Course No: S995

Orange Unified School District

PHYSICS C AP

Year Course

GRADE LEVEL: 12

PREREQUISITES: Successful completion of Honors Physics or Physics with a grade of *A* and/or teacher recommendation; Calculus with a grade of *A*/*B* or concurrently taking Calculus.

INTRODUCTION TO THE SUBJECT:

This course is equivalent to a first-year college physics class and is designed to prepare students for the AP® Physics C Mechanics Exam given in May. This course follows the syllabus for the examination, and students passing the exam may receive college credit. The course requires and employs a basic understanding of calculus (differentiation and integration), and also requires a prior course, Honors Physics. The prerequisite calculus course may be taken concurrently. The emphasis is on understanding of the concepts and skills and using the concepts and formulae to solve problems. Laboratory work is an integral part of this course. In addition, students will complete two projects where they apply the core concepts to real world problems.

Students coming out of the courses should have a strong conceptual understanding of physics and well-developed skills in performing and analyzing laboratory experiments. They should also be able to apply their understanding to approach and solve problems that are essentially new to them.

COURSE OBJECTIVES:

BY THE END OF THE COURSE THE STUDENT WILL BE ABLE TO:

Read, understand, and interpret physical information - verbal, mathematical and graphical.

Describe and explain the sequence of steps in the analysis of a particular physical phenomenon or problem:

> Describe the idealized model to be used in the analysis, including simplifying assumptions where necessary;
> State the concepts or definitions that are applicable;
> Specify relevant limitations on applications of these principles;
> Carry out and describe the steps of the analysis, verbally or mathematically;
> Interpret the results or conclusions, including discussion of particular cases of special interest.

Use basic mathematical reasoning - arithmetic, algebra, geometric, trigonometric, or calculus, where appropriate, in a physical situation or problem.

Perform experiments and interpret the results of observations, including making an assessment of experimental uncertainties.

COURSE OVERVIEW AND APPROXIMATE UNIT TIME ALLOTMENTS:

FIRST SEMESTER		**WEEKS**
I.	SI Units, Dimensional Analysis, Data and Measurement	1.5

A. Percent error and standard deviation

Lab: Introduction to modeling

- Students will use track and ball bearing to determine the average velocity of the ball bearing over a given distance and then create a model that can be used to predict data for future trials with the same set up.

II.	Kinematics in 1D, Velocity, Acceleration	2

A. Kinematics of constant acceleration
B. Kinematics of time varying acceleration

Lab: Average velocity and linear kinematics

- Students will use track and ball bearing to examine the relationship between distance and time for objects experiencing constant velocity and uniform acceleration.

III.	Graphical Analysis of Motion, Freefall	1.5

Lab: Freefall

- Students will use PASCO free fall timers and ticker tape timers to determine the acceleration due to gravity.

IV.	Vectors, Kinematics in 2D	2

A. Projectile motion

Lab: Projectile motion

- Students will use a ramp and ball bearing to examine the characteristics of projectile motion.

V.	Newton's Laws of Motion (Dynamics)	3

A. Newton's three laws
B. Free body diagrams
C. Tension

WEEKS

D. Weight and normal force
E. Friction

Lab: Newton's laws of motion, friction, force vector resolution
- Students will use air track to examine the proportionality between force and acceleration and to investigate friction
- Students will use force table to extract component vectors from three given force vectors, sum those components and determine the resultant vector magnitude and direction

Project: Elevator project
- Students use kinematics and dynamic equations to investigate the forces and motions experienced by an elevator rider

Midterm: Mechanics

VI. Uniform Circular Motion — 2

A. Kinematics and dynamics

Lab: Centripetal force
- Students will examine the relationship between centripetal force acting on an object experiencing uniform circular motion and determine centripetal velocity, centripetal acceleration and forces acting on the object

Quiz: Uniform Circular Motion

VII. Work and Energy — 2.5

A. Work for constant force
B. Work for distance-varying force
C. Kinetic and potential energy
D. Conservation of energy
E. Work-Energy theorem
F. Power

Lab: Hooke's Law, personal power
- Students investigate the energy transformations with springs
- Students will investigate how much power they can generate running up a flight of stairs

Project: Roller coaster project
- Students use the principles of conservation of energy in designing a scale model of a roller coaster

VIII. Center of Mass, Momentum and Collisions — 2.5

A. Impulse for constant force
B. Impulse for time-varying force

WEEKS

C. Law of conservation of momentum
D. Elastic and inelastic collisions

Lab: Conservation of momentum
- Students use air track to investigate the conservation of linear momentum for elastic and inelastic collisions

IX. Assemblies and Testing 1

Total Weeks 1st Semester: 18

SECOND SEMESTER

I. Rotational Motion 2.5

A. Rotational variables
B. Moment of inertia and torque
C. Angular momentum
D. Conservation of angular momentum
E. Equilibrium
F. Rolling motion

Lab: Torque, moment of inertia
- Students investigate torque by finding the resultant of a number of forces
- Students investigate the effect of shape and mass on the moment of inertia of rolling objects

II. Simple Harmonic Motion 2.5

A. Kinematics and dynamics
B. Simple pendulum
C. Simple harmonic oscillators

Lab: Pendulum, oscillating spring
- Students investigate simple harmonic motion of a small angle pendulum
- Students investigate simple harmonic motion of an oscillating spring

III. Gravitation 1.5

A. Newton's law of gravitation
B. Gravitational potential energy
C. Motion of planets and satellites
D. Kepler's laws

IV. Review for AP Exam 6

V. Post Exam Projects 3.5

VI. Assemblies and Testing 2

Total Weeks 2nd Semester: 18

DATE OF LAST CONTENT REVISION: May 2001

DATE OF BOARD APPROVAL: June 14, 2001

DATE OF CURRENT REVIEW: June 2007

Addendum
THE CALIFORNIA CONTENT STANDARDS
PHYSICS

Motion and Forces

1. Newton’s laws predict the motion of most objects. As a basis for understanding this concept:

   a. *Students know* how to solve problems that involve constant speed and average speed.
   b. *Students know* that when forces are balanced, no acceleration occurs; thus an object continues to move at a constant speed or stays at rest (Newton’s first law).
   c. *Students know* how to apply the law F = *ma* to solve one-dimensional motion problems that involve constant forces (Newton’s second law).
   d. *Students know* that when one object exerts a force on a second object, the second object always exerts a force of equal magnitude and in the opposite direction (Newton’s third law).
   e. *Students know* the relationship between the universal law of gravitation and the effect of gravity on an object at the surface of Earth.
   f. *Students know* applying a force to an object perpendicular to the direction of its motion causes the object to change direction but not speed (e.g., Earth’s gravitational force causes a satellite in a circular orbit to change direction but not speed).
   g. *Students know* circular motion requires the application of a constant force directed toward the center of the circle.
   h. *Students know* Newton’s laws are not exact but provide very good approximations unless an object is moving close to the speed of light or is small enough that quantum effects are important.
   i. *Students know* how to solve two-dimensional trajectory problems.
   j. *Students know* how to resolve two-dimensional vectors into their components and calculate the magnitude and direction of a vector from its components.
   k. *Students know* how to solve two-dimensional problems involving balanced forces (statics).
   l. *Students know* how to solve problems in circular motion by using the formula for centripetal acceleration in the following form: $a = v^2/r$.

m. *Students know* how to solve problems involving the forces between two electric charges at a distance (Coulomb's law) or the forces between two masses at a distance (universal gravitation).

Conservation of Energy and Momentum

2. The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects. As a basis for understanding this concept:

a. *Students know* how to calculate kinetic energy by using the formula $E = (½)mv^2$.
b. *Students know* how to calculate changes in gravitational potential energy near Earth by using the formula (change in potential energy) = *mgh (h* is the change in the elevation).
c. *Students know* how to solve problems involving conservation of energy in simple systems, such as falling objects.
d. *Students know* how to calculate momentum as the product *mv*.
e. *Students know* momentum is a separately conserved quantity different from energy.
f. *Students know* an unbalanced force on an object produces a change in its momentum.
g. *Students know* how to solve problems involving elastic and inelastic collisions in one dimension by using the principles of conservation of momentum and energy.
h. *Students know* how to solve problems involving conservation of energy in simple systems with various sources of potential energy, such as capacitors and springs.

Heat and Thermodynamics

3. Energy cannot be created or destroyed, although in many processes energy is transferred to the environment as heat. As a basis for understanding this concept:

a. *Students know* heat flow and work are two forms of energy transfer between systems.
b. *Students know* that the work done by a heat engine that is working in a cycle is the difference between the heat flow into the engine at high temperature and the heat flow out at a lower temperature (first law of thermodynamics) and that this is an example of the law of conservation of energy.
c. *Students know* the internal energy of an object includes the energy of random motion of the object's atoms and molecules, often referred to as *thermal energy*. The greater the temperature of the object, the greater the energy of motion of the atoms and molecules that make up the object.
d. *Students know* that most processes tend to decrease the order of a system over time and that energy levels are eventually distributed uniformly.
e. *Students know* that entropy is a quantity that measures the order or disorder of a system and that this quantity is larger for a more disordered system.
f. *Students know* the statement "Entropy tends to increase" is a law of statistical probability that governs all closed systems (second law of thermodynamics).

g. *Students know* how to solve problems involving heat flow, work, and efficiency in a heat engine and know that all real engines lose some heat to their surroundings.

Waves

4. Waves have characteristic properties that do not depend on the type of wave. As a basis for understanding this concept:

a. *Students know* waves carry energy from one place to another.
b. *Students know* how to identify transverse and longitudinal waves in mechanical media, such as springs and ropes, and on the earth (seismic waves).
c. *Students know* how to solve problems involving wavelength, frequency, and wave speed.
d. *Students know* sound is a longitudinal wave whose speed depends on the properties of the medium in which it propagates.
e. *Students know* radio waves, light, and X-rays are different wavelength bands in the spectrum of electromagnetic waves whose speed in a vacuum is approximately 3×10^8 m/s (186,000 miles/second).
f. *Students know* how to identify the characteristic properties of waves: interference (beats), diffraction, refraction, Doppler effect, and polarization.

Electric and Magnetic Phenomena

5. Electric and magnetic phenomena are related and have many practical applications. As a basis for understanding this concept:

a. *Students know* how to predict the voltage or current in simple direct current (DC) electric circuits constructed from batteries, wires, resistors, and capacitors.
b. *Students know* how to solve problems involving Ohm's law.
c. *Students know* any resistive element in a DC circuit dissipates energy, which heats the resistor. Students can calculate the power (rate of energy dissipation) in any resistive circuit element by using the formula Power = IR (potential difference) xI (current) = I^2R.
d. *Students know* the properties of transistors and the role of transistors in electric circuits.
e. *Students know* charged particles are sources of electric fields and are subject to the forces of the electric fields from other charges.
f. *Students know* magnetic materials and electric currents (moving electric charges) are sources of magnetic fields and are subject to forces arising from the magnetic fields of other sources.
g. *Students know* how to determine the direction of a magnetic field produced by a current flowing in a straight wire or in a coil.
h. *Students know* changing magnetic fields produce electric fields, thereby inducing currents in nearby conductors.
i. *Students know* plasmas, the fourth state of matter, contain ions or free electrons or both and conduct electricity.

j. *Students know* electric and magnetic fields contain energy and act as vector force fields.

k. *Students know* the force on a charged particle in an electric field is qE, where E is the electric field at the position of the particle and q is the charge of the particle.

l. *Students know* how to calculate the electric field resulting from a point charge.

m. *Students know* static electric fields have as their source some arrangement of electric charges.

n. *Students know* the magnitude of the force on a moving particle (with charge q) in a magnetic field is qvB sin(a), where a is the angle between v and B (v and B are the magnitudes of vectors v and B, respectively), and students use the right-hand rule to find the direction of this force.

o. *Students know* how to apply the concepts of electrical and gravitational potential energy to solve problems involving conservation of energy.