COURSE: General Physics
Grade Level: 9-12

MAIN/ GENERAL TOPIC	SUB-TOPIC:	ESSENTIAL QUESTIONS:	WHAT THE STUDENTS WILL KNOW:	WHAT THE STUDENT WILL BE ABLE TO DO:	Assessments:	WHEN INTRODUCED
Fundamental SI units	Basic Units	What are the basic units used by all physicists around the world?	The basic SI units are the: Meter (distance), Kilogram (mass), Second (time), Candela (luminous intensity) temperature (degrees K),	Use fundamental units to measure in lab Apply appropriate units to appropriate quantities	Basic skills lwksts and labs	Week 1-3
	Derived Units	How can the basic units be combined to create units for quantities that result from changes.	Units for: Motion (m/s, m/s/s) Force (Newton: Kgm/s/s) , Momentum: kgm/s, Work/Energy (Joule: Nm or Kgm/s/s or electron-volt eV), Power (watt (J/s) Spring stiffness (N/m) Electric field strength (N/C) Potential difference (Volt), Electrical current (Ampere) Electrical Resistance (Ohm) Frequency (hertz)	Use derived units to measure in lab Apply appropriate units to appropriate quantities and calculations	Basic skills worksheets and labs	Week 1-3
Measurement	Precision vs. accuracy	What is the difference between precision and accuracy	Precision is how finely a quantity can be measured. Accuracy is how close a measurement is to the actual value	Compare accuracy in experimental results Determine the precision of a measurement instrument. Estimate a measurement to one decimal place past the marked scale of the instrument	Basic skills worksheets and labs	Week 1-3
	Significant figures	What digits in a quantity are significant	Calculation cannot improve precision. A calculation is only as precise as its least precise measurement	Identify the measurement in a calculation that has the fewest number of significant figures and round to that decimal place.	Basic skills worksheets and labs	Week 1-3
	Acceptable error	What is an acceptable level of uncertainty in data?	No measurement is perfect and is limited by the precision of the least accurate instrument in the experiment	Recognize sources of error Recognize acceptable and unacceptable differences in data values. Be able to express error as a deviation from an actual value.	Basic skills worksheets and labs	Week 1-3
	Graphing	What is an acceptable way to visually represent Data?	Line graphs show relationships between variables. Line graphs are actually a “curve of best fit” not connected points Equations are derived from particular types of graphs. Ex. linear	Explain the placement of an unknown element in the Periodic table based on its properties. Interpret and write isotopic notation.	Lab reports, modeling labs	Week 1-3
The Scientific Method	Scientific procedures	What methods to learn about the universe and share their findings?	.A well run experiment has: • A hypothesis that predicts an outcome • A clear definitive plan • Data that is organized using charts and graphs • Conclusions based on data • Assessments of experimental error	Plan, write and carry out experiments to answer a specific question.	Lab reports	Week 1-3

Kinematics	Motion	What is motion and how do we define it?	Motion depends on a relative point of view	.Describe motion from a reference point using positive and negative integers and traditional directions (Up, Down, Left, Right, North South, East, West , Clockwise Counterclockwise etc)	Lab: Constant motion carts	Week 1-3
	Vectors	How do vectors and scalars differ?	Vectors are measurable quantities that include direction. Vectors are properly expressed in three dimensions. (X,Y,Z) Vectors can be added or subtracted Examples of vectors: displacement, velocity, acceleration, momentum, Examples of scalars: time, distance, energy, electric charge etc	Distinguish vector and scalar quantities Add and subtract vector quantities Use geometry and trigonometry to analyzed vector quantities Determine the resultant of two or more vectors graphically or algebraically Draw scaled force diagrams with protractor and ruler. Resolve a vector into horizontal and vertical components.	Basic Skills Wkshts and Labs Lab: Vector Treasure map	Week 1-3
	Velocity	How do we measure changes in position with respect to time?	Changes in distance with respect to time are called speed Changes in displacement with respect to time are called velocity. An objects total change in displacement divided by the total time of the displacement is its average velocity V = d/t = (Vfinal +Vinitial)/2	Calculate average velocity. Determine average velocity from a Displacement vs. Time Graph or Velocity vs. Time Graph	Lab Constant motion carts	Week 4-6
	Acceleration	How do we measure changes in velocity with respect to time?	Change in velocity with respect to time is called acceleration. a = (Vfinal – Vinitial)/time	Determine acceleration from graphs of distance ,velocity, and acceleration vs time	Project Building a Mousetrap Car	Week 4-6
	Motion graphs	How can we represent motion graphically and what information can we gather from that.	Slopes and Areas created by graphs give us information about an object's motion	Create and Interpret graphs for an object's Velocity, Acceleration and Position.	Lab Using a motion detector	Week 4-6
Dynamics and Momentum	Momentum	How do we define momentum?	Momentum is defined as an object's mass multiplied by its velocity p = mv Momentum is a vector quantity	Calculate the momentum of an object or particle	Lab Changes in momentum	21-23
	Impulse	What changes an object's momentum? How do changes in momentum occur	A change in Momentum is called an impulse (J) An Impulse is a force acting over a certain time span $J = (F_{net})(t) = p_{if} - p_i$	Calculate an object's change in momentum	Lab: Calculating Impulse	21-23

	Force	What is a force?	Unbalanced forces cause changes in momentum (acceleration) An object in equilibrium has no net force and therefore no change in momentum There are four fundamental forces in Nature: Gravitational, Electromagnetic, Weak and Strong Nuclear Forces Gravitational force is the attraction of two objects due to their mass Gravity decreases exponentially with distance $F_{gravity} = Gm_1m_2/r^2$ $G = 6.67x10^{11} Nm^2/kg^2$ $F_{electric} = kq_1q_2/r^2$ $k = 8.99 \times 10^9\ Nm^2/C^2$ Net force results in a change in momentum or acceleration (F = ma) Forces perpendicular to the direction of motion crate circular motion. ($F_{centripetal} = mV^2/r$ Friction is a contact force that opposes motion Friction is proportional to normal force ($F_{friction} = \mu F_{normal}$) For any two materials the maximum coefficient of static friction is greater than the coefficient of kinetic friction	Name the four fundamental forces Calculate Gravitational and Electric Force Define the gravitational field strength (acceleration due to gravity) of the earth or other object. Calculate the centripetal force on an object Determine the tangential velocity of an object in circular motion Use "action reaction" to determine the net force on an object Calculate or deduce the force of friction on an object Sum the forces and force components on an object in equilibrium (at rest or in constant motion.)	Lab: Weight vs Mass Lab: Centripetal Force Lab: Coefficient of friction	Week 7-15
Energy	Energy	What is energy	Energy is conserved and can be converted to different forms in a system Work external to the system changes the total energy of a system Energy is a scalar quantity On Earth potential energy between in an earth object system is (mass)(g)(height above surface) Kinetic energy of an object at speed much less than *c* is $.5(m)(v^2)$ Potential energy of a spring is $(.5)(k)(dx^2)$	Describe and explain the exchange between potential energy, kinetic energy, and internal energy for a simple mechanical system such as a pendulum, roller coaster, spring, freely falling object. Predict velocities, heights, and spring compression based on energy conservation. Determine the energy stored in a spring. Determine the factors that affect the period of a pendulum Observe and explain energy conversion in real-world situations. Recognize and describe conversions among different forms of energy in real or hypothetical devices such and a motor, generator, photocell , battery .	Lab: "quantum Leap"	Week 16-20
	Work	What changes the energy in a system	W = (Force)(Distance) W = Change in Energy	Calculate the amount of work done on a system.		Week 16-20

	Power	How do we determine the rate of energy change (work) in a system?	$P = W/t = FV$ $P_{electric} = VI = I^2R = V^2/R$	Compare the power developed when the same work is done at different rates Determine the amount of power dissipated by an electric circuit	Lab Watt's your power?	Week 9-12
Electricity	Electric Charge	How is charge defined? What is an electric field? What is electric force? How do charges behave in a conductor? How do charges behave in an insulator? What is the smallest amount of charge?	Determine	Describe the interaction between charged objects Draw field lines to represent the electric field around a charged object Draw the net field between two charged plates. Calculate the electric force on a charged particle in an electric field. Diagram the distribution of charge on a conductor or an insulator	Lab: electroscope Lab: the electrophorus	Week 24-27
	Electric Current	What is an electric Current?	Charges in motion are simply defined as an electric current.	Measure a current with an ammeter Calculate the current in a wire	Lab Ohm's law	Week 24-27
	Potential Difference	What happens when we move charges through electric fields?	A charged object in a field has electric potential As a charge moves against the direction of the electric field it increases in electric potential The difference in electric potential between two points in the electric field is called potential difference or voltage The unit of potential difference is the Volt	Explain how electric potential changes in an electric field Compare electric potential to gravitational potential Measure potential difference with a volt meter	Project Bulding an electric motor	Week 24-27
	Electric Circuits	What is an electric current? How do electrons move in paths? What effect do various paths have on current and potential difference? How can we measure current and Voltage?	Current is flow of charge/sec An electric circuit must be a unbroken path of conducting material The sum of all the potential differences in a circuit is zero in any path from one terminal of the battery to the other terminal of the battery The sum of all currents entering a junction (node) in a circuit is equal to the sum of all the currents leaving that junction	Measure the current and voltage in a circuit Use measurements to determine the resistance of a circuit element. Interpret graphs of voltage versus current. Construct simple and parallel circuits Draw and interpret circuit diagrams which include voltmeters, ammeters, switches, resistors and lamps. Predict the behavior of light bulbs in series and parallel circuits. Calculate the equivalent resistance of a circuit	Lab: series circuits Lab Parallel circuits	Week 28-30
	Resistors	What effects the resistance of a particular resistor	Ohmic resistors obey ohm's Law $R= V/I$ Non ohmic resistors to not conform to Ohm's Law Resistance is dependent on The type and number of mobile charges and the density of mobile charges in a material. This can be expressed as the resistivity of the material ρ. $R = \rho L/A$ Resistance increases with temperature	Measure and compare the resistance of conductors of various lengths and cross-sectional area.	Lab Resistance of a Wire	Week 28-30

	Magnets	What is a magnetic field? How are magnetic fields created? How do magnetic fields effect moving charges	Magnetic fields are created by charges in motion Permanent magnets are created by alignment of magnetic domains in soft iron Magnets have a North and South pole determined by the direction of magnetic field in those regions Magnetic fields generate forces on moving charges Magnetic field lines are closed loops through the magnet Moving magnetic fields generate potential differences in conductors.	Detect the presence of a magnetic field near a current carrying wire Draw magnetic fields around and between the poles of permanent magnets Describe a the effect of a moving magnetic field on a conductor	Lab: fields around magnets	Week 31-32
Waves and wave phenomena	Waves, Light and Sound	What is a pulse? What is a wave? How do waves interact with each other, and different media? What is "light" (electromagnetic waves)? What is Sound? How does superposition apply to waves? What is reflection? What is refraction? What is diffraction? What is interference? What is the relationship between wave speed, frequency and wavelength? What is amplitude?	Pulses are generated by disturbances parallel or perpendicular to a medium. Perpendicular pulses are called transverse Parallel pulses are called longitudinal A wave is a repeating series of pulses The distance between any two points in phase on a wave is a wavelength The displacement of the wave from the undisturbed medium is the amplitude Amplitude is related to the energy carried by the wave The distance a pulse travels divided by the time it takes to travel that distance is its speed (v) Frequency is inversely proportional to wave period Wave speed is proportional to frequency and wavelength $V = f\lambda$ Electromagnetic energy is the wave function of photons. It moves at a constant velocity *c* in a vacuum. Light color is determined by frequency. Light frequency is constant in any medium therefore light is slower in transparent media. The ratio of these velocities is defined by Snell's law ($n_1 \sin \theta_1 = n_2 \theta_2$, $n = c/v$)	Compare the characteristics of two transverse waves such as amplitude, frequency, wavelength, speed, period, and phase. Draw wave forms with various characteristics Indentify nodes and antinodes in standing waves. Differentiate between transverse and longitudinal waves. Determine the speed of sound in air. Predict the superposition of two waves interfering constructively and destructively (indicating nodes, antinodes, and standing waves) Observe , sketch, and interpret the behavior of wave fronts as they reflect, refract and diffract. Draw ray diagrams to represent the reflection and refraction of waves. Determine empirically the index of refraction of a transparent medium Distinguish between convex and concave lenses and mirrors Determine the focal length of a convex lens	Lab: Pulses in a spring Lab Snell's Law Lab: Images and Lenses Lab Speed of sound	Week 33-40