Saint Patrick High School

Curriculum Guide Physics

Department:	Science	**Grade and Level:**	11th and 12th grade
Class:	Physics	**Term (Semester or Year):**	Year course

Required Text:	• CK 12- Physics Interactive Edition)
Additional Resources (i.e. texts, materials, apps, etc.):	iPad Apps Showbie GoodReader Pages iMovie iBooks iTunes U Keynote BookPress Educreations Nearpod Vernier Video Physics Numbers myHomework Ck12app **Scientific Calculator (TI-30X IIS or graphing calculator)**

Course Description

This is a one-year laboratory course for Juniors and Seniors in the fundamental principles of physics. Some of the topics covered are: the scientific process, graphing fundamentals, measurements, waves & sound, light & optics, kinematics, forces, and electricity. Successful completion of this course will assist an average student in future science courses in high school and college whether or not the student majors in science.

Unit Themes (Table of Contents)

Semester One

Theme 1:	Math Basics & Scientific Process
Theme 2:	Waves & Sound
Theme 3:	Light & Optics
Theme 4:	Kinematics: Constant Velocity
Theme 5:	Kinematics: Acceleration (Qualitative & Quantitative)
Theme 6:	Projectile Motion (Honors)

Semester Two

Theme 1:	Forces
Theme 2:	Newton's Laws
Theme 3:	Momentum
Theme 4:	Work & Energy
Theme 5:	Electricity & Magnetism

Agreed Upon Assessments

Forms of assessments may include but are not limited to….

- Unit quizzes and tests
- Labs
- Projects

Expectations

Students have many projects that require them to work collaboratively, evaluate the work of their peers, and communicate their findings to a broader audience using a variety of mediums. Each project has specific research guidelines and directions to use.

Unit:	Math Basics & Scientific Process	**Duration:**	2-3 weeks

Specific Unit Standards

Disciplinary Core Idea: None

Practices: 1) Analyzing & Interpreting Data: Analyze data using tools, technologies, and/or models (e.g. computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

2) Develop and/or use a model to generate data to support explanations, analyze systems, or solve problems.

Cross-Cutting Concepts: Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

Essential Questions:

- What is the proper way to record measurements from scientific instruments?
- How does one determine and properly use significant figures?
- How does one convert between regular numerical notation to scientific notation and vice versa?
- How does one read, draw and use vectors?
- What is the proper way to convert units?
- What is the proper way to make a graph?
- What are the different types of graphs and how does one decide which type of graph to use?
- What are the differences between independent variables and dependent variables?
- What are the steps of the scientific process?

Affirmation Statements:

Students will be able to…:

- read measurements from scientific instruments to the proper decimal position.
- take a scientific measurement and recreate the gradations of the scale used from the instrument.
- determine the number of significant figures that are in measured quantities.
- add/subtract measured values and maintain the appropriate number of significant figures.
- multiply/divide measured values and maintain the appropriate number of significant figures.
- understand the format for scientific notation.
- convert from regular notation values into scientific notation and vice versa.
- convert improperly written scientific notation values into properly written scientific notation values.
- understand the differences and similarities of the English and Metric systems.
- understand the metric prefixes.

● convert from one measured unit to another using proper Dimensional Analysis technique.
● Draw vectors using scales to represent large distances on paper.
● Understand vectors have magnitude and distance.
● Understand the essential components of a graph (including: title, axis, labels, units, numbers, key)
● Understand the differences between independent and dependent variables
● Understand the different aspects of the scientific process
● How to apply the scientific process to solve problems in a logical fashion.

Common Assessments:

- Paper Tower Activity
- Spaghetti Bridge Lab
- Around the Room Activity
- Vector Map Activity
- Graphing & Scientific Process Exam

Unit:	Waves and Sound	Duration:	Approximately one month

Essential Questions:

- How do wave interactions influence systems?
- What are the properties of waves?
- What are the different ***types*** of waves?
- What are the different ***parts*** of waves?
- What is the mathematical relationship between different parts of a wave?
- What is the Doppler Effect?
- How can one calculate the apparent change in frequency of an object due to the Doppler Effect?

Specific Unit Standards

PS4-1 Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

- [Clarification Statement: Examples of data could include electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the Earth.]
- [Assessment Boundary: Assessment is limited to algebraic relationships and describing those relationships qualitatively.]

PS4.A.3 Waves can add or cancel one another as they cross, depending on their relative phase (i.e. relative position of peaks and troughs of the waves), but they emerge unaffected by each other.

Affirmation Statements:

Students will be able to…:

Explain how wave interactions influence systems

Describe the properties of waves

Identify and provide examples of wave types:

- Transverse
- Longitudinal
- Combined transverse and longitudinal (seismic and ocean)

Identify wave parts:

- Crest
- Trough
- Wavelength
- Amplitude
- Equilibrium

Calculate and describe the relationships between:

- Frequency
- Period
- Wave speed

Use mathematical representations to support a claim regarding relationships among the

frequency, wavelength, and speed of waves traveling in various media.

Apply their knowledge of sound waves to calculations and detailed explanations of Doppler Effect (Honors).

Common Assessments:

- Soundproof Phone Case Project
- Waves & Sound Summative Exam
- Speed of Sound Lab
- Pendulum Lab

Unit:	Light & Optics	**Duration:**	4-5 Weeks

Essential Questions:

- What is electromagnetic radiation and how is it used?
- What are the different parts of the Electromagnetic Spectrum?
- What is the relationship between the different parts of the Electromagnetic Spectrum?
- What are some practical applications for electromagnetic waves?
- What is the color spectrum and how can colors be analyzed in terms of wavelength and frequency?
- How does the Doppler Effect explain some of the observed properties of light?
- What is/How are refraction and reflection different?
- What are lenses and how do lenses affect the behavior of light?
- How do ray diagrams help determine the location, orientation, size and type of image produced by a lens or mirror?
- How is light both a particle and a wave?
- How does Snell's Law explain the behavior of light as it passes through different media such as water, air, or glass?

Specific Unit Standards

PS4-1 Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

- [Clarification Statement: Examples of data could include electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the Earth.]
- [Assessment Boundary: Assessment is limited to algebraic relationships and describing those relationships qualitatively.]

PS4-3 Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and for some situations one model is more useful than the other.

HS-PS4-5 Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy

Affirmation Statements:

Students will be able to:

List the parts of the EM Spectrum (Radio, Microwaves, Infrared, etc.)

Rank types of EM waves in terms of wavelength and frequency.

Identify various applications for EM waves.
Describe the color spectrum and analyze the colors in terms of wavelength and frequency.
Apply their knowledge of electromagnetic waves to calculations and detailed explanations of Doppler Effect (Honors)
Explain what reflection and refraction are
Explain how reflection and refraction are different
Explain how light behaves in concave and convex mirrors
Explain how lenses work (Honors)
Explain how Snell's law explains the behavior of light through different media (air, water, glass, etc)
Perform calculations involving visible light

Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other (Honors)

Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter (Honors).

Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

Use Ray Diagrams to determine the location, orientation, size and type of image produced by a lens or mirror (Honors).

Common Assessments

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- Solar Flare Emergency Preparedness Manual
- Glowstick/Color Mixing Lab
- Color Mixing Phet Lab
- Optics Lab
- Light & Optics Exam

Unit:	Kinematics: Constant Velocity	**Duration:**	3 weeks

Essential Questions:

- How do objects move?
- What are the two key differences between speed and velocity?

- What is the difference between distance and displacement?
- How to interpret x vs. t & v vs. t graphs.
- What are the kinematic equations and how can they be used to assess moving objects?

Specific Unit Standards:

Disciplinary Core Idea: None

Practices: 1) Analyzing & Interpreting Data: Analyze data using tools, technologies, and/or models (e.g. computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

2) Develop and/or use a model to generate data to support explanations, analyze systems, or solve problems.

3) Constructing Explanations and Designing Solutions: Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

4) Engaging in Argument from Evidence: Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence.

5) Using Mathematical and Computational Thinking: Use mathematical representations of phenomena to describe explanations.

Cross-Cutting Concepts: Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

Cause and Effect: Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.

Affirmation Statements:

Students will be able to…:

Explain how objects move
Explain how speed and velocity are different
Construct and analyze a graph using a given set of data.
Determine the meaning and value of the slope of a graph.
Determine the meaning and value of the y-intercept.
Write an equation for a line on a graph.
Write a verbal expression to describe a line on a graph.
Manipulate and select lab materials and equipment properly.
Create qualitative and quantitative position vs. time & velocity vs. time graphs
Analyze qualitative and quantitative position vs time & velocity vs. time graphs
Formulate kinematic equations using graphs.
Solve for various quantities using kinematic equations.
Create a motion map to represent the motion of an object moving with constant velocity.

Common Assessments:

- Toy car lab
- Possible projects: Battle Carts or Speed Carts
- CV and Acceleration Exam (Honors)
- CV Exam (Reg)

Unit:	Kinematics: Acceleration	**Duration:**	2-3 Weeks

Essential Questions:

- How does one interpret a vs. t graphs?
- What do the variables vi , vf , a, Δx, and t stand for? What units are used for each?
- What makes an object in free fall move?
- What is acceleration and how is it determined?

- How is acceleration different from velocity?

Specific Unit Standards:

Disciplinary Core Idea: None

Practices: 1) Analyzing & Interpreting Data: Analyze data using tools, technologies, and/or models (e.g. computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

2) Develop and/or use a model to generate data to support explanations, analyze systems, or solve problems.

3) Constructing Explanations and Designing Solutions: Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

4) Engaging in Argument from Evidence: Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence.

5) Using Mathematical and Computational Thinking: Use mathematical representations of phenomena to describe explanations.

Cross-Cutting Concepts: Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

Cause and Effect: Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.

Affirmation Statements:

Students will be able to…:

Compare position vs. time, velocity vs. time, and acceleration vs. time graphs.
Explain what makes objects in free fall move
Create and analyze qualitative/quantitative acceleration vs. time graphs.
Determine acceleration from a velocity vs. time graph.
Calculate acceleration using an equation.
Create a motion map to represent an accelerating object.
Write a description of motion from a graph or motion map.
Summarize the motion of an object from a graph or motion map.

Common Assessments:

- Picket Fence Lab
- CV and Acceleration Test (Honors)
- Quantitative Acceleration Quest (Reg)
- Qualitative Acceleration Quest (Reg)

Unit:	Projectile Motion (Honors)	**Duration:**	Two Weeks

Essential Questions:

- What are the characteristics of 2-Dimensional projectiles?
- How can the time of flight, height, and range of a projectile be determined?
- How is the velocity of a projectile broken into its components?

Specific Unit Standards:

Disciplinary Core Idea: None

Practices: 1) Analyzing & Interpreting Data: Analyze data using tools, technologies, and/or models (e.g. computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

2) Develop and/or use a model to generate data to support explanations, analyze systems, or solve problems.

3) Constructing Explanations and Designing Solutions: Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

4) Engaging in Argument from Evidence: Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence.

5) Using Mathematical and Computational Thinking: Use mathematical representations of phenomena to describe explanations.

Cross-Cutting Concepts: Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

Cause and Effect: Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.

Affirmation Statements:

Students will be able to…:

Determine components of velocity

Apply Equations used for uniform acceleration to two dimensional motion

Create a motion map to represent motion in two dimensions

Create qualitative and quantitative position vs time, velocity vs time, and acceleration vs time graphs

Common Assessments:

- Projectile Motion Exam
- Projectile Motion Lab
- Possible Project: Golf Ball Challenge/Paper Rocket

Unit:	Forces	**Duration:**	Three Weeks

Essential Questions:

- What is a force?
- What are the different types of forces that can act on an object?
- How do these different forces affect the motion of an object?
- How can you calculate the different types of forces?

Specific Unit Standards:

PS2-1: Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object

● [Clarification Statement: Examples could include an unbalanced force on one side of a ball can make it start moving; and, balanced forces pushing on a box from both sides will not produce any motion at all]
● [Assessment Boundary: Assessment is limited to one variable at a time: number, size, or direction of forces]

Affirmation Statements:

Students will be able to…:

Describe and calculate the following forces: applied, tension, normal, friction, gravity
Create Free body diagrams of forces acting on objects.
Create system schema describing interactions of various objects.
Find the resultant force
Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object.

Common Assessments:

- Forces Exam
- Forces Lab
- Catapult Project

Unit:	Newton's Laws	**Duration:**	Three Weeks

Essential Questions:

● How do objects move?
● How do forces affect objects in space?
● What does Newton's 1st, 2nd, and 3rd Law state?
● What is Inertia?
● How are the variables m, a, and F related?
● What are the differences between mass and weight?
● What is the Universal Law of Gravitation?
● What factors affect the gravitational force between objects?
● How do Newton's Laws explain the behavior of satellites, planets, and moons?

Specific Unit Standards:

PS2-1: Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
● Clarification Statement: Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object rolling down a ramp, or a moving object being pulled by a constant force.
● Assessment Boundary: Assessment is limited to one-dimensional motion and to macroscopic objects moving at non-relativistic speeds.

PS2-4:Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

● [Clarification Statement: Emphasis is on both quantitative and conceptual descriptions of gravitational and electric fields.]
● [Assessment Boundary: Assessment is limited to systems with two objects.]

ESS1-4: Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.
● [Clarification Statement: Emphasis is on Newtonian gravitational laws governing orbital motions, which apply to human-made satellites as well as planets and moons.]
● [Assessment Boundary: Mathematical representations for the gravitational attraction of bodies and Kepler's Laws of orbital motions should not deal with more than two bodies, nor involve calculus.]

Affirmation Statements:

Students will be able to…:
Define each of Newton's Laws
Analyze various situations with respect to each of Newton's Laws.
Describe the relationship between inertia and mass.
Describe the relationship between acceleration/mass and acceleration/force.
Solve for acceleration, force or mass using Newton's 2nd Law.
Students can solve for Fg using the Universal Law of Gravitation
Describe motion of satellites, planets, and moons
Explain relationships between variables that affect gravitational forces between objects

Common Assessments:

- Newton's Law Exam
- Newton's Law Station Lab

Unit:	Momentum	**Duration:**	Two Weeks

Essential Questions:

● What is momentum and how is it calculated?
● How does impulse affect objects that are involved in a collision?
● How is momentum conserved during collisions?
● What is the difference between elastic, inelastic, and separation collisions?
● How is momentum conserved in a collision?

Specific Unit Standards:

PS2-2: Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.
● Clarification Statement: Emphasis is on the quantitative conservation of momentum in interactions and the qualitative meaning of this principle.
● Assessment Boundary: Assessment is limited to systems of two macroscopic bodies moving in one dimension.

Affirmation Statements:

Students will be able to…:

Calculate momentum.
Calculate impulse.
Summarize the relationship between force, time and impulse.
Distinguish between elastic, inelastic, and separation collisions
Analyze collisions using momentum equations and trigonometry.
Create vector diagrams of collisions.
Use conservation of momentum to calculate the final velocity of objects during collisions.

Common Assessments:

- Momentum Exam
- Momentum Simulation
- Momentum Lab

Unit:	Work & Energy	**Duration:**	4-5 Weeks

Essential Questions:

● What is the definition of Energy?
● What is the definition of Work?
● What is the connection between energy and work?
● What is the difference between energy transfer and energy storage?
● How can energy be transferred?
● What are the equations for gravitational potential energy, elastic, kinetic energy?
● What does it mean that Energy is conserved?
● What is Conservation of Energy?
● What is dissipated energy?
● How is Total Energy found?
● What are the equations for Work and Power?
● What are the units for Energy, Work and Power?

Specific Unit Standards:

PS3-1: Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
PS3-2: Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).

PS3-3: Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy
PS3-5: Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

Affirmation Statements:

Students will be able to…:

- Distinguish between energy transfer and storage.
- Recognize energy storage mechanisms:
    - Gravitational
    - Kinetic
    - Elastic
    - Dissipated
- Recognize and identify modes of energy transfer:
    - working
    - heating
    - radiating
- Sketch energy bar charts and energy flow charts to show energy storage and transfer.
- Explain work as:
    - energy transfer to/from system via external forces.
    - force applied over a distance
- Calculate energy and related quantities such as:
    - velocity
    - height
    - mass
    - distance
    - k-value

    - Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
    - Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).
    - Determine how much power an object can output
    - Determine the total energy of an object

Common Assessments:

- Rube Goldberg Project
- Energy/Work Lab
- Work & Energy Exam

Unit:	Electricity & Magnetism	**Duration:**	5-6 Weeks

Essential Questions:

- How do electric and magnetic forces affect objects?
- What is necessary to make a complete circuit?
- What is Ohm's Law and how does voltage, current and resistance relate to each other?
- What characteristics do light bulbs in series have?
- What characteristics do light bulbs in parallel have?
- How is electricity paid for?
- What causes a circuit breaker to trip?
- How is the power of an electrical device calculated?
- Determine the voltage, current and resistance of resistors in series and parallel using schematic diagrams.
- How do objects obtain a charge?
- What is Coulomb's Law and what is it used for?
- How do three charged objects act when in a line?
- What are the 3 charging methods?

Specific Unit Standards:

PS2-4: Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

[Clarification Statement: Emphasis is both quantitative and conceptual descriptions of gravitational and electric fields.]

[Assessment Boundary: Assessment is limited to systems with two objects.

PS2-5: Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.

[Assessment Boundary: Assessment is limited to designing and conducting investigations with provided materials and tools]

Affirmation Statements:

Students will be able to:

- Problem solve with Ohm's Law – solving for voltage, current, and resistance.
- Understand the characteristics of light bulbs in series and parallel.
- Determine the cost of running an electrical appliance.
- Determine the power of electrical appliances.
- Draw and understand schematic diagrams for series and parallel circuits.
- Determine the voltage, current, and resistance of all resistors in a complex combination circuit.
- Draw a 'picture' of an atom.
- Discuss how atoms become charged.
- Describe the 3 methods that objects get charged.
- Problem solve using Coulomb's Law.
- Determine the net force acting on one object sitting between two charged objects.

Common Assessments:

- CASTLE Electricity labs
- Magnetism Station Lab
- Electricity and Magnetism Lab