CALVARY CHAPEL CHRISTIAN SCHOOL

12808 WOODRUFF AVENUE, DOWNEY, CA 90242 (562) 803-4076

COURSE SYLLABUS

Course Title:	**AP Physics**
Minutes per week:	**250**
Course Credit:	**2 Semesters (10 units)**
Grade Level:	**11^{th}, 12^{th}**
Prerequisite:	**Completion of Algebra II with a grade of "B" or better and Completion of/or concurrent enrollment in AP Calculus is suggested. Requires prior Algebra II or Chemistry teacher's permission and Department Head approval**

A. COURSE DESCRIPTION

AP Physics is an advanced lab science that studies the natural laws that govern God's universe. As a consequence of God's orderly nature, these laws are best understood in a mathematical framework. Physics is applied mathematics and therefore, the course is highly mathematical. Course content includes: metric system, kinematics, dynamics mechanics gravitation, vectors in two dimensions, momentum, work energy, calorimetry, basic thermodynamics, law of conservation, pressure, buoyancy, simply hydrostatics, thermal expansion of matter, wave motion, sound, light optics, elementary quantum theory, electric fields, simple electric circuits, magnetic fields and electromagnetism. Registration for the AP tests in the spring is required. *A lab accompanies this course.*

B. BEHAVIORAL OBJECTIVES

Students will demonstrate the ability to accomplish the following:

- Express the three fundamental quantities of length, mass, and time using the metric system or System Inernationale (SI)
- Express computational results using Greek prefixes.
- Carry out mathematical operations using scientific notation.
- Explain the need for significant digits.
- Explain rules for determining significant digits.
- Perform order-of-magnitude calculations, approximations, and guesstimates.
- Understand the rules for handling significant digits and how to handle them when performing calculations.
- Understand how to convert units.

- Define scalar quantity and site examples.
- Define vector quantity and site examples.
- Define vector sum and resultant of two or more vectors.
- Use the Tip-to-Tail Method to find the resultant of vectors.
- Determine the x and y-components of a given vector by graphical methods.
- Calculate x and y-components of a vector.
- Calculate the magnitude and the direction of a vector when its rectangular components are given.
- Locate points, express angles, express rotation sense, and express distances in Frame of Reference—the Cartesian coordinate system.
- Distinguish between displacement and distance and speed and velocity.
- Calculate displacement, distance, speed, and velocity.
- Demonstrate by definition and example ad understanding of the distinction between mass and weight.
- Write the value of the acceleration due to gravity in metric units.
- Define the unit of force, Newton.
- Define density and solve problems using density.
- Define equilibrium.
- Define equilibrant.
- State the conditions necessary for equilibrium.
- Demonstrate an understanding of Static Equilibrium
- Solve vector equations in tension problems.
- In terms of structure, distinguish the differences between solids, liquids, gases, and plasma.
- Understand the difference between elements, compounds, and mixtures.
- Distinguish between protons, neutrons, and electrons.

- Describe the composition of an atom of any particular element in terms of the subatomic particles.

- Know the difference between an atom, an ion, and a molecule.

- Define Brownian movement.

- State the Kinetic Molecular Theory.

- Demonstrate and understanding of the difference between a specific temperature and temperature interval.

- Demonstrate working skill with the Celsius, Fahrenheit, Kelvin, and Rankine temperature scales and the inner conversion between them.

- Relate average speed to distance traveled and time elapsed to solve problems involving such parameters.

- Define average velocity and solve problems using definition.

- Define acceleration and suggest means for measuring it.

- Define average acceleration and solve problems using definition.

- Discuss the forces of kinetic and static friction and suggest a means of measuring them.

- Define the coefficient of friction.

- Calculate the normal force.

- Calculate the friction force.

- Solve problems involving friction for unknown forces or coefficient of friction.

- Clearly demonstrate an understanding of torque and apply this understanding to various applications.

- State whether the resulting torque is positive or negative by convention when a force is applied to an extended body pivoted at some point.

- Calculate the resultant torque about any point given the magnitude and the position of the forces applied to an extended body.

- On a Position vs. Time graph determine the average velocity between two points.

- Recognize that the slope of a straight line on a Position vs. Time graph is the velocity.
- Recognize that the area under the curve on a Position vs. Time graph is the displacement traveled.
- Calculate the velocity and displacement given the Position vs. Time graph.
- On a Velocity vs. Time graph determine the average acceleration between two points.
- Recognize that the slope of a straight line on a Velocity vs. Time graph is the acceleration.
- Calculate the acceleration on a Velocity vs. Time graph.
- Demonstrate an understanding of Newton's First Law of Motion.
- State specific examples to illustrate an understanding of Newton's Third Law of Motion.
- Demonstrate an understanding of Newton's Second Law of Motion.
- Relate Newton's First and Second Laws to kinematics.
- Solve Newton's Second Law problems by setting the resultant force equal to the total mass times the acceleration and solve for the unknown parameters.
- Define physical work.
- State the conditions necessary for the performance of physical work.
- Define the joule as work or energy unit.
- Write a mathematical statement for calculating the work done by a given force and demonstrate that the equation is dimensionally correct.
- Recognize that the area beneath a Force vs. Distance curve is work done over the distance interval.
- Understand the relationship between work, energy, and power.
- Define and unit of watt for power.
- Demonstrate by example an understanding of the concept of power.
- Define Instantaneous Velocity.

- Calculate the Instantaneous Velocity on a Position vs. Time graph by approximating the slope at that point.
- Distinguish between average velocity and instantaneous velocity.
- Define Instantaneous Acceleration.
- Calculate the Instantaneous Acceleration on a Velocity vs. Time graph by approximating the slope at that point.
- Distinguish between average acceleration and instantaneous acceleration.
- Draw a free-body diagram representing all forces acting on an object that is in static equilibrium.
- Draw a free-body diagram representing all forces acting on an object that is in translational equilibrium.
- Analyze the motion of an accelerating elevator.
- Define Static Equilibrium.
- Solve Beam problems using condition of equilibrium for unknown forces
- State the six types of simple machines.
- Recognize that machines do not change the work required but only reduce the effort force and increase the effort distance.
- Determine the mechanical advantage of a pulley.
- Calculate the effort force given the load and mechanical advantage.
- Define mechanical efficiency.
- Calculate the work output given the mechanical efficiency and the work input.
- Develop equations involving a sliding block with friction.
- Calculate either P, μ_k, w, F_N, or θ for a sliding block problem.
- Apply the condition of equilibrium to write two equations involving components of given vectors along the x-axis and the y-axis of a frame of reference.
- Solve simultaneous equations derived from the condition of equilibrium for unknown forces.

- Draw a free-body diagram for a body of a system of bodies in motion with a constant acceleration.

- Write three general kinematic equations that involve the parameters distance, initial velocity, final velocity, acceleration, and time.

- Use the kinematic equations to solve motion at constant acceleration problems.

- Understand that heat is an energy form.

- Represent the heat gained or lost in a given process in terms of calories, joules, or BTUs.

- Give two or more examples illustrating the distinction between quantity of heat and temperature of a material.

- Demonstrate by example and by experiment an understanding of specific heat and the distinction from heat capacity.

- Explain practical advantages or disadvantages of metals with large specific heat capacities.

- Apply the Law of Conservation of Energy to a given process to determine unknown parameters such as mass, specific heat, or temperature.

- Define impulse and momentum.

- Derive an equation illustrating the relationship of a change in momentum to the impulse.

- Recognize that the area beneath a Force vs. Time curve is impulse and that impulse is the change in momentum.

- Define the derivative of a function.

- Use the summation and power rules of differentiation to find the derivatives of a polynomial function of t.

- Recognize that the derivative of the position function with time is the velocity.

- Calculate the velocity at any time using the derivative.

- Define the second derivative.

- Recognize that the second derivative of the position function with time or the first derivative of the velocity with time is the acceleration.

- Calculate the acceleration at any time using the second derivative.
- Define the Integral.
- Use the summation and power rules of integration to find the integrals of a polynomial function of t.
- Recognize that the definite integral of the velocity function is the area under the curve which it the displacement.
- Calculate the displacement between two points in time given the velocity function and using definite integrals.
- Understand the distinction between the center of mass and center of a system.
- Calculate the location of the center of mass in simple systems.
- Describe the behavior of an object in free fall when neglecting air resistance.
- Recognize that the equations of kinematics directly apply to bodies in free fall.
- Use the quadratic equation to determine the time it takes a body with an initial velocity to reach the ground and explain the meaning of the extraneous solution.
- Calculate the position and velocity at specific times for a body dropped from rest, projected vertically downward, and projected vertically upwards with some initial velocity.
- Define and illustrate the degree, the radian, and the revolution as angular measure and convert between them.
- State angular kinematics concepts in linear kinematics terms and expressions.
- Define angular velocity and angular acceleration and describe procedures for measuring and expressing them.
- Define the properties of fluids.
- Distinguish between mass density, weight density, and specific gravity.
- Calculate the pressure from a column of liquid.
- Understand that only the depth of the liquid determines the pressure and not the shape of the container holding the liquid.
- Understand that at a given depth the pressure is the same in all directions.

- Define the concept of pressure and that of absolute pressure.
- State and apply Pascal's Principle.
- Analyze the motion of a body accelerating on an inclined plane with friction.
- Calculate acceleration down the plane with and without friction.
- Calculate normal force.
- Draw vector diagram.
- Use Newton's Law of Gravitation to derive the acceleration due to gravity on the surface of the earth and for the surfaces of other planets when the radii and the masses of the planets are given.
- Use Newton's Universal Law and Newton's Second Law of Motion to express weight for any location in the universe.
- Determine mass from weight or weight from mass where a value for the acceleration due to gravity is known.
- Describe an experiment that would measure the Universal Gravitational Constant.
- Determine the acceleration due to gravity for various positions on the surface and above the surface of the earth.
- State Kepler's Three Laws of Planetary Motion.
- Use Kepler's Third Law to relate the radius of an orbit to its period.
- Define potential energy.
- Define gravitational potential energy.
- Write an equation that will determine the gravitational potential energy of a known mass or weight relative to a given location is space.
- Define kinetic energy.
- Calculate the kinetic energy of a body when its mass or weight is given.
- State and write the Law of Conservation of Mechanical Energy.
- Distinguish by definition between elastic, inelastic, and completely inelastic collisions.

- Relate energy changes in elastic and completely inelastic collisions.
- Understand that momentum and kinetic energy are conserved in an elastic collision.
- Apply the Law of conservation of Linear Momentum to problems involving colliding bodies.
- Use energy and momentum principles to discuss what occurs after an elastic collision.
- Predict the velocities of two colliding bodies after impact when the masses and initial velocities are given.
- Apply the Law of Conservation to solve recoil problems.
- Predict the scattering angles after a two-dimensional elastic collision.
- Define index of refraction.
- Understand the relationships between index of refraction and Snell's Law
- Calculate speed of light in different media.
- Calculate refracted angle using Snell's Law.
- Distinguish between an ideal gas and a real gas, giving reasons why some gases closely approximate the ideal condition.
- Demonstrate by example an understanding of (1) Boyle's Law, (2) Charles' Law, (3) Gay-Lussac's Law, (4) Avogadro's Law, (5) the Combined Gas Law and (6) the Ideal Gas Law.
- Determine the tension and acceleration on an Atwood machine.
- Determine the tension and acceleration of two bodies, one on a frictionless table top and the other hanging from an ideal pulley.
- Determine the tension and acceleration of two bodies, one on a frictionless inclined plane and the other hanging from and ideal pulley.
- Explain what color is, how it is produced, and how colors are combined to product other colors.
- Describe the regions to the electromagnetic spectrum, place them in proper relationship to each other according to frequency or wavelength, identify the origin of each region, and give at least one natural and one artificial source for each.
- Identify and describe the sources of visible light.

- Discuss the experimental history that lead to an accurate determination of the speed of light.
- Define and compare the various methods of measuring illumination.
- Calculate unknown luminous intensity from photometer data.
- Show that all circular motion equations are dimensionally correct.
- Write three circular motion equations that involve the parameters angel, initial angular velocity, final angular velocity, angular acceleration, and time.
- Use the circular motion equations to solve motion at constant angular acceleration problems.
- Develop equations to relate linear motion to circular motion for a rolling object.
- State the conditions that are necessary for uniform circular motion.
- State Archimedes' Principle and its relation to buoyancy.
- Calculate buoyancy force given the volume or percent volume of a floating object.
- Calculate the tension in a tethered buoy submerged in a liquid.
- Discuss the nature of electrical charge.
- Understand charge quantization.
- Recognize that all charges are multiple of the fundamental unit of charge, e.
- Demonstrate that charge is conserved.
- Define the ampere as the unit of electrical current.
- Distinguish between conventional flow and electron flow.
- Define emf and it role in DC electrical theory.
- Define voltage or potential difference.
- State Ohm's Law for electrical components.
- Define the unit of resistance, the ohm.
- Determine the potential drop across a resistance carrying a given current.

- Define the factors that determine the resistance of a given wire.

- Calculate the resistance of a wire given its resistivity, length, and radius.

- Explain Boyle's and Charles's Law in terms of the Kinetic Theory of Gases.

- Describe the changes that take place during phase changes in terms of atomic and molecular structure of matter.

- Apply the Law of Conservation of Energy to a given process that includes the latent heat of fusion or vaporization.

- Distinguish between the physiological and physical definitions of sound.

- Compute the velocity of sound in air at a given temperature.

- State ways of approximating the speed of sound in liquids and gases knowing the speed of sound in air.

- State and give a mathematical equation for Hooke's Law.

- Explain the meaning of the negative sign in the equation expressing Hooke's Law.

- Calculate Elastic Potential Energy

- Relate the voltage drop across a resistor carrying a current to its energy loss.

- Define the watt as the unit of electrical power.

- Determine the power loss across a given current carrying resistance.

- Define the sing conventions of the flow of conventional current to the polarity signs on a resistor.
- Solve two-body tension problems to include friction.

- Understand the principles of reflection, refraction, dispersion, and diffraction as they relate to mechanical waves.

- Use the superposition principle and determine the resultant wave when two waves merge.

- Calculate the speed along a string.

- Discuss the trajectory of a projectile in the earth's gravitational field.

- Illustrate graphically how the motion of a horizontally projected baseball compares with that of a baseball dropped from rest.

- Illustrate with diagrams how the vertical motion of a baseball thrown at any angle is similar to the motion of a baseball thrown vertically.

- Predict the position and velocity of a projectile as a function of time when the projection angle and initial speed are given.

- Predict the range, maximum altitude, and time of flight for a given projectile when the initial speed and the angle of projection are given.

- Illustrate an understanding of relative motion in one and two dimensions

- Define centripetal acceleration.

- Calculate centripetal acceleration using the radius and linear or angular velocity.

- Understand how acceleration is possible without a change in speed.

- Apply centripetal force and gravitation to satellites.

- Write and apply Kirchhoff's Rules for electrical networks in the determination of unknown currents.

- Discuss the meaning of the *expression conservative force*.

- Understand the significance of a conservative force.

- Understand that the gravitational field is a conservative field.

- Understand that the spring force is a conservative force.

- Understand that friction is not a conservative force.

- Discuss the Work-Energy Theorem and express it as a mathematical statement.

- Demonstrate by example and by experiment the relationship between the performance of work and the corresponding change in kinetic energy.

- Define Dot Product.

- Calculate work when the direction of force and the direction of motion are not the same.

- Calculate voltage drops for resistor hooked in series.

- Describe simple harmonic motion (SHM) through examples.

- Define the parameters of SHM.
- Describe the relationships between force and displacement in simple harmonic motion.
- Describe and illustrate how the magnitude and direction of velocity varies as a function of time in SHM.
- Calculate the frequency or period when the position and acceleration of an object at any instant during SHM are given.
- Define centrifugal force.
- Apply understandings of centrifugal force to examples of motion in a vertical circle.
- Calculate tension in cables involving circular motion.
- Describe the characteristics of plane mirrors.
- Demonstrate an understanding of the nature of the images formed by plane mirrors.
- Distinguish between virtual and real images.
- Distinguish between plane mirrors and spherical mirrors.
- Understand the characteristics of a converging mirror.
- Describe the images formed by a converging mirror.
- Use ray-tracing techniques to construct images formed by a converging mirror.
- Define the focal length of a spherical mirror.
- Calculate the resistance across a bank of resistors in series, parallel, and combined.
- Define and describe voltage, current, and equivalent resistance for resistors connected in series, parallel, and combined.
- State Ohm's Law for an entire electrical circuit and apply it to the solution of electrical problems involving the total resistance of the circuit.
- Calculate the total resistance of an entire DC circuit.
- Compute power loss in a DC circuit.
- Define the moment of inertia of a body.

- Define the rotational inertia of point masses rotating about a fixed point.

- State mathematically Newton's Second Law of Motion as it relates to rotational accelerations.

- Calculate torque or angular acceleration for point mass inertia problems.

- Calculate the coefficient of kinetic friction for a body that is moving in circular motion on an unbanked track.

- Use simplified formula for finding parallel resistance for a pair of resistors.

- Distinguish between laminar and turbulent flow.

- Discuss limitation of an ideal fluid.

- Define volumetric flow rate.

- Calculate volumetric flow rate given the cross sectional area and the velocity of the fluid.

- Define continuity for fluid flow.

- Using the Continuity equation, calculate the velocity of the fluid at various points along a pipe with varying diameter.

- Understand the characteristics of a diverging mirror.

- Describe the images formed by a diverging mirror.

- Use ray-tracing techniques to construct images formed by a diverging mirror.

- Calculate the moment of inertia for disks, rings, solid spheres, hollow spheres, long thin rods rotating about its center, and long thin rods rotating about its end.

- Solve mathematically Newton's Second Law of Motion as it relates to rotational accelerations of various shapes above.

- Describe the shape of an exponential growth curve (positive exponent).

- Describe the shape of an exponential decay curve (negative exponent).

- Define time constant.

- Solve an exponential equation for final voltage for a discharge of a capacitor given the time.

- Discuss the effects of size and the shape of a conductor on its ability to store charge.
- Derive a relationship between applied voltage, capacitance, and total charge.
- Write the exponential equation for the voltage across a discharging capacitor.
- Draw the exponential curve for the voltage across a discharging capacitor.
- Write the exponential equation for the current through a discharging capacitor.
- Draw the exponential curve for the current through a discharging capacitor.
- Understand that the voltage of a capacitor cannot change instantaneous with time.
- Predict the change in length of a metal rod of known length and material as the rod is heated through a known temperature range.
- Develop a method to determine a relationship for the change in area of a sheet of material as it is heated or cooled over a given temperature range.
- Predict the volume overflow when a container of known volume and material filled with a given liquid is heated over a given temperature interval.
- Describe the phase changes for water.
- Understand Bernoulli's Equation and its application to ideal fluids.
- Demonstrate an understanding of the workings of an air foil.
- Describe how the moment of inertia and angular speed of a body determine the rotational kinetic energy.
- Apply the Law of Conservation of Mechanical Energy to rotating and to rolling bodies.
- Define rotational work and rotational power using torque and derive equations for computation in applied situations.
- Define angular momentum and give at least two examples illustrating application.
- Write the equation for the motion of a mass oscillating on a spring.
- Calculate the period or frequency of a mass-spring system.
- Understand the change of energy from kinetic to spring potential energy for a mass-spring system.

- State and apply the Law of Conservation of Angular Momentum.
- Calculate the horizontal component of centripetal force for a body moving in a circular path.
- Calculate the vertical component for a body moving in a circular path.
- Calculate the angle necessary to bank the track to make the force direct perpendicular to the track's surface.
- Calculate the magnitude of the normal force for a body on a banked track.
- Determine the tension in a cable with a mass being swung in circular motion.
- Develop three simultaneous equations to solve for the tension and acceleration of bodies where inertia is not neglected.
- Solve two-body tension problems to involve pulleys with mass
- Discuss the significance of Joule's experiment.
- Demonstrate by two examples in each case the application of heat transfer by radiation, conduction, and convection currents.
- Define a *thermodynamic system*.
- Give two examples in which the internal energy of a system can be changed.
- State the First Law of Thermodynamics, give two examples in which the low is demonstrated, and represent the first law mathematically.
- Define and give illustrated examples of each of the following thermodynamic processes: (a) adiabatic, (b) isochoric, (c) isothermal, and (d) isobaric.
- Discuss the separation of light using a prism.
- Define total internal reflection.
- Discuss how a prism could be used as a plane mirror.
- Calculate the critical angle given the indices of refraction for two adjacent materials with light passing through them.
- Define and calculate the energy of a charged capacitor.
- Write the exponential equation for the voltage across a charging capacitor.

- Draw the exponential curve for the voltage across a charging capacitor.
- Write the exponential equation for the current through a charging capacitor.
- Draw the exponential curve for the current through a charging capacitor.
- Distinguish between converging and diverging lenses.
- Understand the characteristics of converging and diverging lenses.
- Describe the images formed by converging and diverging lenses.
- Use ray-tracing techniques to construct images formed by lenses.
- Define the focal length for a lens.
- State the four fundamental forces: (a) electrical force, (b) gravitational force, (c) strong nuclear force, and (d) weak nuclear force.
- Distinguish between an insulator and a conductor.
- Define static charge.
- Explain how to charge a body by induction.
- Understand that the period of a pendulum is only a function of its length and g.
- Determine the period and total energy of a simple pendulum undergoing SHM.
- Determine the period of a physical pendulum.
- Define amplitude.
- Define phase angle.
- Write the sinusoidal motion equation for an object moving in SHM relating amplitude, frequency or angular velocity, and phase angle.
- Write and apply Kirchhoff's rules for electrical networks in the determination of unknown currents.
- Analyze multiloop circuits using Ohm's Law and Kirchhoff's Rules.
- Solve three simultaneous equations to solve multiloop circuits.
- Describe and illustrate transverse and longitudinal wave motion.

- Describe, relate, and illustrate the meaning of frequency speed, and wavelength as they apply to wave motion.
- Understand the mathematics of traveling waves.
- Use the Doppler Effect to predict the apparent change in sound frequency that occurs as a result of relative motion between a source and an observer.
- Explain the operation and the limitations of the efficiency of a heat engine.
- Determine the efficiency of a heat engine in terms of heat input and heat output.
- Determine the efficiency of a heat engine in terms of input temperature and output temperature.
- Understand that the Carnot efficiency is the maximum possible efficiency for a heat engine.
- State the Plank statement of the Second Law of Thermodynamics.
- Use the Mirror-Thin Lens Equation to solve problems.
- Calculate the magnification of a spherical mirror or lens.
- Understand the sing convention for the Mirror-Thin Lens Equation.
- Write Coulomb's Law and express it in terms of an equation.
- Apply Coulomb's Law to problems involving systems of point charges.
- Solve electrostatic force vector problems.
- Calculate the equivalent capacitance of a number of capacitors arranged in (1) series, (2) parallel, and (3) series and parallel combination.
- Define resonance.
- Define fundamental frequency.
- Define nodes and antinodes.
- Draw standing wave patterns for resonators and stringed instruments.
- Define pitch, intensity and quality.
- Distinguish between harmonics and overtones as they apply to a vibrating system.

- Understand resonance in stringed instruments.
- Calculate the resonance frequency for a stringed instrument given its length.
- Understand resonance in open and closed resonators.
- Calculate the resonance frequency for an open and closed resonator given its length.
- Give examples of open and closed resonators.
- Understand the mathematics of standing waves.
- Discuss the origin and significance of beats.
- Differentiate between state and phase.
- Define state variable.
- Understand thermodynamic equilibrium.
- Differentiate between reversible and irreversible processes.
- Explain the significance of a PV diagram in describing (a) adiabatic, (b) isochoric, (c) isothermal, and (d) isobaric thermodynamic processes.
- Understand the four steps involved in the Carnot Cycle.
- Draw a PV diagram demonstrating the Carnot Cycle labeling all steps.
- Understand that the work for each step of the cycle is the area under the curve.
- Understand that the net work is the area enclosed by the cycle.
- Calculate work as $P\Delta V$.
- Define the electric field in terms of an isolated point charge.
- Show how the electric field is similar to a gravitational field.
- Calculate the magnitude and direction of the force that would act on a test charge placed at a given point in an electric field.
- Calculate the electric field of a system of charge distributions.
- Discuss the motion of a charged particle.

- Distinguish by definition and example between potential energy, electric potential, and electric potential difference.
- Distinguish between positive and negative work.
- Compute the potential energy of a known charge at a given distance from another known charge and state whether the potential energy is positive or negative.
- Determine the electric potential at any point due to a charge of known magnitude.
- Calculate the electric potential at a point in the neighborhood of a number of isolated charges.
- Find the force that would be exerted on a given charge placed between two opposite charged parallel plates of known separation and potential difference.
- Draw electric field lines around a charged particle.
- Define the electron volt, eV, and be able to express energy in terms of this unit.
- Understand the four steps involved in the Otto Cycle.
- Draw a PV diagram demonstrating the Otto Cycle labeling all steps.
- Understand the operation of a refrigerator.
- Understand how to draw the refrigerator as a heat engine in reverse.
- State the Clausius statement of the Second Law of Thermodynamics.
- Define the tesla.
- Write the basic law of magnetic force and apply it to physical situations.
- Define permeability.
- Calculate the magnetic field strength for a current flowing though a wire and the radius from the wire.
- Draw the direction of the magnetic field using the right-hand rule.
- Use the right-hand rule to determine the north pole of an electromagnet.
- Use the right-hand rule in determining the direction of magnetic forces on a positive particle.

- Explain the magnetic field in terms of the force acting on a charged particle.
- Discuss the motion in circular orbits of charged particles in a uniform magnetic field.
- Define magnetic flux giving its units.
- State the Second Law of Thermodynamics.
- Define the entropy of a system.
- Calculate the change in entropy for isothermal processes.
- Define the dielectric strength of a material and describe the part it plays in limiting the charge that can be placed on a conductor.
- Calculate the capacitance of a parallel-plate capacitor when the area of the plate is given and they are separated by a medium of known dielectric strength.
- Define permittivity and give examples illustrating its effect on a capacitor.
- Understand the theory, operation, and use of the ammeter, voltmeter, and galvanometer in DC circuits.
- Explain how induced emfs are created by changing magnetic flux through a single loop.
- Predict the polarity of an induced emf.
- Describe ways in which magnetic flux can change.
- Discuss induced emf and current.
- Write Faraday's Law of Induction and apply it to induced emf through a loop.
- State Lenz's Law and use it to determine the direction of an induced current.
- Describe the main components of a DC generator.
- Explain how back emf reduces the net voltage delivered by a generator.
- Define Inductance.
- Discuss the field lines of a magnet.
- Discuss the basic features and properties of the earth's magnetic field.
- Explain how to determine the direction of a magnetic field using a compass.

- Define self and mutual inductance.

- Define the time constant for an inductor and resistor.

- Write the exponential equation for the current through an energized or denergized inductor.

- Draw the exponential curve for the current through an energized or denergized inductor.

- Write the exponential equation for the voltage across an energized or denergized inductor.

- Draw the exponential curve for the voltage through an energized or denergized inductor.

- Understand that the current through an inductor cannot change instantaneous with time.

- Determine secondary voltage and current given the number of primary and secondary turns in a transformer.

- Prove using heat engine diagrams that Carnot efficiency is the maximum efficiency for a heat engine.
- Show that an engine with a greater efficiency violates the Plank's and Clausius' Statements of the Second Law of Thermodynamics.

- Describe the main components of an AC generator.

- Write the equation for an AC voltage.

- Discuss the advantage of using a transformer.

- Understand the energy levels for an earthquake are logarithmic.

- Discuss the Richter scale.

- Calculate the magnitude of an earthquake on a Richter scale given the relative intensities of the earthquakes.
-
- Relate the energy of a sound wave to its intensity.

- Calculate the intensity level in decibels for a sound wave whose intensity is given in watts per square meter.

- Define loudness.

- Calculate the loudness for a sound wave.

- Differentiate between radio, TV, microwaves, infrared, visible, ultraviolet, x-rays, gamma rays as forms of electromagnetic radiations.

- Discuss Maxwell's Equations.

- Calculate the speed of light from toothed-gear problems.

- Use Huygen's Principle to explain diffraction and refraction.

- Discuss Young's experiment and its significances.

- Explain how the phenomena of diffraction and interference demonstrate the wave nature of light.

- Give graphic examples of constructive and destructive interference.

- Discuss single-slit and double slit diffraction.

- Explain how diffraction gratings are used in spectroscopy.

- Describe how thin films produce colorful displays.

- Understand the interference pattern produced by light reflecting off the two surfaces of a thin film.

- Discuss Newton's rings and explain how they are formed.

- Derive the diffraction-grating equation.

- Apply the diffraction-grating equation to solve problems involving diffraction gratings.

- Describe the phenomenon of polarization.

- Discuss surface tension and viscosity.

- Write Poiseuille's equation and give several examples.

- Understand the effect of friction on fluid flow through a horizontal pipe of circular section.

- Calculate stress and strain.

- Use Young's modulus to calculate the change in length in a rod under stress.

- Recognize the limitations to Newtonian mechanics.

- Understand Einstein's special theory of relativity.
- State Postulate 1: The laws of physics are the same in every inertial frame of reference.
- State Postulate 2: The observed speed of light it the same for all observers.
- Understand the conclusion to the Michelson-Morley experiment.
- Explain how an interferometer works and how it was used in the Michelson-Morley experiment.
- Understand the Lorentz Transformation was an attempt to solve the Michelson-Morley Equations.
- Understand that because there is no absolute frame of reference, neither observation from any observer is preferred over the other.
- Understand that by knowing the relative velocity of our reference frame and the observer's reference frame allows one to predict what an observer in a different reference frame will see.
- Understand the difference between local and distant simultaneity.
- Understand that the proper time is the shortest time interval that is possible for any observer to measure.
- Calculate relativistic time.
- Calculate relativistic lengths.
- Calculate relativistic mass.
- Calculate relativistic momentum.
- Understand that the speed of any mass cannot exceed the speed of light.
- Calculate relativistic addition of velocities.
- Discuss the fundamental particles of an atom.
- Discuss the Millikan Oil-Drop Experiment and its importance in modern physics.
- Use the Planck equation to calculate the energies associated with frequency and wavelength of light.
- Discuss the role of photons as energy carriers.

- Sketch diagrams for the Lyman, Balmer, Pashcen, Brackett, and Pfund Series.
- Demonstrate with appropriate diagrams an understanding of emission spectra.
- Calculate the energy emitted per photon per Bohr orbit quantum jump.
- Distinguish the various forms of radiation.
- Balance equations for radioactive decays.
- Calculate radioactive decay problems given a nucleotides half-life.
- Distinguish between fission and fusion.
- Define blackbody radiation.
- Describe the photoelectric effect.
- Use Einstein photoelectric equation to calculate classical velocities of photoelectrons.
- Relate the photoelectric effect to stopping potential and threshold frequency.
- Discuss the Thomson and Rutherford atomic models.
- Discuss the Rutherford scattering experiment.
- Discuss the importance of the Compton Effect.
- Write Bohr's First Postulate and use it to verify standing de Broglie waves.
- Write and illustrate the meaning of Bohr's Second Postulate.
- Discuss the de Broglie hypothesis and state circumstances under which the wave nature of matter is observed.
- Calculate the wavelengths of matter waves.
- Discuss the Einstein mass-energy relationship and use it to calculate the energy released in mass-to-energy conversions.
- Take an entire exam and perform as well as possible.
- Understand how the exam is graded, and realize that no student is expected to know all of the answers.
- Realize that in Free-Response section, students are given choices of problems to answer.

- Realize that students are given partial credit for what they have correct about the working of each problem.

- Understand how important it is to write legibly and show work in an organized fashion.

C. Course Content

1. Introduction and Mathematical Concepts

Physics and it Relation to Other Fields, Models, Theories, and Laws, Measurement and Uncertainty, Units, Standards, and the SI System, Converting Units, Mathematics in Physics

2. Kinematics in One Dimension

Reference Frames and Displacement, Average Velocity, Instantaneous Velocity, Acceleration, Motion at Constant Acceleration, Falling Objects, Graphical Analysis of Linear Motion

3. Kinematics in Two Dimensions

Vectors and Scalars, Addition of Vector—Graphical Methods, Subtraction of Vectors, Multiplication of a Vector by a Scalar, Adding Vectors by Components, Projectile Motion, Projectile Motion is Parabolic, Relative Velocity

4. Forces and Newton's Laws of Motion

Force, Newton’s First Law of Motion, Mass, Newton’s Second Law of Motion, Newton’s Third Law of Motion, Weight—the Force of Gravity, The Normal Force, Vector Forces, Free-Body Diagrams, Friction, Incline Planes

5. Dynamics of Uniform Circular Motion

Kinematics of Uniform Circular Motion, Dynamics of Uniform Circular Motion, A Car Rounding a Curve, Centrifugal Force, Centripetal Force, Newton’s Law of Universal Gravitation, Gravity near the Earth’s Surface, Geophysical Applications, Satellites and “Weightlessness”, Kepler’s Laws and Newton’s Synthesis, Types of Forces in Nature

6. Work and Energy

Work Done by a Constant Force, Work Done by a Varying Force, Kinetic Energy, The Work-Energy Principle, Potential Energy, Conservative and Nonconsevative Forces, Mechanical Energy and its Conservation, Other Forms of Energy Transforms and the Law of Conservation of Energy, Power

7. Impulse and Momentum

Momentum and it Relation to Force, Conservation of Momentum, Collisions and Impulse, Conservation of Energy and Momentum in Collisions, Elastic Collisions in One-Dimension, Inelastic Collisions, Collisions in Two or Three Dimensions, Center of Mass, Center of Mass and Translational Motion

8. Rotational Kinematics

Angular Quantities, Kinematic Equations for Uniformly Accelerated Rotational Motion, Rolling Motion, Rotational Kinetic Energy

9. Rotational Dynamics

Torque, Rotational Dynamics, Torque and Rotational Inertia, Angular Momentum and its Conservation, Vector Nature of Angular Quantities, Moments of Inertia

10. Simple Harmonic Motion and Elasticity

Simple Harmonic Motion, Energy in the Simple Harmonic Oscillator, The Period and Sinusoidal Nature of SHM, The Simple Pendulum, Damped Harmonic Motion, Forced Vibrations, Resonance, Refraction and Diffraction, Hooke's Law, Springs, Energy Stored in a Spring, Statics-the Study of Forces in Equilibrium, The Conditions for Equilibrium, Stability and Balance, Elasticity, Stress and Strain

11. Fluids

Density and Specific Gravity, Pressure in Fluids, Atmospheric Pressure and Gauge Pressure, Pascal's Principle, Measurement of Pressure, Buoyancy and Archimedes' Principle, Fluids in Motion, Flow Rate and the Equation of Continuity, Bernoulli's Equation, Viscosity, Flow in Tubes, Poiseuille's Equation, Surface Tension and Capillarity

12. Temperature and Heat

Atomic Theory of Matter, Temperature and Thermometers, Thermal Equilibrium and the Zeroth Law of Thermodynamics, Thermal Expansion, Anomalous Behavior of Water Below 4°C

13. The Transfer of Heat

Heat as Energy Transfer, Distinction Between Temperature, Heat, and Internal Energy, Specific Heat, Calorimety, Latent Heat, Heat Transfer: Conduction, Convection, and Radiation

14. The Ideal Gas Law and Kinetic Theory

The Gas Laws and Absolute Temperature, Ideal Gas Law, Ideal Gas Law in terms of Molecules: Avogadro's Number, Kinetic Theory and the Molecular Interpretation of Temperature, Real Gases and Changes of Phase, Internal Energy of an Ideal Gas

15. **Thermodynamics**
    The First Law of Thermodynamics, Simple Systems, The Second Law of Thermodynamics, Heat Engines, Refrigerators, Air Conditioners, Heat Pumps, Entropy and the Second Law of Thermodynamics, Order to Disorder, Unavailability of Energy: Heat Death, Statistical Interpretation of Entropy

16. **Waves and Sound**
    Wave Motion, Types of Waves: Transverse and Longitudinal, Energy Transported by Waves, Reflection and Interference of Waves, Standing Waves, Characteristics of Sound, Intensity of Sound, The Ear and its Response: Loudness, Sources of Sound: Vibrating Strings and Air Columns, Quality of Sound and Noise, Doppler Effect

17. **The Principle of Linear Superposition and Interference Phenomena**
    Interference of Sound Waves, Beats, Diffraction

18. **Electric Forces and Electric Fields**
    Static Electricity, Electric Charge and its Conservation, Electric Charge in the Atom, Insulators and Conductors, Induced Charge, Electroscopes, Coulomb's Law, the Electric Field, Field Lines

19. **Electric Potential Energy and the Electric Potential**
    Electric Potential and Potential Difference, Relation Between Electric Potential and Electric Field, Equipotential Lines, The Electron Volt (a Unit of Energy), Electric Potential Due to Point Charges, Capacitance, Dielectrics, Storage of Electrical Energy

20. **Electric Circuits**
    The Electric Battery, Electric Current, Ohm's Law, Resistance and the Resistor, Resistivity, Electric Power, Resistors in Series and in Parallel, Kirchoff's Rules, Circuits Containing Capacitors in Series and in Parallel, Circuits Containing a Resistor and a Capacitor, Dc Ammeters and Voltmeters

21. **Magnetic Forces and Magnetic Fields**
    Magnets and Magnetic Fields, Electric Currents Produce Magnetism, Force of an Electric Current in a magnetic Field, Definition of **B**, Forces on an Electric Charge Moving in a Magnetic Field, Magnetic Field Due to a Straight Wire, Forces Between Two Parallel Wires, Definition of Ampere and the Coulomb, Torque on a Current Loop, Magnetic Moment

22. **Electromagnetic Induction**
    Induced EMF, Faraday's Law and Induction, Lenz's Law, EMF Induced in a Moving Conductor, Changing Magnetic Flux Produces and Electric Field, Electric Generators, Inductance, Energy Stored in a Magnetic Field, *LR* Circuits,

23. Alternating Current Circuits
Alternating Current, Transformers

24. Electromagnetic Waves
Changing Electric Fields Produce Magnetic Fields, Maxwell's Equations, Calculation of the Speed of Electromagnetic Waves, Light as and Electromagnetic Wave and the Electromagnetic Spectrum

25. The Reflection of Light: Mirrors
The Ray Model of Light, Reflection: Image Formation by a Plane Mirror, Formation of Images by Spherical Mirrors

26. The Refraction of Light: Lenses
Index of Refraction, Snell's Law, Total Internal Reflection, Thin Lenses, Ray Tracing, Thin Lens Equation

27. Interference and the Wave Nature of Light
Huygens' Principle of Diffraction, Interference—Double Slit Experiment, The Visible Spectrum, Diffraction by a Single Slit, Diffraction Grating, Interference by Thin Films, Michelson Interferometer, Polarization

28. Special Relativity
Galilean-Newtonian Relativity, The Michelson-Morley Experiment, Postulates of the Special Theory of Relativity, Simultaneity, Time Dilation, Length Contraction, Momentum and Mass, The Ultimate Speed, $E = mc^2$, Mass and Energy, Relativistic Addition of Velocities

29. Particles and Waves
Waves versus Particles, Wave-Particle Duality, Wave Nature of Matter, De Broglie's Hypothesis

30. The Nature of the Atom
Discovery and Properties of the Electron, Planks Quantum Hypothesis, Photon Theory of Light and the Photoelectric Effect, Photon Interactions, Compton Effect, Early Modes of the Atom, The Bohr Model, Quantum Mechanics

31. Nuclear Physics and Radioactivity
Structure and Properties of the Nucleus, Radioactivity, Alpha Decay, Beta Decay, Gamma Decay, Conservation of Nucleon Number and Other Conservation Laws, Half-life, Rate of Decay

32. Ionizing Radiation, Nuclear Energy, and Elementary Particles

Nuclear Reactions and the Transmutation of Elements, Nuclear Fission, Fusion, Particle and Antiparticles, Particle Interactions and Conservation Laws

33. Review and AP Exam Practice
Review Previous Exams, Give Previous Exams

D. METHODS OF INSTRUCTION

1. Lecture

2. Interactive participation of students – discussion

3. Demonstrations

E. METHODS OF EVALUATION

1. Homework

2. Projects

3. Labs

4. Quizzes – weekly

5. Chapter tests

6. Midterm and Semester Final Exams

F. BIBLICAL INTEGRATION

1.Perfect and just measurements. *Deut 25:15*

2. Various units of measurement in the Bible: Cubit, Homer, Ephah, etc.
   Just weights and measures. *Lev 19:35, Deut 25:13*-15

3. God measure the heavens with the span of His hand. *Isa 40:12, 48:13*

4. Jesus as a problem solver in the feeding of the 5000. *Matt 6:36-44*

5. As Christians we should always looked to the Lord to give us direction in our lives.
   Prov 3:6, Prov. 11:5

6. Saul's Conversion to Paul. *Phil 3:5-8*

7. Christians should be moving on a path toward sanctification. Ultimate fulfillment is when

we enter into His presence. *I John 3:2-5*

8. We will be changed in a twinkling of an eye. *1 Cor 15:52*

9. The Lord commanded Ezekiel to go into the flatlands that lie between the Tigris and Euphrates Rivers. *Eze 3:22,23*

10. In 2 Cor 4:17, Paul compares the weight of the world to the greater weight of glory in heaven.

11. One of the influences (force) in our lives is your friends. Good friends improve our character. Prov 27:17

12. God created and sustains the universe through His Son Jesus Christ. Jesus manifests the Godhead in creation. All praise and honor must be directed to Him. *Neh 9:6, Col 1:17*

13. God created all matter. *Gen 1:1*

14. Why were the Jewish religious leaders perplexed about how to answer the anticipated question from Jesus about John the Baptist? *Mark 11:31*

15. Why do we call upon the Lord and not do what he commands? *Luke 6:46*

16. For every action there is an equal and opposite reaction. *Hos 4:6*

17. Because they had rejected God, God had rejected them.
18. The omnipotence of God. *Jer 32:17* The omnipotence of God. *Jer 32:17, 1 Cor 1:23-25*

19. We are all born with talents and abilities that represent a potential for doing good, but this potential must be trained and taught Common sense says we should cooperate with those teaching us, but “The sluggard is wiser in his own conceit than seven men that can render a reason.” Prov 26:16

20. We have a potential to sin so be careful less we fall. *1 Cor 10:12*

21. Some people think that living a godly life would be an unbearable burden. This is only apparent weight, however, Jesus declared “My yoke is easy, and my burden is light.” *Matt 11:30*

22. The elements will melt with fervent heat. *2 Pet 3:10*

23. God sustains us in the presence of opposing forces. Psalm 55

24. Do not have a hard heart, but let God teach you through His Word, both studied and preached. *Heb 4:2*

25. The children of Israel wandered in the Sinai for 40 years because of lack of faith. *Num 14:33*

26. Circular motions of the heavens. *Job 38:31-32* The earth is a sphere. *Isa 40:22*

27. God conserves and preserves His creation through His power. *Gen 2:1-2*

28. Though God may work in different ways His character never Changes.
Himself – Psa *102:26* His glory – Psa *104:31* His mercy – Psa *106:1*
His goodness – *Psa 52:1* His peace – *Psa 72:7* His truth – *Psa 117:2*
His righteousness – *Psa 113:3* His name – *Psa 135:13*

29. No amount of good works can an unbeliever do to escape God's judgments. *John 3:18*

30. The source of spiritual light is Jesus Christ. *2 Cor 4:6* The shining of Moses' face. *Ex 33*

31. Become an expert at comparing light sources. *Gal 5:22-23, 2 Cor 11:14*

32. Do not resist the ordinance of God. *Rom 13:2* Resist the Devil. *James 4:7*

33. God will give us a mouth and wisdom, which all our adversaries will not be able to resist. Luke 21:15

34. Jesus is our solid foundation. The Church *Matt 16:18*

35. Wise man builds his house on the rocks. *Matt 7:25*
36. The Spirit of God flows out of us like a river. *John 7:38, Rev 22:1*

37. Endure temptations. *James 1:12*

38. Constructive wave interference. *Acts 27:41*

39. Jonathan shoots an arrow to warn David of King Saul's decision concerning him. *1 Sam 20:18-23*

40. The Lord is my light. *Psa 27:1* Jesus is the light of the world. *John 8:12*

41. The Word is a lamp. *Psa 119:105* We are children of the light. *1 Thes 5:5*
We should shine as lights. *Phil 2:15*

42. God can see into our hearts. *Psa 26:2*

43. Be attracted to the light. *John 3:20-21*

44. The Holy Spirit for power. *John 7:38, Act 2:2-4, John 4:14*

45. God gave each of us a certain measure of faith; use what you have! *Rom 12:3*

46. God gave us the capacity to love one another. *John 13:34, 1 John 2:7, 2 John 5*

47. What is the temperature of your spiritual life? *Rev 3:15:16*

48. Be equally yoked. *II Cor 6:14*

49. All phase of water are shown in the Bible. *Job 35:27-32, Job 36:6*

50. The flood that was upon the earth. Gen 7:17-20

51. Peer Pressure *Job 2:9*

52. The protection from floods of evil promised. *Isa 59:19*

53. The Lord has power to change time. *2 Kings 20:10-11*

54. Periodic character of the seasons. *Gen 8:22* Everything has a season. *Eccl 3:1-8*

55. Help your Christian brothers and sisters to radiate Christ by noticing and commending their Christian virtues—not for their glory but for Christ's *Philem. 5-6*

56. The rainbow reminds us of God's promise not to destroy the earth again with a flood. *Gen 9:12,13*

57. Total mass & energy remained constant since the sixth day of creation. *Gen 2:2-3*

58. First Law *Gen 2:1-2, Neh 9:6, Exo 20:11, Exo 31:17*

59. Use a spiritual telescope. *Job 36:3*

60. Second Law *Eccl 3:20, Isa 51:6*

61. Magnify the Lord with a song of thanksgiving. *Psa 69:30*

62. Magnify God work. *Job 36:24*

63. Our sin nature is an aberration in mankind. Rely on the Holy Spirit as a "corrective lens" to permit us to shine forth undistorted. *Acts 1:8*

64. The greatest heat engine that affects us is the interactions in the atmosphere that cause weather. *Eccles. 1:5-7*

65. Does the Bible predict uniformitarianism? *2 Pet 3:3-4*

66. Electrostatic charges attract or repel each other with incredible force. However, this force diminishes with distance. How close is your walk with the Lord? *James 4:8, Isa 29:13*

67. The second coming of the Son of man will be like lightning. Matt 24:27

68. Do not store anger. *Eph 4:31-32*

69. A compass always seeks a magnetic north. Are you continuously seeking Christ? *John 12:32*

70. Are you seeking Christ with all your heart are you just giving lip service? *Matt 15:8*

71. It is God who chose you, not the other way around. *John 6:44*

72. The corruption of the world is an inevitable end to all natural processes. If God were not to intervene, the universe would succumb to this principle. Those who are saved will escape this judgment. *2 Pet 1:4*

73. Shield yourself from the counsel of evil people. *I Kings 12:8, Psa 1:1*

74. Group as Christians. Matt 18:20

75. Do our work survive God's "polarizing filter"? *1 Cor 3:11-15*

76. God answers are faster than we imagine. *Isa 65:24*

77. God's thoughts are higher than our thoughts. *Isa 55:8-9*

78. Strong Nuclear Force. *2 Pet 3:10*

79. The Bible makes it clear that life on earth will not be accidentally wiped out because of a nuclear war. *Rev 20:7-9*

80. Man has the responsibility to take care of the earth. *Gen 1:28*

81. Radioactive Carbon Dating.

82. The splitting of Israel into two separate kingdoms. 1 Kings 12:20

G. Text

Physics –*Saxon*