MONTGOMERY COUNTY PUBLIC SCHOOLS

Physics Curriculum Pacing Guide

1st 9 Weeks	SOL Objectives	Vocabulary
90 Minute Class: 2 Days **45 Minute Class:** 4 Days	**INTRODUCTION:** **PH.1 The student will plan and conduct investigations using experimental design and product design processes. Key concepts include:** a) the components of a system are defined; b) instruments are selected and used to extend observations and measurements; c) information is recorded and presented in an organized format; d) the limitations of the experimental apparatus and design are recognized; e) the limitations of measured quantities are recognized through the appropriate use of significant figures or error ranges; f) models and simulations are used to visualize and explain phenomena, to make predictions from hypotheses, and to interpret data; and g) appropriate technology, including computers, graphing calculators, and probeware, is used for gathering and analyzing data and communicating results. **LI: I can design & perform a physics experiment using acceptable scientific method.** **PH.2 The student will investigate and understand how to analyze and interpret data. Key concepts include:** a) a description of a physical problem is translated into a mathematical statement in order to find a solution; b) relationships between physical quantities are determined using the shape of a curve passing through experimentally obtained data; c) the slope of a linear relationship is calculated and includes appropriate units; d) interpolated, extrapolated, and analyzed trends are used to make predictions; and e) situations with vector quantities are analyzed utilizing trigonometric or graphical methods. **LI: I can design & perform a physics experiment using acceptable scientific method.** **PH.3 The student will investigate and demonstrate an understanding of the nature of science, scientific reasoning, and logic. Key concepts include:** a) analysis of scientific sources to develop and refine research hypotheses; b) analysis of how science explains and predicts relationships; c) evaluation of evidence for scientific theories; d) examination of how new discoveries result in modification of existing theories or establishment of new paradigms; and e) construction and defense of a scientific viewpoint. **LI: I can design & perform a physics experiment using acceptable scientific method.**	Accuracy Dependent Variable Dimensional Analysis Hypothesis Independent Variable Inverse Relationship Line of Best Fit Linear Relationship Model Measurement Physics Precision Quadratic Relationship Scientific Law Scientific Theory Significant Figures Scientific Method

	PH.4 The student will investigate and understand how applications of physics affect the world. Key concepts include: a) examples from the real world; and b) exploration of the roles and contributions of science and technology. **LI: I can solve a problem from the real world using physics methods.** **Per standard, these items are taught throughout as part of most units and not as a separate unit.**	
90 Minute Class: 4 Days **45 Minute Class:** 8 Days	**<u>MOTION IN 1-D</u>** **PH.5 The student will investigate and understand the interrelationships among mass, distance, force, and time through mathematical and experimental processes. Key concepts include:** a) linear motion; **LI: I can use graphical methods to describe relationships between displacement, velocity, acceleration & time.** **I can use algebraic methods to solve for variables from the kinematic equations.**	displacement velocity acceleration distance speed free-fall
90 Minute Class: 5 Days **45 Minute Class:** 10 Days	**<u>2-D MOTION & VECTOR</u>** **PH.5 The student will investigate and understand the interrelationships among mass, distance, force, and time through mathematical and experimental processes. Key concepts include:** a) linear motion; c) gravitation; and **LI: I can differentiate between vector and scalar quantities.** **I can use trigonometry to solve 2D MOTION (vector) problems.** **I can solve problems for variables using 2 dimensional kinematics --- (displacement, v, a, F)**	Parabola Centripetal Motion Kinematics Dynamics Mass Volume Terminal Velocity Vector scaler Resultant components Trajectory Sine Cosine Tangent Projectile Frame of Reference Magnitude
90 Minute Class: 5 Days	**<u>FORCES</u>** **PH.5 The student will investigate and understand the interrelationships among mass,**	displacement velocity acceleration Parabola

45 Minute Class: 10 Days	**distance, force, and time through mathematical and experimental processes. Key concepts include:** a) linear motion; c) gravitation; and d) planetary motion **LI: I can: state (& differentiate between) Newton's 3 Laws of Motion.** **I can: use & apply Newton's Laws to solve real world problems about** **-linear motion** **-gravitation** **-planetary motion**	Centripetal motion Kepler's Laws Air Resistance Free-body Diagrams Coefficient of Friction Static & Kinetic Friction Newton's Laws Inertia Normal Force Tension Applied Force Net Force Weight Equilibrium
90 Minute Class: 5 Days **45 Minute Class:** 10 Days	**<u>WORK & ENERGY</u>** **PH.5 The student will investigate and understand the interrelationships among mass, distance, force, and time through mathematical and experimental processes. Key concepts include:** g) work, power, and energy **LI: I can state the relationships between work, power & time.** **PH.6 The student will investigate and understand that quantities including mass, energy, momentum, and charge are conserved. Key concepts include:** a) kinetic and potential energy; and **LI: I can recognize different types of energy.** **PH.7 The student will investigate and understand that energy can be transferred and transformed to provide usable work. Key concepts include:** a) transfer and storage of energy among systems including mechanical, thermal, gravitational, electromagnetic, chemical, and nuclear systems; and b) efficiency of systems **LI: I can use the Law of Conservation of Energy to solve problems (for variables such as energy, time, mass, velocity, etc.).**	Work Power Kinetic energy Potential energy Conservation of Energy Gravitational potential energy Elastic potential energy

2nd 9 Weeks	SOL Objectives	Vocabulary
90 Minute Class: 5 Days **45 Minute Class:** 10 Days	**MOMENTUM** **PH.6 The student will investigate and understand that quantities including mass, energy, momentum, and charge are conserved. Key concepts include:** c) mass/energy equivalence	Momentum Impulse Elastic collision Inelastic collision
90 Minute Class: 5 Days **45 Minute Class:** 10 Days	**CIRCULAR MOTION & GRAVITY** **PH.5 The student will investigate and understand the interrelationships among mass, distance, force, and time through mathematical and experimental processes. Key concepts include:** e) gravitation; f) planetary motion; and **PH.10 The student will investigate and understand how to use the field concept to describe the effects of gravitational, electric, and magnetic forces. Key concepts include:** a) inverse square laws (Newton's law of universal gravitation and Coulomb's law); and b) technological applications	Force Field Gravitational Field Weightlessness Microgravity Black Hole Gravitational Interaction Inverse Square Law Centripetal Force Kepler's Laws Torque Tangential Velocity
90 Minute Class: 4 Days **45 Minute Class:** 8 Days	**WAVES** **PH.8 The student will investigate and understand wave phenomena. Key concepts include:** a) wave characteristics; b) fundamental wave processes; and	Frequency Amplitude Period Wavelength Wave speed Oscillation Harmonic motion Vibration Longitudinal Transverse Constructive inference Destructive inference Node & Antinode

90 Minute Class: 4 Days **45 Minute Class:** 8 Days	**<u>SOUND</u>** **PH.1-PH.4** **PH.8 The student will investigate and understand wave phenomena. Key concepts include:** a) wave characteristics; b) fundamental wave processes; and c) light and sound in terms of wave models.	Frequency Amplitude Period Wavelength Doppler Effect Compression Rarefaction Medium Pitch Beats Resonance
90 Minute Class: 4 Days **45 Minute Class:** 8 Days	**<u>LIGHT & OPTICS</u>** **PH.1-PH.4** **PH.7 The student will investigate and understand that energy can be transferred and transformed to provide usable work. Key concepts include:** a) transfer and storage of energy among systems including mechanical, thermal, gravitational, electromagnetic, chemical, and nuclear systems; and b) efficiency of systems **PH.8 The student will investigate and understand wave phenomena. Key concepts include:** a) wave characteristics; b) fundamental wave processes; and c) light and sound in terms of wave models. **PH.9 The student will investigate and understand that different frequencies and wavelengths in the electromagnetic spectrum are phenomena ranging from radio waves through visible light to gamma radiation. Key concepts include:** a) the properties, behaviors, and relative size of radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, and gamma rays; b) wave/particle dual nature of light; and c) current applications based on the respective wavelengths.	Frequency Amplitude Period Wavelength E/M spectrum E/M waves Refraction Reflection Diffraction Concave Convex Polarization Light speed Lens Focal point Focal length Interference

3rd 9 Weeks	SOL Objectives	Vocabulary
90 Minute Class: 4 Days **45 Minute Class:** 8 Days	**ELECTRIC FORCE/FIELDS** **PH.1-PH.4** **PH.10 The student will investigate and understand how to use the field concept to describe the effects of gravitational, electric, and magnetic forces. Key concepts include:** a) inverse square laws (Newton's law of universal gravitation and Coulomb's law); and b) technological applications	electric force charge attract repel conductor insulator fundamental charge coulomb electrically polarized electric field static electricity electrostatic charge induction
90 Minute Class: 5 Days **45 Minute Class:** 10 Days	**ELECTRIC ENERGY/CURRENT** **PH.1-PH.4** **PH.5 The student will investigate and understand the interrelationships among mass, distance, force, and time through mathematical and experimental processes. Key concepts include:** h) work, power, and energy **PH.6 The student will investigate and understand that quantities including mass, energy, momentum, and charge are conserved. Key concepts include:** b) kinetic and potential energy; and **PH.7 The student will investigate and understand that energy can be transferred and transformed to provide usable work. Key concepts include:** c) transfer and storage of energy among systems including mechanical, thermal, gravitational, electromagnetic, chemical, and nuclear systems; and d) efficiency of systems **PH.11 The student will investigate and understand how to diagram, construct and analyze basic electrical circuits and explain the function of various circuit components. Key concepts include:** a) Ohm's law; c) electrical power; and d) alternating and direct currents	Current Resistance Series Parallel Inverse square law Capacitance DC/AC Power Electric potential Resistance Conductor Insulator Voltage

90 Minute Class: 4 Days **45 Minute Class:** 8 Days	**CIRCUITS** **PH.11 The student will investigate and understand how to diagram, construct and analyze basic electrical circuits and explain the function of various circuit components. Key concepts include:** a) Ohm's law; b) series, parallel, and combined circuits; c) electrical power; and d) alternating and direct currents **PH.7 The student will investigate and understand that energy can be transferred and transformed to provide usable work. Key concepts include:** a) transfer and storage of energy among systems including mechanical, thermal, gravitational, electromagnetic, chemical, and nuclear systems; and b) efficiency of systems	Current Resistance Series Parallel Fuse
90 Minute Class: 5 Days **45 Minute Class:** 10 Days	**MAGNETISM & INDUCTION** **PH.7 The student will investigate and understand that energy can be transferred and transformed to provide usable work. Key concepts include:** a) transfer and storage of energy among systems including mechanical, thermal, gravitational, electromagnetic, chemical, and nuclear systems; and b) efficiency of systems **PH.10 The student will investigate and understand how to use the field concept to describe the effects of gravitational, electric, and magnetic forces. Key concepts include:** a) inverse square laws (Newton's law of universal gravitation and Coulomb's law); and b) technological applications **PH.11 The student will investigate and understand how to diagram, construct and analyze basic electrical circuits and explain the function of various circuit components. Key concepts include:** b) series, parallel, and combined circuits;	Electromagnet Electromagnetic Induction Faraday's Law Magnetic domains Magnetic fields Electric motor Electric generator Magnetic force Right-hand Rule Flux Transformers

90 Minute Class: 4 Days **45 Minute Class:** 8 Days	**ATOMIC** **PH.6 The student will investigate and understand that quantities including mass, energy, momentum, and charge are conserved. Key concepts include:** a) elastic and inelastic collisions; c) mass/energy equivalence. **PH.12 The student will investigate and understand that extremely large and extremely small quantities are not necessarily described by the same laws as those studied in Newtonian physics. Key concepts include:** a) wave/particle duality; b) wave properties of matter; c) quantum mechanics and uncertainty; **PH.9 The student will investigate and understand that different frequencies and wavelengths in the electromagnetic spectrum are phenomena ranging from radio waves through visible light to gamma radiation. Key concepts include:** b) wave/particle dual nature of light; and	elastic collision inelastic collision Blueshift Redshift Radiation electromagnetic spectrum electron proton neutrino photon beta particle gamma ray binding energy conservation of energy conservation of momentum dispersion quantum superposition resonance polarization Doppler effect theory of relativity superconductor fusion fission mass defect photoelectric effect uncertainty principle rest mass/energy decay

4th 9 Weeks	**SOL Objectives**	**Vocabulary**
90 Minute Class: 4 Days **45 Minute Class:** 8 Days	**SUBATOMIC** **PH.7 The student will investigate and understand that energy can be transferred and transformed to provide usable work. Key concepts include:** a) transfer and storage of energy among systems including mechanical, thermal, gravitational, electromagnetic, chemical, and nuclear systems; and b) efficiency of systems **PH.12 The student will investigate and understand that extremely large and extremely small quantities are not necessarily described by the same laws as those studied in Newtonian physics. Key concepts include:** e) solid state physics; f) nanotechnology; g) superconductivity; and	Radioactive decay Alpha, beta and gamma Superconductivity

	h) radioactivity i) superconductivity; and j) radioactivity.	
90 Minute Class: 3 Days **45 Minute Class:** 6 Days	**<u>FLUIDS</u>** **PH.5 The student will investigate and understand the interrelationships among mass, distance, force, and time through mathematical and experimental processes. Key concepts include:** d) gravitation	

90 Minute Class: 4 Days **45 Minute Class:** 8 Days	**<u>HEAT</u>** **PH.7 The student will investigate and understand that energy can be transferred and transformed to provide usable work. Key concepts include:** a) transfer and storage of energy among systems including mechanical, thermal, gravitational, electromagnetic, chemical, and nuclear systems; and b) efficiency of systems **PH.5 The student will investigate and understand the interrelationships among mass, distance, force, and time through mathematical and experimental processes. Key concepts include:** g) work, power, and energy	Conductor Convection Greenhouse Effect Insulator Newton's law of cooling Radiant energy Radiation Terrestrial radiation
90 Minute Class: 3 Days **45 Minute Class:** 6 Days	**<u>THERMODYNAMICS</u>** **PH.7 The student will investigate and understand that energy can be transferred and transformed to provide usable work. Key concepts include:** a) transfer and storage of energy among systems including mechanical, thermal, gravitational, electromagnetic, chemical, and nuclear systems; and b) efficiency of systems **PH.5 The student will investigate and understand the interrelationships among mass, distance, force, and time through mathematical and experimental processes. Key concepts include:** g) work, power, and energy	calorimeter fossil fuels petroleum natural gas coal heat radiation greenhouse effect Hess's Law enthalpy of formation