GREAT PLAINS TECHNOLOGY CENTER
COURSE OF STUDY

Career Cluster: Science, Technology, Engineering and Mathematics

Career Pathway: Engineering and Technology

Career Major: Pre-Engineering Mechanical

Course Title: AP Physics B

Course Length: Secondary Students: 131.25 Hours

Instructor: Tracy Wicker
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Certifications: Oklahoma Department of Education Standard Teaching Certificate
Project Lead the Way Certified in Principles of Engineering
Computer Integrated Manufacturing, and AP Physics B

Credits: 1 unit of credit per year

Prerequisites: Algebra II or above; High school junior or senior; School counselor/ Principal recommendation; Concurrent participation in 2nd year Pre-Enginering courses.

Course Description:

In this uniquely focused learning environment, that of a pre-engineering academy, this AP Physics B course covers the second half of the AP Physics B Course Objectives and is taught in a full year with depth of content in mind, therefore, this is the second year of a two year sequence. To complete the full AP Physics B Course, both classes Pre-AP and AP Physics must be successfully completed at this pre-engineering academy to qualify for taking the AP Physics B test.

"Pre-AP Physics B" content will include Newtonian Mechanics (excluding oscillations), Heat, Kinetic Theory, and Thermodynamics, while "AP Physics B" content will include Electricity and Magnetism, Waves (including oscillations) and Optics, and Modern Physics. Both courses comprise the entire AP Physics B course objectives as prescribed by the College Board/Advanced Placement Program.

This general course will include theoretical aspects of physics concepts, mathematical problem-solving techniques, and experimental laboratory activities. The laboratory component of the course will consist of hands-on activities utilizing both calculator-based and traditional devices for data collection and analysis. Most labs are of the "design" format, such that they are presented as a problem to be solved or a question to be answered.

Course Goals:

Students successfully completing this AP Physics B program and adequately performing on the College Board exam will be eligible for college credit which typically applies toward an engineering technology degree in most university programs. If a student is planning to seek an engineering degree, a calculus-based physics course, AP Physics C is required. Students need to be fully aware of college major requirements. This course, in all aspects, will prepare a student to be successful in any college level physics.

<u>Course Objectives and Outline</u>

Chapter 13-Vibrations and Waves (Theory 40%, Hands-On 60%) **<u>August</u>**

I. NEWTONIAN MECHANICS (continued from Pre-AP Physics B, year one)

F. Oscillations

1. Understand simple harmonic motion:
   - a) Sketch/identify graph of displacement verses time, determine amplitude, period, and frequency.
   - b) Write expression for displacement in the form Asinωt or Acosωt.
   - c) Identify points where velocity is zero, maximum positive or negative.
   - e) State qualitatively relation between acceleration and displacement.
   - f) Identify points where acceleration is zero, maximum positive or negative.
   - h) Apply relation between frequency and period.
   - j) State how total energy of oscillating system depends on amplitude, sketch/identify graph of KE or PE as function of time, and identify points where energy is all KE or PE.
   - k) Prove sum of KE and PE is constant.
2. Apply knowledge of simple harmonic motion to mass on a spring:
   - b) Apply expression for the period of oscillation of a mass on a spring.
3. Apply knowledge of a pendulum:
   - b) Apply expression for the period of a pendulum.
   - c) State approximation must be made in deriving period.

<u>Lab-Pendulum Periods using CBL/TI84 Calculator, Vernier Photogate and other equipment</u>
<u>Lab-Hooke's Law Design Lab</u>

Chapter 14-Sound (Theory 40%, Hands-On 60%) **<u>September</u>**

IV. WAVES AND OPTICS (15% of topics tested on Physics B exam)

A. Wave Motion

1. Understand traveling waves:
   - a) Sketch/identify graphs of traveling waves and determine amplitude, wavelength, and frequency.
   - b) State and apply relation of wavelength, frequency, and velocity.
   - c) Sketch/identify graphs describing reflection from fixed or free end of a string.
   - d) Know qualitative factors determining speed of waves on a string and speed of sound.
2. Understand standing waves:
   - a) Sketch standing wave modes for a stretched string fixed at both ends, and determine amplitude, wavelength, and frequency.
   - b) Describe possible standing waves in an open or closed end pipe and determine wavelength and frequency.
3. Understand Doppler Effect:
   - a) Explain mechanism causing frequency shift in moving-source and moving-observer, and derive expression for frequency heard by observer.
   - b) Write and apply equations for moving-source and moving-observer Doppler Effect; and sketch/identify graphs.
4. Understand principle of superposition to apply to traveling waves in opposite directions.

<u>Lab-Sound Waves using a Vernier Microphone/CBL/TI84 Calculator and tuning forks</u>

Chapter 15-Electric Forces and Fields (Theory 90%, Hands-On 10%) **<u>October</u>**

II. ELECTRICITY AND MAGNETISM (25% of topics tested on Physics B exam)

A. Electrostatics

1. Charge, Field, and Potential

a) Understand concept of electric field:

(1) Define force on a test charge.

(2) Calculate magnitude and direction of force on a positive or negative test charge

(4) On a diagram of electric field flux lines, determine direction of field, locations where field is strong and weak, and where positive and negative charges must be present.

(5) Analyze motion of a particle of specific charge and mass within an electric field.

b) Understand electric potential:

(1) Calculate electric work done on a positive or negative change moving through a potential difference.

(2) Determine direction and magnitude of electric field given a sketch of equipotentials for a charge configuration.

(3) Apply conservation to determine speed of a charged particle accelerated through a potential difference.

(4) Calculate the potential difference between two points in a uniform electric field.

2. Coulomb's Law and Field and Potential of Point Charges

a) Understand Coulomb's Law and principle of superposition:

(1) Determine force acting on specific point charges and describe electric field.

(2) Use vector addition to determine electric field produced by two or more point charges.

b) Know the potential function for a point charge:

(1) Determine electric potential in vicinity or one or more point charges.

3. Fields and Potentials of Other Charge Distributions

b) Know fields of highly symmetric charge distributions:

(2) Describe electric field of:

(a) Parallel charged plates

<u>MiniLab-Electric Fields with Static</u>

Chapter 16-Electric Potential and Energy of a Capacitor (Theory 60%, Hands-On 40%) **<u>November</u>**

B. Conductors, Capacitors, Dielectrics

1. Electrostatics with Conductors

a) Understand nature of electric field in and around conductors:

(1) Explain mechanics responsible for absence of field inside conductors and why excess resides on surface.

(2) Explain why conductor is equipotential and apply when conductors are connected by wires.

(3) Determine direction of force on charged particle near an uncharged or grounded conductor.

b) Describe and sketch electric field and potential inside/outside a charge conducting sphere.

c) Understand induced charge and electrostatic shielding:

(1) Describe qualitative process of charging by induction.

(2) Determine direction of force on charged particle near an uncharged or grounded conductor.

2. Capacitors

a) Know definition of capacitance as it relates to stored charge and voltage:

b) Understand energy stored in a capacitor:

(1) Relate voltage, charge, and stored energy of a capacitor.

(2) Recognize when energy stored in a capacitor is converted into other forms.

c) Understand parallel-plate capacitors:

(1) Describe field inside capacitor, and relate strength to potential difference within plate separation.

(4) Determine how changes in dimension of plates will affect value of capacitance.

C. Electric Circuits

3. Capacitors in Circuits

a) Understand capacitors in series and parallel:

(1) Calculate equivalent capacitance of series or parallel combinations.

(2) Describe how stored charge is divided between capacitors in parallel.

(3) Determine ratio of voltages for two capacitors in series.

c) Calculate voltage or stored charge under steady-state conditions with capacitor in circuit with battery and resistors.

e) Analyze behavior of circuit containing several capacitors and resistors:

(1) Determine voltages and currents immediately after switch closed and after steady-state conditions.

<u>Lab-Capacitors Lab using CBL/TI84 Calculator and Vernier voltage probe</u>

Chapter 17/18-Properties of Voltage, Current, Resistance, and Power; Electric Circuits <u>**December**</u>

(Theory 50%, Hands-On 50%)

C. Electric Circuits

1. Current, Resistance, Power

a) Understand electric current:

b) Understand conductivity, resistivity, and resistance:

(1) Relate current and voltage for a resistor.

(3) Describe resistance of a resistor is dependent on length and cross-sectional area.

(6) Apply rate of heat production in a resistor.

2. Steady-State Direct Current Circuits with Batteries and Resistors Only

a) Understand series and parallel combinations:

(1) Identify series and parallel arrangements in circuit diagram.

(2) Determine ratio of voltages across series and parallel connected resistors.

(3) Calculate equivalent resistance in series and parallel circuit combinations.

(4) Calculate voltage, current, and power dissipation for a resistor in a network.

(5) Design a simple series-parallel circuit and draw diagram with symbols.

b) Understand ideal and real batteries:

(1) Calculate terminal voltage of battery of known emf, resistance, and current.

c) Know and apply Ohm’s Law and Kirchhoff’s rules to DC circuits:

d) Understand voltmeters and ammeters:

(1) State whether resistance is high or low.

(2) Identify correct methods of connecting meters into circuits to take measurements.

<u>Lab-Series/Parallel Circuit Design Lab</u>

Chapter 19-Magnetic Forces and Fields (Theory 50%, Hands-On 50%) <u>**January**</u>

D. Magnetostatics

1. Forces on Moving Charges in Magnetic Fields

a) Understand force by a charged particle in a magnetic field:
   (1) Calculate magnitude and direction of force in terms of q, v, and B.

   (2) Deduce direction of field from information about forces in the field.
   (3) State and apply the formula for the radius of a circular path of a charge that moves perpendicular to a field and derive this formula from Newton's 2nd Law and magnetic force law.
   (4) Describe the general path and motion of a particle in a uniform field with specific initial velocity.
   (5) Describe quantitatively how a particle will move with constant velocity through crossed electric and magnetic fields.

2. Forces on Current-carrying Wires in Magnetic Fields
   (a) Understand force experienced by a current in a magnetic field:
   (1) Calculate magnitude and direction of force in straight-line segments of wire.
   (2) Indicate direction of magnetic forces on loop of wire in magnetic field and tell how the loop will rotate.

3. Fields of Long Current-carrying Wires
   a) Understand magnetic field produced by long straight current-carrying wire:
   (1) Calculate magnitude and direction of field at point in vicinity of wire.
   (2) Use superposition to determine magnetic field.
   (3) Calculate force or attraction/repulsion between two long wires.

<u>Lab-Magnetic Field of a Slink using CBL/TI84 Calculator and Vernier magnetic field probe</u>

Chapter 20-Induction and Magnetic Flux (100% Theory) **<u>February</u>**

E. Electromagnetism
   1. Electromagnetic Induction
   a) Understand magnetic flux:
   (1) Calculate flux through a loop
   b) Understand Faraday's Law and Lenz's Law:
   (1) Recognize situations in which changing flux will cause induced emf or current in loop.
   (2)Calculate magnitude and direction of induced emf and current:
   (a) Square loop of wire pulled at a constant velocity in or out of uniform magnetic field.
   (b) Loop of wire in spatially uniform field whose magnitude is constantly changing.
   (e) Loop of wire that rotates at constant rate about axis perpendicular to uniform field.
   (f) Conducting bar moving perpendicular in uniform field

<u>Lab-Induction using a Primary/Secondary Coil Demo</u>

Chapter 21-Electromagnetic Waves (100% Theory)

IV. WAVES AND OPTICS (15% of topics tested on Physics B exam)
   B. Physical Optics
   2. Understand electromagnetic spectrum:
   b) Know names associated with electromagnetic radiation and be able to arrange in order of increasing wavelength the following: visible light of various color, ultraviolet light, infrared light, radio waves, x-rays, and gamma rays.

Chapter 22-Reflection and Refraction of Light (75% Theory, 25% Hands-On) **<u>March</u>**

B. Physical Optics

1. Understand interference and diffraction of waves:
    a) Apply principles of interference to sources oscillating in phase:
        (1) Constructive and destructive interference of waves reaching observation point.
        (2) Interference max or min for two sources or determine frequencies or wavelengths that can lead to interference.
        (3) Relate amplitude and intensity produced by two or more sources that constructively interfered.
    b) Apply principles of interference and diffraction to waves passing through single or double slit diffraction grating.
        (1) Sketch/identify intensity pattern resulting from monochromatic waves passing through single slit and how this pattern will change if slit width or wavelength is changed.
        (2) Calculate angles or positions on a distant screen where intensity is zero for a single-slit pattern.
        (3) Sketch/identify intensity pattern resulting from monochromatic waves passing through double slit and identify features of single-slit versus two-slit interference.
        (4) Calculate angle or positions on a distance screen where intensity max and min occur from two-slit interference.
        (5) Identify interference pattern formed by grating of many equally spaced narrow slits, calculate location of intensity max, and qualitatively explain why multiple-slit grating is better than a two- slit grating for making accurate wavelength measurements.
    c) Apply principles of interference to light reflected by thin films:
        (1) State when phase reversal occurs during reflection from interface between two media of different indices of refraction.
        (2) Determine when and how reflection produces Newton's rings and how glass may be coated to minimize reflection.
2. Understand dispersion:
    a) Relate a variation of index of refraction with frequency to a variation in refraction.
3. Understand transverse nature of light waves to qualitatively explain light polarization.
4. Understand inverse-square law to calculate intensity of light given different power and distances from source.

<u>Lab-Refraction Design Lab using Snell's Law</u>

Chapter 23-Geometric Optics (60% Theory, 40% Hands-On) **<u>April</u>**

C. Geometrical Optics

1. Understand principles of reflection and refraction:
    a) Determine speed and wavelength of light when changing as going from one medium into another.
    b) Show diagram of the direction of reflected and refracted rays.
    c) Use Snell's Law to relate incident/reflected rays and indices of refraction of media.
    d) Identify conditions for total internal reflection.
2. Understand image formation by plane or spherical mirrors:
    a) Relate focal point to center of curvature.
    b) Locate real image, determine size or virtual or real image, if upright or inverted, enlarged or reduced in size.
3. Understand image formation by converging or diverging lenses:
    a) Determine if focal length is increased or decreased as result of change in curvature of surface, index of refraction, or medium in which it is immersed.

b) Locate real image, finding focal point, and stating if image is upright or inverted, real or virtual.
c) Use thin lens equation to relate object distance and size, focal length, and image distance and size.
d) Analyze situations in which an image formed by one lens serves as an object for another lens.

Lab-Converging and Diverging Lenses Lab

Chapter 28, 29 & 30-Atomic Physics, Nuclear Physics and Nuclear Energy and Elementary Particles (100% Theory) **May**

V. MODERN PHYSICS (10% of topics tested on AP Physics exam)

A. Atomic Physics and Quantum Effects

1. Describe Rutherford Scattering Experiment and how it provides evidence of atomic nucleus.
2. Know properties or photons and understand photoelectric effect:
   a) Relate energy of a photon in joules or electron-volts to its wavelength or frequency.
   b) Relate linear momentum of photon to its energy or wavelength, and apply conservation to processes involving emission, absorption, or reflection of photons.
   c) Calculate number of photons per second emitted by monochromatic source with specific wavelength and power.
   d) Describe typical photoelectric effect experiment and how it provides evidence for photon nature of light.
   e) Qualitatively describe how number of photoelectrons and their max KE depend on wavelength and intensity.
   f) Determine max KE of photoelectrons for different photon energy or wavelength.
   g) Sketch/graph stopping potential versus frequency for photoelectric effect experiment, and calculate approximate value of h/e.
3. Understand concept of energy levels for atoms:
   a) Calculate energy or wavelength of photons emitted or absorbed in a transition between specified energy levels or the energy/wavelength required to ionize an atom.
   b) Qualitatively explain the origin of emission or absorption spectra of gases.
   c) Given the wavelengths/energies of photons emitted/absorbed in a two-step transition, calculate wavelength/energy for a single-step transition between the same levels.
   d) Write expression for energy levels of hydrogen in terms of ground state energy, diagram these levels, and explain how it accounts for the various series in spectrum.
   e) State the assumptions and conclusions for the Bohr Model for the hydrogen atom.
4. Understand the DeBroglie wavelength:
   a) Calculate wavelength of a particle as a function of its momentum.
   b) Describe Davisson-Germer experiment, and explain how it provides evidence for wave nature of electrons.
5. Understand nature and production of x-rays.
6. Understand Compton scattering:
   a) Describe Compton's experiment, state and analyze results.
   b) Qualitatively account for increase of photon wavelength and explain significance of Compton wavelength.

B. Nuclear Physics

1. Understand half-life in radioactive decay:

a) Recognize half-life is independent of number of nuclei present or of external conditions.
b) Sketch/graph what fraction of radioactive sample remains as function of time, and indicate half-life on a graph.
c) Determine what fractions of nuclei have decayed after a given elapsed time for a specified isotope.

2. Understand significance of mass number and charge of nuclei:
   a) Interpret symbols for nuclei that indicate quantity.
   b) Use conservation of mass number and charge to complete nuclear reaction.
   c) Determine mass number and charge of a nucleus after undergoing a decay process.
   d) Describe the α, β, and λ decay and write reaction to describe each.
   e) Explain why existence of the neutrino makes it possible to reconcile the β decay conservation laws.
3. Know the nature of the nuclear force to compare its strength and range with the electromagnetic force.
   a) Understand nuclear fission to describe neutron-induced fission and explain why chain reaction is possible.
4. Understand relationship between mass and energy:
   a) Qualitatively relate energy released in nuclear processes to change in mass.
   b) Apply $E=mc^2$ in nuclear processes.

Grading Scale:
A=90-100
B=80-89
C=70-79
D=60-69
F=Below 60
N=No grade (see Student Handbook for details)
W=Withdrawn from course
I=Incomplete

Knowledge Assessment-50%
Knowledge assignments will include, but not limited to, end-of-chapter problems, supplemental problems, and tests. Students are expected to complete all practice exercises whether assigned in class or for homework.

Performance Assessments-25%
Performance includes, but is not limited to, group or individual activities, and Physics notebook.

Employability Skills-25%
One employability grade per week will be given; each day is worth 20 points. The desired behavior for the engineering/physics classroom is as follows:

Policies And Procedures For Class:
Students should enter the engineering/physics classroom as a young professional. Once in the classroom, prepare for instruction so that once roll has been taken, no interruption to the teacher or learning environment will be made. Students not riding school buses should be in classroom by 8:15 a.m. and 11:55 a.m. to be punctual.

The following **Employability skills are EXPECTED behaviors:**

- Proper GPTC student identification displayed
- Avoid tardiness
- Meet deadlines
- Brings necessary supplies
- Maintains work area & equipment
- Protect learning environment
- Conserves resources
- Self-disciplined
- Shows initiative
- Honest/Trustworthy
- Follows directives, rules
- Appropriate computer/network use
- Appropriate grooming/dress/hygiene
- Works cooperatively/team player
- Respect others, ideas, opinions, property

Note: Make-up work will be handled as specified in the student handbook. Please be sure to read and understand all high school student policies, especially make-up of assignments and employability due to school activities or regular absences, student behavior/discipline, and internet use.

Safety Procedures/Precautions:
Students will be trained in all necessary safety as it pertains to the class and will be required to pass a written safety exam with 100% efficiency. Students will have ample opportunity to pass this exam; the test results will be kept in the student's personnel file in the instructor's office.

Instructional Materials and Supplies:
Serway, Raymond; Faughn, Jerry. *College Physics*. 0-030-35114-6. California: Brooks/Cole-Thompson Learning, 2005

Graphing calculator: TI84Plus (provided by GPTC for check-out)

Supplied by student:
One 3-ring binder: 2 inches thick (for combining Pre-AP and AP Physics)
Ruled, loose leaf, notebook paper (absolutely no spiral edges)
Pencil, preferably mechanical with lead and eraser refills (absolutely no ink)
Package of stick-on tabs for dividing notebook