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: Pre-AP Physics

Course Length: Secondary Students: 180.00 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: I unit of credit per year

Prerequisites: Algebra I or above; High school junior or senior; School counselor/ Principal recommendation; Concurrent participation in 1st year Pre-Engineering courses

Course Description:

In this uniquely focused learning environment, that of a pre-engineering academy, this Pre-AP Physics B course covers the first 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 first 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. The second half of the AP Physics B curriculum is taught in the successive full year.

"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.

Course Objectives/Outline:

Chapter 1-Introduction (Theory 50%, Hands-On 50%) **August**

Standards of length, mass and time; dimensional analysis, uncertainty and significant figures, factor-label method of unit conversion, coordinate systems, right triangle trigonometry, and problem-solving strategy.

Lab-Measurement and Precision of Instruments

September

(Outline designation below follows Course Objectives for AP Physics B, Teacher's Guide, College Board)

Chapter 2-Motion in One Dimension (Theory 40%, Hands-On 60%)

I. NEWTONIAN MECHANICS (35% of topics tested on Physics B exam)
   A. Kinematics
      1. Motion in One Dimension
         a) General relationships among position, velocity, and acceleration for the motion of a particle along a straight line:
            (1) Given a graph of position, velocity, or acceleration, as a function of time, recognize in what time intervals the other two are positive, negative, or zero, and identify or sketch a graph of each as a function of time.
         b) Special case of motion with constant acceleration:
            (1) Write expressions for velocity and position as functions of time, and identify or sketch graphs of these quantities.
            (2) Use equations $v=v_o+at$, $d_o=d_o+v_ot+at^2/2$, and $v^2-v_o^2=2a(d-d_o)$ to solve problems involving one-dimensional motion with constant acceleration.

Lab-Graph Matching Application with Calculator Based Ranger and TI-84 Calculator

Chapter 3-Motion in Two Dimensions (Theory 40%, Hands-On 60%) **October**

      2. Motion in Two Dimensions
         a) Displacement and velocity vectors:
            (1) Relate velocity, displacement, and time for motion with constant velocity.
            (2) Calculate and resolve vectors into components along perpendicular axes.
            (3) Add vectors to find net displacement of particle
            (4) Subtract displacement vectors to find location or calculate average velocity of particle
            (5) Add or subtract velocity vectors to calculate change in velocity or average acceleration of particle

            Graphical Method of Vector Addition and Subtraction,
            Algebraic Method of Vector Addition and Subtraction
         b) Projectile motion in uniform gravitation field:
            (1) Write horizontal and vertical velocity components and position as functions of time, and sketch/identify graphs of these components.
            (2) Analyze motion of a projectile projected above ground level with a specified initial velocity.

Lab-"Deck of Cards", Displacement Vector Addition Design Lab using compass

Chapter 4-The Laws of Motion (Theory 30% Hands-On 70%) **November**

B. Newton's Laws of Motion

1. Static Equilibrium (First Law)
   a) Analyze situations of a particle at rest, moving with constant velocity, or under influence of several forces.
2. Dynamics of a Single Particle (Second Law)
   a) Understand relation between the force acting on a body and the resulting change in the body's velocity:
      (1) Calculate velocity change as a result of constant force.
      (2) Determine average force on a body which undergoes change in velocity.
   b) Understand F=ma as is applies to forces such as gravity, the pull of strings, or contact forces.
      (1) Draw free-body diagram with all real forces acting on a body.
      (2) Write vector summations of separate horizontal and vertical force components.

December

Lab-Static Equilibrium Design Lab using a Force Table

   c) Analyze situations and determine magnitude and direction of net forces in the following situations where a body is under the influence of a specified **acceleration:**
      (1) Motion up or down with constant acceleration
      (2) Motion in a horizontal circle
      (3) Motion in a vertical circle
   d) Understand the coefficient of friction:
      (1) Write down relationship between normal and frictional forces.
      (2) Analyze situations in which a body slides down a rough inclined plane or is pulled or pushed across a rough surface.
      (3) Analyze static friction to determine when a body will start to slip or calculate the magnitude of static frictional forces.
3. Systems of Two or More Bodies (Third Law)
   a) Identify body on which reaction force acts and state magnitude and direction.
   b) Analyze force of contact between two bodies that accelerate together or between two surfaces the slide across one another.
   c) Analyzing motion between bodies of a system joined by a string over a massless pulley.

Lab-Coefficient of Friction Design Lab using Force Probe, CBL/TI-84 and Inclined Plane

Chapter 5-Energy (Theory 40%, Hands-On 60%) **January**

C. Work, Energy, and Power

1. Work and the Work-Energy Theorem
   a) Definition of work:
      (1) Calculate work by a constant force that undergoes a displacement.
      (2) Calculate work done by a force as the area under the linear force vs. position graph
      (4) Use scalar product operation to calculate work by a force undergoing a displacement in a plane.
   b) Understand work-energy theorem:
      (2) Calculate change in kinetic energy or speed that results from doing work on a body.
      (3) Calculate work by net force or each of net forces on a body undergoing a change in speed of kinetic energy.
      (4) Apply theorem to determine change in kinetic energy and speed

as a result of forces or to determine the required force to bring a body to rest.

2. Conservative Forces and Potential Energy
   (5) Write expression for the force exerted by an ideal spring and for the potential energy stored in a stretched or compressed spring.
3. Conservation of Energy
   b) Understand conservation:
      (1) Identify situations when mechanical energy is conserved or not.
      (2) Apply conservation in analyzing motion in a gravitational field and subject to constraints imposed by strings and surfaces.
      (3) Apply conservation in analyzing motion under the influence of springs.
4. Power
   a) Definition of power:
      (1) Calculate power required to maintain motion with constant acceleration
      (2) Calculate work by a force that supplies constant power or average power supplied by force of specific amount of work.

Lab-Energy of a Bouncing Ball using CBR and TI84 Calculator

Chapter 6-Momentum and Collisions (Theory 50%, Hands-On 50%) **February**

D. Systems of Particles, Linear Momentum
   2. Impulse and Momentum
      (a) Relate mass, velocity, and linear momentum for a body and calculate total linear momentum of a system of bodies.
      (b) Relate impulse to a change in linear momentum and average force acting on a body.
   3. Conservation of Linear Momentum, Collisions
      a) Understand conservation:

      (2) Identify situations in which linear momentum or a component is conserved.
      (3) Apply conservation to determine final velocity when two bodies along same line or at right angles collide and stock together, and calculate how much kinetic energy is lost.
      (4) Determine unknown masses or velocities, and calculate how much kinetic energy is lost.

Lab-Construct and launch model rocket with height and final velocity calculations

Chapter 7-Circular Motion (Theory 50%, Hands-On 50%) **March**

E. Circular Motion and Rotation
   1. Uniform Circular Motion:
      a) Relate the radius of the circle and the speed or rate of revolution to magnitude of centripetal acceleration.
      b) Describe direction of a particle's velocity and acceleration at any instant during motion.
      c) Sketch or identify graphs of components of velocity and acceleration vectors at any instant.
   2. Angular Momentum and Its Conservation
      a) Understand conservation:
         (1) Recognize conditions of conservation and relate to one- and two-particle systems such as satellite orbits.

         Lab-Circular Motion Lab

G. Gravitation
   1. Newton's Law of Universal Gravitation:

b) Determine the force that one spherically symmetrical mass exerts on another.

c) Determine the strength of the gravitational field at a specified point outside spherically symmetrical mass.

2. Understand motion of a body in orbit under influence of gravitational forces:
   a) For a circular orbit:
      (1) Recognize motion does not depend on body's mass; describe qualitatively how velocity, period and centripetal acceleration depend on radius; derive expressions for velocity and period of revolution in orbit.
   b) For a general orbit:
      (2) Apply conservation of momentum to determine the velocity and radial distance at any point in orbit.
      (3) Apply conservation of momentum and energy to relate speeds of a body at two extremes in an elliptic orbit.

Chapter 8-Rotational Equilibrium and Dynamics (Theory 50%, Hands-On 50%) **April**

3. Torque and Rotational Statics
   a) Understand concept of torque:
      (1) Calculate magnitude and direction of torque by a force.
      (2) Calculate torque due to gravity.
   b) Analyze problems in statics:
      (1) State conditions for translational and rotational equilibrium:
      (2) Apply conditions of equilibrium under a combined influence of forces at different locations.

Lab-Rotational Equilibrium Lab

Chapter 10, 11, 12-Thermal Physics, Thermal Energy, and Laws of Thermodynamics **May**
(Theory 60%, Hands-On 40%)

II. HEAT, KINETIC THEORY, & THERMODYNAMICS (15% of topics tested on Physics B exam)

A. Fluid Mechanics
   1. Hydrostatic Pressure
      a) Fluid exerts pressure in all direction.
      b) Fluid at rest exerts pressure perpendicular to contact surfaces.
      c) Use relationship between pressure and depth in a liquid, $\Delta p = \rho g \Delta h$
   2. Buoyancy
   3. Fluid flow continuity
   4. Bernoulli's Equation

B. Temperature and Heat
   1. Understand "mechanical equivalent of heat" to calculate how much substance will be heated by mechanical work.
   2. Understand specific heat, heat of fusion, and heat of vaporization:
      a) Identify and relate to a graph of quantity of heat added to a substance, its temperature, the melting point, boiling point, heats of fusion and vaporization and specific heat of each phase.
      b) Determine amount of heat needed to raise its temperature, or cause it to melt or vaporize.
   3. Understand heat transfer and thermal expansion:
      a) Determine final temperature when substances at different temperatures are mixed and come to thermal equilibrium.
      b) Calculate flow of heat through slabs of material of certain thicknesses, areas, and temperature differences between the two faces.
      c) Analyze qualitatively what happens to size and shape of a body when

heated.

C. Kinetic Theory and Thermodynamics
    1. Ideal Gases
        a) Kinetic theory model of an ideal gas:
            (1) State assumptions of the model.
            (2) State the connection between temperature and mean translational kinetic energy, and apply it to determine mean speed of gas molecules as a function of mass and temperature.
            (3) State the relationship among Avogadro's number, Boltzmann's constant, the gas constant R, and express energy of a mole of a mono-atomic ideal gas as a function of its temperature.
            (4) Explain qualitatively how model explains collisions with container walls and predicts pressure is proportional to temperature for a fixed volume.
        b) Apply ideal gas law and thermodynamic principles:
            (1) Relate pressure and volume of a gas during isothermal expansion or compression.
            (2) Relate pressure and temperature during constant-volume heating or cooling, or volume and temperature during constant pressure heating or cooling.
            (3) Calculate work done by a gas during constant pressure expansion or compression.
            (4) Understand adiabatic expansion or compression of a gas.
            (5) Identify/sketch representing above processes on a pV diagram.
    2. Laws of Thermodynamics
        a) Apply first law of thermodynamics:
            (1) Relate heat done by a gas, work performed, and internal energy changes.
            (2) Relate work done by a gas in a cyclic process to an area in a pV diagram.
        b) Understand second law of thermodynamics, concept of entropy, heat engines and the Carnot cycle:
            (1) Determine how entropy will change during a particular situation.
            (2) Compute maximum efficiency of heat engine operating between two given temperature.
            (3) Computer actual efficiency of a heat engine.
            (4) Relate heat exchange to temperature in each reservoir in a Carnot cycle.

<u>Lab-Bimetallic Strip/Convection Chimney/Thermal Expansion/Latent Heat Demonstrations</u>

Grading Scale:
A=90-100
B=80-89
C=70-79
D=60-69
F=Below 0
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 role 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:

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

Supplied by student:

- One 3-ring binder: 1.5 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

Course Text:

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