknown gases are made and explored analytically and experimentally.