COURSE OUTLINE

NAME OF COURSE: PHYSICS

COURSE NUMBER: SCI 401 **WRITTEN / REVISED:** SEPTEMBER, 2011

LEVEL OF COURSE: HONORS **NUMBER OF CREDITS:** SIX (6)

PRE-REQUISITE: ALGEBRA II **CO-REQUISITE:** PRECALCULUS

PREFACE/BACKGROUND STATEMENTS (INCLUDES STATEMENT OF PHILOSOPHY): This course is an algebra based college level physics course designed to enhance the student's knowledge of physical science. This course also serves as preparation for the Calculus based AP Physics C.

GENERAL OBJECTIVES:
The general objectives of this course include:

1. That physics must contribute to the general intellectual development of the student.
2. That the student be a problem solver developing analytical skills.
3. That the student be given opportunity to reason, to learn to express their thoughts clearly, and be able to follow the development of ideas presented, whether orally or from the written page.
4. Physics should sharpen the students' skills as observers and experimenters.
5. The course should develop the students understanding of the laws of physics.

ASSIGNMENTS:

1. Web Assign Homework
2. Projects
3. Teacher Generated Questions

EVALUATION:

1. Quizzes & Tests
2. Lab Report
3. Mid-Term & Final Exams

CORE CURRICULUM CONTENT STANDARDS:

5.1 - Scientific Practices
- A. Understanding Scientific Explanations
- B. Generate Scientific Evidence Through Active Investigations
- C. Reflect on Scientific Knowledge
- D. Participate Productively in Science

5.2 – Physical Science
- C. Forms of Energy
- D. Energy Transfer
- E. Forces and Motion

Part I: Mechanics

Unit I: Describing Motion: Kinematics in One Dimension Time = 2 weeks
Objectives:
After studying the material of this chapter, students should be able to:

1. Understand the general relationships among position, velocity and acceleration for the motion of a particle in a straight line.
2. Given the graph of one of the kinematic quantities, position, velocity or acceleration, as a function of time, they can recognize in what time intervals the other two are positive, negative or zero, and can identify or sketch a graph of each as a function of time.
3. Understand the special case of motion with a constant acceleration.
4. Write down expressions for velocity and position as functions of time, and identify or sketch graphs of these quantities.
5. Use the equations of motion, for the special case of constant acceleration, to solve problems involving one-dimensional motion with constant acceleration including free-fall.

Unit 2: Kinematics in Two Dimensions; Vectors Time = 2 weeks
Objectives:
After studying the material of this chapter, students should be able to:

1. Relate velocity, displacement and time for motion with a constant velocity.
2. Calculate the component of a vector along a specified axis, or resolve a vector into components along two unspecified mutually perpendicular axes.
3. Add vectors in order to find the net displacement of a particle that undergoes successive straight-line displacements.
4. Subtract displacement vectors in order to find the location of one particle relative to another, or calculate the average velocity of a particle.
5. Add or subtract velocity vectors in order to calculate the velocity change or average acceleration of a particle, or the velocity of one particle relative to another.
6. Understand the motion of projectiles in a uniform gravitational field.
7. Write down expressions for the horizontal and vertical components of velocity and position as functions of time, and sketch or identify graphs of these components.
8. Use these expressions in analyzing the motion of a projectile that is projected above the level ground with a specified initial velocity.

Unit 3: Dynamics: Newton's Laws of Motion Time = 3 weeks
Objectives:
After studying the material of this chapter, students should be able to:

1. Analyze situations in which a particle remains at rest, or moves with constant velocity, under the influence of several forces.
2. Understand the relationship between the force that acts on a body and the resulting change in the body's velocity.

3. Calculate, for a body moving in one direction, the velocity change that results when a constant force *F* acts over a specified time interval.
4. Determine, for a body moving in a plane whose velocity vector undergoes a specified change over a specified time interval, the average force that acted on the body.
5. **U**nderstand how Newton's Second Law, $F = ma$, applies to a body subject to forces such as gravity, the pull of strings, or contact forces.
6. Draw a well-labeled diagram showing all real forces that act on a body.
7. Write down the vector equation that results from applying Newton's Second Law to the body, and take components of this equation along appropriate axes.
8. **U**nderstand the significance of the coefficient of friction.
9. Write down the relationship between the normal and frictional forces on a surface.
10. Analyze situations in which a body slides down a rough inclined plane or is pulled or pushed across a rough surface.
11. Analyze static situations involving friction to determine under what circumstances a body will start to slip, or to calculate the magnitude of the force of static friction.
12. Students should understand Newton's Third Law so that, for a given force, they can identify the body on which the reaction force acts and state the magnitude and the direction of this reaction.
13. Students should be able to apply Newton's Third Law in analyzing the force of contact between two bodies that accelerate together along a horizontal or vertical line, or between two surfaces that can slide across one another.
14. Students should know that the tension is constant in a light string that passes over a mass less pulley and should be able to use this fact in analyzing the motion of a system of two bodies joined by a string.

Unit 4: Circular Motion; Gravitation Time = 2 weeks

Objectives:

After studying the material of this chapter, you should be able to:

1. Analyze situations in which a body moves with specified acceleration under the influence of one or more forces so they can determine the magnitude and direction of the net force, or of one of the forces that make up the net force, in situations such as the following: motion up or down (e.g. constant acceleration in an elevator for example), **m**otion in a horizontal circle (e.g., car rounding a banked curve), motion in a vertical circle (e.g., rider on a Ferris wheel).
2. Understand the uniform circular motion of a particle.
3. Relate the radius of a circle and the speed or rate of revolution of a particle undergoing uniform circular motion to the magnitude of the centripetal acceleration.
4. Describe the direction of a particle's velocity and acceleration at any instant during uniform circular motion.
5. Determine the components of the velocity and acceleration vectors at any instant, and sketch or identify graphs of these quantities, while undergoing uniform circular motion.

Unit 5: Work and Energy **Time = 3 weeks**

Objectives:

After studying the material of this chapter, you should be able to:

1. Understand the definition of work:
2. Calculate the work done by a specified constant force on a body that undergoes a specified displacement.
3. Relate the work done by a force to the area under the graph of force as a function of position, and calculate this work in the case where the force is a linear function of position.
4. Use the scalar product operation to calculate the work performed by a specified constant force *F* on a body that undergoes a displacement in a plane.
5. Understand the work-energy theorem.
6. Calculate the change in kinetic energy or speed that results from performing a specified amount of work on a body.
7. Calculate the work performed by the net force on a body that undergoes a specified change in speed or kinetic energy.
8. Apply the work energy theorem to determine the change in a body's kinetic energy and speed that result from the application of specified forces, or to determine the force that is required to bring a body to rest in a specified distance.
9. Understand the concept of potential energy.
10. Write an expression for the force exerted by an ideal spring and for the potential energy stored in a stretched or compressed spring.
11. Calculate the potential energy of a single body in a uniform gravitational field.
12. Understand the conservation of energy.
13. Identify situations in which mechanical energy is or is not conserved.
14. Apply conservation of energy in analyzing the motion of bodies that are moving in a gravitational field and are subjects to constraints imposed by strings or surfaces.
15. Apply conservation of energy in analyzing the motion of bodies that move under the influence of springs.
16. Recognize and solve problems that call for application of both conservation of energy and Newton's Laws.
17. Understand the definition of power.
18. Calculate the power required to maintain the motion of a body with constant acceleration (e.g., to move a body along a level surface, or to overcome friction for a body that is moving at constant speed).
19. Calculate the work performed by a force that supplies constant power, or the average power supplied by a force that performs as specified amount of work.

Unit 6: Linear Momentum **Time = 2 weeks**

Objectives:

After studying the material of this chapter, you should be able to:

1. Understand impulse and linear momentum.
2. Relate mass, velocity, and linear momentum for a moving body, and calculate the total linear momentum of a system of bodies.

3. Relate impulse to the change in linear momentum and the average force acting on a body.
4. Understand linear momentum conservation.
5. Identify situations in which linear momentum, or a component of linear momentum, is conserved.
6. Apply linear momentum conservation to determine the final velocity when two bodies that are moving along the same line, or at right angles, collide and stick together, and calculate how much kinetic energy is lost in such a situation.
7. Analyze collisions of particles in one or dimensions to determine unknown masses or velocities, and calculate how much kinetic energy is lost in a collision.

Unit 7: Rotational Motion* **Time = 1 weeks**

Objectives:

After studying the material of this chapter, you should be able to:

1. Understand the concept of torque.
2. Calculate the magnitude and sense of the torque associated with a given force.
3. Calculate the torque on a rigid body due to gravity.
4. State the conditions for translational and rotational equilibrium of a rigid body.
5. Apply these conditions in analyzing the equilibrium of a rigid body under the combined influence of a number of coplanar forces applied at different locations.

Part II: Waves and Optics

Unit 8: Vibrations and Waves **Time = 2 weeks**

Objectives:

After studying the material of this chapter, you should be able to:

1. State the conditions required to produce SHM.
2. Determine the period of motion of an object of mass *m* attached to a spring of force constant *k*.
3. Calculate the velocity, acceleration, potential, and kinetic energy at any point in the motion of an object undergoing SHM.
4. Write equations for displacement, velocity, and acceleration as sinusoidal functions of time for an object undergoing SHM if the amplitude and angular velocity of the motion are known. Use these equations to determine the displacement, velocity, and acceleration at a particular moment of time.
5. Determine the period of a simple pendulum of length *L*.
6. State the conditions necessary for resonance. Give examples of instances where resonance is a) beneficial and b) destructive. Explain how damped harmonic motion can be achieved to prevent destructive resonance.
7. Distinguish between a longitudinal wave and a transverse wave and give examples of each type of wave.
8. Describe wave reflection from a barrier, refraction as the wave travels from one medium into another, constructive and destructive interference as waves overlap, and diffraction of waves as they pass around an obstacle.

Unit 9: Sound **Time = 2 weeks**

Objectives:

After studying the material of this chapter, you should be able to:

1. Determine the speed of sound in air at one atmosphere of pressure at different temperatures.
2. Distinguish between the following terms: pitch, frequency, wavelength, sound intensity, loudness.
3. Determine intensity level in decibels of a sound if the intensity of the sound is given in W/m^2.
4. Determine the beat frequency produced by two tuning forks of different frequencies.
5. Solve for the frequency of the sound heard by a listener and the wavelength of the sound between a source and the listener when the frequency of the sound produced by the source and the velocity of both the source and the listener are given.
6. Explain how a shock wave can be produced and what is meant by the term "sonic boom."

Unit 10: Light: Geometric Optics **Time = 2 weeks**

Objectives:

After studying the material of this chapter, the student should be able to:

1. State the names given to the different segments of the electromagnetic spectrum.
2. Know the wavelengths associated with segments of the electromagnetic spectrum.
3. State the equation which relates the speed of an electromagnetic wave to the frequency and wavelength and use this equation in problem solving.
4. Distinguish between mirror reflection and diffuse reflection.
5. Draw a ray diagram and locate the position of the image produced by an object placed a specified distance from a plane mirror.
6. Distinguish between a convex and a concave mirror. Draw rays parallel to the principal axis and locate the position of the principal focal point of each type of spherical mirror.
7. Draw ray diagrams and locate the position of the image produced by an object placed a specified distance from a concave or convex mirror. State the characteristics of the image.
8. Use the mirror equations and the sign conventions to determine the position, magnification and size of the image produced by an object placed a specified distance from a spherical mirror.
9. State Snell's law and use this law to predict the path of a light ray as it travels from one medium into another. Explain what is meant by the index of refraction of a medium.
10. Explain what is meant by total internal reflection. Use Snell's law to determine the critical angle as light travels from a medium of higher index of refraction into a medium of lower index of refraction.

11. Distinguish between a convex and a concave lens. Draw rays parallel to the principal axis and locate the position of the principal focal points for each type of thin lens.
12. Draw ray diagrams and locate the position of the image produced by an object placed a specified distance from either type of thin lens. State the characteristics of the image.
13. Use the thin lens equation to determine the position, magnification, and size of the image produced by a concave or convex lens.

Part III: Electricity & Magnetism

Unit 11: Electric Charge and Electric Field Time = 2 weeks

Objectives:

After studying the material of this chapter, the student should be able to:

1. Understand the concept of electric field.
2. Define it in terms of the force on a net charge.
3. Calculate the magnitude and direction of the force on a positive or negative charge placed in a field
4. Given a diagram on which the an electric field is represented by flux lines, determine the direction of the field at a given point, identify locations where the field is strong and where it is weak, and identify where positive and negative charges must be located.
5. Analyze the motion of a particle of specified charge and mass in a uniform electric field.
6. **U**nderstand Coulomb's Law and the principle of superposition.
7. Determine the force that acts between specified point charges, and describe the electric field of a single point charge.
8. Use vector addition to determine the electric field produced by two or more point charges.
9. Describe the electric field of parallel charged plates.

Unit 12: Electric Potential Time = 2 weeks

Objectives:

After studying the material of this chapter, the student should be able to:

1. Understand the concept of electric potential.
2. Calculate the electrical work done on a positive or negative charge that moves through a specified potential difference.
3. Given a sketch for the equipotentials for a charge configuration, determine the direction and approximate magnitude of the electric field at various positions.
4. Apply conservation of energy to determine the speed of a charged particle that has been accelerated through a specified potential difference.
5. Calculate the potential difference between two points in a uniform electric field, and state which is at a higher potential.
6. Know the potential function for a point charge so they can determine the electric potential in the vicinity of one or more point charges.
7. Understand the nature of electric fields in and around conductors.

8. Explain the mechanics responsible for the absence of electric field inside a conductor, and why all excess charges must reside on the surface of the conductor.
9. Explain why a conductor must be an equi-potential, and apply this principle in analyzing what happens when conductors are connected by wires.
10. Determine the direction of the force on a charged particle brought near an uncharged or grounded conductor.
11. Prove and apply the relationship between the surface charge density on a conductor and the electric field strength near its surface.
12. Describe and sketch the graph of the electric field and potential inside and outside a charged conducting sphere.
13. Understand induced charge and electrostatic shielding.
14. Describe quantitatively the process of charging by induction.
15. Determine the direction of the force on a charged particle brought near an uncharged or grounded conductor.
16. Know the definition of capacitance so the can relate stored charge and voltage for a capacitor.
17. Understand energy storage in a capacitor.
18. Relate voltage, charge, and stored energy for a capacitor.
19. Recognize a situation in which energy stored is a capacitor is converted to other forms.
20. Understand the physics of the parallel-plate capacitor.
21. Describe the electric field inside the capacitor, and relate the strength of this field to the potential difference between the plates and plate separation.
22. Determine how changes in dimension will affect the value of the capacitance.

Unit 13: Electric Currents **Time = 2 weeks**

Objectives:

After studying the material of this chapter, the student should be able to:

1. Understand the definition of electric current so they can relate the magnitude and direction of the current in a wire or ionized medium to the rate of flow of positive and negative charge.
2. Understand conductivity, resistivity, and resistance.
3. Relate the current and voltage for a resistor.
4. Describe how the resistance of a resistor depends upon its length and cross-sectional area.
5. Apply the relationships for the rate of heat production in a resistor.

Unit 14: DC Circuits **Time = 2 weeks**

Objectives:

After studying the material of this chapter, the student should be able to:

1. Understand the behavior of series and parallel combinations of resistors.
2. Identify on a circuit diagram whether resistors are in series or in parallel.
3. Determine the ratio of the voltages across resistors connected in series or the ratio of currents through resistors connected in parallel.

4. Calculate the equivalent resistance of two or more resistors connected in series or parallel, or a network of resistors that can be broken down into series or parallel combinations.
5. Calculate the voltage, current, and power dissipated for any resistor in such a network of resistors connected to a single battery.
6. Design a simple series-parallel circuit that produces a given current and terminal voltage for one specified component, and draw a diagram for the circuit using conventional symbols.
7. Understand the properties of ideal and real batteries so they can calculate the terminal voltage of a battery of specified *emf* and internal resistance from which a known current is flowing.
8. Apply Ohm's Law and Kirchoff's rules to direct-current circuits in order to determine a single unknown current, resistance, or voltage.
9. Understand the properties of voltmeters and ammeters so they can state whether the resistance of each is high or low and identify correct methods of connecting meters into circuits for the purpose of measuring current or voltage.
10. Understand the behavior of capacitors connected in series or parallel.
11. Calculate the equivalent capacitance of a series or parallel combination.
12. Describe how stored charge is divided between two capacitors connected in parallel.
13. Determine the ratio of voltages for two capacitors connected in series.
14. Calculate the voltage or stored charge, under steady-state conditions, for a capacitor connected to a circuit consisting of a battery and resistors.
15. Develop skill in analyzing the behavior of circuits containing several capacitors and resistors so they can Determine voltages and currents immediately after a switch has been closed and also after steady-state conditions have been established.

Unit 15: Magnetism **Time = 2 weeks**

Objectives:

After studying the material of this chapter, the student should be able to:

1. Understand the force experienced by a charged particle in a magnetic field.
2. Calculate the magnitude and direction of the force in terms of *q, v,* and *B,* and explain why the magnetic field can do know work.
3. Deduce the direction of a magnetic field from information about the forces experienced by charged particles moving through the field.
4. State and apply the formula for the radius of the circular path of a charge that moves perpendicular to a uniform magnetic field, and derive this formula from Newton's Second Law and magnetic force law.
5. Describe the most general path possible for a charged particle moving in a uniform magnetic field, and describe the motion of a particle that enters a uniform magnetic field moving with a specified initial velocity.
6. Describe quantitatively under what conditions particle will move with constant velocity through crossed electric and magnetic fields.
7. Understand the force experienced by a current in a magnetic field.

8. Calculate the magnitude and direction of the force on a straight segment of a current carrying wire in a uniform magnetic field.
9. Indicate the direction of magnetic forces on a current carrying loop of wire in a magnetic field, and determine how the loop will tend to rotate as a consequence of these forces.
10. Understand the magnetic field produced by a long straight current-carrying wire.
11. Calculate the magnitude and direction of the field at a point in the vicinity of a current carrying wire.
12. Use superposition to find the magnetic field produced by two current carrying wires.
13. Calculate the force of attraction or repulsion between two long current carrying wires.

Part IV: Other Topics*

Unit 16: Fluids* **Time = 2 weeks**

Objectives:

After studying the material of this chapter, you should be able to:

1. Understand that a fluid exerts pressure in all directions.
2. Understand that a fluid at rest exerts pressure perpendicular to any surface that it contacts.
3. Understand and be able to use the relationship between pressure and depth in a liquid, $\Delta P = \rho g \Delta h$.
4. Understand that the difference in pressure on the upper and lower surfaces of an object immersed in a fluid results in an upward force on the object.
5. Understand and be able to apply Archimedes' Principle: the buoyant force on a submersed object is equal to the weight of the fluid it displaces.
6. Understand that for laminar flow, the flow rate of a liquid through its cross-section is the same at any point along its path.
7. Understand and apply the equation of continuity, $\rho_1 v_1 A_1 = \rho_2 v_2 A_2$.
8. Understand that the pressure of a flowing liquid is low where the velocity is high, and vice versa.
9. Understand and be able to apply Bernoulli's equation

$$P_1 + \rho_1 g h_1 + \frac{1}{2}\rho_1 v_1^{\,2} = P_2 + \rho_2 g h_2 + \frac{1}{2}\rho_2 v_2^{\,2}.$$

Unit 17: Heat* **Time = 2 weeks**

Objectives:

After studying the material of this chapter, you should be able to:

1. Understand the mechanical equivalent of heat so they can: calculate how much a substance will be heated by the performance of a specified quantity of mechanical work.
2. Understand the concept of specific heat, heat of fusion, and heat of vaporization.
3. Identify, given a graph relating the quantity of heat added to a substance and its temperature, the melting point, and boiling point and determine the heats of fusion and vaporization and the specific heat of each phase.

4. Determine how much heat must be added to a sample of a substance to raise its temperature from one specified value to another, or to cause it to melt or vaporize.
5. Understand heat transfer and thermal expansion.
6. Determine the final temperature achieved when substances, all at a different temperature, are mixed and allowed to come to thermal equilibrium.
7. Calculate how the flow of heat through a slab of material is affected by changes in the thickness or the area of the slab, or the temperature difference between the two faces of the slab.
8. Analyze qualitatively what happens to the size and shape of a body when it is heated.

Unit 18: The Laws of Thermodynamics* Time = 2 weeks

Objectives:

After studying the material of this chapter, you should be able to:

1. Understand the kinetic theory model of an ideal gas.
2. State the assumptions of the model.
3. State the connection between temperature and mean translation kinetic energy, and apply it to determine the mean speed of gas molecules as a function of their mass and the temperature of the gas.
4. State the relationship among Avogadro's number, Boltzmann's constant, and the gas constant *R*, and express the energy of a mole of a monatomic ideal gas as a function of its temperature.
5. Explain qualitatively how the model explains the pressure of a gas in terms of the collisions with the container walls, and explain how the model predicts that, for fixed volume, pressure must be proportional to temperature.
6. Students should know how to apply the ideal gas law and thermodynamic principles.
7. Relate the pressure and volume of a gas during and isothermal expansion or compression.
8. Relate the pressure and temperature of a gas during constant volume heating or cooling, or the volume and temperature during constant pressure heating or cooling.
9. Calculate the work performed on or by a gas during an expansion or compression at constant pressure.
10. Understand the process of adiabatic expansion or compression of a gas.
11. Identify or sketch on a *PV* diagram the curves that represent each of the above processes.
12. Apply the first law of thermodynamics.
13. Relate the heat absorbed by a gas, the work performed by the gas, and the internal energy change of the gas for any of the processes above.
14. Relate the work performed by a gas in a cyclic process to the area enclosed by a curve on a *PV* diagram.
15. Understand the second law of thermodynamics, the concept of entropy, and heat engines and the Carnot cycle.

16. Determine whether entropy will increase, decrease, or remain the same during particular situation.
17. Compute the maximum possible efficiency of a heat engine operating between two given temperatures.
18. Compute the actual efficiency of a heat engine.
19. Relate the heats exchanged at each thermal reservoir in a Carnot cycle to the temperature of the reservoirs.

COURSE EVALUATION CRITERIA

1. Tests & Quizzes	50-60%
2. Home Work	25-30%
3. Lab Reports	25-30%

TEXTBOOKS & RESOURCES

1. Text – PHYSICS: Principles with Applications, 6th ed. - Giancoli
2. Homework – Web Assign online
3. Lab Manual – Physics with Calculators – Vernier
4. Lab Manual - Practical Physics Labs – Peter Goodwin
5. Lab Manual – Physics: A Laboratory Manual – Puri, Zober & Zober

MATERIALS

1. Classroom Equipment
2. Smartboard
3. Vernier LabPro with Probes
4. Graphing Calculator (TI-84+ recommended)

COURSE REVISIONS

1. June 2014

MID-TERM & FINAL EXAM REVISIONS

1. January 2011
2. June 2011

High Point Regional High School's curriculum and instruction are aligned to the State's Core Curriculum Content Standards and address the elimination of discrimination by narrowing the achievement gap, by providing equity in educational programs and by providing opportunities for students to interact positively with others regardless of race, creed, color, national origin, ancestry, age, marital status, affectionate or sexual orientation, gender, religion, disability or socioeconomic status.