PHYSICS AP - C Mechanics
EASTERN REGIONAL HIGH SCHOOLS

COURSE OUTLINE

Class Time: The class meets 7 periods a week. Two double periods are allotted for Laboratory work. Lab consists of at least 20% of course time. The course emphasizes the application of calculus to real physical problems.

Lab Time: The class involves 2 periods a week for laboratory experience. **Emphasis is placed on students creating and designing their own experiments from given materials. Most labs do not come with instructions. Students are given a problem and a set of available materials. They set up the experiment, collect the data, analyze the data and must support their conclusions. Students write a formal lab report that is kept in a portfolio. For most labs, students are required to discuss and defend their methods and results with the class.**

Course Materials:
Text

Serway and Beichner, *Physics for Scientists and Engineers,* Fifth Edition

1st SEMESTER 18 Weeks - MECHANICS

1. Calculus
   a. Limits
   b. Derivatives
   c. Integration
   d. Setting limits of integration

2. Kinematics
   a. Two dimensional motion
   b. Three dimensional motion
   c. Vectors in three dimensions
   d. Dot and Cross Product
   e. Deriving equations using calculus
   f. Projectile motion
   g. Circular motion
   h. Relative motion

   LABS:

   1. Tracking Aircraft with vectors

      - Students apply 3-D geometry and vectors to calculate the position and velocity of an aircraft. Students are given: rulers, protractors, stop watches. They must find a method to collect data from moving aircraft, and use it to determine the aircrafts motion vectors.

   2. Projectile Motion

      - students will write the equations for real projectiles and calculate their trajectories. They must predict the range of a water balloon before they ever launch one. They must determine the necessary data and apply the related equations of motion.

3. Newton's Laws

a. Newton's First Law
b. Newton's Second Law
c. Newton's Third Law
d. Force diagrams
e. Net force and acceleration
f. Friction

LABS:

1. Identifying and measuring the forces for a mechanical system - pulleys and tension (Atwood machine)

4. Circular Motion
   a. Centripetal force
   b. Centripetal acceleration
   c. Non-uniform circular motion

   LABS:

   1. Forces in a rotating system - friction on a turntable
      - Students, using a turntable and meter stick, must set up an experiment to determine the coefficient of friction between two surfaces.
   2. Conical Pendulum
      - Students are given: string, protractors, rulers, masses, and a stopwatch. They must set up an experiment which will show the relationship between period, velocity, and displacement angle

5. Resistive forces
   a. Linear friction equations
   b. Velocity dependant forces
   c. Differential equations
   d. The exponential function
   e Time constants
   f. Drag coefficient
   g. Numerical Modeling in Particle Dynamics

   LABS:

   1. Deriving the equation for a bead falling through oil
      - Students will use numerical modeling to write the equation of motion for a falling bead in oil.
   2. Drag coefficient for a Coffee filter using motion sensors

6. Work-Kinetic Energy
   a. Work done by a constant force
   b. Work-Force integrals
   c. Work done by friction

d. Power

LABS

1. Work done by a non-conservative force: Kinetic Friction
   Calculation of energy loss for sliding objects.

7. Potential Energy
   a. Conservative forces and Potential Energy
   b. Non-conservative forces
   c. Conservation of Energy
   d. Energy diagrams and equilibrium

   LABS

8. Linear Momentum
   a. conservation of linear momentum
   b. impulse
   c. momentum change and force-time integrals
   d. elastic collisions
   e. inelastic collisions
   f. two dimensional collisions
   g. conservation of momentum applied to rocket propulsion

   LABS:

   1. 2-D collisions: Shuffleboard

9. Angular motion
   a. angular displacement
   b. angular velocity
   c. angular acceleration
   d. rotational energy
   e. torque and angular acceleration
   f. moment of inertia

   LABS:

   1. Moment of Inertia
      - Students will determine the moment of inertia of irregular shaped objects.
   2. Angular acceleration- sliding/pure rolling motion of a bowling ball

10. Angular momentum
    a. rolling motion of a rigid object
    b. torque and angular momentum
    c. systems of particles
    d, conservation of angular momentum
    e. motion of gyroscopes

    LABS

1. Conservation of angular momentum using a wheel and rotating chair
   - Students will calculate and write the equations for a real example. They will describe and explain the motion using conservation of angular momentum.

11. Static Equilibrium
    a. conditions for equilibrium - torque and force
    b. center of gravity
    c. elastic properties of solids

    LABS
    1. Finding the center of Gravity for irregular shaped objects
    2. Determine the torque of a motor.
       - students are given electric motors. They are to design experiments that will indirectly determine torque using rotational inertial and angular acceleration.

12. Oscillatory motion
    a. Simple Harmonic Motion
    b. calculus and simple harmonic equations
    c. energy in a harmonic oscillator
    d. pendulum
    e. simple differential equations
    f. damped oscillations
    e. resonance

    LABS
    1. Experimentally deriving the period of a pendulum equation: Equations from graphs.
    2. Simple Harmonic Motion for spring-mass systems

13. Gravity
    a. Newton's Law of universal gravitation
    b. free-fall acceleration
    c. Kepler's laws
    d. Motion of satellites
    e. gravitational fields
    f. gravitational potential energy and the work-force integral
    g. energy of orbits
    h. escape speed
    i. gravity inside of a planet

    LABS
    1. Measuring G using photogates